



Standard Specification for PE and PP Mechanical Fittings for use on NPS 3 or Smaller Cold-water Service Polyethylene (PE) or Crosslinked Polyethylene (PEX) Pipe or Tubing¹

This standard is issued under the fixed designation F3536; 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 describes requirements and test methods for the qualification of PE and PP plastic bodied mechanical fittings intended to join cold water service pipe and tubing of NPS 3 or less. This includes plastic mechanical fittings intended for use on pipe and tubing covered by the following standards: [D3035](#), [D2737](#), [D2239](#), [F876](#), [D2239](#), [F2769](#), AWWA C901, and AWWA C904. Also, included in this specification are requirements for materials and qualification testing.

1.2 Plastic mechanical fittings for hot and cold-water systems inside buildings as well as for district heating applications are not covered by this 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

[D638](#) Test Method for Tensile Properties of Plastics

¹ This test method is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.10 on Fittings. Current edition approved Feb. 1, 2022. Published February 2022. DOI: 10.1520/F3536-22

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.

[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

[D2239](#) Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter

[D2513](#) Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings

[D2737](#) Specification for Polyethylene (PE) Plastic Tubing

[D3035](#) Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter

[F412](#) Terminology Relating to Plastic Piping Systems

[F477](#) Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

[F714](#) Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

[F876](#) Specification for Crosslinked Polyethylene (PEX) Tubing

[F1498](#) Specification for Taper Pipe Threads 60° for Thermoplastic Pipe and Fittings

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

2.2 AWWA Standards:³

[AWWA Standard C901](#) Polyethylene (PE) Pressure Pipe and Tubing, 3/4 in. (19 mm) through 3 in. (76 mm), for Water Service

[AWWA Standard C904](#) Cross-linked Polyethylene (PEX) Pressure Tubing, 1/2 in. (13 mm) through 3 in. (76 mm) for Water Service

[AWWA C800](#) Underground Service Line and Fittings

2.3 Federal Standard:⁴A

[FED-STD 123G](#) Marking for Shipment (Civil Agencies)

[Military Standard 129P](#) Military Marking for Shipment and Storage

³ Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, <http://www.awwa.org>.

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

2.4 NSF Standards:⁵

NSF/ANSI Standard 14 for Plastic Piping Components and Related Materials

NSF/ANSI Standard 61 for Drinking Water System Components – Health Effects

2.5 PPI Documents:⁶

PPI TR-4 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.

2.6 ISO Standards:⁷

ISO 7686 Plastics pipes and fittings — Determination of opacity

ISO 3458 Plastics piping systems — Mechanical joints between fittings and pressure pipes — Test method for leak-tightness under internal pressure

ISO 17885 Mechanical fittings for pressure piping systems — Specifications

3. Terminology

3.1 Definitions of terms used in this specification are in accordance with Terminology F412 unless otherwise specified. Abbreviations are in accordance with Terminology D1600 unless otherwise specified

3.1.1 The term “pipe” used herein refers to both “pipe” and “tubing” unless specifically stated otherwise.

3.1.2 The term “fitting” refers to a mechanical connecting device as described in 3.2.1.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *mechanical fitting, n*—fitting for making a mechanical joint to provide for pressure integrity, leak tightness, and depending on category (as specified in Specification D2513 section 6.10) for resistance to tensile loads, as defined in this specification.

3.2.2 *pressure class, n*—numerical designation, which is a convenient rounded number for reference purposes, for plastic pipe systems conveying water, it corresponds to the maximum continuous operating pressure which can be sustained with water at 73 °F, based on the maximum design factor.

3.2.3 *NPS*—Nominal Pipe Size

4. Materials and Manufacture

4.1 The fitting bodies shall be manufactured from Polyethylene [PE] or Polypropylene [PP] material.

4.2 The material requirements in the case of PE fittings are described in Specification D2513, Section 4.

4.3 The material requirements in the case of PP fittings are described in ISO 17885, Section 8.2.

⁵ Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48105, <http://www.nsf.org>.

