Designation: D3309 – 96a (Reapproved 2002)

An American National Standard

Standard Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems[1]

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 Materials[3]

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.

Current edition approved Sept. 10, 1996. Published November 1996. Originally published as D3309 – 74. Last previous edition D3309 – 96a. DOI: 10.1520/D3309-96AR02.

[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 Testing[3]
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 Pipe[4]
ANSI Z 17.1 Preferred Numbers[4]

2.3 *AWWA Standard:*
Manual M-11 Steel Pipe Design and Insulation[5]

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 Storage[6]

2.6 *NSF Standard:*
Standard No. 14 for Plastic Piping Components and Related Materials[7]
Standard No. 61 for Drinking Water System Components—Health Effects[7]

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 ⅛ 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 ⅛ 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 ⅛ 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 ⅛ 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.

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

[5] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.

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

[7] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140.

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.

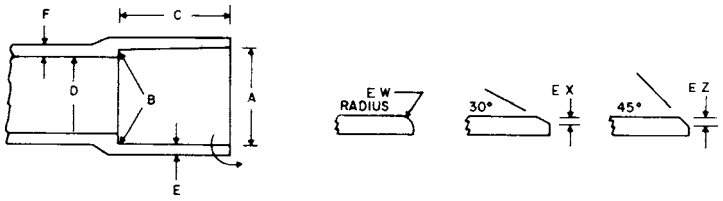
6.5.2 Socket-type joints heat fused according to the manufacturer's instructions and conditioned in accordance with 7.1 shall meet the requirements of 6.5.1 when tested in accordance with 7.4.

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					
⅛	0.250	±0.003	±0.003	0.040[D]	+0.007
3/16	0.312	±0.003	±0.004	0.062[D]	+0.010
¼	0.375	±0.003	±0.004	0.062[D]	+0.010
⅜	0.500	±0.003	±0.006	0.062[D]	+0.010
½	0.625	±0.004	±0.008	0.062[D]	+0.010
¾	0.875	±0.004	±0.008	0.080	+0.010
1	1.125	±0.005	±0.010	0.102	+0.010
1¼	1.375	±0.005	±0.010	0.125	+0.013
1½	1.625	±0.006	±0.012	0.148	+0.015
2	2.125	±0.006	±0.015	0.193	+0.019
Pipe					
¾	1.050	±0.004	±0.010	0.095	+0.021
1	1.315	±0.005	±0.010	0.119	+0.026
1¼	1.660	±0.005	±0.012	0.151	+0.026
1½	1.900	±0.006	±0.012	0.173	+0.026
2	2.375	±0.006	±0.012	0.216	+0.026

[A] All dimensions are in inches (1 in. = 25.4 mm).
[B] The 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.
[C] The maximum out-of-roundness apply to pipe or tubing as extruded.
[D] For tubing sizes of ½ in. and below, wall thickness minimums are not a function of SDR.

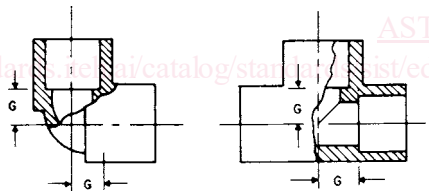
TABLE 2 Dimensions for Socket Fusion Fittings for PB 21, SDR 11.0 Pipe and Tubing[A,B]



Nominal Size	*A* Socket Entrance Diameter			*B* Socket Bottom Diameter			*C* Socket Length, min	*D* Inside Diameter, min	Wall Thickness min[C]		Entrance, min
	Average Diameter	Tolerance on Diameter	Max Out-of-Round[D]	Average Diameter	Tolerance on Diameter	Max Out-of-Round[D]			*E*	*F*	*EW EX EZ*
Tubing											
⅜	0.485	±0.005	±0.008	0.481	±0.005	±0.008	0.500	0.364	0.102	0.128	0.031
½	0.605	±0.005	±0.008	0.601	±0.005	±0.008	0.500	0.489	0.102	0.128	0.031
¾	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
1¼	1.340	±0.008	±0.010	1.332	±0.008	±0.010	0.687	1.125	0.125	0.156	0.031
1½	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											
¾	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
1¼	1.620	±0.008	±0.012	1.612	±0.008	±0.012	0.875	1.300	0.151	0.189	0.031
1½	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

