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An American National Standard

Standard Specification for Black Crosslinked Polyethylene (PEX) Pipe, Fittings and Joints For Gas Distribution Applications[1]

This standard is issued under the fixed designation F2968/F2968M; 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.

1. Scope*

1.1 This specification covers outside diameter controlled, black metric-sized and IPS-sized crosslinked polyethylene (PEX) pipe, fittings and joints, made in pipe dimension ratios ranging from 6 to 17, and pressure rated for gas distribution. Included are requirements and test methods for material, workmanship, dimensions, burst pressure, hydrostatic sustained pressure, stabilizer functionality, bent-pipe hydrostatic pressure, degree of crosslinking, chemical resistance, and squeeze-off. Requirements for pipe and fittings markings are also given. The pipe, fittings and joints covered by this specification are intended for buried gas distribution and gas transmission pressure piping applications.

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 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

NOTE 1—Metric sized (SI units) pipe should only be joined with corresponding metric sized fittings, and inch sized pipe should only be joined with corresponding inch sized fittings. Inch sized fittings should not be used for metric sized pipe, and metric sized fittings should not be used for inch sized pipe.

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
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
D1603 Test Method for Carbon Black Content in Olefin Plastics
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
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
D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique
F412 Terminology Relating to Plastic Piping Systems
F876 Specification for Crosslinked Polyethylene (PEX) Tubing
F1041 Guide for Squeeze-Off of Polyolefin Gas Pressure Pipe and Tubing
F1055 Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing

[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.

*A Summary of Changes section appears at the end of this standard

F1563 Specification for Tools to Squeeze-off Polyethylene (PE) Gas Pipe or Tubing
F1948 Specification for Metallic Mechanical Fittings for Use on Outside Diameter Controlled Thermoplastic Gas Distribution Pipe and Tubing
F2897 Specification for Tracking and Traceability Encoding System of Natural Gas Distribution Components (Pipe, Tubing, Fittings, Valves, and Appurtenances)

2.2 *Federal Standard:*[3]
FED-STD-123 Marking for Shipment (Civil Agencies)

2.3 *Military Standard:*[3]
MIL-STD-129 Marking for Shipment and Storage

2.4 *ISO Standards:*[4]
ISO 1167 Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method
ISO 14531-2 Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 2: Fittings for heat-fusion jointing
ISO 14531-3 Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 3: Fittings for mechanical jointing (including PE-X/metal transitions)

2.5 *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 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 crosslinked polyethylene is PEX. Plastic pipe denotes a particular diameter schedule of plastic pipe that is outside diameter controlled.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *crosslinked polyethylene, n*—a polyethylene material that has undergone a change in molecular structure using a chemical or a physical process whereby the polymer chains are chemically linked.

3.2.2 *PEX pipe material designation code*—The PEX pipe material designation code shall consist of the abbreviation for crosslinked polyethylene (PEX) followed by four Arabic digits as shown in Table 1, and as defined in Terminology F412 for PEX pipe materials.

4. Pipe Classification

4.1 *General*—This standard covers black PEX pipe that is pressure rated based on HDB at 73ºF [23ºC] and 200ºF [93ºC]. Pressure ratings for temperatures between 73ºF [23ºC] and 200ºF [93ºC] are determined by temperature interpolation in accordance with PPI TR-3.

4.2 *Classification*—PEX pipes are classified by their PEX pipe material designation codes as shown in Table 1.

5. Materials

5.1 *General*—PEX pipes, meeting the requirements of this specification, are defined by means of *(1)* degree of crosslinking per 6.7, and *(2)* long-term strength tests per Test Method D2837 to determine HDB per Table 1. The HDB is a property of the PEX compound, which is used to make the PEX pipe.

5.2 *Basic Materials*—PEX pipe and fittings shall be made from PE compounds, which have been crosslinked by peroxides, azo compounds, or silane compounds in extrusion, or by electron beam after extrusion, such that the pipe meets the performance requirements of Section 6. The materials, procedure for mixing, and the process for crosslinking shall result in a product with Hydrostatic Design Basis ratings equal to or better than those shown in Table 1, when determined in accordance with procedures no less restrictive than those of Test Method D2837, and the PEX material shall have a Plastics Pipe Institute (PPI) long-term hydrostatic design stress and hydrostatic design basis rating per PPI TR-3. See Appendix X1 for additional information on PPI hydrostatic stress ratings.

5.3 *Pipe Material Designation Code*—The PEX material meeting the requirements of this specification shall be designated PEX 0006, PEX 0008 or PEX 0009.

NOTE 2—The first two digits in the pipe material designation code are for chlorine resistance and UV resistance. A "0" indicates "not tested". If either of these properties has been tested, then the "0" is replaced by the appropriate digit.

5.4 *Density*—When determined in accordance with 7.5, the PE base resin used for PEX pipe, without carbon black, used for PEX pipe shall have a minimum average density of 0.926 g/cm^3.

