



Standard Specification for Polyamide 12 Gas Pressure Pipe, Tubing, and Fittings¹

This standard is issued under the fixed designation F2785; 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 covers requirements and test methods for the characterization of polyamide 12 pipe, tubing, and fittings for use in fuel gas mains and services for direct burial and reliner applications. The pipe and fittings covered by this specification are intended for use in the distribution of natural gas.

1.1.1 Pipe and fittings covered by this specification shall not be joined using taper pipe threads. Joining methods qualified in accordance with the requirements of Title 49 CFR Part 192.283 are acceptable. Generic fusion guidelines are given in **Appendix X1**. Design considerations are discussed in **Appendix X2**. In-plant quality control programs are specified in **Annex A1**.

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

NOTE 1—Pipe and fittings utilizing heat fusion joining techniques produced from compounds meeting the requirements of Group 3, Class 2, and Grade 3 (PA323 or PA11) are intended for use with pipe manufactured from compounds meeting the requirements of Group 3, class 2 and Grade 3. Pipe and fittings utilizing heat fusion joining techniques produced from compounds meeting the requirements of Group 4, Class 2 and Grade 3 (PA 423 or PA12) are intended for use with pipe manufactured from compounds meeting the requirements of Group 4, Class 2 and Grade 3. As per the recommendations of the respective resin manufacturers, no cross fusion between PA 323 (PA11) and PA 423 (PA12) compounds is permitted.

1.5 *This international standard was developed in accordance with internationally recognized principles on standard-*

¹ This test method is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.60 on Gas.

Current edition approved April 15, 2018. Published June 2018. Originally approved in 2009 as F2785–09. Last previous edition approved in 2012 as F2785–12. DOI: 10.1520/F2785-18.

ization 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

- D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents
- D618 Practice for Conditioning Plastics for Testing
- D648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
- D638 Test Method for Tensile Properties of Plastics
- D789 Test Methods for Determination of Solution Viscosities of Polyamide (PA)
- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- 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
- D1898 Practice for Sampling of Plastics (Withdrawn 1998)³
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- D2774 Practice for Underground Installation of Thermoplastic Pressure Piping
- D2290 Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe
- D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
- D6779 Classification System for and Basis of Specification for Polyamide Molding and Extrusion Materials (PA)
- F412 Terminology Relating to Plastic Piping Systems

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

- F1025** Guide for Selection and Use of Full-Encirclement-Type Band Clamps for Reinforcement or Repair of Punctures or Holes in Polyethylene Gas Pressure Pipe
- F1473** Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins
- F1733** Specification for Butt Heat Fusion Polyamide(PA) Plastic Fitting for Polyamide(PA) Plastic Pipe and Tubing
- F1973** Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems
- F2138** Specification for Excess Flow Valves for Natural Gas Service
- F2145** 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
- F2767** Specification for Electrofusion Type Polyamide-12 Fittings for Outside Diameter Controlled Polyamide-12 Pipe and Tubing for Gas Distribution
- F2897** Specification for Tracking and Traceability Encoding System of Natural Gas Distribution Components (Pipe, Tubing, Fittings, Valves, and Appurtenances)
- 2.2 *ANSI Standards:*⁴
- B 16.40** Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems
- B 31.8** Gas Transmission and Distribution Piping Systems
- 2.3 *Federal Standards:*⁵
- Fed. Std. No. 123** Marking for Shipment (Civil Agencies) **OPS Part 192 Title 49**, Title 49 Code of Federal Regulations **49 CFR Part 192.283** Plastic pipe: Qualifying joining procedures.
- 2.4 *Military Standards:*⁶
- MIL-STD-129** Marking for Shipment and Storage
- MIL-STD-1235** (ORD) Single- and Multi-Level Continuous Sampling Procedures and Tables for Inspection by Attributes
- 2.5 *ISO Standards:*⁶
- 307** Plastics -- Polyamides -- Determination of viscosity number
- 3146** Plastics -- Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers by capillary tube and polarizing-microscope methods
- 1183** Plastics -- Methods for determining the density of non-cellular plastics -- Part 1: Immersion method, liquid pycnometer method and titration method
- 527–1** Plastics -- Determination of tensile properties -- Part 1: General principles

