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.

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Standard Specification for Polyamide-12 (PA12) Line Pipe[1]

This standard is issued under the fixed designation F3524/F3524M; 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 polyamide-12 (PA12) materials, pipe and fittings for pressure or non-pressure oil and gas producing applications to convey fluids such as oil, dry or wet gas, multiphase fluids, and non-potable oilfield water. This specification does not cover pipe for gas distribution applications.

1.1.1 See Specification F2785 for PA12 pipe and fittings intended for use in the distribution of natural gas, or for use with liquefied petroleum gas.

1.1.2 Pipe and fittings covered by this specification shall not be joined using taper pipe threads. Butt fusion joining shall be done in accordance with Practice F3372. In-plant quality control programs are described in Appendix X1. Design considerations are discussed in Appendix X2.

1.2 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard

1.3 *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.*

1.4 *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
D648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
D789 Test Method for Determination of Relative Viscosity of Concentrated Polyamide (PA) Solutions
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
D1600 Terminology for Abbreviated Terms Relating to Plastics
D1603 Test Method for Carbon Black Content in Olefin Plastics
D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
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
D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D6779 Classification System for and Basis of Specification for Polyamide Molding and Extrusion Materials (PA)
F412 Terminology Relating to Plastic Piping Systems
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

[1] This test method is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.68 on Energy Piping Systems.

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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.

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

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Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems
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
F2785 Specification for Polyamide 12 Gas Pressure Pipe, Tubing, and Fittings
F3372 Practice for Butt Fusion Joining of PA12 Pipe and Fittings

2.2 *ISO Standards:*[3]
307 Plastics -- Polyamides -- Determination of viscosity number
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
16486-1 Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 1: General

2.3 *Military Standard:*[4]
Military Standard 129P Standard Practice—Military Marking for Shipment and Storage

2.4 *Federal Standard:*[4]
FED-STD-123G Federal Standard Marking for Shipment (Civil Agencies)
Federal Register Vol. 71, No. 50, March 15, 2006

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

2.6 *NORSOK Standards:*[6]
M-710 , 3rd Edition Qualification of non-metallic materials and manufacturers – Polymers

3. Terminology

3.1 *Definitions*—Unless otherwise specified, definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *multiphase fluid, n*—oil, gas, and water in any combination produced from one or more oil or gas wells, or recombined oil or gas well fluids that may have been separated in passing through surface facilities.

3.2.2 *oilfield water, n*—fresh or salt water transported by pipeline, regardless of purity or quality, from wells or surface locations for the purpose of providing water injection to underground reservoirs; or disposing of waste water from hydrocarbon or gas production, processing, or storage facilities.

3.2.3 *production run, n*—the continuous extrusion of pipe of a specific diameter, wall thickness and material compound.

3.2.3.1 *Discussion*—Continuous production may be temporarily interrupted by loss of power or circumstances such as breakdowns or screen changes, etc.; however, a change of diameter or wall thickness (dimension ratio) or material compound constitutes a new production run.

3.2.4 *rounding device, n*—equipment, devices, clamps, and so forth, used to temporarily hold the pipe round while measurements are made.

3.2.5 *sample, n*—pipe or an element of pipe that represents a quantity of pipe and provides a specimen or specimens for testing.

3.2.6 *specimen, n*—pipe or an element of pipe that is subjected to test.

3.2.7 *standard thermoplastic material designation code, n*—the pipe material designation code shall consist of the abbreviation for 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.

3.2.7.1 *Discussion*—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 example, PA 42316 is a grade of polyamide 12 with a 1600 psi design stress for water at 73.4 °F [23 °C].

4. Materials

4.1 Polyamide-12 compounds suitable for use in the manufacture of pipe and fittings under this specification shall meet the following requirements:

[3] 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] 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.