5.5 *Carbon Black*—PE compounds used to make PEX pipe shall contain 2.0 to 3.0 percent well dispersed carbon black as measured in the PEX pipe by Test Methods D1603 or D4218.

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

TABLE 1 PEX Pipe Material Designation Codes

PEX Pipe Material Designation Code	73ºF [23ºC] HDB Psi [MPa]	200ºF [93ºC] HDB Psi [MPa]
PEX 0006	1250 [8.62]	630 [4.34]
PEX 0008	1600 [11.03]	630 [4.34]
PEX 0009	1800 [12.41]	630 [4.34]

[3] DLA Document Services Building 4/D 700 Robbins Avenue Philadelphia, PA 19111-5094 http://quicksearch.dla.mil/

[4] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

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

5.7 *Chemical Resistance*—The PEX material 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 7.11.

NOTE 3—This test is only an indication of what will happen as a result of short-term exposure to these chemicals. For long-term results, additional testing is required.

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.

6.2 *Out-of Roundness*—The maximum out-of roundness requirements shown in Table 2 and Table 3 for pipe apply to the average measured diameter in accordance with 7.4.1.

6.3 *Dimensions and Tolerances:*

6.3.1 *Outside Diameters*—The outside diameters and tolerances shall be as shown in Table 2 or Table 3, when measured in accordance with 7.4 and 7.4.1.

6.3.2 *Wall Thickness*—The wall thickness and tolerances shall be as shown in Table 4 or Table 5, when measured in accordance with 7.4 and 7.4.2.

6.4 *Sustained Pressure 73°F [23°C]*—The PEX pipe shall not fail in less than 1000 h when tested in accordance with 7.6. For PEX 0006 the stress shall be 1320 psi [9.1 MPa], for PEX 0008 the stress shall be 1650 psi [11.3 MPa], and for PEX 0009 the stress shall be 2050 psi [14.1 MPa]. 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 HDB.

TABLE 3 Inch-sized Outside Diameters and Tolerances for PEX Pipe

Pipe Size	Outside Diameter	Tolerances for Outside Diameter (±)
in.	in.	in.
3	3.500	0.016
4	4.500	0.020
5	5.563	0.025
6	6.625	0.030
8	8.625	0.039
10	10.750	0.048
12	12.750	0.057
14	14.000	0.063
16	16.000	0.072
18	18.000	0.081
20	20.000	0.090
22	22.000	0.099
24	24.000	0.108
26	26.000	0.117
28	28.000	0.126
30	30.000	0.135
32	32.000	0.144
34	34.000	0.153
36	36.000	0.162
42	42.000	0.189
48	48.000	0.216
54	54.000	0.243

6.5 *Minimum Hydrostatic Burst Pressure (Quick Burst)*—The pipe shall fail in a ductile manner when tested in accordance with 7.7. For pipe sizes above 4 in [110 mm] nominal diameter, the testing lab shall be allowed to replace the quick burst test by the apparent ring tensile strength test in 6.6.

6.6 *Apparent Tensile Strength at Yield*—When tested in accordance to 7.8, the PEX pipe shall demonstrate a minimum

TABLE 2 Metric-sized Outside Diameters and Tolerances for PEX Pipe

Pipe Size	Average Outside Diameter	Tolerances for Average Diameter	Out-of-Roundness
mm	mm	mm	mm
16	16.15	±0.15	1.2
20	20.15	±0.15	1.2
25	25.15	±0.15	1.2
32	32.15	±0.15	1.3
40	40.20	±0.20	1.4
50	50.20	±0.20	1.4
63	63.20	±0.20	1.5
75	75.25	±0.25	1.6
90	90.30	±0.30	1.8
110	110.35	±0.35	2.2
125	125.40	±0.40	2.5
140	140.45	±0.45	2.8
160	160.50	±0.50	3.2
180	180.55	±0.55	3.6
200	200.60	±0.60	4.0
225	225.70	±0.70	4.5
250	250.75	±0.75	5.0
280	280.85	±0.85	9.8
315	315.95	±0.95	11.1
355	356.10	±1.10	12.5
400	410.20	±1.20	14.0
450	451.35	±1.35	15.6
500	501.50	±1.50	17.5
560	561.70	±1.70	19.6
630	631.90	±1.90	22.1
710	713.20	±3.20	24.8
800	813.00	±3.60	28.0
900	904.05	±4.05	31.5
1000	1004.50	±4.50	35.0