- 527–2** Plastics -- Determination of tensile properties -- Part 2: Test conditions for moulding and extrusion plastics
- 178** Plastics -- Determination of flexural properties
- 179** Plastics -- Determination of Charpy impact properties -- Part 1: Non-instrumented impact test
- 75–1** Plastics -- Determination of temperature of deflection under load -- Part 1: General test method
- 75–2** Plastics -- Determination of temperature of deflection under load -- Part 2: Plastics and ebonite
- ISO 22621 Part 1** Plastics piping systems for the supply of gaseous fuels for maximum operating pressure up to and including 2 MPa (20 bar) – Polyamide (PA) : General
- 2.6 *Plastic Pipe Institute:*⁷
- PPI TR3** 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
- PPI TR4** Hydrostatic Design Bases and Maximum Recommended Hydrostatic Design Stresses for Thermoplastic Piping Materials
- PPI TN7** Nature of Hydrostatic Stress Rupture Curves
- 2.7 *Other Standards:*⁸
- National Fire Protection Association: NFPA 58**, Storage and Handling Liquefied Petroleum Gases

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 The gas industry terminology used in this specification is in accordance with ANSI B31.8 or CFR OPS Part 192 Title 49, unless otherwise indicated.
- 3.3 The term *pipe* used herein refers to both pipe and tubing unless specifically stated otherwise.
- 3.4 *Definitions of Terms Specific to This Standard:*
- 3.4.1 *re-rounding equipment, n*—equipment used to reform the pipe and permanently reduce ovality to 5% or less.
- 3.4.2 *rounding equipment, n*—equipment, devices, clamps, and so forth, used to temporarily hold the pipe round while out-of-roundness measurements are made, or a joining procedure (heat fusion, electrofusion, or mechanical) is performed.
- 3.4.3 *standard thermoplastic material designated code, n*—the pipe material designation code shall consist of the abbreviation for the polyamide (PA) followed by Arabic numerals which describe the short term properties in accordance with Classification **D6779**, the hydrostatic design stress for water at 73.4°F (23°C) in units of 100 psi with any decimal figures dropped. Where the hydrostatic design stress code contains less than two figures, a zero is used before the number. Thus, a complete material designation code shall consist of two letters and five figures for polyamide pipe materials. For

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁵ Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.

⁶ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, <http://www.iso.ch>.

⁷ Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, <http://www.plasticpipe.org>.

⁸ Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

example, PA 42316 is a grade of polyamide 12 with a 1600 psi design stress for water at 73.4°F (23°C). The hydrostatic design stresses for gas are not used in this designation code.

3.4.4 *thermoplastic pipe dimension ratio (DR), n*—the ratio of pipe diameter to wall thickness. It is calculated by dividing the specified outside diameter of the pipe, in inches, by the minimum specified wall thickness, in inches. The standard dimension ratio (SDR) is a common numbering system which is derived from the ANSI preferred number series R 10.

3.4.5 *toe-in, n*—a small reduction of the outside diameter at the cut end of a length of thermoplastic pipe.

4. Requirements for Materials

4.1 *General*—The polyamide material used to make pipe and fittings shall be virgin or reworked material (see 4.5) and shall have a Plastics Pipe Institute (PPI) long-term hydrostatic design stress and hydrostatic design basis rating as determined per PPI TR3 and PPI TR4.

4.2 *Classification*—Polyamide materials suitable for use in the manufacturing of pipe and fittings under this specification shall be classified in accordance with Classification D6779, as shown in Table 1.

4.3 *Short- and Long-Term Properties*—Polyamide pipe and fittings shall be made from a PA material which also satisfies the combinations of short- and long-term property requirements shown in Table 2.

