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An American National Standard

Standard Specification for Polyamide 11 (PA 11) and Polyamide 12 (PA12) Mechanical Fittings for Use on Outside Diameter Controlled Polyamide 11 and Polyamide 12 Pipe and Tubing[1]

This standard is issued under the fixed designation F2145; 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 Polyamide 11 (PA 11) and Polyamide 12 (PA 12) bodied mechanical fittings for use with outside diameter controlled PA 11, nominal 2 pipe size (IPS), and smaller complying with Specification F2945, and PA 12, nominal 2 pipe size (IPS), and smaller complying with Specification F2785. In addition, it specifies general requirements of the material from which these fittings are made.

1.2 The test methods described in this specification are not intended to be used as routine quality tests.

1.3 This specification covers the types of mechanical fittings covered in 3.2.1.

1.4 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.

1.5 The following safety hazards caveat pertains only to the test methods portion, Section 7, 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.*

1.6 The text of this specification references notes and footnotes, which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of this specification.

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]

D638 Test Method for Tensile Properties of Plastics

D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

D1600 Terminology for Abbreviated Terms Relating to Plastics

D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products

F412 Terminology Relating to Plastic Piping Systems

F1588 Test Method for Constant Tensile Load Joint Test (CTLJT)

F2785 Specification for Polyamide 12 Gas Pressure Pipe, Tubing, and Fittings

F2945 Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings

2.2 *ASME Standard:*

ASME B31.8 Gas Transmission and Distribution Piping Systems[3]

2.3 *Federal Standard:*

CFR, Title 49, Part 192 Transportation of Natural and Other Gas By Pipeline: Minimum Federal Safety Standards[4]

2.4 *Plastic Pipe Institute Standard:*

PPI TR-4 PPI Listing of Hydrostatic Design Bases (HDB), Pressure Design Bases (PDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe[5]

3. Terminology

3.1 *Definitions:*

[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.

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.

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

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

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

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

3.1.2 The Gas Industry Terminology is in accordance with ASME B31.8 or CFR, Title 49, Part 192 unless otherwise specified.

3.1.3 The term "pipe" refers to both "pipe" and "tubing". The term "fitting" refers to a mechanical connecting device as described in 3.1.5 and 3.1.7.

3.1.4 *joint, n*—the location at which two pieces of pipe and a fitting are connected together. For example, an installed coupling has two joints.

3.1.5 *joint, mechanical, n*—a connection between piping components and employing physical force to develop a seal or produce alignment.

3.1.6 *long-term-strength (LTS), n*—the estimated tensile stress that when applied continuously will cause failure at 100 000 h. This is the intercept of the stress regression line with the 100 000 h coordinate.

3.1.7 *mechanical fitting, n*—fitting for making a mechanical joint to provide for pressure integrity, leak tightness, and resistance to end loads.

3.1.7.1 *category 1 mechanical fitting, n*— fitting for assembling pipes, which includes a compression zone to provide for pressure integrity, leak tightness, and resistance to end loads sufficient to cause no less than 25 % elongation of the PA 11 or PA 12 piping as described in this specification.

3.1.8 *MAOP, n*—The Maximum Allowable Operating Pressure of the fuel gas piping system in psig as determined in accordance with CFR, Title 49, Part 192 and as represented in the following:

$$MAOP = P = 2 \times S/(DR - 1) \times f_D \quad (1)$$

where:

S = the PA 11 or PA 12 material's HDB as published in PPI TR-4,

DR = the pipe's dimension ratio determined by dividing the pipe's specified nominal outside diameter by the pipe's specified wall thickness; and,

f_D = the design factor for thermoplastic fuel gas piping as set by the authority having jurisdiction. In the United States, the design factor is cited in CFR, Title 49, Part 192.121.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *Types of Mechanical Fittings:*

3.2.2 *in-line fitting, n*—mechanical fitting used to make a mechanical joint where the bore axis of compression and sealing zones of the fitting is essentially the same as the connected pipe, for example, couplings, ells, and tees.

