



**Summary of Substantive Changes  
between the 2014, 2019 and 2022 editions of  
ASTM F2623 “Polyethylene of Raised Temperature (PE-RT) Systems for Non-Potable Water  
Applications”**

**Presented to the IAPMO Standards Review Committee on January 9, 2023**

**General:** The change to this standard will have an impact on currently listed products. The substantive change is:

- Introduction of requirements for system components in Sections 4, 5, 6, 7, and 9.
- Section 4, identify nominal tubing size and specification of max continuous pressure.
- Section 5, specification of PE-RT tubing and material requirements.

**Title Change:**

*Standard Specification for Polyethylene of Raised Temperature (PE-RT) ~~SDR-9 Tubing~~ [Systems for Non-Potable Water Applications](#)*

**Section 2, Referenced Documents: Reference standards were added as follows:**

[D1435 Practice for Outdoor Weathering of Plastics](#)

[D2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications](#)

[D2683 Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing](#)

[D3261 Specification for Butt Heat Fusion Polyethylene \(PE\) Plastic Fittings for Polyethylene \(PE\) Plastic Pipe and Tubing](#)

[F1055 Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene \(PEX\) Pipe and Tubing](#)

[F1282 Specification for Polyethylene/Aluminum/Polyethylene \(PE-AL-PE\) Composite Pressure Pipe](#)

[F1290 Practice for Electrofusion Joining Polyolefin Pipe and Fittings](#)

[F1807 Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Cross-linked Polyethylene \(PEX\) Tubing and SDR9 Polyethylene of Raised Temperature \(PE-RT\) Tubing](#)

[F2080 Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethylene \(PEX\) Pipe and SDR9 Polyethylene of Raised Temperature \(PE-RT\) Pipe](#)

[F2159 Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps for SDR9 Cross-linked Polyethylene \(PEX\) Tubing and SDR9 Polyethylene of Raised Temperature \(PE-RT\) Tubing](#)

[F2620 Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings](#)

[F2735 Specification for Plastic Insert Fittings For SDR9 Cross-linked Polyethylene \(PEX\) and Polyethylene of Raised Temperature \(PE-RT\) Tubing](#)

[F2769 Specification for Polyethylene of Raised Temperature \(PE-RT\) Plastic Hot and Cold-Water Tubing and Distribution Systems](#)

[G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials](#)



## 2.5 PPI Standard:

[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](#)

## 2.6 ISO Standard:

[ISO 16871 Plastics piping and ducting systems—Plastics pipes and fittings—Method for exposure to direct \(natural\) weathering](#)

## Section 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 polyethylene of raised temperature is PE-RT. Plastic tubing denotes a particular diameter schedule of plastic pipe in which the outside diameter ~~of the tubing is equal to the nominal size plus 1/8 in.~~ ~~Plastic pipe outside diameter schedule~~ conforms to ANSI B36.10.

3.2 Definitions of Terms Specific to This Standard:

[3.2.1 barrier layer, n—a very thin polymeric film within the tube wall or around the circumference of the tubing which provides a means for greatly reducing the transmission of oxygen from the atmosphere and into the fluid within the tube.](#)

[3.2.2 fitting, n—an appurtenance such as coupling, elbow or tee used to connect tubing or as an accessory to tubing.](#)

[3.2.4 manifold, n—an appurtenance that has at least one inlet and multiple outlets.](#)

[3.2.9 system components, n—fittings and manifolds.](#)

## Section 4, Classification:

4.1 ~~General Tubing~~—This specification covers PE-RT tubing ~~material~~ in one standard dimension ratio, 9.0, and ~~nominal tubing sizes from NTS 1/8 through NTS 6~~ having pressure ratings ~~for~~ ~~based on~~ water at 73 °F (23 °C) and 180 °F (82 °C) and optionally at 140 °F (60 °C), ~~with a maximum continuous use temperature of 180 °F (82 °C).~~ The pressure ratings decrease as the temperature is increased ~~and is uniform for all nominal tubing sizes.~~

[4.2 System Components—This specification covers system components, such as fittings and manifolds, for use in systems with PE-RT tubing on the basis of the requirements of this specification.](#)

## Section 5, Materials and Manufacture:

5.1 ~~General PE-RT Tubing~~:

5.1.1 The ~~plastic PE-RT compound~~ used to make tubing shall ~~be virgin plastic or reworked plastic, as specified in 5.3 and shall Plastics Pipe Institute (PPI) long-term~~ have hydrostatic ~~design stress and pressure basis (HDB)~~ ratings at 73 °F (23 °C), 140 °F (60 °C) and 180 °F (82 °C) ~~in accordance with Table 1 that are determined in accordance PPI TR-3. The ratings at 140°F are an optional standard.~~