4.4 *Resistance to Rapid Crack Propagation (RCP) for Materials*—The material classification (formulation) used in the manufacture of pipe and fittings under this specification shall be tested for resistance to failure by RCP in accordance with 6.7. The data obtained shall be made available upon request without limitations on disclosure, and shall not subsequently be subject to disclosure limitations when used by others. The values obtained are applicable to all pipes with the wall thickness of the pipe tested and all thinner wall pipes.

4.5 *Rework Material*—Clean rework material of the same commercial designation, generated from the manufacturer’s

TABLE 2 Short and Long Term Property Requirements

| PA Material Designation Code | Short-Term in Accordance with D6779 | Long-Term in Accordance with D2837 |
|------------------------------|-------------------------------------|------------------------------------|
| PA42316 | PA423 | HDB of 3150 psi for 73°F (23°C) |

own pipe and fitting production shall not be used unless the pipe and fittings produced meet all the requirements of this specification.

4.6 *Documentation*—A documentation system to allow for traceability of raw materials including percentage and material classification (or designation, if applicable) of rework materials used in the manufacture of the pipe product meeting the requirements of this specification shall exist and be supplied to the purchaser, if requested.

5. Requirements for Pipe and Fittings

5.1 *General*—Pipe shall be supplied in either coils or straight lengths. Any pipe supplied in coils must meet the same requirements before and after coiling.

5.2 *Workmanship*—The pipe and fittings shall be homogeneous throughout and free of visible cracks, holes, foreign inclusion, blisters, and dents, or other injurious defects. The pipe and fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.

5.3 *Pipe and Tubing Dimensions and Tolerances:*

5.3.1 *Dimension*—The dimensions shall be specified by wall thickness and outside diameter.

5.3.1.1 *Diameters*—The outside diameter shall meet the requirements given in Table 3 or Table 4 when measured in accordance with 6.5.

5.3.1.2 *Toe-In*—When measured in accordance with 6.5.1.1, the outside diameter at the cut end of the pipe shall not be more than 1.5 % smaller than the undistorted outside diameter. Measurement of the undistorted outside diameter shall be made no closer than 1.5 pipe diameters or 11.8 in. (300 mm),

TABLE 1 Classification D6779

| Classification | ASTM Test Method | ISO Test Method | Designation |
|---|------------------|----------------------------|---------------------------------------|
| PA 4 (group) 2 (class) 3 (grade) | | | Polyamide PA 12 Heat stabilized |
| Viscosity number, min. | D789 | ISO 307 | 211 |
| Specific gravity | D792 | ISO 1183 | 1.00–1.06 |
| Tensile strength, min, psi (MPa) | D638 | ISO 527–1 and ISO 527–2 | 5000 (35) |
| Tensile Modulus, min, psi (MPa) | | ISO 527–1 and ISO 527–2 | 145000 (1000) |
| Charpy impact resistance, min | | ISO 179 | 25 |
| Deflection temperature, at 264 psi (1.82 MPa), min °F (°C) | D648 | ISO 75–1 and ISO 75–2 | 95 (35) |

TABLE 3 Outside Diameters and Tolerances for PA12 Pipe, in. (mm)

| Nominal Pipe Size | Outside Diameter | Tolerance | Maximum out-of-roundness |
|-------------------|------------------|-----------------|--------------------------|
| 1/2 | 0.840 (21.3) | ±0.004 (±0.102) | 0.016 (0.41) |
| 3/4 | 1.050 (26.7) | ±0.004 (±0.102) | 0.02 (0.51) |
| 1 | 1.315 (33.4) | ±0.005 (±0.127) | 0.02 (0.51) |
| 1 1/4 | 1.660 (42.1) | ±0.005 (±0.127) | 0.024 (0.61) |
| 1 1/2 | 1.900 (48.3) | ±0.006 (±0.152) | 0.024 (0.61) |
| 2 | 2.375 (60.3) | ±0.006 (±0.152) | 0.024 (0.61) |
| 3 | 3.500 (88.9) | ±0.008 (±0.203) | 0.03 (0.76) |
| 4 | 4.500 (114.3) | ±0.009 (±0.229) | 0.03 (0.76) |
| 5 | 5.563 (141.3) | ±0.010 (±0.254) | 0.06 (1.52) |
| 6 | 6.625 (168.3) | ±0.011 (±0.279) | 0.07 (1.78) |