3.2.3 *mechanical saddle fitting, n*—mechanical fitting used to make a mechanical joint that allows a lateral connection to an exiting main in which a portion of the fitting is contoured to match the O.D. of the pipe to which it is attached. Herein referred to as the *saddle fitting mating pipe* or *main pipe size*.

4. Materials and Manufacture Requirements

4.1 Polyamide 11 (PA 11) and Polyamide 12 (PA12) pressure containing materials subject to continuous stress, either hoop or axial, shall meet the requirements of Specification F2945 for Polyamide 11 and Specification F2785 for PA12, have an ASTM material specification, and the materials long-term strength, such as the long-term hydrostatic strength, determined in accordance with Test Method D2837, excepting that failure data can be obtained from specimens such as the following: tensile bars, plane strain, or actual fitting samples.

4.2 The physical properties of the PA 11 and PA 12 material used to produce the fitting shall be available from the fitting manufacturer upon request.

4.3 Specifications outlining all the physical properties and effects of environmental conditions for the PA 11 and PA 12 material used to produce the fitting shall be available from the fitting manufacturer upon request.

NOTE 1—Materials in long term contact with natural gas of line quality and LP gas vapor should be demonstrated not to adversely affect the performance of the fitting.

NOTE 2—Materials should have demonstrated resistance to environmental stress cracking when exposed, under stress to chemical compounds encountered in, or external gas piping systems, and a demonstrated resistance to bacteriological decomposition. Such compounds include ice thawing chemicals, fertilizers, insecticides, herbicides, leak detection fluids, acids, bases, and, antifreeze solutions used to thaw frozen lines. The effects of liquid environments such as antifreeze agents, odorants, and hydrocarbons are known to be deleterious to some plastics, particularly under service conditions.

5. Dimensions

5.1 The dimensions and tolerance shall be determined by the manufacturer.

6. Qualification Requirements

6.1 *General*—Unless otherwise specified, each nominal size of fitting shall be tested. Testing of the thickest wall pipe that the fitting is designed to be used with qualifies it with use of lesser wall thickness.

6.1.1 Mechanical joint qualifications shall be performed on assembled joints using the fitting manufacturers joining procedure. All mechanical fitting offered by the manufacturer shall be capable of meeting the requirements of this standard when connecting Polyamide 11 complying with Specification F2945 or Polyamide 12 gas piping complying with Specification F2785. To verify the structural integrity of the fitting body, representative samples shall be subjected to the requirements of 6.2.1. It is not the intent of the specification to require testing of all fitting configurations, that is, tees, ells, etc., but each mechanical joint design in each size.

6.1.2 All mechanical fitting described in 3.2.1 shall have an internal pipe reinforcing tubular insert stiffener that extends at least under the seal and gripping device, where used. The saddle portion of saddle-type fittings do not require an internal tubular stiffener due to the nature of the connection.

6.2 *Performance Requirements:*

6.2.1 *Elevated Temperature Sustained Pressure*—The fitting joint or pipe in the area affected by the fitting shall not fail as defined in Test Method D1598, when tested in accordance with

7.2. The fitting or joint meets this requirement when tested in accordance with any one of the two conditions (A or B) listed in 7.2.

6.2.2 *Tensile Strength*—The pipe joint shall accommodate the tensile loading when tested in accordance with 7.3.

6.2.2.1 *In-Line Fitting, Category 1*—The joint 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 the pipe fails outside the joint area when tested in accordance with 7.3.

6.2.2.2 *Mechanical Saddle Fittings*—The joint between the saddle and mating pipe shall not fail by rotation or leakage when tested in accordance with 7.6.

6.2.2.3 Joint restrain capabilities less than as defined above shall constitute failure of the test.

6.2.3 *Temperature Cycling Test*—The mechanical joint shall provide a pressure seal after 10 cycles of the temperature cycling test when tested in accordance with 7.4.

6.2.4 *Constant Tensile Load Joint Test*— The joint shall not fail leakage or pullout when loaded to an axial tensile stress of 1320 psi (9.1 Mpa) and tested in accordance with 7.5.

7. Test Methods

7.1 *General*—The test methods of the specification covers the mechanical joint designs. Test methods that are applicable from other specifications will be referenced in the section pertaining to that particular test.