[6] Available from Standards Norway, Strandveien 18, P.O. Box 242 N-1326 Lysaker, NORWAY. Email: petroleum@standard.no

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4.1.1 *General*—The polyamide material used to make pipe and fittings shall be virgin material and shall have a Plastics Pipe Institute (PPI) long-term hydrostatic design stress and hydrostatic design basis (HDB) rating or a Minimum Required Strength (MRS) as determined per PPI TR-3 and listed in PPI TR-4 (Table 1). The long-term hydrostatic test specimens shall be saturated to a minimum of 95 % of the equilibrium water content at the test temperature before starting the test. The testing shall be done with water inside and outside the test specimens.

4.1.2 *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 2.

4.1.3 *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 1.

4.1.4 *Color and Ultraviolet (UV) Stabilization*—PA12 compounds in pipe and fittings shall be protected against degradation by UV radiation and contain 2 to 3 percent carbon black. Carbon black compounds shall be pre-compounded by the resin manufacturer. The resin manufacturer shall certify the percentage carbon black for each resin lot in accordance with Test Method D1603 or Test Method D4218.

4.1.5 The pipe manufacturer shall have procedures for ensuring that materials meeting 4.1 are received in a condition that is suitable for processing, including receiving inspection to discover damage or contamination from shipping.

4.2 *Rework Material*—Clean rework material of the same commercial designation, generated from the manufacturer's own pipe and fitting production shall not be used unless the pipe and fittings produced meet all the requirements of this specification.

4.2.1 The manufacturer shall have procedures for ensuring that rework material is clean before use and shall have procedures for tracing rework material from its initial processing as virgin material through the manufacturer's rework process to ensure that material blends containing rework material comply with 4.2. Testing rework material for compliance with Table 2 classification and Table 1 properties is not required.

4.3 *Slow Crack Growth Resistance*—PA 12 materials shall meet a slow crack growth resistance minimum requirement of 500 hours when tested in accordance with 7.6.

4.4 *Elevated Temperature Service*—Polyamide 12 piping materials intended for use at temperatures above 100 °F [38 °C] shall have a PPI recommended hydrostatic design basis (HDB) listing in PPI TR-4 determined at the specific temperature in accordance with Test Method D2837. In the absence of an HDB established at the specified temperature, the HDB at the higher temperature may be interpolated per PPI TR-3 Part D.2 provided there are recommended HDB listings at temperatures above and below the intended operating temperature.

5. Pipe Requirements

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.

5.2.1 Cut pipe ends shall be squarely cut and clean without ledges, shaving tails, burrs or cracks.

5.2.2 The interior of the pipe shall be free of cuttings, shavings and debris when produced.

5.3 *Dimensions and Tolerances:*

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

5.3.2 *Pipe Diameter*—The outside diameter of the pipe shall meet the outside diameter in accordance Table 3 or 5.3.7 when measured in accordance with Test Method D2122. The outside diameter measurement shall be taken at a distance at least 1.5 times the average outside diameter or 11.8 in. [300 mm], whichever is less, from the cut end of the pipe.

5.3.3 *Toe-In*—When measured in accordance with Test Method D2122, 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], whichever distance is less, from the cut end of the pipe. Undistorted outside diameter shall meet the requirements of Table 3.

5.3.4 *Ovality*—The ovality (elliptical shape) of pipe when exiting production line processing equipment but before coiling or packaging for shipment shall not exceed 5 percent when determined in accordance with 7.4.

NOTE 1—Ovality is a field correctable condition that results from packaging or storage. When coiled, pipe will deflect to an oval or elliptical profile, and when packaged or stored, higher DR pipe may deflect to an oval or elliptical profile. If necessary, commercially available equipment

TABLE 1 Short and Long Term Property Requirements

PA Material Designation Code	Short-Term in Accordance with D6779 PA42316	Long-Term in Accordance with D2837	Long-Term in Accordance with ISO 9080
PA42316	PA423	Minimum HDB of 3150 psi at 73 °F [23 °C] and Minimum HDB of 2000 psi at 140 °F [60 °C] or Minimum HDB of 1600 psi at 180 °F [82° C]	Minimum MRS of 18 MPa at 20 °C [68° F]

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