TABLE 4 Tubing Diameters, Wall Thicknesses, and Tolerances, in. (mm)

| Nominal Tubing Size (CTS) | Outside Diameter | Tolerance | Maximum Wall Thickness | Wall Thickness Tolerance |
|---------------------------|------------------|----------------|------------------------|--------------------------|
| 1/2 | 0.625 (15.9) | ±0.004 (±0.10) | 0.090 (2.27) | +0.009 (+0.23) |
| 1/2 | 0.625 (15.9) | ±0.004 (±0.10) | 0.104 (2.64) | +0.010 (+0.25) |
| 3/4 | 0.875 (22.2) | ±0.004 (±0.10) | 0.090 (2.27) | +0.009 (+0.23) |
| 1 | 1.125 (28.6) | ±0.005 (±0.13) | 0.090 (2.27) | +0.012 (+0.31) |
| 1 | 1.125 (28.6) | ±0.005 (±0.13) | 0.099 (2.51) | +0.011 (+0.28) |
| 1 | 1.125 (28.6) | ±0.005 (±0.13) | 0.101 (2.56) | +0.012 (+0.31) |
| 1 | 1.125 (28.6) | ±0.005 (±0.13) | 0.121 (3.07) | +0.015 (+0.38) |
| 1 1/4 | 1.375 (34.9) | ±0.005 (±0.13) | 0.090 (2.27) | +0.011 (+0.28) |
| 1 1/4 | 1.375 (34.9) | ±0.005 (±0.13) | 0.121 (3.07) | +0.015 (+0.38) |

whichever distance is less, from the cut end of the pipe. Undistorted outside diameter shall meet the requirements of Table 3 or Table 4.

5.3.1.3 *Wall Thickness*—The wall thickness shall be as specified in Table 4 or Table 5 when measured in accordance with 6.5.1.2. The minimum wall thickness at any point of measurement shall be not less than the minimum wall thickness specified in Table 4 or Table 5.

5.3.1.4 *Wall Thickness Eccentricity Range*—The wall thickness eccentricity range shall be within 12 % when measured in accordance with 6.5.1.3.

5.3.1.5 *Ovality*—The ovality (cross section) of 3 in. IPS (88.9 mm) and smaller pipe shall not exceed 5 % when measured in accordance with 6.5.3. Measurements of coiled pipe shall be made on a sample cut from the coil, and in case of disagreement, conditioned per 6.3.

TABLE 5 Wall Thickness and Tolerances for PA12 Pipe, in. (mm)^{A,B}

| Nominal Pipe Size (IPS) | DR ^C | Minimum | Tolerance |
|-------------------------|-----------------|---------------|----------------|
| 1/2 | 9.33 | 0.090 (2.29) | +0.011 (+0.28) |
| 3/4 | D | 0.090 (2.29) | +0.011 (+0.28) |
| 1 | 11.0 | 0.095 (2.41) | +0.011 (+0.28) |
| 1 1/4 | D | 0.090 (2.29) | +0.011 (+0.28) |
| 1 1/2 | 11 | 0.120 (3.05) | +0.014 (+0.36) |
| | D | 0.090 (2.29) | +0.011 (+0.28) |
| 2 | 11 | 0.151 (3.84) | +0.018 (+0.46) |
| | D | 0.090 (2.29) | +0.011 (+0.28) |
| 3 | 11 | 0.173 (4.39) | +0.021 (+0.53) |
| | 11 | 0.216 (5.49) | +0.026 (+0.66) |
| | 9.33 | 0.255 (6.48) | +0.031 (+0.79) |
| 4 | 13.5 | 0.259 (6.58) | +0.031 (+0.79) |
| | 11.5 | 0.304 (7.72) | +0.036 (+0.91) |
| | 11 | 0.318 (8.08) | +0.038 (+0.96) |
| | 9.33 | 0.375 (9.53) | +0.045 (+1.14) |
| 6 | 17 | 0.265 (6.73) | +0.032 (+0.81) |
| | 13.5 | 0.333 (8.46) | +0.040 (+1.02) |
| | 11.5 | 0.391 (9.93) | +0.047 (+1.19) |
| | 11.0 | 0.409 (10.39) | +0.049 (+1.25) |
| | 9.33 | 0.482 (12.24) | +0.058 (+1.47) |
| | 17 | 0.390 (9.91) | +0.047 (+1.19) |
| | 13.5 | 0.491 (12.47) | +0.059 (+1.50) |
| | 11.5 | 0.576 (14.63) | +0.069 (+1.75) |
| | 11.0 | 0.602 (15.29) | +0.072 (+1.83) |

