



Standard Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers requirements and methods of test for materials, dimensions and tolerances, hydrostatic-burst strength, chemical resistance, and longitudinal tensile properties, for reinforced epoxy resin pipe and fittings for use in gas mains and services for direct burial and insertion applications. The pipe and fittings covered by this specification are intended for use in the distribution of natural gas, petroleum fuels (propane-air and propane-butane vapor mixtures), manufactured and mixed gases where resistance to gas permeation, toughness, resistance to corrosion, aging, and deterioration from water, gas, and gas additives are required. Methods of marking are also given. Design considerations are discussed in **Appendix X1**.

1.2 The values in SI units are to be regarded as the standard.

1.3 The following safety hazards caveat pertains only to the test method portion, Section 8, 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 and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no similar or equivalent ISO standard.

1.4 A recommended inplant quality control program is given in **Appendix X2**.

2. Referenced Documents

2.1 ASTM Standards:²

D 396 Specification for Fuel Oils

- D 543** Practices for Evaluating the Resistance of Plastics to Chemical Reagents
- D 618** Practice for Conditioning Plastics for Testing
- D 883** Terminology Relating to Plastics
- D 1598** Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
- D 1599** Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
- D 1898** Practice for Sampling of Plastics³
- D 2105** Test Method for Longitudinal Tensile Properties of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube
- D 2143** Test Method for Cyclic Pressure Strength of Reinforced, Thermosetting Plastic Pipe
- D 2290** Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe by Split Disk Method
- D 2412** Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Pipe Loading
- D 2924** Test Method for External Pressure Resistance of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
- D 2992** Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
- D 2996** Specification for Filament Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
- D 3567** Practice for Determining Dimensions of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
- D 3839** Guide for Underground Installation of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
- D 3892** Practice for Packaging/Packing of Plastics
- D 5685** Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings

3. Terminology

3.1 Definitions:

³ Withdrawn.

¹ This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.23 on Reinforced Plastic 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.

3.1.1 General—Definitions are in accordance with Terminology D 883 or F 412. Abbreviations are in accordance with Terminology D 1600, unless otherwise indicated. The abbreviation for fiberglass pipe is RTRP and the abbreviation for fiberglass fittings is RTRF.

3.1.2 The gas industry technology used in this specification is in accordance with definitions given in The Department of Transportation of Natural and Other Gas by Pipeline Minimum Safety Standards.

3.1.3 *Standards Reinforced Thermosetting Resin Pipe Materials Designation Code*—The pipe material designation code shall consist of the abbreviation RTRP followed by type and grade in arabic numerals, class by a capital letter and the long term steady pressure strength by a second capital letter. The fittings material designation shall consist of the abbreviation RTRF followed by type (method of manufacture), grade (general type of resin), class (configuration of joining system), and pressure rating.

4. Classification

4.1 *Pipe*—The pipe covered in this specification is made by the filament winding process and is described in Specification D 2996. Requirements of this pipe are based on short-term tests defined in this specification.

4.2 *Fittings*—This specification covers *a*) reinforced epoxy resin fittings described in specification D 5685 and made of the type of materials covered in Section 5, and *b*) metal fittings which have been designed and tested in accordance with the provisions of The Department of Transportation Title 49 of The Code of Federal Regulations Part 192 – Transportation of Natural Gas and Other Gas by Pipeline: Minimum Federal Safety Standards, which are capable of being joined to the pipe and will provide a suitable gas distribution system.

5. Materials

5.1 The resins and reinforcements used to make pipe shall be as specified in 5.1.1.

5.1.1 This specification covers glass fiber reinforced epoxy resin pipe and fittings as defined in Specification D 2996—RTRP 11 AU, RTRP 11 CU, and RTRP 11 HU and fittings as defined in specification D 5685—RTRF 11A1D, RTRF 21A1D, RTRF 11F2D and RTRF 21A2D.

NOTE 2—The particular reinforced thermosetting resin included initially in this specification for gas pressure piping was selected on the basis of engineering test studies made by Battelle Memorial Institute, experimental use in field installations, and technical data supplied by the manufacturers of the plastics materials used to make the pipe and fittings. It is the intent of ASTM Committee D-20 on Plastics to consider for inclusion other resins and reinforcements in this specification when

evidence is presented to show that they are suitable for gas service. Minimum requirements are an ASTM pipe specification and long-term strength determined in accordance with Test Method D 2992, Procedure B, in addition to the requirements of this specification.

