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An American National Standard

Standard Specification for Polyethylene of Raised Temperature/Aluminum/Polyethylene of Raised Temperature (~~PERT/AL/PE-RT~~)(PE-RT/AL/PE-RT) Composite Pressure Pipe¹

This standard is issued under the fixed designation F3346; 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~~—Scope*

1.1 This specification covers a coextruded polyethylene composite pressure pipe with a butt welded aluminum tube reinforcement between the inner and outer layers. The inner and outer polyethylene layers are bonded to the aluminum tube by a melt adhesive. Included is a system of nomenclature for the polyethylene-aluminum-polyethylene of raised temperature (~~PERT/AL/PE-RT~~)(PE-RT/AL/PE-RT) pipes, the requirements and test methods for materials, the dimensions and strengths of the component tubes 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 air conditioning and refrigeration (ACR), underground irrigation systems, radiant panel heating systems, baseboard, snow- and ice-melt systems, and gases that are compatible with composite pipe.

1.2 This specification relates only to composite pipes incorporating a butt welded aluminum tube having both internal and external polyethylene layers. The welded aluminum tube is capable of sustaining internal pressures. Pipes consisting of metallic layers not butt welded together and plastic layers other than polyethylene are outside the scope of this specification. [3/astm-f3346-24](#)

1.3 Specifications for fittings for use with pipe meeting the requirements of this specification are given in [Annex A1](#).

1.4 This specification excludes crosslinked polyethylene-aluminum-crosslinked polyethylene pipes (see Specification [F1281](#)).

1.5 *Units*—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 *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.*

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. Current edition approved ~~June 1, 2019~~Feb. 1, 2024. Published ~~June 2019~~February 2024. Originally approved in 2019. Last previous edition approved in 2019 as ~~F3346-19~~. DOI: ~~10.1520/F3346-19~~10.1520/F3346-24

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

2. Referenced Documents

2.1 ASTM Standards:²

- D618 Practice for Conditioning Plastics for Testing
- 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
- D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- 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
- D3895 Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
- E8/E8M Test Methods for Tension Testing of Metallic Materials
- F412 Terminology Relating to Plastic Piping Systems
- F1281 Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe

2.2 ASHRAE Standard:⁴

ASHRAE Standard 15 Safety Standard for Refrigeration Systems

2.3 Uniform Classification Committee:⁵

Uniform Freight Classification

2.4 National Motor Freight Association Standard:⁵

National Motor Freight Classification

2.5 Federal Standard:⁶

Fed. Std. No. 123 Marking for Shipments (Civil Agencies)

2.6 Underwriters Laboratory Standards:⁷

UL 207 Refrigerant-Containing Components and Accessories

UL 1963 Refrigerant Recovery/Recycling Equipment

2.7 Military Standard:⁶

MIL-STD-129 Marking for Shipment and Storage

2.8 PPI Standard:⁸

PPI TR-3 Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), Minimum Required Strength (MRS) Ratings, and Categorized Required Strength (CRS) for Thermoplastic Piping Materials or Pipe

PPI TR-4 PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), 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.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *assembly, n*—a system made up of pipe, fittings, flanges, valves, or other piping components.

4. Pipe Classification

4.1 *Pipe Diameter*—The PE-RT/AL/PE-RT composite pipes are classified by outside diameter.

NOTE 1—*Pipe Dimension Ratio*—The concept of dimension ratio is not relevant to PE-RT/AL/PE-RT laminated pipes, and cannot be used to relate pressure rating with total wall thickness.

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 Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, <http://www.ashrae.org>.

⁵ Available from National Motor Freight Traffic Association, Inc. (NMFTA), 1001 N. Fairfax St., Suite 600, Alexandria, VA 22314-1798, <http://www.nmfta.org>.

⁶ Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.

⁷ Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, <http://www.ul.com>.

⁸ Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, <http://www.plasticpipe.org>.

5. Materials

5.1 *General*—The PE-RT/AL/PE-RT pipe is composed of one metallic layer, two layers of the same polyethylene melt adhesive and two layers of the same 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 when tested in accordance with **9.5**.

