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Standard Specification for Specification for Crosslinked Polyethylene (PEX) Material Gas Pressure Pipe and Tubing[1]

This standard is issued under the fixed designation F2818; 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.

ε[1] NOTE—Sections 2 and 5.9 were editorially corrected in May 2015.

1. Scope

1.1 This specification covers requirements and test methods for material dimensions and tolerances, hydrostatic burst strength, chemical resistance, and impact resistance of PEX pipe and tubing for use in fuel gas mains and services for direct burial applications.

1.2 The text of this specification references notes and footnotes 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 standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *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]

D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D1505 Test Method for Density of Plastics by the Density-Gradient Technique

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

D1898 Practice for Sampling of Plastics (Withdrawn 1998)[3]

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

D2290 Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe

D2513 Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings

D2765 Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics

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

D4883 Test Method for Density of Polyethylene by the Ultrasound Technique

F412 Terminology Relating to Plastic Piping Systems

F1473 Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins

F1563 Specification for Tools to Squeeze-off Polyethylene (PE) Gas Pipe or Tubing

F1041 Guide for Squeeze-Off of Polyolefin Gas Pressure Pipe and Tubing

2.2 *Other Standards:*

B31.8 Gas Transmission and Distribution Piping Systems[4]

PPI-TR3 Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB),

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.60 on Gas.

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

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

Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe [5]

CFR Part 192 Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards[6]

3. Terminology

3.1 *Definitions*—are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600, unless otherwise specified.

3.2 The gas industry terminology used in this specification is in accordance with ANSI B31.8 or 49 CFR Part 192, unless otherwise indicated.

3.3 The term *pipe* used herein refers to both pipe and tubing unless specifically stated otherwise.

3.4 *Definitions of Terms Specific to This Standard:*

3.4.1 *toe-in*—a small reduction of the outside diameter at the cut end of a length of thermoplastic pipe.

4. Ordering Information

4.1 *General*—The plastic used to make pipe and fittings shall have a Plastics Pipe Institute (PPI) long-term hydrostatic design stress and hydrostatic design basis rating. PEX pipe are primarily defined by means of three criteria, namely, *(1)* nominal density, *(2)* degree of crosslinking, and *(3)* long-term strength tests. There is a strong correlation between nominal density and results of short-term strength tests.

4.2 *Basic Materials*—PEX pipe shall be made from polyethylene compounds which have been crosslinked by peroxides, Azo compounds, or silane compounds in extrusion, or by electron beam after extrusion, or by other means such that the pipe meets the performance requirements of this specification. The materials, procedure for mixing, and the process for crosslinking shall result in a product with minimum recommended long term hydrostatic design basis (HDB) equal to or greater than 1250 psi at 73.4°F (23°C) (PEX XX06) and 800 psi at 180°F (82.2°C) when determined in accordance with PPI-TR3 and Test Method D2837.

4.3 *Density*—The PEX pipe material shall have a minimum density of 0.926 g/cc when determined in accordance with Test Methods D1505, D792, or D4883.

4.4 *Outdoor Storage Stability*—PE materials shall be Code C or E as defined in Specification D3350. Code C material shall contain 2 to 3 percent well dispersed carbon black, and due to the absorptive properties of the carbon black, is considered to be stabilized against deterioration from unprotected exposure to UV for at least 10 years. Code E material shall be stabilized and protected against deterioration from unprotected UV exposure for not less than 3 years.

4.5 *Rework Material*—PEX rework shall not be used in the manufacture of PEX pipes made in accordance to this specification.

5. Requirements

5.1 *General*—Pipe shall be supplied in either coils or straight lengths. Any pipe supplied in coils must meet the same requirements before and after coiling. The requirements apply to pipe after crosslinking.

5.2 *Workmanship*—The pipe and fittings shall be homogeneous throughout and free of visible cracks, holes, foreign inclusion, blisters, and dents, or other injurious defects. The pipe and fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.

5.3 *Pipe and Tubing Dimensions and Tolerances:*

5.3.1 *Dimension*—The dimensions shall be specified by wall thickness and outside diameter.