6. Requirements

6.1 *Workmanship*—The pipe and fittings shall be free of visible cracks, holes, foreign inclusions, blisters, and other injurious defects. The pipe and fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.

6.2 *Pipe Dimensions and Tolerances:*

6.2.1 *Diameters*—The outside diameter of the pipe shall be in accordance with Table 1 when measured in accordance with 8.4.1.

6.2.2 *Wall Thickness*—The wall thickness of the pipe shall meet the requirements given in Table 1 when measured in accordance with 8.4.1.

6.2.3 *Lengths*—The pipe shall be in lengths as specified on the purchase order when measured in accordance with 8.4.1.

NOTE 3—Either threaded adaptors or bonded joints are acceptable. Jointers of up to 5 % of the shipment are acceptable to meet the length requirements. No section less than 1.5 m (5 ft) long can be used to make a joint and only one jointer can be used in a length.

6.3 *Fittings Dimensions and Tolerances*— The fittings dimensions shall enable the pipe and fittings to be joined and shall be measured in accordance with 8.4.2.

NOTE 4—Subcommittee D 20.23 is working towards development of dimensional requirements for fittings; however, it will be some time before the requirements are available. Therefore, the method of measuring is provided only to have a standard method of measuring fittings dimensions for inspection purposes.

6.4 *Short-Term Rupture Strength (Burst Pressure)*—The minimum hoop stress at burst for pipe covered by this specification shall be as listed in Table 2 when tested in accordance with 8.5. The minimum burst requirements for fittings covered by this specification shall be 4.82 MPa (700 psi) internal pressure or 27.5 MPa (4000 psi) hoop tensile stress, whichever is greater, when tested in accordance with 8.5 at temperatures of 23°C (73.4°F) and 65.6°C (150°F), and calculated using the equation listed in Test Method D 1599 for hoop stress. The calculations shall use the fittings wall thickness and diameter at a point where the wall thickness is at a minimum and which is also in the section of the fittings which is not reinforced by the pipe.

6.5 *Crush Strength*—The minimum stiffness factor at 5 % deflection of the pipe shall be as shown in Table 2 when tested in accordance with Test Method D 2412.

TABLE 1 Pipe Dimensions, mm (in.)

Nominal	Outside Diameter	Tolerance	Minimum Wall Thickness
2	60.325 (2.375)	+1.524, -0.457 (+0.060, -0.018)	1.524 (0.060)
3	88.900 (3.500)	+1.524, -0.457 (+0.060, -0.018)	1.524 (0.060)
4	114.300 (4.500)	+1.524, -0.457 (+0.060, -0.018)	1.780 (0.070)
6	168.275 (6.625)	+1.678, -0.711 (+0.066, -0.028)	2.540 (0.100)
8	219.075 (8.625)	+2.184, -1.016 (+0.086, -0.040)	3.227 (0.125)
10	273.050 (10.750)	+2.743, -1.219 (+0.108, -0.048)	3.830 (0.150)
12	323.850 (12.750)	+3.251, -1.422 (+0.128, -0.056)	4.215 (0.175)

TABLE 2 Minimum Physical Property Requirements for Pipe

Physical Property	Test Method	23°C (73.4°F)	65.6°C (150°F)
Short-term rupture strength (burst) min, hoop stress, psi	D 1599	35 000	40 000
Static hydrostatic hoop stress 10 ⁵ h (estimated), min, psi	D 2992	15 000	14 000
Hydrostatic collapse min, psig	D 2924	14.7	11.0
Longitudinal tensile strength, min, psi	D 2105	8 900	8 300
Parallel plate crush strength, min	D 2412	45	41
pipe stiffness factor at 5% deflection			

6.6 *Chemical Resistance*—The pipe shall not change more than $\pm 12\%$ in apparent tensile strength when measured in accordance with 8.7.

NOTE 5—A suitable chemical resistance test for fittings is not available at the present time and will be added when available.

6.7 *Longitudinal (Tensile Strength)*—The minimum longitudinal tensile strength for pipe covered by this specification shall be as listed in Table 2 when tested in accordance with Test Method D 2105.

6.8 *Hydrostatic Collapse*—The minimum factor for pipe covered by this specification shall be as listed in Table 2 when tested in accordance with Test Method D 2924.