^AThe sizes listed in Table 5 are those commercially available sizes used by the gas industry.

^BThe minimum is the lowest wall thickness of the pipe at any cross section. The maximum permitted wall thickness, at any cross section, is the minimum wall thickness plus the stated tolerance. All tolerances are on the plus side of the minimum requirement.

^CThe DR shown are designations commonly accepted by the gas industry and do not calculate exactly.

^DThe wall thicknesses are minimum and are not a function of the dimension ratios.

NOTE 2—Other factors, that is, installation compaction, static soil loading, and dynamic vehicular loads may increase the ovality; therefore, 5 % was chosen as the limit for the amount contributed by manufacturing, packing, in-plant storage, and shipping.

(1) Before or during installation, coiled pipe larger than 3 in. IPS (88.9 mm) shall be processed by the installer through re-rounding equipment that corrects ovality to 5% or less.

NOTE 3—Ovality is a packaging condition that occurs when roundable pipe is wound into a coil—the pipe flattens out as it is coiled. Ovality is corrected when joining equipment is applied to roundable pipe, or by field processing roundable pipe through re-rounding and straightening equipment during installation.

5.3.1.6 *Length*—The pipe shall be supplied in straight lengths or coils as agreed upon between the manufacturer and the purchaser. The length shall not be less than the minimum length agreed upon when corrected to 73°F (23°C).

5.3.1.7 When sizes other than those listed in Table 3, Table 4 or Table 5 are used, tolerances shall be: for outside diameter, use same tolerance of next smaller size; for wall thickness, use same tolerance percentage as shown in the tables.

5.4 *Slow Crack Growth Resistance*—PA 12 materials shall meet a slow crack growth resistance requirement of 500 hours when tested in accordance with 6.6.

5.5 *Resistance to Rapid Crack Propagation (RCP)*—Additional testing for resistance to RCP is required when the wall thickness of the pipe being produced in accordance with this standard exceeds that of the pipe used to establish the resistance to RCP. In these circumstances, additional testing for resistance to failure by RCP in accordance with 6.7 shall be conducted. The data obtained shall be made available upon request without limitations on disclosure, and shall not subsequently be subject to disclosure limitations when used by others.

NOTE 4—The requirements and testing for resistance to RCP do not provide information for all possible conditions of use. The user should consult with the manufacturer and other appropriate sources such as resin suppliers, research, academia, etc., to determine that the RCP resistance provided by the pipe producer is sufficient for the intended use.

5.6 *Minimum Hydrostatic Burst Pressure/Apparent Tensile Strength (Quick Burst)*—The pipe or system shall fail in a ductile manner when tested in accordance with Test Method D1599 at a hoop stress greater than 3900 psi (27 MPa). For pipe sizes above 4-in. nominal diameter, the testing laboratory shall be allowed to replace the quick burst test (Test Method D1599) by the apparent ring tensile strength test (Test Method D2290). The minimum apparent tensile strength at yield when determined in accordance with 6.10 shall be 3900 psi (27 MPa).