[5.1.1.1 Ratings at 140 °F \(60 °C\) that are interpolated in accordance with PPI TR-3 shall be acceptable.](#)

[5.1.1.2 Polyethylene compound shall comply with Requirements For Polyethylene \(PE\) Materials To Qualify For A Higher Design Factor in PPI TR-3, and shall have a 73 °F \(23 °C\) hydrostatic design stress \(HDS\) rating of 800 psi \(5.52 MPa\).](#)

[5.1.1.3 Polyethylene compound shall comply with Specification D3350 cell classification requirements in accordance with Table 2.](#)



5.1.1.4 Polyethylene compound shall comply with Specification D3350 requirements for thermal stability, brittleness temperature and tensile elongation at break.

~~5.2.5.1.2 Barrier Layers—It is optional and acceptable for PE-RT tubing may to incorporate an optional interior wall, a gas barrier layer in the mid-wall or outer wall layer or a combination of such layers both, of non-PE-RT material for the express purpose of providing gas barrier properties to the pipe reducing to reduce gas transmission through the tubing wall. A barrier layer incorporating a material to bond between PE-RT material and gas barrier layer material shall be acceptable. The tubing shall meet the minimum wall thickness requirements of this standard without using the barrier layer thickness in the determinations. PE-RT tubing with a barrier layer within the wall of the tubing (neither exterior layer nor interior layer) shall demonstrate a hydrostatic design stress (HDS) rating equivalent to that of PE-RT tubing without a barrier layer. This determination shall be made in accordance with policies no less restrictive than those of the PPI HSB and meet the requirements of this standard.~~

5.1.2.1 The material used for an optional oxygen barrier layer shall be a material that provides oxygen barrier properties such as ethylene-vinyl alcohol copolymer (EVOH).

NOTE 1—Gas barrier layer material and bonding material if used, do not contribute to the internal pressure capacity of PE-RT tubing.

5.2 Rework Material—Clean ~~rework~~ PE-RT material of the same commercial designations, ~~generated from the manufacturer's own tubing production shall not be used unless the tubing produced meet all the requirements of this specification.~~ that complied with 5.1.1 through 5.1.1.4 when originally manufactured by the same manufacturer shall be acceptable as rework material when blended with new PE-RT compound that complies with 5.1.1 through 5.1.1.4. Rework material shall not contain barrier layer materials.

5.2.1 PE-RT tubing containing rework material and system components containing rework material shall meet the requirements of this specification.

5.3 Fittings—Fitting materials shall meet the applicable material requirements of at least one of the Specifications D2683, D3261, F1055, F1807, F2080, F2159, or F2735. Polyethylene material used in fusion fittings shall meet the requirements of 5.1.1 through 5.1.1.4.

~~5.4 Classification—Polyethylene materials suitable for use in the manufacture of tubing under this specification shall be classified in accordance with Specification D3350 and as shown in Table 1. The material shall have minimum HDS and pressure ratings as per Table 2. The ratings at 140°F are optional.~~

~~5.5 Tubing Material Designation—The tubing meeting the requirements of this specification shall be designated PE-RT.~~

## **Section 6, Requirements:**

6.1 Workmanship—The tubing and fittings shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, or other defects. The tubing shall be as uniform as commercially practicable in color, opacity, density, and other physical properties. The walls of fittings and manifolds shall be free of cracks, holes, blisters, voids, foreign inclusions, or other defects that are visible to the naked eye and may affect fitting integrity. All sealing surfaces shall be smooth and free of foreign material.

6.2 Dimensions and Tolerances:

6.2.1 Outside Diameters of Tubing—The outside diameters and tolerances shall be as shown in Table 3, when measured in accordance with 7.4 and 7.4.1. Optional barrier layer(s) shall not increase the outside diameter beyond the Table 3 maximum outside diameter.

6.2.2.1 Layers—Tubing made according to this specification incorporating barrier layers, including optional bonding material, shall meet the minimum total wall thickness and tolerances requirements as specified in Table 4. In addition, the layer(s) shall not result in the reduction of the total PE-RT material



wall(s) below that specified in Table 4. In the case of tubing with a middle layer, the total base PE-RT material wall thickness shall be the sum of the inner and outer base PE-RT material wall thicknesses exclusive of barrier and bonding/tie layers.

