Designation: ~~D2239 – 12a (Reapproved 2020)~~ D2239 – 21

An American National Standard

Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter[1]

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~~to 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.*

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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

[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, 2020~~Aug. 1, 2021. Published ~~November 2020~~August 2021. Originally approved in 1964. Last previous edition approved in ~~2012~~2020 as ~~D2239 – 12a.~~D2239 – 12a(2020). DOI: ~~10.1520/D2239-12AR20.~~10.1520/D2239-21.

[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**

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~~NSF/ANSI/CAN 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

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:

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

where:~~*Where:*~~
PR = pressure rating for water, 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.~~

NOTE 1—PR and HDS must have the same units. See Appendix X1 for maximum pressure ratings for water.

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

[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.

TABLE 1 Polyethylene Compound Requirements

Requirement	Material Designation			
	~~PE1404~~ PE2708	~~PE2708~~ PE3608	~~PE3608~~ PE4710	~~PE~~
	Required Value			
~~Minimum HDB at 140 °F (60 °C), psi (MPa), per Test Method D2837 and PPI TR-3~~	~~A~~	~~800 (5.5)B~~	~~800 (5.5)B~~	~~800~~
Minimum HDB at 140 °F (60 °C), psi (MPa), in accordance with Test Method D2837 and PPI TR-3	800 (5.5)A	800 (5.5)A	1000 (6.9)A	
~~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~~
HDS for water at 73 °F (23 °C) psi (MPa), in accordance with Test Method D2837 and PPI TR-3	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 Cond. 1 ≤20 g Cond.~~
Melt flow rate in accordance with Test Method 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	
Specification D3350 Cell Classification Property Requirement		Required Value		
~~Density (natural base resin)~~	~~1~~	~~2~~	~~3~~	
Density (natural base resin)	2	3	4	
~~SCG Resistance~~	~~4~~	~~7~~	~~6~~	
SCG Resistance	7	6	7	
~~Color and UV Stabilizer CodeC~~	~~C~~	~~C, D or E~~	~~C, D or E~~	~~C, D~~
Color and UV Stabilizer CodeB	C, D or E	C, D or E	C, D or E	

~~A HDB at 140 °F (60 °C) not required. Contact manufacturer about pipe use at temperatures other than 73 °F (23 °C).~~
A ~~Contact~~ Contact manufacturer or see PPI TR-4 for listed value.
B ~~See~~ See 5.1.1.

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~~ in accordance with 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 2—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. The base resin that is used for an external color layer or color stripes shall be the same base resin as the body of the pipe in accordance with Table 1.

5.2 ~~*Potable Water*~~*Health Effects Requirement*—PE compound intended for contact with potable ~~water~~ water, or when otherwise required, shall be evaluated, tested, and certified for conformance with NSF/ANSI Standard No. 61 or the health effects portion of ~~NSF/ANSI~~NSF/ANSI/CAN Standard No. 14 by a certifying organization acceptable to the regulatory authority having jurisdiction.

5.3 *Oxidative Resistance*—For pipe that is intended for use in the transport of potable water containing oxidizing disinfectants (for example, hypochlorous acid or chloramines), or when required by the application, customer or regulatory authority having jurisdiction, the PE compound shall have an oxidative resistance classification of CC3 in accordance with Specification D3350. The oxidative resistance classification of CC3 is used in conjunction with pipe dimensions in accordance with 6.2.1.1 and 6.2.2.1 to ensure the intended pipe service life is met with respect to oxidative resistance (see Note 3). When the pipe meets these requirements, it shall be marked CC3 as in accordance with 9.1.8. When the pipe does not meet the compound and dimensional requirements as above it shall not be marked CC3. An oxidative resistance classification is not required for other potable water services that do not contain oxidizing disinfectants or when it is not required by the application, customer or regulatory authority having jurisdiction.

NOTE 3—See www.plasticpipe.org for further information on potable water disinfectants in small diameter PE pipe and the use of oxidative resistance classification for specific applications.

5.4 *Rework Material*—Clean polyethylene compound from the manufacturer's own pipe production that met 5.1 through ~~5.2~~5.3 as new PE compound is suitable for re-extrusion into pipe when blended with new PE compound having the same material ~~designation.~~ designation and oxidative resistance classification. 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.

6.2.1.1 Pipe for potable water service containing oxidizing disinfectants or that require an oxidative resistance classification as outlined in 5.3 Oxidative Resistance shall be pipe size ¾ or greater as in accordance with Table 2 in order to meet the expected service life of the pipe in these specific conditions (see Note 3).

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.

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

Pipe Size	Inside Diameter	Tolerance
½	0.622	+0.010 –0.010
¾	0.824	+0.010 –0.015
1	1.049	+0.010 –0.020
1¼	1.380	+0.010 –0.020
1½	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.

6.2.2.1 Pipe for potable water service containing oxidizing disinfectants or that require an oxidative resistance classification as outlined in 5.3 Oxidative Resistance shall be SIDR 9, 7 or 5.3 as in accordance with Table 3 in order to meet the requirements for the expected service life of the pipe in these specific conditions (see Note 3).

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~~ in accordance with 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~~ in accordance with Table 1 used in production at the facility shall be conducted twice annually ~~per~~ in accordance with 7.8.