TABLE 4 Metric-sized Wall Thickness and Tolerances for PEX Plastic Pipe

	Minimum Wall Thickness (t), mm (tolerance is plus 12%)							
Pipe Size [mm]	DR 6	DR 7.4	DR 9	DR 11	DR 13.6	DR 16.2	DR 17	DR 21
16	3.0	2.3	2.0	...	...	...	...	...
20	3.4	3.0	2.3	2.0	...	...	...	...
25	5.4	3.5	3.0	2.3	2.0	...	...	...
32	5.4	4.4	3.6	3.0	2.4	2.0	2.0	2.3
40	6.7	5.5	4.5	3.7	3.0	2.5	2.4	2.8
50	8.3	6.9	5.6	4.6	3.7	3.1	3.0	3.4
63	10.5	8.6	7.1	5.8	4.7	3.9	3.8	4.3
75	12.5	10.3	8.4	6.8	5.6	4.6	4.5	5.1
90	15.0	12.3	10.1	8.2	6.7	5.6	5.4	6.1
110	18.3	15.1	12.3	10.0	8.1	7.7	6.6	7.4
125	20.8	17.1	14.0	11.4	9.2	7.7	7.4	8.3
140	23.3	19.2	15.7	12.7	10.3	8.7	8.3	9.3
160	26.6	21.9	17.9	14.6	11.8	9.9	9.5	10.6
180	29.9	24.6	20.1	16.4	13.3	11.1	10.7	11.9
200	33.2	27.4	22.4	18.2	14.7	12.4	11.9	13.2
225	37.4	30.8	25.2	20.5	16.6	13.9	13.4	14.9
250	41.5	34.2	27.9	22.7	18.4	15.5	14.8	16.4
280	46.5	38.3	31.3	25.4	20.6	17.3	16.6	18.4
315	52.3	43.1	35.2	28.6	23.2	19.5	18.7	20.7
355	59.0	48.5	39.7	32.2	26.1	21.9	21.1	23.4
400	...	54.7	44.7	36.3	29.4	24.7	26.2	23.7
450	...	61.5	50.3	40.9	33.1	27.8	26.7	29.5
500	...	...	55.8	45.4	36.8	30.9	29.7	32.8
560	...	...	62.5	50.8	41.2	34.6	33.2	36.7
630	...	...	70.3	57.2	46.3	38.9	37.4	41.3
710	...	...	79.3	64.5	52.2	43.9	42.1	46.5
800	...	...	89.3	72.6	58.8	49.4	47.4	52.3
900	...	...	...	81.7	66.2	56.6	53.3	58.8
1000	...	...	...	90.2	72.5	61.8	59.3	65.4

TABLE 5 Inch-sized Wall Thickness and Tolerances for PEX Plastic Pipe

	Minimum Wall Thickness (t), in (tolerance is plus 12%)							
Pipe Size, in.	DR 7.3	DR 8.3	DR 9	DR 11	DR 13.5	DR 15.5	DR 17	DR 21
3	0.479	0.422	0.389	0.318	0.259	0.226	0.206	0.167
4	0.616	0.542	0.500	0.409	0.333	0.290	0.265	0.214
5	0.762	0.670	0.618	0.506	0.412	0.359	0.327	0.265
6	0.908	0.798	0.736	0.602	0.491	0.427	0.390	0.315
8	1.182	1.039	0.958	0.784	0.639	0.556	0.507	0.411
10	1.473	1.295	1.194	0.977	0.796	0.694	0.632	0.512
12	1.747	1.536	1.417	1.159	0.944	0.823	0.750	0.607
14	1.918	1.687	1.556	1.273	1.037	0.903	0.824	0.667
16	2.192	1.928	1.778	1.455	1.185	1.032	0.941	0.762
18	2.466	2.169	2.000	1.636	1.333	1.161	1.059	0.857
20	...	2.409	2.222	1.818	1.481	1.290	1.176	0.952
22	...	...	2.444	2.000	1.630	1.419	1.294	1.048
24	...	...	2.667	2.182	1.778	1.548	1.412	1.143
26	...	...	...	2.364	1.926	1.677	1.529	1.238
28	...	...	...	2.545	2.074	1.806	1.647	1.333
30	...	...	...	2.727	2.222	1.935	1.765	1.429
32	...	...	...	2.909	2.370	2.065	1.882	1.524
34	...	...	...	3.091	2.519	2.194	2.000	1.619
36	...	...	...	3.273	2.667	2.323	2.118	1.714
42	...	...	...	...	...	2.710	2.471	2.000
48	...	...	...	...	...	3.097	2.824	2.286
54	...	...	...	...	...	...	3.176	2.571

of 3000 psi [20.7 MPa] for PEX 0006, 3700 psi [25.5 MPa] for PEX 0008, and 4600 psi [31.7 MPa] for PEX 0009.

6.7 *Degree of Crosslinking*—When tested in accordance with 7.9, the degree of crosslinking for PEX pipe material shall be within the range from 65 to 89 % inclusive. Depending on the process used, the following minimum percentage crosslinking values shall be achieved: 73 % by peroxides, 65 % by electron beam, or 65 % by silane compounds.

6.8 *Stabilizer Functionality*—Stabilizer Functionality shall be tested in accordance with 7.10. The test need only be performed for the original validation of pipe made from a particular compound.

6.9 *Bent Pipe Hydrostatic Sustained Pressure Strength:*

6.9.1 *General*—PEX pipe sizes and DR's deemed suitable for bending by the pipe manufacturer shall meet the requirements in 6.9.2.