5.3.1.1 *Diameters*—The outside diameter shall meet the requirements given in Table 1 or Table 2 when measured in accordance with 6.5.

5.3.1.2 *Toe-In*—When measured in accordance with 6.5.1.1, the outside diameter at the cut end of the pipe shall not be more than 1.5 % smaller than the undistorted outside diameter. Measurement of the undistorted outside diameter shall be made no closer than 1.5 pipe diameters or 11.8 in. (300 mm), whichever distance is less, from the cut end of the pipe. Undistorted outside diameter shall meet the requirements of Table 1 or Table 2.

5.3.1.3 *Wall Thickness*—The wall thickness shall be as specified in Table 2 or Table 3 when measured in accordance with 6.5.1.2. The minimum wall thickness at any point of

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

[6] Available from Superintendent of Documents, U.S. Government Printing Office, Washington DC 20402.

TABLE 1 Outside Diameters and Tolerances for Plastic Pipe, in. (mm)

Iron Pipe Size (IPS)	Outside Diameter	Tolerance	Maximum Out of Roundness
			SDR 17 SDR 13.5 SDR 11
½	0.840 (21.3)	±0.004 (±0.102)	0.016(0.406)
¾	1.050 (26.7)	±0.004 (±0.102)	0.02(0.508)
1	1.315 (33.4)	±0.005 (±0.127)	0.02(0.508)
1¼	1.660 (42.1)	±0.005 (±0.127)	0.024(0.61)
1½	1.900 (48.3)	±0.006 (±0.152)	0.024(0.61)
2	2.375 (60.3)	±0.006 (±0.152)	0.024(0.61)
3	3.500 (88.9)	±0.008 (±0.203)	0.03(0.762)
4	4.500 (114.3)	±0.009 (±0.229)	0.03(0.762)
6	6.625 (168.3)	±0.011 (±0.279)	0.07(1.778)

TABLE 2 Plastic Tubing-Diameters, Wall Thicknesses, and Tolerances, in. (mm)

Copper Tubing Size (CTS)	Outside Diameter	Tolerance	Minimum Wall Thickness	Wall Thickness Tolerance
¼	0.375 (9.52)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
⅜	0.500 (12.7)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
½	0.625 (15.9)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
½	0.625 (15.9)	±0.004 (±0.10)	0.090 (2.27)	+0.009 (+0.23)
½	0.625 (15.9)	±0.004 (±0.10)	0.104 (2.64)	+0.010 (+0.25)
¾	0.875 (22.2)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
¾	0.875 (22.2)	±0.004 (±0.10)	0.077 (1.95)	+0.008 (+0.20)
¾	0.875 (22.2)	±0.004 (±0.10)	0.090 (2.27)	+0.009 (+0.23)
1	1.125 (28.6)	±0.005 (±0.13)	0.062 (1.58)	+0.007 (+0.18)
1	1.125 (28.6)	±0.005 (±0.13)	0.090 (2.27)	+0.011 (+0.28)
1	1.125 (28.6)	±0.005 (±0.13)	0.099 (2.51)	+0.012 (+0.31)
1	1.125 (28.6)	±0.005 (±0.13)	0.101 (2.56)	+0.012 (+0.31)
1	1.125 (28.6)	±0.005 (±0.13)	0.121 (3.07)	+0.015 (+0.38)
1¼	1.375 (34.9)	±0.005 (±0.13)	0.062 (1.58)	+0.007 (+0.18)
1¼	1.375 (34.9)	±0.005 (±0.13)	0.090 (2.27)	+0.011 (+0.28)
1¼	1.375 (34.9)	±0.005 (±0.13)	0.121 (3.07)	+0.015 (+0.38)
1¾	1.875 (47.6)	±0.006 (±0.15)	0.062 (1.58)	+0.007 (+0.18)

measurement shall be not less than the minimum wall thickness specified in Table 2 or Table 3.

5.3.1.4 *Wall Thickness Eccentricity Range*—The wall thickness eccentricity range shall be within 12 % when measured in accordance with 6.5.1.3.