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

NOTE 4—Tensile elongation testing ~~per~~ in accordance with 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~~73 °F ± ~~3.6 °F (23~~4 °F (23 °C ± 2 °C) without regard to humidity for not less than 4 h in accordance with Procedure A of Practice D618, or at ~~73.4~~73 °F ± ~~3.6 °F (23~~4 °F (23 °C ± 2 °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~~73 °F ± ~~3.6 °F (23~~4 °F (23 °C ± 2 °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.

TABLE 4 Minimum Burst Pressure for SIDR Pipe

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

[A]Minimum burst pressure calculated in accordance with

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

~~Where:~~

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 = 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 ±3.6 °F (± 2 °C). Test pressure tolerance ± 5 psi (± 35 kPa)

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.

7.4 *Dimensions and Tolerances*—Use any length of pipe to determine the dimensions. Inside diameter, wall thickness and wall thickness range shall be measured in accordance with Test Method D2122.

7.5 *Carbon Black*—For all pipe manufactured with Code C polyethylene compound, determine in duplicate the carbon black content in accordance with Test Method D1603 or Test Method D4218.

7.6 *Sustained Pressure Test*—Select six PE1404 pipe test specimens. Test in accordance with Test Method D1598 with water at 176 °F (80 °C). Internal test pressure shall be determined in accordance with the equation in Table 5, footnote A. Failure of two of the six specimens tested constitutes failure in the test. Failure of one of six specimens tested is cause for retest of six additional specimens. Failure of one of six specimens tested in retest constitutes failure in the test. Failure of the pipe shall be as defined in Test Method D1598.

7.7 *Burst Pressure*—The test equipment, procedures and failure definitions shall be as specified in Test Method D1599.

7.8 *Elevated Temperature Sustained Pressure Test*—Elevated temperature sustained pressure tests for each Table 1 material designation used in production of pipe in accordance with this specification at the facility shall be conducted ~~per~~ in accordance with Test Method D1598, and Table 5 using water as the pressurizing medium. The "test sample" shall be three specimens of any pipe size or SIDR. One Table 5 Condition for the applicable material designation shall be selected for the test.

7.8.1 For the selected Table 5 Condition, passing results are *(a)* non-failure for all three specimens at a time equal to or greater than the Table 5 minimum average time before failure, or *(b)* not more than one ductile specimen failure and the average time

TABLE 5 Elevated Temperature Sustained Pressure Test[A] Requirements

~~Condition~~	~~Test Temperature, °F (°C)~~	~~PE2708, PE3608, PE4608~~		~~PE4710~~	
		PE2708, PE3608		PE4710	
Test Pressure Hoop Stress, psi (kPa)	Minimum Average Time Before Failure, hours	Condition	Test Temperature, °F (°C)	Test Pressure Hoop Stress, psi (kPa)	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

[A] A Calculate internal test pressure in accordance with

$$P = \frac{2S}{\frac{D_i}{t}} + 1$$

Where:

P = test pressure, psi (kPa)
S = test pressure hoop stress, psi. (kPa)
D_i = measured average inside diameter, in. (mm)
t = measured minimum wall thickness, in (mm)

Test temperature tolerance ± 3.6 °F (± 2 °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 5 conditions are based on PE validation requirements ~~per~~ in accordance with 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 compound designations, at 670 psi test pressure hoop stress, the minimum average time before failure would be 927 hours:

$$927 = 200 + \left((750 - 670) \times \frac{(1200 - 200)}{(750 - 640)} \right)$$

before failure for all three specimens shall be greater than the specified Table 5 minimum average time before failure for the selected Table 5 Condition, or *(c)* successful retest ~~per~~ in accordance with 7.8.3.

7.8.2 For the selected Table 5 Condition, failure to meet this requirement is *(a)* brittle failure of any specimen when tested at Table 5 Condition 1 through 6, or *(b)* ductile failure of all three specimens, or *(c)* unsuccessful retest ~~per~~ in accordance with 7.8.3.

7.8.3 *Provision for Retest for* Table 5 *Conditions 1 through 5*—If a second ductile failure occurs before the Table 5 minimum average time before failure, it is permissible to conduct one retest at a Table 5 Condition of lower stress and longer minimum average time before failure for the material designation. The retest sample shall be three additional specimens of the same pipe size and material designation from the same time frame as the test sample ~~per~~ in accordance with 7.8. For the retest, any specimen failure before the Table 5 minimum average time before failure at the retest condition constitutes failure to meet this requirement. For Table 5 Condition 6 no retest is permissible

7.9 *Bend-back Test Method:*

7.9.1 Squarely cut four 1 ⅛ to 1 ⅜ in. (29 to 35 mm) wide rings from pipe. Condition the rings ~~per~~ in accordance with 7.1.

7.9.2 Split each ring longitudinally so that when reverse bent ~~per~~ in accordance with 7.9.3, the pipe ID for each quadrant around the pipe will be tested.

7.9.3 In a well-lit area, perform the following procedure within 5 min: *(a)* Bend each split ring specimen so that the pipe inside surface is on the outside surface of the bend. *(b)* Using an apparatus such as a bench vise or other suitable equipment, close the legs of the specimen together. When the specimen legs are closed together, the top of the bend-back specimen shall extend above the point of closure by 3 ± ½ times the minimum wall thickness ~~per~~ in accordance with Table 3. *(c)* With the unaided (naked) eye, visually examine the reverse-bent pipe ID surface.

7.9.4 Visible brittle cracking or crazing indicates failure.

7.10 *Elongation-at-Break Test Method:*