5.3 *Polyethylene*:

5.3.1 Polyethylene resin used to make pipe meeting the requirements of this specification shall be virgin resin, reworked plastic, or both, and shall have a Plastic Pipe Institute (PPI) HDB established at 23 °C (73 °F) and 82 °C (180 °F).

5.3.1.1 Only polyethylene plastics having an HDB at 82 °C (180 °F) shall be used to manufacture pipe rated at 82 °C (180 °F).

5.3.1.2 The inner PE compound shall meet the color and UV stabilizer code of A, B, C, D or E in accordance with Specification **D3350**. The outer layer PE compound shall meet the color and UV stabilizer code of E in accordance with Specification **D3350**.

5.4 *Polyethylene Melt Adhesive*—The polyethylene melt adhesive 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**.

6. Requirements

6.1 *General*—The requirements and test methods in this specification cover PE-RT/AL/PE-RT pipes. Tests on the individual layers that comprise this composite pipe are outside the scope of this specification. The raw materials used, however, must conform to the requirements in Section 5.

6.2 *Dimensions and Tolerances of Pipe*:

6.2.1 *Pipe Diameter*—The minimum outside diameter and tolerances of the pipe shall meet the requirements given in **Table 1**, when measured in accordance with **9.1** and **9.1.2**. Maximum and minimum (out-of-roundness) tolerances apply only to measurements made on pipe prior to coiling.

6.2.2 *Pipe Wall Thickness*—The total pipe wall thickness shall meet the requirements given in **Table 2**, when measured in accordance with **9.1** and **9.1.3**. The minimum wall thickness at any point of measurement of the pipe shall not be less than the minimum wall thickness specified in **Table 2**.

6.2.3 *Polyethylene Layer Thickness*—The thickness of the inner and outer layers of polyethylene PE-RT in the PE-RT/AL/PE-RT pipe shall have a minimum value and tolerance as specified in **Table 2**. The polyethylene PE-RT thickness is measured in accordance with **9.2**.

6.2.4 *Pipe Length*—The pipe shall be supplied coiled or in straight lengths as agreed upon with the purchaser with an allowable tolerance of –0 mm.

TABLE 1 Outside Diameters, Aluminum Thickness, and Tolerances for PE-RT/AL/PE-RT

Diameter Nominal (DN)	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	12.00 (0.472)	+0.30 (0.012)	0.4 (0.016)	0.16 (0.006)	+0.09 (+0.0035)
14	14.00 (0.552)	+0.30 (0.012)	0.4 (0.016)	0.16 (0.006)	+0.09 (+0.0035)
16	16.00 (0.630)	+0.30 (0.012)	0.5 (0.020)	0.23 (0.009)	+0.09 (+0.0035)
18	18.00 (0.709)	+0.30 (0.012)	0.5 (0.020)	0.23 (0.009)	+0.09 (+0.0035)
20	20.00 (0.787)	+0.30 (0.012)	0.5 (0.020)	0.28 (0.011)	+0.09 (+0.0035)
25	25.00 (0.984)	+0.30 (0.012)	0.5 (0.020)	0.36 (0.014)	+0.09 (+0.0035)
32	32.00 (1.260)	+0.30 (0.012)	0.5 (0.020)	0.46 (0.018)	+0.09 (+0.0035)

^AThe out-of-roundness specification applies only to pipe prior to coiling.

TABLE 2 Wall Thickness for PE-RT/AL/PE-RT Composite Pipe

Diameter Nominal (DN)	Total Wall Thickness, min, mm (in.)	Wall Tolerance (+) mm	Outer PEPE-RT Layer Thickness, min, mm (in.)	Inner PEPE-RT Layer Thickness, min, mm (in.)
12	2.45 (0.965)	0.40 (0.016)	0.40 (0.016)	1.00 (0.039)
14	2.50 (0.984)	0.40 (0.016)	0.40 (0.016)	1.20 (0.047)
16	2.45 (0.965)	0.40 (0.016)	0.40 (0.016)	1.20 (0.047)
18	2.75 (0.108)	0.40 (0.016)	0.40 (0.016)	1.30 (0.051)
20	2.70 (0.106)	0.40 (0.016)	0.40 (0.016)	1.40 (0.055)
25	3.25 (0.128)	0.40 (0.016)	0.40 (0.016)	1.40 (0.055)
32	3.75 (0.148)	0.40 (0.016)	0.40 (0.016)	1.40 (0.055)