5.3.1.5 *Length*—The pipe shall be supplied in straight lengths or coils as agreed upon between the manufacturer and the purchaser. The length shall not be less than the minimum length agreed upon when corrected to 73°F (23°C).

5.3.1.6 When sizes other than those listed in Table 1, Table 2, or Table 3 are used, tolerances shall be: for outside diameter, use same tolerance of next smaller size; for wall thickness, use same tolerance percentage as shown in the tables.

5.3.2 *Degree of Crosslinking*—The degree of crosslinking for PEX pipe shall be within the range from 65 to 89 % inclusive. Depending on the process used, the following minimum percentage crosslinking values shall be achieved: 70 % by peroxides, 65 % by Azo compounds, 65 % by electron beam, or 65 % by silane compound. The degree of crosslinking on a pipe sample is obtained as follows:

5.3.2.1 Place a pipe sample in a lathe with automatic feeding. Shave a strip that consists of the full wall thickness. The strip thickness shall be approximately 0.004 in. (0.1 mm) which is obtained by setting the lathe feeding accordingly.

5.3.2.2 Test the specimens in accordance with Test Method D2765, Method B, with the only deviation: test specimen preparation. For the purpose of this specification, degree of crosslinking (*V*) is defined as 100 % minus extract percent equals *V*.

NOTE 1—Test Method D2765, Method A may be used in lieu of Method B. Method A gives more accurate and reproducible values but require a special grinder for sample preparation.

5.4 *Chemical Resistance*—The pipe and fittings shall not increase in weight more than 0.5 % (1.0 % for toluene in methanol). Where the test specimen is a pipe ring, the material shall not change more than ±12 % in apparent tensile yield strength when measured in accordance with 6.9. Where the test specimen is a plaque, the material shall not change more than ±12 % in tensile strength at yield when measured in accordance with Test Method D638.

NOTE 2—This pipe test is only an indication of what will happen as a result of short term exposure to these chemicals. For longterm results, additional testing is required.

5.5 *Sustained Pressure 73°F (23°C)*—The pipe shall not fail in less than 1000 h when tested in accordance with Test Method D1598. For PEX XX06 material, the stress shall be 1320 psi (9.1 MPa), for PEX XX08 material, the stress shall be 1600 psi (11.03 MPa).

5.6 *Elevated Temperature 203°F (95°C)*—PEX piping materials intended for use at temperatures above 100°F (38°C) shall have the PPI hydrostatic design basis (HDB) determined at the specific temperature in accordance with Test Method D2837.

NOTE 3—Many design factors for elevated temperature service cannot be covered in this specification. Users should consult applicable codes for limitations on pertinent maximum temperatures.

NOTE 4—In the absence of an HDB established at the specified temperature, the HDB of a higher temperature may be used in determining a design pressure rating at the specified temperature by arithmetic interpolation.

5.7 *Minimum Hydrostatic Burst Pressure/Apparent Tensile Strength (Quick Burst)*—The pipe shall fail in a ductile manner when tested in accordance with Test Method D1599. For pipe sizes above 4-in. nominal diameter, the testing lab shall be allowed to replace the quick burst test (Test Method D1599) by the apparent ring tensile strength test (Test Method D2290). The minimum apparent tensile strength at yield when determined in accordance with 6.7 shall be 2520 psi (17.4 MPa).

5.8 *Apparent Tensile Strength at Yield*—When tested in accordance to 6.8, the PEX pipe shall demonstrate a minimum of 2600 psi for PEX XX06 materials and 3000 psi for PEX XX08 materials.

5.9 *Squeeze-Off*—This requirement is limited to pipe sizes, wall thicknesses, squeeze procedures, and conditions deemed suitable for squeeze-off in service by the pipe manufacturer. Squeeze-off shall be performed per Guide F1041 using tools that meet Specification F1563. There shall be no leakage or visual evidence of splitting, cracking, breaking or reduction in 1000-h sustained pressure category when pipe is tested as follows:

TABLE 3 Wall Thickness and Tolerances for Plastic Pipe, in.(mm)[A,B]