⁶ Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, <http://www.plasticpipe.org>.

⁷ Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <https://www.iso.org>.

4.3.1 Polypropylene compounds shall contain a minimum of 0.2 % carbon black or equivalent HALS (hindered amine light stabilizer).

4.4 The manufacturer shall determine the pressure class, the fitting category classification, material designation, installation and operating temperature limits, as applicable, of the mechanical fitting. To verify the pressure class, the manufacturer has to perform Performance Tests detailed in 6.2.

4.5 The fittings should be manufactured from virgin material and can allow a proportion of reworked material. Reworked material shall not be introduced at a ratio exceeding 10 %. Reworked plastic shall be clean rework material of the same commercial designation, generated from the manufacturer’s own fitting production, and shall not be used unless the fitting produced meets all the requirements of this specification. Recycled materials shall not be used.

4.6 Products intended for contact with potable water shall be evaluated, tested and certified for conformance with ANSI/NSF Standard No. 61 or the health effects portion of NSF Standard No. 14 by an accredited certifying organization.

4.7 The physical properties of each material used to produce the fitting shall be available from the fitting manufacturer upon request.

4.8 Elastomeric sealing elements in fittings shall be made from a material complying with the high-head application requirements of Specification F477.

4.9 Any lubricants or greases used in the production of fittings shall have no deleterious effect on the performance of the fitting or piping system it is installed into. If the fitting is intended for potable water service any use of lubricants or greases shall be in conformance with 4.6.

5. Physical Properties

5.1 Thread joints shall conform to F1498. The material used to form threads must be strong enough to avoid stripping when installed correctly and withstands all long and short term performance requirements for the fitting qualification

6. Qualification Requirements

6.1 *General*—The requirements defined herein are intended to verify the integrity of the fitting design and are not considered to be a production quality assurance requirement.

6.1.1 Each pipe type and, nominal size, of fitting shall be tested. It is not the intent of this specification to require testing of all fitting configurations, that is, tees, elbows, etc., but each mechanical joint design in each size. For OD controlled pipe, testing of assemblies containing the thickest wall pipe that the fitting is designed to be used with qualifies the use of that fitting with pipe of lesser wall thickness, unless otherwise specified. For ID controlled pipe every wall thickness shall be tested.

6.1.2 Mechanical fitting qualifications shall be performed on assembled joints using the fitting manufacturer’s joining procedure. All applicable mechanical fittings offered by the manufacturer shall be capable of meeting the requirements of this standard when connecting pipe and tubing covered in

standards outlined in 1.1. To verify the structural integrity of the fitting body, representative samples shall be subjected to the requirements of 6.2.

6.2 Performance Requirements:

6.2.1 *Sustained Pressure*—The fitting, joint or pipe or pipe shall not fail as defined in Test Method D1598, when tested in accordance with 7.2. at the stresses, and temperatures and minimum time as specified in Table 1.

6.2.2 *Hydrostatic Burst Pressure*—When tested in accordance with Test Method D1599, the pipe or tubing shall fail before the fitting in a hoop stress test at pressures indicated by the Specification D3035, Table 4.

6.2.3 Tensile Strength:

6.2.3.1 *For Category 1 fittings*—The fitting shall provide resistance to a force on the pipe equal to or greater than that which will cause no less than 25 % elongation of pipe, or pipe failure outside the joint area, when tested in accordance with 7.4.

6.2.3.2 *For Category 2 fittings*—no tensile test is required.

6.2.3.3 *For Category 3 fittings*—shall meet the manufacturer’s axial pipe pull out rating when tested according 7.4.

6.3 *Dimensional Requirements*—The mechanical fittings in accordance with this standard shall be manufactured with such dimensions and tolerances that permit their use with the applicable pipe and tubing per 1.1.

