



Standard Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings¹

This standard is issued under the fixed designation D 2517; 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.

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

ε¹ NOTE—Keywords section was editorially updated in July 2002.

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:

D 396 Specification for Fuel Oils²

D 543 Test Method for Resistance of Plastics to Chemical Reagents³

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing³

D 883 Terminology Relating to Plastics⁴

D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure⁴

D 1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings⁴

D 1898 Practice for Sampling of Plastics⁵

D 2105 Test Method for Longitudinal Tensile Properties of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube⁴

D 2143 Test Method for Cyclic Pressure Strength of Reinforced, Thermosetting Plastic Pipe⁴

D 2290 Test Method for Apparent Tensile Strength of Ring or Tubular Plastics and Reinforced Plastics by Split Disk Method⁴

D 2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Pipe Loading⁴

D 2924 Test Method for External Pressure Resistance of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe⁴

D 2992 Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings⁴

D 2996 Specification for Filament Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe⁴

D 3567 Practice for Determining Dimensions of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings⁴

D 3839 Practice for Underground Installation of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe⁴

D 3892 Practice for Packaging/Packing of Plastics

D 5685 Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings

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² Annual Book of ASTM Standards, Vol 05.01.

³ Annual Book of ASTM Standards, Vol 08.01. Subcommittee D 20.23 has completed work to develop methods which are adapted for RTRP.

⁴ Annual Book of ASTM Standards, Vol 08.04.

⁵ Annual Book of ASTM Standards, Vol 08.02.

3. Terminology

3.1 Definitions:

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 reinforced epoxy resin fittings described in specification D 5685 and made of the type of materials covered in Section 5, 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 and RTRP 11 CU 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. Joiners 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.

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

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			

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
t-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.

8.8.3.6 Check the temperature in the room and determine the cure time from instructions supplied with the adhesive.

8.8.3.7 When the required amount of time has elapsed, remove the specimen from the clamping fixture, and place it in grips of the universal testing machine. Good alignment in the grips is essential. Set speed control at 5.1 to 6.4 mm (0.20 to 0.25 in.)/min and start the testing machine. Record the breaking load.

8.8.4 *Calculation*—Calculate the ultimate shear strength of the adhesive using the following equation and report to three significant figures:

$$\sigma = P/A \quad (1)$$

where:

σ = ultimate shear stress, MPa (or psi),
 P = ultimate load, N (or lbf), and
 A = bond area, mm²(or in.²).

For each series of tests, calculate the arithmetic mean of all values obtained to three significant figures and report as the “average value.” Calculate the standard deviation as follows and report to two significant figures:

$$s = [(\sum X^2 - n\bar{X}^2)/(n - 1)]^{1/2} \quad (2)$$

where:

s = estimated standard deviation,
 X = value of a single observation,
 n = number of observations, and
 \bar{X} = arithmetical average of the set of observations.

9. Packaging and Marking

9.1 *Pipe*—All required marking shall be legible and so applied without indentation as to remain legible under normal handling and installation practices. These markings shall consist of the manufacturer’s name or trademark, the nominal pipe size, and the standard reinforced plastic pipe identification at each end of the pipe. In addition to the above, the pipe shall bear an appropriate code number which will ensure identification of the pipe as to the month and year of production and raw materials used in the production of said pipe. The manufacturer shall maintain such additional records as are necessary to confirm identification of all coded pipe. Marking shall include the designation ASTM D 2517.

9.2 *Fittings*—All fittings shall be marked on the body or hub. The marking shall consist at least of the manufacturer’s name or trademark, or both, and the symbol for the type of material and size. Marking shall include the designation ASTM D 2517.

9.3 *Adhesives*—All adhesive containers shall be marked on the container. The marking shall consist of the manufacturer’s name or trademark, or both, manufacturing date, shelf life, and storage requirements.

9.4 All packing, packaging, and marking provisions of Practice D 3892 shall apply to this specification.

10. Keywords

10.1 filament wound; compression molded; configuration of joining system; rupture strength; crush strength; chemical resistance; apparent tensile properties; adhesive

APPENDIXES

(Nonmandatory Information)

X1. DESIGN

X1.1 General

X1.1.1 The design of a plastic piping system for gas must include consideration of the effect of the environment while under stress, as well as internal and external loads. The combined effects of time, stress, and environment must be investigated as an overall basis for selecting a specific kind and size of plastic pipe. The selection of design stresses for RTRP is the prerogative of the Department of Transportation (DOT) Office of Pipeline Safety. The AGA Plastic Pipe Committee and members of Committee D-20 are cooperating with DOT to provide assistance in selecting safe design stress levels for the various kinds of plastic pipe.