[A]All dimensions are in inches (1 in. = 25.4 mm).
[B]All sketches and designs of fittings are illustrative only.
[C]The minimum is the lowest wall thickness at any cross section.
[D]Maximum 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	
⅜	0.359
½	0.382
¾	0.507
1	0.633
1¼	0.758
1½	0.884
2	1.134
Pipe	
¾	0.750
1	0.875
1¼	1.000
1½	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)

[A]PB 21 joint components shall include: 1. Nominal 1 in. PB 21 Heat fused joints after conditioning according to 7.1. 2. Nominal ½-in. compression-type plastic fittings. 3. Nominal ½-in. plastic-to-metal transition fitting.
[B]The 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)

[A]Nominal 1-in. PB 21 heat-fused joints after conditioning according to 7.1.
[B]The fiber stress used to derive this test pressure is 7.57 MPa (1100 psi) at 82°C (180°F).

6.6 *Thermocycling*—Plastic-to-metal transition fittings and compression-type plastic fittings assembled using the manufacturers' 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.

6.7 *Excessive Temperature and Pressure Capability of Tubing and Pipe*—In the event of a heating system malfunction, polybutylene pipe and tubing shall have adequate strength to accommodate short-term conditions, 48 h of 99°C (210°F) and 150 psi (1.04 MPa), until repairs can be made. Pipe and tubing shall be tested in accordance with 7.7.

6.7.1 *Hydrostatic Burst Strength*—None of the test specimens shall fail as defined in Test Method D1599 at a pressure less than that specified in Table 6.

6.7.2 *Sustained Hydrostatic Pressure* —None of the test specimens shall fail as defined in Test Method D1598 in less than 1000 h at the pressure specified in Table 6.

6.8 *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 for Pipe, Tubing, and Fittings

7.1 *Conditioning*—Because of the crystalline transformation that takes place after polybutylene resins are cooled from the melt, it is necessary to delay physical testing until 10 days after pipe extrusion, molding of fittings, or socket fusion of joints. During this 10-day period, store the pipe fitting or assembly at temperatures between 4 and 38°C (40 and 100°F). Take the test specimens after 8 days and condition at 23 ± 2°C (70 to 77°F) and 50 ± 5 % relative humidity for not less than 40 h prior to test in accordance with Practice D618, for those tests where conditioning is required.

7.2 *Test Conditions*—Conduct the tests in the Standard Laboratory Atmosphere of 23 ± 2°C (70 to 77°F) and 50 ± 5 % relative humidity, unless otherwise specified in the test methods or in this specification.

7.3 *Sampling*—A sufficient quantity of pipe, tubing, or fittings, as agreed upon by the purchaser and the seller, shall be selected from each lot or shipment and tested to determine conformance with this specification (see Practice D1898). In the case of no prior agreement, random samples selected by the testing laboratory shall be deemed adequate.

7.4 *Sustained Hydrostatic Pressure*—Determine in accordance with Test Method D1598, except for the following sections:

7.4.1 Assemble test sections in accordance with manufacturer's instructions in Appendix X2. Select six specimens at random.

7.4.2 Condition socket fused joints in accordance with 7.1.

7.4.3 Test temperature shall be 82 ± 2°C (180 ± 4°F).

7.4.4 The external test environment shall be air at 82 ± 2°C (180 ± 4°F).

TABLE 6 Minimum Requirements for PB 21 SDR 11 Pipe Tubing at 99°C (210°F)

Pressure	(MPa)	psi
Hydrostatic burst strength[A]	(1.45)	210
Sustained hydrostatic internal pressure,[B] 1000 h	(1.04)	150

[A] The fiber stress used to derive this test pressure is 1050 psi (7.25 MPa) at 99°C (210°F).

[B] The fiber stress used to derive this test pressure is 750 psi (5.18 MPa) at 99° (210°F).

7.4.5 Fill the specimens with water at a temperature of at least 50°C (120°F). Condition the specimens filled with water in air at the test temperature 82 ± 2°C (180 ± 4°F) for at least 16 h.

