



Standard Specification for Specification for Crosslinked Polyethylene (PEX) Material Gas Pressure Pipe and Tubing¹

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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, 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

- 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

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.

- 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 and Publications:*
- B31.8 Gas Transmission and Distribution Piping Systems⁴
 - PPI-TR3 Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB),

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 Pipe⁵

CFR Part 192 Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards⁶

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.

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

⁶ Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.access.gpo.gov>.

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

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
1/2	0.840 (21.3)	±0.004 (±0.102)	0.016(0.406)
3/4	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)
1 1/4	1.660 (42.1)	±0.005 (±0.127)	0.024(0.61)
1 1/2	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
1/4	0.375 (9.52)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
3/8	0.500 (12.7)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
1/2	0.625 (15.9)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
1/2	0.625 (15.9)	±0.004 (±0.10)	0.090 (2.27)	+0.009 (+0.23)
1/2	0.625 (15.9)	±0.004 (±0.10)	0.104 (2.64)	+0.010 (+0.25)
3/4	0.875 (22.2)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
3/4	0.875 (22.2)	±0.004 (±0.10)	0.077 (1.95)	+0.008 (+0.20)
3/4	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)
1 1/4	1.375 (34.9)	±0.005 (±0.13)	0.062 (1.58)	+0.007 (+0.18)
1 1/4	1.375 (34.9)	±0.005 (±0.13)	0.090 (2.27)	+0.011 (+0.28)
1 1/4	1.375 (34.9)	±0.005 (±0.13)	0.121 (3.07)	+0.015 (+0.38)
1 3/4	1.875 (47.6)	±0.006 (±0.15)	0.062 (1.58)	+0.007 (+0.18)

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
1/2	<i>D</i>	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)
3/4	<i>D</i>	0.090 (2.29)	+0.011 (+0.279)
	11.0	0.095 (2.41)	+0.011 (+0.279)
1	<i>D</i>	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)
1 1/4	<i>D</i>	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)
1 1/2	<i>D</i>	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 °F ± 10 °F (19.4 °C ± 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