6.3 Adhesion Test:

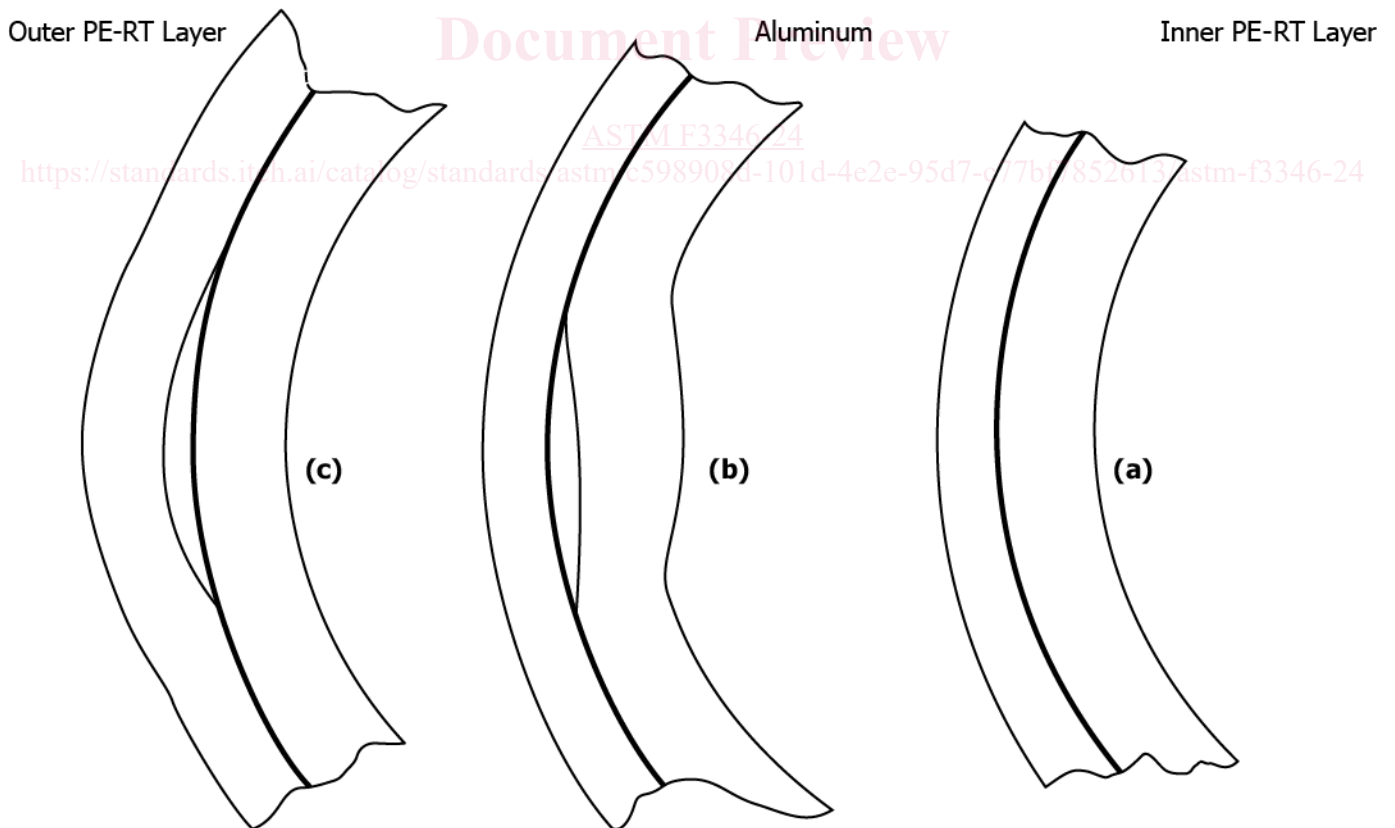
6.3.1 There shall be no delamination of the PE-RT and AL, either on the bore side or the outside (see Fig. 1). The test shall be conducted in accordance with 9.3.1.