6.4 The fitting design shall enable the use of an internal pipe stiffener if that is required to pass the performance requirements.

7. Test Methods

7.1 The test methods in this specification cover mechanical fitting designs. Test methods that are applicable from other specifications will be referenced in the section pertaining to that particular test.

7.1.1 *Conditioning*—unless otherwise specified, condition the specimens (pipe and fittings) prior to joining at 73 °F ± 4 °F (23 °C ± 2 °C) for not less than 16 h.

7.1.2 *Test Conditions*—conduct the tests at the standard laboratory temperature 73 °F ± 4 °F (23 °C ± 2 °C) unless otherwise specified.

7.1.3 *Test Specimens*—Test joints shall be prepared with the appropriate size pipe, complying with the dimensional requirements of the applicable pipe specifications. Applicable pipe specifications include Specifications: D2737, D3035, F714, D1600, D2239 and F876. Fittings and pipe shall be joined in accordance with the fitting manufacturer’s installation procedures.

TABLE 1 Sustained Pressure Test Requirements

Test Temperature °F (°C) ^A	Hoop Stress ^B Psi (MPa) ^A	Minimum Time Before Failure (hours)
176 (80)	750 (5)	200
73 (23)	1600 (11)	1000

^A Test temperature tolerance (± 4 °F) ± 2 °C. Test pressure tolerance ± 2 %; test pressure hoop stress values are rounded to the nearest 5 psi or 1 MPa.

^B Calculate internal test pressure in accordance with Eq 1.

7.2 Sustained Pressure Test:

7.2.1 Test six specimens (assembled joints in accordance 7.1.3) in accordance with Test Method D1598 using the lowest DR pipe permitted per the applicable pipe specification.

7.2.2 The length of pipe used on either end of the assembled specimens shall be 12 in. or five times the nominal outside diameter of the pipe, whichever is greater. The test shall be conducted at both temperature/hoop stress/time combinations shown in Table 1. Calculate the test pressure using Eq 1 at the lowest DR (thickest wall) for intended use.

$$P = \frac{2S}{DR - 1} \quad (1)$$

where:

P = test pressure, psig,
 S = hoop stress from Table 1, psi,
 DR = dimension ratio (OD/wall)

7.2.3 Failure of any one of the six specimens tested constitutes failure of the test. Failure of the pipe shall be as defined in Test Method D1598.

7.3 Hydrostatic Burst Pressure Test,

7.3.1 Test four joints assembled in accordance with 6.1.2.

7.3.2 The pipe or tubing shall fail in a ductile manner when tested in accordance with Test Method D1599. Failure of the pipe away from the fitting or joint does not constitute a specimen failure.

7.3.3 The minimum hoop stress at pipe or tubing failure shall be 2 900 psi when calculated using Eq 2.

$$S = \frac{P(DR - 1)}{2} \quad (2)$$

where:

S = hoop stress, psi,
 P = burst pressure, psig,
 DR = dimension ratio (OD/wall)

7.3.4 Failure of the fitting or joint shall constitute specimen failure. Any type of leak or loss of integrity of the fitting or joint would constitute a failure.

7.3.5 Failure of any one of the four specimens shall constitute failure of the test.

7.4 Tensile Strength Test:

7.4.1 In-line couplings shall be tested with the apparatus specified in Test Method D638.

7.4.2 Test specimens shall be prepared so that the minimum length of unreinforced pipe is equal to five times the nominal outside diameter of the pipe being tested.

7.4.3 A specimen consists of two lengths of unreinforced pipe joined by one straight coupling (fitting to be tested) so that each specimen has two joints.

7.4.4 One fitting consists of two joints.

7.4.5 Test each nominal wall thickness for which the fitting is intended for use.

7.4.6 Test six specimens for each nominal wall thickness for which the fitting is intended to be used, at a speed of 0.2 in (5mm) / min ± 25 %.