X1.2 Internal Pressure

X1.2.1 The design stresses for natural gas are based on the 100 000-h hydrostatic strength of the pipe of 75°F obtained in accordance with Procedure B of Practice D 2992. The

100 000-h strengths of the plastics included in the applicable ASTM specifications are as follows:

Plastic Pipe Material Designation	Long-Term (100 000-h) Strength at 23°C (73°F)
RTRP (glass fiber reinforced epoxy resin pipe)	15 000 psi

Strengths for other RTRP materials will be added when these materials are included in the applicable ASTM specifications. The design stresses are obtained by multiplying the 100 000-h strength by design factors or service factors in accordance with the class of location as described in Chapter IV of the ASME Code for Pressure Piping B 31, ASME B 31.8, Gas Transmission and Distribution Piping System and The Department of Transportation Minimum Federal Safety Standards for Gas Lines (Part 192 Title 49 Code of Federal Regulations).

X1.3 External Loads

X1.3.1 It is recognized that certain minimum requirements exist for the support of earth loads from backfill and other

external forces. Proper installation techniques can be used with flexible conduit (as defined by Marston and Spangler)⁶ to support relatively large earth loads without excessive deflection by mobilizing lateral passive soil forces. Proper installa-

⁶ Spangler, M. G., "Secondary Stresses in Buried High Pressure Lines," The Iowa State College Bulletin, Engineering Report 23 of the Iowa Engineering Experiment Station, 1954–1955.

tion technique ensures that the necessary passive soil pressure at the sides of the pipe will be developed and maintained. It is also recognized that the internal pressures may be valuable in minimizing the deflection caused by earth loads. However, the magnitude of this latter effect is somewhat subjective, and therefore installation procedures defined in Test Method D 3839 are recommended instead of more specific information.

X2. RECOMMENDED IN-PLANT QUALITY CONTROL PROGRAM FOR REINFORCED EPOXY RESIN PIPE INTENDED FOR USE IN NATURAL GAS SERVICE

X2.1 Introduction

X2.1.1 The following in-plant quality control program covering material, performance requirements, and marking shall be used in manufacture to provide reasonable assurance that the RTRP pipe and fittings for use with the type of RTRP supplied under this code meets the requirements of the applicable standard. The pipe and fittings producers shall maintain records on all aspects of this program and supply these to the purchaser, if requested.

X2.2 Material

X2.2.1 The pipe and fittings manufacturer shall use only those raw materials that are allowed by the applicable standard and shall so certify.

X2.3 Pipe Tests

X2.3.1 *Product Quality Control (See Note X2.1)*—The tests in Table X2.1 shall be made per size per processing unit at the denoted frequencies and the test results recorded and filed for inspection, upon request.

NOTE X2.1—When the pipe fails to meet the specification (or standard) requirement in any test, additional tests shall be made on the pipe produced back to the previous acceptable results to select the pipe produced in the interim that does pass the requirement. Pipe that does not meet the requirement shall be rejected.

TABLE X2.1 Pipe Tests

Property	Test Method	Test Frequency
Visual	...	all
Dimensions:		
Diameter	D 3567	900 m (3000 ft) or once/3h
Wall thickness	D 3567	1500 m (5000 ft) or once/lot ^A
Mechanical properties:		
Burst pressure	D 1599	5000 ft
Short-term static (20 h) or cyclic ^B	D 1598 (D 2143)	24 h

^AWhichever is most frequent.

^BA cyclic pressure test made in accordance with the procedure in Test Method D 2143 may be substituted for the static test requirements if it has been demonstrated that the results of the two methods are equivalent.

X2.4 Test Methods

X2.4.1 The test methods may be those generally used by the manufacturer, but in case of question, those given in the applicable ASTM standard shall be used.

X2.5 Records

X2.5.1 A code number shall be included in the marking on the pipe. If required, on the directional fittings, the code number may be used to identify in the records the following:

X2.5.2 The compound,

X2.5.3 The date of manufacture,

X2.5.4 The shift,

X2.5.5 The test results required in this in-plant quality control program, and

X2.5.6 The manufacturer.

SUMMARY OF CHANGES

Committee D20 has identified the location of the following changes to this standard since the last issue (D 2517–94) that may impact the use of this standard.

(1) Added fitting specification

(2) Expanded materials section to cover fittings.

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