6.2.3 Dimensions of Fittings—The dimensions and tolerances of fittings shall meet the specific requirements contained in Specifications D2683, D3261, F1055, F1807, F2080, F2159, F2735, or other recognized specification.

6.3 Sustained Pressure—The tubing and system components, assembled using the system component manufacturer's instructions and tested as assemblies, shall not fail, balloon, burst, or weep as defined in Test Method D1598, at the test pressures given in Table 5 when tested in accordance with 7.5.

6.4 Burst Pressure—The tubing and system components, assembled using the system component manufacturer's instructions and tested as assemblies, shall meet ~~the~~ minimum burst pressures ~~for PE-RT plastic tubing shall be~~ as given in Table 6 without failure, when determined in accordance with 7.6.

## Section 7, Test Methods:

7.1 Conditioning—Condition the specimens at ~~73.4 ± 3.6~~ 4°F (23 ± 2°C) and 50 ± ~~5.10~~ 5 % 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 ± ~~1.82~~ 1°F (±1°C) and ± ~~25~~ 5 % relative humidity.

7.2 Test Conditions—Conduct the test in the standard laboratory atmosphere of ~~73.4 ± 3.6~~ 4°F (23 ± 2°C) and 50 ± ~~5.10~~ 5 % relative humidity, unless otherwise specified in the test methods or in this specification. In cases of disagreement, the tolerances shall be ± ~~1.82~~ 1°F (±1°C) and ± ~~25~~ 5 % relative humidity.

7.3 Sampling—A sufficient quantity of tubing or systems components, as agreed upon by the purchaser and the seller, shall be selected and tested to determine conformance with this specification. In the case of no prior agreement, random samples selected by the testing laboratory shall be deemed adequate.

7.3.1 Test Specimens—Unless otherwise specified in this standard or as agreed upon by the purchaser and the seller, the quantity and size of the specimens to be tested shall be as specified by the test method referred to in this standard. Manifolds with integral shut-offs (valves) shall be in the full-open or unrestricted position.

7.4.3 Barrier Layer and Bonding/Tie Layer(s)—Make measurements of the layer or layers using either a video microscope, a microscope with graduations or optical comparator to determine the maximum and minimum values. Precision of layer measurements shall be at minimum 0.0005 in. (0.013 mm). Maximum and minimum barrier layer thicknesses inclusive of bonding/tie layer(s) shall be determined by 2 or more equally spaced samplings around the pipe circumference. For the purposes of this standard the minimum PE-RT wall shall be calculated as follows:

7.4.3.1 Minimum PE-RT wall thickness = Minimum total wall thickness per 7.4.2 minus the average of the measured barrier and bonding/tie layer thicknesses per 7.4.3.

NOTE 5—It has been common practice to apply Merbromin (marketed as Mercurochrome trade name) or similar chemical die solution to the cut end of the pipe in order to add a color tint to the an otherwise clear EVOH layer.

7.5 Sustained Pressure Test—Select the test specimens at random. Test ~~six specimens~~ assemblies of at least six system component specimens and six tubing specimens, with at least six joints, ~~as~~ per Test Method D1598 in water at 73°F (23°C) and 180°F (82.2°C) as shown in Table 5. If the optional 140°F (60°C) rating is desired, perform an additional test at 140°F (60°C) in accordance with Table 5. Each specimen of tubing shall be at least five times the nominal diameter in length and not less than 12 in.



(~~2530~~ cm) or more than 3.0 ft (~~9190~~ cm) between end closures. Maintain the specimens at the pressures indicated for the appropriate temperatures for a period of 1000 h. Failure of two of the six specimens tested at ~~either any~~ temperature constitutes failure in the test. Failure of one of six specimens tested at any temperature is cause for retest of six additional specimens at that temperature. Failure of one of six specimens tested at ~~either any~~ temperature in retest constitutes failure in the test. Failure of the tubing shall be defined in accordance with Test Method D1598 and shall include leakage or separation at any of the joints. Delamination of the tubing shall constitute failure.

7.6 Burst Pressure—Determine the sample complies with the minimum burst pressure requirements by testing at least five specimens assemblies of system component specimens and five tubing specimens, with a minimum total of five joints, in accordance with Test Method D1599 Method B. The pressure values are given in Table 6. If the optional 140 °F rating is desired, perform a test at 140 °F (60 °C) in accordance with Table 5. Each specimen of tubing shall be at least five times the nominal diameter in length and not less than 12 in. (2530 cm) or more than 3.0 ft (90 cm) between joints. Failure shall be defined in accordance with Test Method D1599 and shall include leakage or separation at any of the joints.