6.4 Apparent Tensile Strength of Pipe—The pipe rings, when tested in accordance with 9.4, shall meet the minimum strength as specified in Table 3.

6.5 Minimum Burst Pressure—The minimum burst pressure for PE-RT/AL/PE-RT pipe shall be as given in Table 3, when determined in accordance with 9.6.

6.6 Sustained Pressure:

6.6.1 The PE-RT/AL/PE-RT pipe rated at 60 °C (140 °F) shall not fail, balloon, burst, or weep, as defined in Test Method D1598, when tested for 10 h at the test pressure given in Table 4 at a temperature of 60 °C (140 °F) in accordance with 9.7.



(a) Good pipe showing no delamination, (b) Delamination between the inner layer and the aluminum, and (c) Delamination between the outer layer and the aluminum.

FIG. 1 Detection of Delamination

TABLE 3 Minimum Pipe Ring Strengths and 23 °C (73 °F) Burst Pressure of PE-RT/AL/PE-RT Composite Pipe

Diameter Nominal (DN)	Minimum Pipe Ring Strength N (lb)	Minimum 23 °C (73.4 °F) Burst Pressure, kPa (psi)
12	2100 (470)	6000 (880)
14	2200 (495)	5500 (800)
16	2400 (540)	5000 (730)
18	2400 (540)	5000 (730)
20	2400 (540)	4000 (580)
25	2650 (595)	4000 (580)
32	3200 (720)	4000 (580)

TABLE 4 Minimum Sustained Pressure for PE-RT/AL/PE-RT Composite Pipe

Diameter Nominal (DN)	Minimum Sustained Pressure PE-RT/AL/PE-RT, kPa (psi)	Minimum Sustained Pressure PE-RT/AL/PE-RT, kPa (psi)
	at 60 °C (140 °F)	at 82 °C (180 °F)
12	2480 (360)	2340 (340)
14	2480 (360)	2340 (340)
16	2480 (360)	2340 (340)
18	2480 (360)	2340 (340)
20	2480 (360)	2340 (340)
25	2480 (360)	2340 (340)
32	2100 (305)	1960 (285)

6.6.2 PE-RT/AL/PE-RT pipe rated at 82 °C (180 °F) shall not fail, balloon, burst, or weep as defined in Test Method **D1598** when tested in accordance with **9.7** for 10 h at the test pressure given in **Table 4** at a temperature of 82 °C (180 °F).

6.7 *Pressure design basis (PDB)*—All pipe meeting the requirements of this specification shall have a PDB of 400 psi at 23 °C (73 °F) and 200 psi at 82 °C (180 °F) obtained by categorizing the long-term hydrostatic pressure strength determined in accordance with Test Method **D2837** and PPI TR-3. PDB is specific to the particular wall construction and pipe diameter.

6.8 *Refrigerant Exposure*—All pipe designed to be used with refrigerant shall be tested in accordance with **9.8** for compatibility with each refrigerant as specified by the manufacturer.

7. Workmanship

7.1 The pipe shall be free of visible cracks, holes, foreign inclusions, blisters, and other known injurious defects. The pipe shall be as uniform as commercially practicable in color, opacity, and regularity of the distribution of the polyethylene inside and outside.

8. Sampling and Conditioning

8.1 *Sampling*—Take a sample of the PE-RT/AL/PE-RT pipe sufficient to determine conformance with this specification. The number of specimens designated for each test shall be taken from pipe selected at random.

NOTE 2—Sample size and testing frequency of lots for quality control must be established by the manufacturer to ensure conformance to the specification. Sampling and frequency will vary with the specific circumstances.

8.2 *Test Specimens*—Not less than 50 % of the test specimens required for any pressure test shall have at least part of the marking in their central sections. The central section is that portion of the pipe that is at least one pipe diameter away from an end closure.