Iron Pipe Size (IPS)	DR[C]	Minimum	Tolerance
½	D	0.062 (1.58)	+0.007 (+0.178)
	11.0	0.076 (1.93)	+0.009 (+0.229)
	9.33	0.090 (2.29)	+0.011 (+0.279)
¾	[D]	0.090 (2.29)	+0.011 (+0.279)
	11.0	0.095 (2.41)	+0.011 (+0.279)
1	[D]	0.090 (2.29)	+0.011 (+0.279)
	13.5	0.097 (2.46)	+0.012 (+0.305)
	11.0	0.120 (3.05)	+0.014 (+0.356)
	9.9	0.133 (3.38)	+0.016 (+0.406)
	9.33	0.140 (3.56)	+0.017 (+0.432)
1¼	[D]	0.090 (2.29)	+0.011 (+0.279)
	17.0	0.098 (2.49)	+0.012 (+0.305)
	13.5	0.123 (3.12)	+0.015 (+0.381)
	11.0	0.151 (3.84)	+0.018 (+0.457)
	10.0	0.166 (4.22)	+0.020 (+0.508)
	9.33	0.178 (4.52)	+0.021 (+0.533)
	6.0	0.277 (7.04)	+0.033 (+0.838)
1½	[D]	0.090 (2.29)	+0.011 (+0.279)
	17	0.112 (2.85)	+0.013 (+0.330)
	13.5	0.141 (3.58)	+0.017 (+0.432)
	11	0.173 (4.39)	+0.021 (+0.533)
2	11	0.216 (5.49)	+0.026 (+0.660)
3	21	0.167 (4.24)	+0.020 (+0.508)
	17	0.206 (5.23)	+0.025 (+0.635)
	13.5	0.259 (6.58)	+0.031 (+0.787)
	11.5	0.304 (7.72)	+0.036 (+0.914)
	11	0.318 (8.08)	+0.038 (+0.965)
4	17	0.265 (6.73)	+0.032 (+0.813)
	13.5	0.333 (8.46)	+0.040 (+1.016)
	11.5	0.391 (9.93)	+0.047 (+1.194)
	11.0	0.409 (10.39)	+0.049 (+1.246)
	9.33	0.482 (12.24)	+0.058 (+1.473)
6	17	0.390 (9.91)	+0.047 (+1.194)
	13.5	0.491 (12.47)	+0.059 (+1.499)
	11.5	0.576 (14.63)	+0.069 (+1.753)
	11.0	0.602 (15.29)	+0.072 (+1.829)

[A] The sizes listed in Table 3 are those commercially available sizes used by the gas industry.
[B] 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.
[C] The DR shown are designations commonly accepted by the gas industry and do not calculate exactly.
[D] These wall thicknesses are minimum and are not a function of the dimension ratios.

5.9.1 Prepare six randomly selected pipe specimens in accordance with Test Method D1598 except they shall be unfilled.

5.9.2 The squeeze-off shall be effected at the mid-point of the test specimen, 90° to the point of the measured minimum wall thickness. Close the squeeze bars to the gap stop in Specification F1563 and hold in constraint for 4 h. Remove squeeze bar and reround pipe by closing squeeze bars at a point 90° from the squeeze area.

5.9.3 Immediately upon removal of the squeeze-off tool, fill the specimens with ambient temperature water, that is 67 ± 10°F (19.4 ± 5.6°C), condition, and test in accordance with 6.6.

5.10 *Thermal Stability*—Specimens of the pipe inside wall surface not more than 0.005 in. (0.13 mm) thick shall demonstrate a minimum induction temperature of 428°F (220°C) when tested in accordance with the Test Method for Thermal Stability in Specification D3350.

5.11 *Slow Crack Growth Resistance*—Test Method is F1473 on compression molded plaques or PEX pipe sample. Stress is 2.4 MPa based on unnotched area. Temperature is 80°C. Notch depth in accordance with Table 1 in Test Method F1473. The minimum of the average of the two tests shall be 100 h. Do at least four tests in case of a dispute.

5.12 *Joints:*

5.12.1 *Mechanical*—Mechanical fittings shall be installed in accordance with the user's written procedures and the fitting manufacturer's installation instructions. The joint shall be tested in accordance with the specific design category as outlined in 6.10.

