



Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe¹

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1. Scope*

1.1 This specification covers a coextruded crosslinked polyethylene composite pressure pipe with a welded aluminum tube reinforcement between the inner and outer layers. The inner and outer crosslinked polyethylene layers are bonded to the aluminum tube by a melt adhesive. Included is a system of nomenclature for the crosslinked polyethylene-aluminum-crosslinked polyethylene (PEX-AL-PEX) pipes, the requirements and test methods for materials, the dimensions of the component layers and finished pipe, adhesion tests, and the burst and sustained pressure performance. Also given are the requirements and methods of marking. The pipe covered by this specification is intended for use in potable water distribution systems for residential and commercial applications, water service, building supply lines, underground irrigation systems, and radiant panel heating systems, baseboard, snow- and ice-melt systems, and gases that are compatible with the composite pipe and fittings.

NOTE 1— Piping covered by this specification is not recommended for use in indoor flammable gas applications.

1.2 This specification covers only composite pipes incorporating a welded aluminum tube. Pipes consisting of metallic layers not welded together are outside the scope of this specification.

1.3 Specifications for connectors for use with pipe meeting the requirements of this specification are given in **Annex A1**.

1.4 This specification excludes polyethylene-aluminum-polyethylene pipes (see Specification **F1282**).

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.6 The following precautionary caveat pertains only to the test methods portion, Section 9, 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.

1.7 *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
- D883** Terminology Relating to Plastics
- 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 (Withdrawn 2024)³
- D1898** Practice for Sampling of Plastics (Withdrawn 1998)³
- D2122** Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- D2765** Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics
- D3350** Specification for Polyethylene Plastics Pipe and Fittings Materials
- E8/E8M** Test Methods for Tension Testing of Metallic Materials
- F412** Terminology Relating to Plastic Piping Systems
- F1282** Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe
- F1974** Specification for Metal Insert Fittings for Polyethylene/Aluminum/Polyethylene and Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure Pipe

¹ This specification is under the jurisdiction of ASTM Committee **F17** on Plastic Piping Systems and is the direct responsibility of Subcommittee **F17.11** on Composite.

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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.

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

- 2.2 *National Sanitation Foundation Standard: Standard No. 61 Drinking Water System Components—Health Effects*⁴
- Standard No. 14 *Plastics Piping System Components and Related Materials*⁴
- 2.3 *Federal Standard: Fed. Std. No. 123 Marking for Shipments (Civil Agencies)*⁵
- 2.4 *Military Standard: MIL-STD-129 Marking for Shipment and Storage*⁵
- 2.5 *Uniform Classification Committee Standard: Uniform Freight Classification*⁶
- 2.6 *National Motor Freight Traffic Association Standard: National Motor Freight Classification*⁷

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *assembly*—the joint between a fitting and a length of pipe.

3.2.2 *PEX-AL-PEX pipe*—composite pipe produced by co-extrusion or extrusion of layers of polyethylene/aluminum/polyethylene bonded together with a melt adhesive and cross-linked by irradiation or chemical means in combination heat and moisture.

3.2.3 *pipe hoop stress*—for simplicity the value of the hoop stress quoted assumes a homogeneous wall. Local values of stress will vary with the different layers (see 3.2.3.1).

3.2.3.1 *Discussion*—Thick walled plastic pipes produced from one material have hoop stresses that vary through the wall, and are usually described by the Lamé Theory. The composite nature of the PEX-AL-PEX pipe, composed of materials with very different Young’s Modulus values, will, on pressurization, not have a uniform stress distribution through

the thickness of the wall of the pipe. The PEX-AL-PEX pipes have a hoop stress distribution that differs substantially from both the thick and thin walled pipe cases.

4. Pipe Classification

4.1 *Pipe Diameter*—The PEX-AL-PEX pipes are classified by the outside diameter.

4.2 *Pipe Dimension Ratio*—The concept of dimension ratio is not relevant to PEX-AL-PEX composite pipes, and cannot be used to relate pressure rating with total wall thickness.

5. Materials

5.1 *General*—The PEX-AL-PEX pipe is composed of one metallic layer, two layers of polymeric adhesive, and two layers of crosslinked polyethylene. For pipe made to this specification the constituent materials must meet the following requirements:

5.2 *Aluminum*—The aluminum shall have a thickness as specified in **Table 1**. The material shall have minimum elongations and ultimate tensile strengths of 20 % and 100 MPa (14 600 psi), respectively. The tests shall be conducted according to Test Methods **E8/E8M**.

5.3 *Crosslinked Polyethylene:*

5.3.1 The polyethylene shall be, in the final finished state in the pipe, crosslinked as defined in Terminology **D883**.

5.3.2 Polyethylene plastics used to make pipe meeting the requirements of this specification shall be virgin resin meeting the requirements of either Grade PE20A, B, or C; Grade PE23A, B, or C; Grade PE30A, B, or C; or Grade PE33A, B, or C in accordance with Specification **D3350**.

5.3.3 Class B compounds shall have sufficient ultraviolet (UV) stabilizers to protect the pipe from deleterious effects due to continuous outdoor exposure during storage and shipping. Pipe produced from Class B compounds are not suitable for exposed outdoor application. Class A, B, and C compounds shall have sufficient antioxidants to meet the requirements in Specification **D3350**.

5.4 *Melt Adhesive*—The material shall have a density cell of 1, 2, or 3; a melt index cell of 1, 2, or 3; and a color code of A or B, in accordance with Specification **D3350**.

5.5 *Rework Material*—The use of reclaimed, recycled, or rework plastics is not permitted.

TABLE 1 Outside Diameters, Aluminum Thickness, and Tolerances for PEX-AL-PEX

Diameter Nominal (DN)	Nominal Pipe Size (NPS)	Minimum Outside Diameter, mm (in.)	Tolerance on Minimum, mm (in.)	Maximum Out-of-Roundness, ^a mm (in.)	Minimum Aluminum Thickness, mm (in.)	Tolerance on Thickness, mm (in.)
12	3/8	12.00 (0.472)	+0.30 (0.012)	0.3 (0.012)	0.18 (0.007)	+0.09 (+0.0035)
16	1/4	16.00 (0.630)	+0.30 (0.012)	0.4 (0.016)	0.18 (0.007)	+0.15 (+0.006)
20	5/8	20.00 (0.787)	+0.30 (0.012)	0.5 (0.020)	0.23 (0.009)	+0.23 (+0.009)
25	3/4	25.00 (0.984)	+0.30 (0.012)	0.5 (0.020)	0.23 (0.009)	+0.09 (+0.0035)
26	7/8	26.00 (1.022)	+0.30 (0.012)	0.5 (0.020)	0.53 (0.021)	+0.10 (+0.004)
32	1	32.00 (1.260)	+0.30 (0.012)	0.5 (0.020)	0.28 (0.011)	+0.09 (+0.0035)
40	1 1/4	39.95 (1.573)	+0.30 (0.012)	0.5 (0.020)	0.33 (0.013)	...
50	1 1/2	49.90 (1.964)	+0.30 (0.012)	0.5 (0.020)	0.47 (0.018)	...
63	2	62.90 (2.484)	+0.40 (0.016)	0.5 (0.020)	0.57 (0.022)	...
75	2 1/4	75.10 (2.957)	+0.60 (0.024)	1.0 (0.039)	0.67 (0.026)	...

^a The out-of-roundness specification applies only to tubing prior to coiling.