8.3 *Conditioning*—Condition the specimens at 23 ± 2 °C (73 ± 3 °F) and 50 ± 10 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice **D618**, for those tests where conditioning is required. In cases of disagreement, the tolerances shall be ± 1 °C (± 1.8 °F) and ± 2 % relative humidity.

8.4 *Test Conditions*—Conduct the test in the standard laboratory atmosphere of 23 ± 2 °C (73 ± 3 °F) and 50 ± 10 %

$\pm 10\%$ relative humidity, unless otherwise specified in the test methods or in this specification. In cases of disagreement, the tolerances shall be $\pm 1\text{ }^{\circ}\text{C}$ ($2\text{ }^{\circ}\text{F}$) and $\pm 2\%$ relative humidity.

9. Test Methods

9.1 Dimensions and Tolerances:

9.1.1 *Pipe*—Any length of the PE-RT/AL/PE-RT composite pipe may be used to determine dimensions.

9.1.2 *Outside Diameter*—Measure the outside diameter of the PE-RT/AL/PE-RT pipe in accordance with Test Method [D2122](#).

9.1.3 *Wall Thickness*—Make micrometer measurements of the wall thickness in accordance with Test Method [D2122](#) to determine the maximum and minimum values. Measure the wall thickness at both ends of the pipe to the nearest 0.01 mm (0.0004 in.).

9.2 Polyethylene Layer Thickness:

9.2.1 *Sample Preparation*—Select the sample of pipe at random. Cut the pipe with a sharp knife or other suitable cutter, ensuring that the pipe after cutting is not more than 10% out-of-round.

9.2.2 *Thickness Determination*—Use a hand held magnifying glass equipped with graduated reticule, or a laboratory microscope with graduated reticule. The reticule should measure to the nearest 0.1 mm (0.004 in.). Determine the thickness of the outer coating of polyethylene at six points around the circumference. Only one of the points should be at the aluminum weld.

9.3 Adhesion Test:

9.3.1 Visual Test:

9.3.1.1 *Cutting the Spiral*—Mount a Stanley 1991 or similarly sharp but rigid razor-like blade within a protective housing and angle to cut a $45 \pm 5^{\circ}$ spiral in the pipe ([Fig. 2](#)). Choose a PE-RT/AL/PE-RT pipe at random and insert into the housing and rotate to form the spiral cut. The cut goes through the complete wall on one side of the pipe only. Run the spiral along the pipe for a minimum distance along the pipe axis equal to five times the outside diameter.

9.3.1.2 *Examining for Delamination*—Firmly hold the pipe with the spiral cut at the uncut end and create a ribbon of pipe material by opening out the spiral-cut pipe. Pliers can be used to grip the spiral-cut pipe. Examine the wall of the pipe visually side-on for evidence of delamination between the metal and plastic layers (see [Fig. 1](#)).

9.3.2 Separation Test:

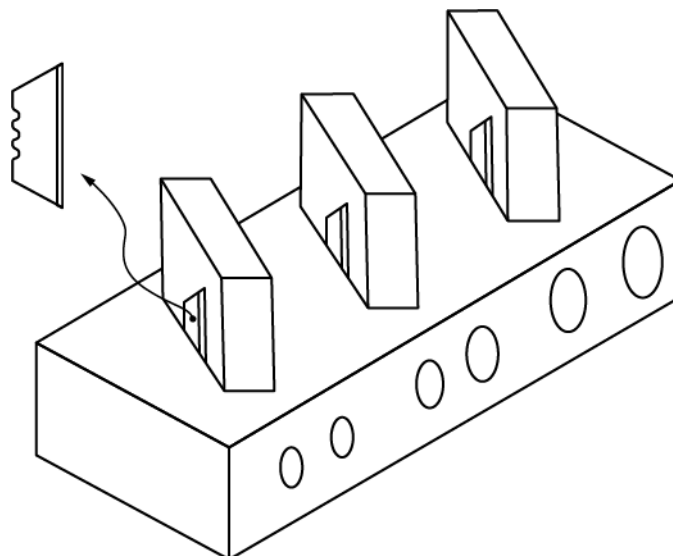


FIG. 2 Spiral Cutter for the Delamination Test