7.1.1 *Conditioning*—Condition the specimen prior to joining at 73.4 °F ± 3.6 °F for not less than 16 h.

7.1.2 *Test Conditions*—Conduct the tests at the standard lab temperature of 73.4 °F ± 3.6 °F.

7.1.3 *Test Specimens:*

7.1.3.1 Tests joints shall be prepared with the appropriate size PA 11 pipe, complying with the dimensional requirements of Specification F2945, in accordance with the manufacturer's joining procedure.

7.1.3.2 Test joints shall be prepared with the appropriate size PA 12 pipe, complying with the dimensional requirements of Specification F2785, in accordance with the manufacturer's joining procedure.

7.2 *Elevated Temperature Sustained Pressure Test:*

7.2.1 The apparatus and report shall be specified in Test Method D1598. Test six joints assembled in accordance with 6.1.1.

7.2.2 The assembled joints shall be tested in accordance with Test Method D1598 with the exception that it is not required that 12 in. or five times the nominal outside diameter of the pipe used in conducting the test be placed on each side of the fitting being tested. The test shall be conducted at one of the time/temperature/hoop stress combinations shown in Table 1 with the test pressure calculated using Eq 2. If ductile failure occurs in the pipe at 176 °F (80 °C) /1600 psi (9.4 MPa) hoop stress, retest at 176 °F (80 °C)/1250 psi (12.6 MPa) hoop stress.

$$P = 2S/(DR - 1) \quad (2)$$

TABLE 1 Elevated Temperature Sustained Pressure Test Conditions

Condition	Minimum Time	Temperature	Pipe Hoop Stress, S
A	1000 h	176 °F ± 3.6 °F (80 °C ± 2 °C)	1250 psi (8.62 MPa)
B	170 h	176 °F ± 3.6 °F (80 °C ± 2 °C)	1600 psi (11.03 MPa)

where:

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

7.2.3 Failure of two of the six specimens tested shall constitute failure in the test. Failure of one of the six specimens tested is cause for retest of six additional specimens. Failure of one of the six specimens in retest shall constitute failure of the test. Evidence of failure of the pipe shall be defined in Test Method D1598.

7.3 *Tensile Strength Test:*

7.3.1 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. It is permissible to test multiple joints together provided that minimum length of unreinforced pipe exists on at least one joint.

7.3.2 In-line fittings shall be tested with the apparatus as specified in Test Method D638 and reported as specified in Test Method D638. Test six joints.

7.3.3 The test shall be conducted at 73.4 °F ± 3.6 °F.

7.3.4 The speed of the testing shall be .2 in./min ± 25 %.

7.3.5 Failure of two of the six specimens tested shall constitute failure of the test. Failure of one of the six specimens is cause of retest of six additional specimens. Failure of one of the six specimens in retest shall constitute failure of the test.

7.4 *Thermal Cycling Test:*

7.4.1 Test shall be conducted on six of the smallest and six of the largest nominal pipe sizes of each mechanical joint design and assembled in accordance with 6.1.1.

7.4.2 Leak test specimens at ambient at 7 psig ± 3 psig and a minimum of 1.5 × MAOP.

7.4.3 Cool specimens to a temperature of -20 °F ± 3.6 °F and maintain for a minimum of 2.5 h.

7.4.4 Condition specimens to a temp of 140 °F ± 3.6 °F and maintain for a minimum of 2.5 h.

7.4.5 Repeat 7.4.3 and 7.4.4 for a total of 10 cycles.

7.4.6 Pressurize 50 % of the specimens of each size at 7 psig ± 3 psig and the remaining 50 % of each size at 1.5 × MAOP of the piping material and SDR that the fittings are designed to be used with. Leak test first at 140 °F ± 3.6 °F and then at -20 °F ± 3.6 °F.

NOTE 3—If immersion is used for leak testing, and the design of the joint is such that air can be trapped within the joint assembly, allow adequate time for all air trapped within the joint to escape prior to observing for leaks.

7.5 *Constant Tensile Load Joint Tests (In-Line Joints Only):*