NOTE 5—Extra care should be used when selecting a joining method on

PEX pipe for gas applications. It has not been shown that PEX gas piping can be joined by butt fusion or socket fusion. It has been shown to be possible to join PEX pipe and tubing using electrofusion fittings; however the performance of such joints has not been fully investigated for all types of PEX piping. For this reason it is recommended that electrofusion fittings be used for joining PEX gas piping only after receiving recommendations for such use by both the manufacturers of the specific PEX gas piping and the electrofusion fittings to be used. PEX gas piping can be joined using mechanical fittings designed and recommended by the manufacturer for joining D2513 PEX piping for use in fuel gas applications.

6. Test Methods

6.1 *General*—The test methods in this specification cover plastic pipe and fittings to be used for gas distribution. Test methods that are applicable from other specifications will be referenced in the section pertaining to that particular test.

6.2 *Sampling*—Take a representative sample of the pipe and fittings sufficient to determine conformance with this specification. About 40 ft (12 m) of pipe is required to perform all the tests prescribed. The number of fittings required varies, depending upon the size and type of fitting. A sampling plan shall be agreed upon by the purchaser and the manufacturer (see Practice D1898).

6.2.1 *Pipe 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.

6.3 *Conditioning*—Unless otherwise specified, condition the specimens prior to test at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 3 5 % relative humidity for not less than 24 h, in accordance with Procedure A of Practice D618 for those tests where conditioning is required and in all cases of disagreement.

6.4 *Test Conditions*——Conduct the test in the standard laboratory atmosphere of 73.4 ± 1.83.6°F (23 ± 12°C) and 50 ± 3 5 % relative humidity, unless otherwise specified.

6.5 *Dimensions and Tolerances:*

6.5.1 *Pipe*—Any length of pipe is used to determine the dimensions. Coiled pipe shall be measured in the natural springback condition, unless specified otherwise.

6.5.1.1 *Diameter*—Measure the diameter of the pipe in accordance with Test Method D2122. The average outside diameter for nonroundable pipe is the arithmetic average of the maximum and minimum diameters at any cross section on the length of the pipe. For roundable pipe, out-of-roundness tolerance applies to measurements made while the pipe is rounded with the manufacturer's recommended equipment. Measure out-of-roundness within one-half pipe diameter or 2 in. (50 mm), whichever is closer, of the rounding equipment. See Test Method D2122 for definitions of nonroundable and roundable pipe.

(1) The pipe surface shall be free of gross imperfections such as, deep scratches, grooves, or high or low (flat) spots around the pipe circumference.

NOTE 6—Excessive out-of-roundness may be caused by manufacturing irregularities around the circumference of the pipe, such as deep scratches, gouges, flat spots, and high spots. Such defects could detrimentally affect joining. To simulate field joining of roundable pipe, out-of-roundness is checked by fitting a rounding device on the pipe, then measuring diameter.

6.5.1.2 *Wall Thickness*—Make a minimum of six measurements at each cross section in accordance with Test Method D2122.

6.5.1.3 *Length*—Measure pipe length and other linear dimensions with a steel tape or other device, accurate to ±1⁄32 in. (±1 mm) in 10 ft (3 m).

6.6 *Sustained Pressure Test:*

6.6.1 Select six test specimens of pipe or fittings at random, condition at the standard laboratory test temperature and humidity, and pressure test in accordance with Test Method D1598.

6.6.1.1 Test specimens shall be prepared so that the minimum length of pipe on each side of the fitting is equal to 5 times the diameter of the pipe but in no case less than 12 in. (304 mm) for sizes less than 6 in. For sizes 6 in. and larger, the minimum length shall be equal to 3 times the diameter or 30 in. (762 mm), whichever is shorter.

6.6.1.2 Pressures used shall be as calculated using the pipe's actual measured minimum wall thickness, outside diameter, and the applicable fiber stress. Piping intended for use at temperatures of 100°F (38°C) and higher shall be tested at both 73°F (23°C) and the maximum design temperature. The test fiber stress shall be 90 % of the hydrostatic design basis (HDB).