7.4.6 Failure of any one of the six specimens constitutes failure in the test.

7.5 *Thermocycling*:

7.5.1 *Summary of Method*—This method describes a pass-fail test for thermally cycling PB plastic-to-metal transition fitting assemblies and compression type plastic fittings over a critical temperature range for a selected number of cycles while subjected to a nominal internal pressure. The test provides a measure of resistance to failure due to the combined effects of differential thermal expansion and creep for PB plastic-to-metal transition fittings, mechanical fittings, and compression plastic fittings intended for continuous use up to and including 82°C (180°F).

7.5.2 *Apparatus*—A nitrogen or air source capable of maintaining a nominal internal pressure of 0.69 ± 0.069 MPa (100 ± 10 psi) on the specimens is required. The immersion system shall consist of two water reservoirs controlled at 16 ± 2°C (60 ± 4°F) and 82 ± 2°C (180 ± 4°F). The specimens shall be cycled from one reservoir to the other or the hot and cold water shall be alternately cycled over the test specimens automatically and returned to the proper reservoirs.

NOTE 4—Automatic cycling may be accomplished by pumping from each reservoir through a delivery system having timer actuated valves to a specimen water trough having synchronized, timer actuated return drains. Any automatic apparatus shall provide for complete immersion of the test specimen in the trough.

7.5.3 *Sampling and Specimen Preparation*—Select at random six specimens of the type and size of PB 21 plastic-to-metal transition of compression-type plastic fitting to be tested. Assemble the fittings with suitable lengths of pipe or tubing meeting the requirements of this specification, and attach to a common manifold. Assemble strictly according to the instructions of the fitting manufacturer. Close the specimen assembly with any suitable end closures that allow "free-end" mounting and will not leak under the thermocycling conditions, and connect the specimen assembly to the pressure source.

7.5.4 *Procedure*—Pressurize the specimen assembly with nitrogen or air to 0.69 ± 0.069 MPa (100 ± 10 psi). Immerse in 16 ± 2°C (60 ± 4°F) water to determine if there are any initial leaks. All leaks shall be eliminated before the thermocycling test is started. Thermally cycle the specimen assembly either manually or automatically and under an internal pressure of 0.69 ± 0.069 MPa (100 ± 10 psi), alternately between 16 ± 2°C (60 ± 4°F) and 82 ± 2°C (180 ± 4°F) by means of immersion in water using the following test cycle:

Water immersion at 82°C (180°F)	2 minutes (min)
Air immersion at ambient	2 minutes (max)
Water immersion at 16°C (60°F)	2 minutes (min)
Air immersion at ambient	2 minutes (max)

Upon the completion of 1000 thermal cycles, immerse the specimen assembly again in 16 ± 2°C (60 ± 4°F) water and check for any sign of gas leakage. Any evidence of leakage at the fitting or separation of the fitting from the pipe or tubing constitutes a failure.

7.5.5 *Interpretation of Results*—Failure of any one of six specimens tested shall constitute failure of this test.

7.6 *Hydrostatic Burst Strength*—Determine the minimum hydrostatic strength for heat fusion joints, plastic-to-metal transition fittings, and compression-type plastic fittings at both 23°C (73°F) and 82°C (180°F) according to Test Method D1599 except as herein specified.

7.6.1 *Assembly*:

7.6.1.1 *Heat-Fused Joints*—Assemble the joints in accordance with the manufacturer's instructions and condition in accordance with 7.1.

7.6.1.2 *Compression-Type Plastic Fittings and Plastic-to-Metal Transition Fittings*—Assemble the fittings in accordance with manufacturer's instructions.

7.6.2 *Procedure*—Test a single specimen assembly containing at least six joints prepared from PB 21 pipe or tubing, and fittings meeting the requirements of this specification. After assembly in accordance with 7.6.1, attach end closures, fill the specimen assembly with water and condition in water at the test temperature for 2 h minimum (or in air for 4 h minimum). In the case of testing at 82°C (180°F) the sample should be filled with water of at least 50°C (120°F) temperature prior to conditioning. Then test immediately.

7.6.2.1 Increase the internal pressure at a constant rate so as to reach the maximum burst requirement in 60 to 70 s. Leakage or separation at any of the joints tested at less than the minimum hydrostatic burst requirements for either temperature specified in Table 4 shall constitute failure in this test.