7. Adhesive Requirements

7.1 Adhesives used to join reinforced epoxy resin pipe shall be suitable for use with the pipe and fittings and meet the requirements listed in 7.2 and 7.3.

NOTE 6—It is recommended that the working (pot) life of the adhesive be agreed upon between the purchaser and the manufacturer.

7.2 *Adhesive Test*—All adhesives covered by this specification shall have a minimum ultimate shear strength of 10.3 MPa (1500 psi) when tested in accordance with 8.8.

7.3 *Packaging*—Each adhesive kit shall contain the necessary components and instruction sheets, which shall include cure times and pot life.

8. Test Methods

8.1 *Sampling*—Take a sample of the pipe and fittings sufficient to determine conformance with this specification. About 15 m (50 ft) of pipe or tubing are required to make the tests prescribed. The number of fittings required varies, depending upon the size and type of fitting. It is suggested that a sampling plan be agreed upon by the purchaser and the manufacturer (see Practice D 1898).

8.2 *Conditioning*—Unless otherwise specified, condition the specimens prior to test at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and $50 \pm 5\%$ relative humidity for not less than 48 h, in accordance with Procedure A of Practice D 618 for those tests where conditioning is required and in all cases of disagreement.

8.3 *Test Conditions*—Conduct the tests in the Standard Laboratory Atmosphere of $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$), unless otherwise specified.

8.4 Dimensions and Tolerances:

8.4.1 *Wall Thickness and Diameter*—Determine in accordance with Practice D 3567.

8.4.2 *Liner Thickness*—When the test specimens contain a liner, determine the average liner thickness in accordance with Practice D 3567.

8.5 *Short-Term Hydrostatic Failure Strength (Minimum Hoop Stress)*—Determine in accordance with Test Method D 1599. Fittings shall be tested with pipe nipples bonded in the sockets.

8.6 *Apparent Tensile Properties*—The apparent tensile strength shall be determined in accordance with Procedure B of Test Method D 2290.

8.7 *Chemical Resistance*—Determine the resistance to the following chemicals in accordance with Procedure II of Test Method D 543, except use ring specimens cut from pipe for this purpose:

Chemical	Concentration, %
Fuel Oil No. 1 (Specification D 396)	100
<i>t</i> -butyl mercaptan	5 in fuel oil
Antifreeze agents (at least one shall be used):	
Methanol	100
Isopropanol	100
Ethylene glycol	100

Cut specimens from the pipe in accordance with 8.6; test five specimens with each reagent. Coat specimen edges with adhesive prior to immersion. Completely immerse the specimens in the chemicals for 72 h. Upon removal from the chemicals, wipe the specimens with a clean dry cloth, condition in the testing room for a period not to exceed 2 h, and then test in tension in accordance with 8.6.

8.8 *Adhesive Test*—The ultimate shear strength for adhesives used to bond pipe and fittings together shall be determined in accordance with the following procedure; it is applicable to all adhesives covered by this specification.

8.8.1 *Principle*—Laboratory shear specimens are made by bonding together two 3 by 13 by 75-mm ($\frac{1}{8}$ by $\frac{1}{2}$ by 3-in.), reinforced thermosetting plastic laminates using the supplied adhesive kits. This specimen is then cured in accordance with instructions supplied with the adhesive. After curing, the specimen is pulled apart in a universal testing machine.

8.8.2 *Test Specimen*—The test specimen shall be made using longitudinally reinforced epoxy resin laminates that are made of the same materials as the pipe with dimensions of 5 by 13 by 75 mm ($\frac{1}{8}$ by $\frac{1}{2}$ by 3 in.). Each specimen shall have a bonding surface on one end made by milling off 5 mils of the surface for a length of 2 mm ($\frac{3}{4}$ in.). Test a minimum of five test specimens.

8.8.3 Procedure:

8.8.3.1 Clean the milled surfaces of two 75-mm (3-in.) long laminates using solvent supplied with adhesive.

8.8.3.2 Mix the adhesive components in accordance with instructions supplied with the adhesives.

8.8.3.3 Wet the cleaned surface of the laminates with the mixed adhesive.

8.8.3.4 Press the adhesive-coated areas of the laminates together, maintaining alignment of edges and clamp so that the specimen is held together using uniform pressure. Pressure used shall be sufficient to yield specimens with adhesive line thicknesses that do not exceed 0.9 mm ($\frac{1}{32}$ in.).

8.8.3.5 Note the time when assembly is completed.