NOTE 7—Air, methane, or nitrogen may be substituted for water as the test medium.

6.6.2 Maintain the specimens at the pressures required, held to ±10 psi (0.07 MPa), for a period of 1000 h at the test temperature ±3.6°F (±2°C) as specified in 6.6.1.2.

6.6.3 Failure of two of the six specimens tested shall constitute failure in the test. Failure of one of the six specimens tested is cause for retest of six additional specimens. Failure of one of the six specimens in retest shall constitute failure in the test. Evidence of failure of the pipe shall be as defined in Test Method D1598.

6.7 *Minimum Hydrostatic Burst Pressure (Quick Burst)*—The test equipment, procedures, and failure definitions shall be as specified in Test Method D1599. Pressures shall be as calculated using the pipe's actual measured minimum wall thickness, outside diameter, and the applicable fiber stress.

6.8 *Apparent Tensile Properties*—The procedure and test equipment shall be as specified in Test Method D2290, Procedure B. The speed of testing shall be 0.5 in. (12.7 mm)/min. Cut "ring" specimens from pipe. They shall be ½-in. (12.7 mm) wide with a ¼-in. (6.3-mm) wide reduced section. Test a minimum of five specimens. This method is applicable to all pipe of nominal ¾-in. (19.0-mm) outside diameter and larger.

6.9 *Chemical Resistance*—Determine the resistance to the following chemicals in accordance with Practices D543. Where available, the test specimen shall be a ring 2 in. SDR 11 pipe cut to the ring dimensions specified in 6.8. For materials that are not readily available as 2 in. SDR 11 pipe, the test specimen shall be a plaque of material 1/4by 2 by 4 in. (6.3 by 50.8 by 101.6 mm) with a 1 in. (25.4 mm) wide reduced section.

Chemicals	Concentration (% by volume)
Mineral oil (USP)	100
Tertiary-butyl mercaptan	5 in mineral oil
Antifreeze agents (at least one shall be used):	
Methanol, or	100
Ethylene glycol	100
Toluene	15 in methanol

Test five specimens with each chemical. Weigh the specimens to the nearest 0.005 g and completely immerse them in the chemicals for 72 h. On removal from the chemicals, wipe the specimens with a clean dry cloth. Condition in air for 2 to 2¼ h and reweigh. Calculate the increase in weight to the nearest 0.01 % on the basis of initial weight. Test the specimen in tension in accordance with 6.8 within ½ h after weighing. Examine the weight and apparent tensile strength of each specimen for conformance to the requirement in 5.4. **Warning—**Because of the possible toxicity of these reagents, refer to the Material Safety Data Sheet on each of these reagents before using or handling them.

6.10 *Categorization of Mechanical Joints*—The following test methods provide a uniform procedure for qualification or categorization of mechanical joints using short term pullout resistance tests and burst tests. The mechanical joint categories and test methods are as follows:

6.10.1 *Category 1*—A mechanical joint design that provides a seal plus a resistance to a force on the pipe end equal to or greater than that which will cause a permanent deformation of the pipe.

6.10.1.1 The apparatus and report shall be as specified in Test Method D638. The test shall be conducted at ambient temperatures, that is, 67 ± 10°F (19.4 ± 5.6°C). The speed of the testing shall be 0.2 in. (5 mm)/min ±25 %. Five specimens shall be prepared following the manufacturer's published installation instructions. Length of the specimens shall be such that the unreinforced distance between the grip of the apparatus and the end of the stiffener is at least five times the nominal outside diameter of the pipe size being tested. Apply a load until permanent deformation (yield) occurs in the unreinforced area of the piping.

6.10.1.2 Results obtained from the above method pertain only to the specific outside diameter, wall thickness, and compound of the piping used in the test and specific fitting design tested.

NOTE 8—The ability to restrain pipe to its yield as specified above does not guarantee that a properly installed joint will prevent pullout under actual long-term field conditions. Joints that cannot pass this test would be expected to pullout under actual long term field conditions. To date, this test is the best available for disqualifying unsound joints.

6.10.2 *Category 2*—A mechanical joint design that provides a seal only. A mechanical joint designed for this category excludes any provisions in the design or installation of the joint to resist any axial pullout forces; therefore, tensile tests are not required.