7.7 *Excessive Temperature and Pressure Capability of Tubing and Pipe*:

7.7.1 *Hydrostatic Burst Strength*—Determine the minimum hydrostatic burst strength for pipe and tubing at 99°C (210°F) according to Test Method D1599.

7.7.2 *Hydrostatic Sustained Pressure*—Determine in accordance with Test Method D1598, except for the following requirements:

7.7.2.1 Select six test specimens at random.

7.7.2.2 Condition pipe or tubing in accordance with 7.1.

7.7.2.3 Test temperature shall be 99 ± 2°C (210 ± 4°F).

7.7.2.4 The external test environment shall be air.

7.7.2.5 Fill specimens with water at a temperature of 99 ± 2°C (210 ± 4°F).

7.7.2.6 Pressurize test specimens to the required pressure and maintain for 1000 h.

7.8 *Elongation Value at Break*:

7.8.1 *Method*—The method, test equipment, and test report shall be as specified in Test Method D1708, using Speed C, 10 to 13 mm/min (0.4 to 0.5 in./min). At least two microtensile specimens[8] taken 180° from each other from a 3–ft length of pipe shall be a minimum of 10 days old or pressure aged for 10 min at 2070 MPa (30 000 psi), according to Practice F699. This method shall be the referee procedure. (An alternative test method is described in Appendix X4.) If a reading within 10 % of the minimum results, a retest over five specimens shall be taken from the original sample to confirm the reading.

NOTE 5—Pipe manufacturers have found that pipe tested within 2 h of extrusion give elongation at break values correlating within ±10 % of those for aged pipe. These conditions may be considered in developing elongation values. In the case of disagreement between seller and purchaser, naturally or pressure-aged samples shall be used.

8. Retest and Rejection

8.1 If the results of any test(s) do not meet the requirements of this specification, the tests(s) shall be conducted again only by agreement between the purchaser and seller. Under such agreement, minimum requirements shall not be lowered, changed, or modified, nor shall specification limits be changed. If upon retest, failure occurs, the quantity of product represented by the test(s) does not meet the requirements of this specification.

9. Marking

9.1 The marking shall be applied in such a manner that it remains legible (easily read) after installation and inspection.

9.2 *Content of Marking*:

9.2.1 Manufacturer's name or trademark.

9.2.2 Certification mark or seal of the laboratory making the evaluation for this purpose (see 10.1).

9.2.3 ASTM D3309 designation.

9.2.4 Material designation in accordance with 3.5 (PB 2110), for polybutylene pipe, tubing and fittings. A for acetal fittings, AC for acetal copolymer fittings and CPVC 41 for chlorinated poly (vinyl chloride) fittings.

9.2.5 Pressure rating (see Appendix X1) at 82°C (180°F),

9.2.6 Nominal size,

9.2.7 Standard dimension ratio (SDR 11), and

9.2.8 A code number identifying the compound and the date of manufacture.

9.3 *Pipe and Tubing*—Markings 9.2.1-9.2.8 shall be required on pipe and tubing at intervals of not more than 1.5 m (5 ft). Markings shall be applied without indentation in some permanent manner so as to remain legible under normal handling and installation practice. Pipe and tubing that is difficult to mark without indenting shall be so marked provided (*1*) the marking does not reduce the wall thickness to less than the minimum value for the pipe or tubing, and (*2*) it is demonstrated that these marks have no effect on the long-term strength of the pipe or tubing.

9.4 *Socket-Fusion Fittings*—Markings 9.2.1-9.2.3 shall be required on socket-type fittings, except where size makes such marking impractical. Where markings are omitted, fittings shall be identified by some symbol that is defined in the manufacturer's trade literature. Marking on fittings shall be molded, hot stamped, or applied in some other permanent manner so as to remain legible under normal handling and installation practice. Where recessed marking is used, care shall be taken to see that wall thicknesses are not reduced below the specified minimums.

9.5 *Transition Fittings, Mechanical Fittings, and Compression Plastic Fittings*—Markings 9.2.1-9.2.3 shall be required on all fittings.

[8] Dies are available from M.S. Instrument Co., Castle-on-Hudson, NY and Testing Machine Inc., Amityville, NY 11701.