5.7 *Sustained Pressure at 73°F (23°C)*—The pipe or system shall not fail in less than 1000 h when tested in accordance with Test Method D1598. The hoop stress shall be 2800 psi (19 MPa).

5.8 *Outdoor Storage Stability*—PA 12 pipe stored outdoors and unprotected for at least two years from date of manufacture shall meet all the requirements of this specification. PA 12 pipe stored outdoors for over two years from date of manufacture is suitable for use if it meets the requirements of this specification.

5.9 *Chemical Resistance*—The weight, yield strength, and relative viscosity requirements for PA 12 pipe when measured in accordance with 6.11 are in Table 6.

5.10 *Elevated Temperature Service*—Polyamide 12 piping materials intended for use at temperatures above 100°F (38°C) shall have the PPI hydrostatic design basis (HDB) determined at the specific temperature in accordance with Test Method D2837. The 100 000-h intercept (long-term strength) shall be categorized in accordance with Table 7 and be listed as the “hydrostatic design basis of XXX psi at XXX °F (C°) for (compound name).”

NOTE 5—Many design factors for elevated temperature service cannot be covered in this specification. Users should consult applicable codes for limitations on pertinent maximum temperatures.

NOTE 6—In the absence of an HDB established at the specified temperature, the HDB of a higher temperature may be used in determining a design pressure rating at the specified temperature by arithmetic interpolation.

5.11 *Joints:*

5.11.1 *Butt Fusion:*

5.11.1.1 Butt fusion joints of polyamide 12 pipe and fittings should be made in accordance with the manufacturer’s recommendations and the user’s written procedure.

5.11.1.2 PA 12 butt fusion joining shall be between components (pipes, fittings, or valves) having the same SDR or DR. Butt fusion between unlike SDR or DR components shall be allowed only if it has been demonstrated that long term performance is not adversely affected. The minimum requirement to demonstrate long term performance shall be the requirements of 5.6 of this specification. The Hydrostatic Design Basis (HDB) of the PA 12 material shall be confirmed using specimens containing butt fusion joints resulting from different SDRs or DRs. Pipe/pipe joints of the material that pass shall validate pipe/pipe, pipe/fitting, or fitting/fitting joints of the same SDR ratio for the material.

5.12 *Fittings*—Fittings shall meet the requirements of the applicable ASTM standards.

TABLE 6 Chemical Resistance

| Chemical | Weight Change, Max% | Yield Strength Change, max% | Relative Viscosity, % |
|--------------------------------|---------------------|-----------------------------|-----------------------|
| Mineral Oil | +0.5 | -12 | ±3 |
| Tertiary-butyl mercaptan (5 %) | +0.5 | -12 | ±3 |
| Methanol | +5 | -35 | ±3 |
| Ethylene glycol | +0.5 | -12 | ±3 |
| Toulene (15%) | +7 | -40 | ±3 |

TABLE 7 Pipe Category

| Property | Test Method | Category | | | | | | | |
|-------------------------------------|-------------|-----------|-----------|-----------|-----------|------------|------------|-------------|-------------|
| | | A | B | C | D | E | F | G | H |
| Temperature °F (°C) | ... | 100 (38) | 120 (49) | 140 (60) | 160 (71) | 180 (82) | ... | ... | ... |
| Hydrostatic Design Basis, psi (MPa) | D2837 | 400 (2.8) | 500 (3.4) | 630 (4.3) | 800 (5.5) | 1000 (6.9) | 1250 (8.6) | 1600 (11.0) | 2000 (13.8) |

Examples: EH – At 140°F the HDB is 2000 psi (13.8 MPa)

5.12.1 *Butt Heat Fusion Fittings*—Butt heat fusion fittings intended for use with PA12 piping systems shall conform to the requirements of Specification F1733.

5.12.2 *Electrofusion Fittings*—Electrofusion fittings intended for use with PA12 piping systems shall conform to the requirements contained within Specification F2767.

5.12.3 *Mechanical Fittings*—Mechanical fittings intended for use with PA12 piping systems shall conform to the requirements contained within Specification F2145.