6.10.2.1 The test assembly shall meet the burst test requirements of 5.7 when tested in accordance with Test Method D1599 with end closures designed in accordance with Test Method D1599.

6.10.3 *Category 3*——A mechanical joint design that provides a seal plus a pipe restraint rating equivalent to the anticipated thermal stresses occurring in a pipeline. This category has a manufacturer's rated pipe end restraint less than the value required to yield the pipe as outlined in 6.10.1 (*Category 1*).

6.10.3.1 The procedures and testing shall be the same as outlined in 6.10.1 (*Category 1*) except the test tensile values shall meet the rated values published by the mechanical fitting manufacturer.

7. Marking

7.1 *Pipe*—All required marking shall be legible, visible, and permanent. To ensure permanence, marking shall be applied so it can only be removed by physically removing part of the pipe wall. The marking shall (1) not reduce the wall thickness to less than the minimum value for the pipe, (2) not have any effect on the long-term strength of the pipe, and (3) not provide leakage channels when elastomeric gasket compression fittings are used to make the joints. These marking shall consist of the word GAS, the designation ASTM F2818, the manufacturer's name or trademark, the normal pipe size including the sizing system used (IPS, CTS, or OD), DR or minimum wall thickness, material designation, and date of manufacture.

7.1.1 In addition to 7.1, the pipe marking shall include a coding that will enable the manufacturer to determine the location of manufacture, pipe production and resin lots, and any additional information which is agreed upon between the manufacturer and purchaser. The manufacturer shall maintain such records for fifty years or for the design service life of the pipe, whichever is longer.

7.1.2 All the markings in 7.1 and 7.1.1 shall be repeated at intervals not exceeding 2 ft (0.61 m). For indented printing, either the indented print line shall be in a color that contrasts with that of the pipe, or a separate print line shall be in a color that contrasts with the pipe. When color is applied to identify gas service, such as with color stripes, a color shell or solid color pipe, yellow color shall be used.

NOTE 9—Using color to identify piping service is not mandatory, but if used, yellow color is required.

TABLE 4 Pipe Category

Property	Test Method	Category							
		A	B	C	D	E	F	G	H
Temperature °F (°C)	....	100 (38)	120 (49)	140 (60)	160 (71)	180 (82)	200 (93)	...	...
Hydrostatic Design Basis, psi (MPa)	D2837	400 (2.8)	500 (3.4)	630 (4.3)	800 (5.5)	1000 (6.9)	1250 (8.6)	1600 (11.0)	2000 (13.8)
Examples: CD—At 140°F (60°C) the HDB is 800 psi (5.5 MPa). EC—At 180°F (82°C) the HDB is 630 psi (4.3 MPa)									

7.1.3 The color of the PEX pipe shall be yellow with a minimum of four equally spaced paired black stripes to identify the pipe as PEX pipe.

7.2 Pipe intended for natural gas service at elevated temperatures greater than 73°F (23°C) shall be marked with additional code letters from Table 4 (the first code letter to identify the temperature of pressure rating, the second code letter to identify HDB at highest rated temperature.

NOTE 10—The non-mandatory, preferred order for all the items required in the print line in the marking sections 7.1 and 7.2 are:
(1) Pipe size including sizing system (IPS, CTS or OD),
(2) SDR (DR) or minimum wall thickness,
(3) Manufacturer's name or trademark,
(4) GAS,
(5) Pipe material designation code,
(6) Elevated temperature code from Table 4,
(7) ASTM F2818,
(8) Manufacturer's lot code (includes date of manufacture in some cases), and
(9) Additional information, including date of manufacture, coil number, sequential footage, third party certification mark etc.
Example: 2 in. IPS SDR 11 MANUFACTURER NAME GAS PEX 0006 CEC ASTM F2818 LOT CODE INFO 02JAN98 coil #506.

8. Quality Assurance

8.1 When the product is marked with this designation, F2818, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

9. Keywords

9.1 Gas; gas distribution; PEX pipe; PEX Tubing; plastic piping; thermoplastic