7.8 Bent Tube Test—~~Determine~~ Conduct the sustained pressure test on one bent tube sample in accordance with Test Method D1598, except for the following: ~~Test at least six specimens, from randomly selected specimens assembled per the manufacturer's instructions with at least 5 pipe diameters between joints.~~ Test temperature shall be 180 °F (82 °C).

#### 7.9 Thermo-cycling:

7.9.1 Summary of Test Method—This test method describes a pass-fail test for thermally cycling PE-RT tubing and mechanical fittings over a critical temperature range for a selected number of cycles while subjected to a nominal internal pressure. This test method provides a measure of resistance to failure due to the combined effects of differential thermal expansion and creep for PE-RT tubing and fittings intended for continuous use up to and including 180 °F (82 °C).

7.9.2 Apparatus—A nitrogen or air source capable of maintaining an internal pressure of 100 ± 10 psig (0.69 ± 0.07 MPa) within the specimens is required. The immersion system shall consist of two water reservoirs controlled at 60 ± 4 °F (16 ± 2 °C) and 180 ± 4 °F (82 ± 2 °C). The specimen shall be cycled from one reservoir to the other or the hot and cold water shall be alternately cycled over the test specimens automatically and returned to the proper reservoirs.

NOTE 6—Automatic cycling may be accomplished by pumping from each reservoir, through a delivery system having timer-actuated valves, to a specimen water trough having synchronized, timer-actuated return drains. Any automatic apparatus shall provide for complete immersion of the test specimen in the trough.

7.9.3 Sampling and Specimen Preparation—Prepare assemblies with at least 6 joints from randomly selected tubing and system component specimens assembled per the system component manufacturer's instructions. Each specimen of tubing shall be at least five times the nominal diameter in length and not less than 12 in. (25 cm) or more than 3.0 ft (90 cm) between end closures. Close the specimen assembly with any suitable end closures that allow "free-end" mounting and will not leak under the thermo-cycling conditions, and connect the specimen assembly to the pressure source.

7.9.3.1 Manifolds with integral shut-offs (valves) shall be tested in the open or unrestricted position.

7.9.4 Procedure—Pressurize the specimen assembly with nitrogen or air to 100 ± 10 psig (0.69 ± 0.07 MPa). Immerse in 60 ± 4 °F (16 ± 2 °C) water to determine if there are any initial leaks. All leaks shall be



eliminated before the thermocycling test is started. Thermally cycle the specimen assembly either manually or automatically and under an internal pressure of  $100 \pm 10$  psig ( $0.69 \pm 0.07$  MPa), alternately between  $60 \pm 4$  °F ( $16 \pm 2$  °C) and  $180 \pm 4$  °F ( $82 \pm 2$  °C) by means of immersion in water using the following test cycle:

Water immersion at 180 °F (82 °C) 2 min (min) Air immersion at ambient 2 min (max) Water immersion at 60 °F (16 °C) 2 min (min) Air immersion at ambient 2 min (max) 7.9.4.1 Upon the completion of 1000 thermal cycles, immerse the specimen assembly again in  $60 \pm 4$  °F ( $16 \pm 2$  °C) water and check for any sign of gas leakage. Any evidence of leakage at the fitting or separation of the fitting from the tubing constitutes a failure.

#### Section 9, Marking:

9.1 Marking on the tubing shall include the following, spaced at intervals of not more than 5 ft:

9.1.1 Nominal tubing size (~~for example, 2 in.~~) such as "NTS 2".

9.1.2 The material designation, PE-RT.

~~9.1.3 The material designation code as determined per 3.2.5, for example, PE 2706.~~

~~9.1.4~~ 9.1.3 Standard dimension ratio, SDR 9.

~~9.1.6~~ 9.1.4 ASTM designation F2623.

9.1.5 ~~Pressure rating for water at 73°F (23°C), 140°F (60°C) (optional) and 180°F (82.2°C) established by this specification. Marking to indicate piping is not intended for potable water (such as NOT FOR POTABLE) unless certified for such use under another specification.~~

~~9.1.7~~ 9.1.6 Manufacturer's name (or trademark) and production code.

~~9.1.8~~ 9.1.7 Standard designation(s) of the fitting systems(s) for which the tubing is recommended for use by the tubing manufacturer.

9.1.8 A distinctive marking that identifies the presence of a middle or outer barrier layer.

9.1.9 Indent marking shall not be permitted.

9.2 Fittings—Markings on system components, or smallest available package, shall include the following:

9.2.1 This designation, F2623, and the standard to which the specified standard specification for the system component.