5.12.4 *Transition Fittings and Anodeless Risers*—Transition fittings and anodeless risers intended for use with PA12 pipings systems shall conform to the requirements contained within Specification F1973.

5.13 *Valves*—Gas valves shall meet the requirements of ANSI Standard B 16.40.

5.14 *Excess Flow Valves*—Excess flow valves shall meet the requirements of Specification F2138.

6. Test Methods

6.1 *General*—The test methods in this specification cover plastic pipe and fittings to be used for gas distribution. Test methods that are applicable from other specifications will be referenced in the paragraph pertaining to that particular test.

6.2 *Sampling*—Take a representative sample of the pipe and fittings sufficient to determine conformance with this specification. About 40 ft (12 m) of pipe is required to perform all the tests prescribed. The number of fittings required varies, depending upon the size and type of fitting. A sampling plan shall be agreed upon by the purchaser and the manufacturer (see Practice D1898).

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

6.3 *Conditioning*—Unless otherwise specified, condition the specimens prior to test at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity for not less than 40 h, in accordance with Procedure A of Practice D618 for those tests where conditioning is required and in all cases of disagreement.

6.4 *Test Conditions*—Conduct the test in the standard laboratory atmosphere of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity, unless otherwise specified.

6.5 Dimensions and Tolerances:

6.5.1 *Pipe*—Any length of pipe is used to determine the dimensions. Coiled pipe shall be measured in the natural springback condition, unless specified otherwise.

6.5.1.1 *Diameter*—Measure the diameter of the pipe in accordance with Test Method D2122. The average outside diameter for nonroundable pipe is the arithmetic average of the maximum and minimum diameters at any cross section on the length of the pipe. For roundable pipe, out-of-roundness tolerance applies to measurements made while the pipe is rounded with the manufacturer’s recommended equipment. Measure out-of-roundness within one-half pipe diameter or 2 in. (50 mm), whichever is closer, of the rounding equipment. See Test Method D2122 for definitions of nonroundable and roundable pipe.

(1) The pipe surface shall be free of gross imperfections such as, deep scratches, grooves, or high or low (flat) spots around the pipe circumference.

NOTE 7—Excessive out-of-roundness may be caused by manufacturing irregularities around the circumference of the pipe, such as deep scratches, gouges, flat spots, and high spots. Such defects could detrimentally affect joining. To simulate field joining of roundable pipe, out-of-roundness is checked by fitting a rounding device on the pipe, then measuring diameter.

6.5.1.2 *Wall Thickness*—Make a minimum of six measurements at each cross section in accordance with Test Method D2122.

6.5.1.3 *Wall Thickness Eccentricity Range*—Measure in a manner such that the maximum, A, and the minimum, B, wall thickness at single points of each cross section measured are obtained. Calculate the wall thickness eccentricity range, E, in percent for each cross section as follows:

$$E = [(A - B)/A] \times 100 \tag{1}$$

6.5.1.4 *Length*—Measure pipe length and other linear dimensions with a steel tape or other device, accurate to ±1/32 in. (±1 mm) in 10 ft (3 m).

6.5.2 *Fittings*—Measure the dimensions of fittings in accordance with Test Method D2122.

6.5.3 *Ovality*:

6.5.3.1 *Apparatus*—A micrometer or vernier caliper accurate to within ±0.001 in. (±0.02 mm).

6.5.3.2 *Procedure*—Take a series of outside diameter (OD) measurements at closely spaced intervals around the circumference to ensure that the minimum and maximum diameters have been determined.

6.5.3.3 *Calculation*—Calculate the percent ovality as follows:

$$\% \text{ ovality} = \frac{\text{maximum OD} - \text{minimum OD}}{\text{OD minimum} + \text{OD maximum}} \times 200 \tag{2}$$

6.6 *Slow Crack Growth Resistance*—Test in accordance with Test Method F1473 on compression molded plaques. Stress is 4.8 MPa. Temperature is 80°C. Notch depth in accordance with Table 1 in Test Method F1473.