



Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Pipe Fittings, Adhesive Bonded Joint Type, for Aviation Jet Turbine Fuel Lines¹

This standard is issued under the fixed designation D 5677; 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.

1. Scope *

1.1 This specification covers a reinforced plastic pipe and fittings system made from epoxy resin and glass-fiber reinforcement, together with adhesive for joint assembly, intended for service up to 150°F (65.6°C) and 150-psig (1034-kPa) operating pressure and surges up to 275 psig (1896 kPa) in aviation jet turbine fuel lines installed below ground.

1.2 The dimensionless designator NPS has been substituted in this specification for such traditional terms as “nominal diameter,” “size,” and “nominal size.”

1.3 The values stated in inch-pound units are to be regarded as standard. The values in parentheses are for information only.

1.4 The following safety hazards caveat pertains only to the test method portion, Section 9, 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.

2. Referenced Documents

2.1 ASTM Standards:

D 381 Test Methods for Existent Gum in Fuels by Jet Evaporation²

D 883 Terminology Relating to Plastics³

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

D 1600 Terminology Relating to Abbreviations, Acronyms, and Codes for Terms Relating to Plastics³

D 2310 Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe⁴

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

D 3241 Test Method for Thermal Oxidation Stability of Aviation Turbine Fuels (JFTOT Procedure)⁵

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

D 3951 Practice for Commercial Packaging⁶

F 412 Terminology Relating to Plastic Piping Systems⁴

F 1173 Specification for Epoxy Resin Fiberglass Pipe and Fittings to Be Used for Marine Applications⁷

2.2 Military Specification:

MIL-T-5624 Turbine Fuel, Aviation, Grades JP-4, JP-5 and JP-5/JP-8 ST⁸

2.3 ANSI Standard:

B16.5 Steel Pipe Flanges and Flanged Fittings⁹

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminologies D 883 and F 412 and abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.1.1 *conductive*—a pipe or fitting that meets the requirements for conductivity listed in Section 6 of Specification F 1173.

3.2 Abbreviations: Abbreviation:

3.2.1 *RTRP, n*—reinforced thermosetting resin pipe.

4. Classification

4.1 General:

4.1.1 Pipe meeting this specification is classified by type, grade, and class similar to Classification D 2310.

4.1.2 Fittings meeting this specification are also classified by type (method of manufacture) and grades (generic type of resin).

¹ This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.23 on Reinforced Plastic Piping System and Chemical Equipment.

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² *Annual Book of ASTM Standards*, Vol 05.01.

³ *Annual Book of ASTM Standards*, Vol 08.01.

⁴ *Annual Book of ASTM Standards*, Vol 08.04.

⁵ *Annual Book of ASTM Standards*, Vol 05.02.

⁶ *Annual Book of ASTM Standards*, Vol 15.09.

⁷ *Annual Book of ASTM Standards*, Vol 01.07.

⁸ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁹ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

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

4.2 Pipe:

- 4.2.1 Type I Filament-Wound Pipe Nonconductive
- 4.2.2 Type Ia Filament-Wound Pipe Conductive
- 4.2.3 Type II Centrifugally Cast Pipe

4.3 Fittings:

- 4.3.1 Type I Filament-Wound Fittings Nonconductive
- 4.3.2 Type Ia Filament Wound Fittings Conductive
- 4.3.3 Type II Molded Fittings Nonconductive

4.4 Grade:

4.4.1 Grade 1 Glass-Fiber-Reinforced Epoxy Resin (Pipe and Fittings)

4.5 Classes (Pipe Only):

- 4.5.1 Class A No Liner
- 4.5.2 Class C Epoxy Resin Liner Nonreinforced
- 4.5.3 Class F Epoxy Resin Liner Reinforced

5. Materials and Manufacture

5.1 *General*—The fiberglass pipe shall be round and straight, and the pipe and fittings shall be of uniform density, resin content, and surface finish. All pipe ends shall be cut at right angles to the axis of the pipe and any sharp edges removed. The bore of the pipe and fittings shall have a smooth, uniform surface with no exposed fibers and may contain a liner. The liner, if used, shall be composed of an epoxy resin formulation and may contain a reinforcement.

5.2 *Material*—The pipe and fittings shall be made from epoxy resins and glass-fiber reinforcement of commercial first quality. Fillers, colorants, and other materials may be added, provided the pipe and fittings meet all the requirements of this specification. Epoxy pipe shall be joined only with epoxy fittings.

5.3 *Adhesive*—Adhesive for joint assembly shall be a material suitable for providing a seal between the pipe and fittings in continuous service up to 150°F (65°C) and 150 psig (1034 kPa) with surges to 275 psig (1896 kPa). The adhesive shall be supplied as a kit which includes containers of all components in the amounts needed for each adhesive mixture. Instructions for use shall be marked on each container or listed on an instruction sheet included in each adhesive kit. When specified in the contract or purchase order, adhesive kits shall be furnished in a sufficient quantity for the particular procurement of pipe and fittings.

6. Dimensions

6.1 *Pipe*—The pipe shall be 2, 3, 4, 6, 8, 10, 12, 14, and 16-in. (50, 80, 100, 150, 200, 250, 300, 350 and 400-mm) nominal sizes as specified and shall have the dimensions and tolerances shown in Table 1.

6.1.1 *Length*—Unless other lengths are specified on the purchase order, the length of the pipe shall be 20 ft (6.1 m), 30 ft (9.2 m), or 40 ft (12.2 m) with a plus tolerance of 2 ft (0.6 m) and a minus tolerance of 5 ft (1.5 m).

6.1.2 *Wall Thickness*—The minimum wall thickness of the pipe shall be not less than 87.5 % of the average wall thickness of the pipe as measured in Section 8 and tested in Section 9.

6.1.3 *Fittings*—Fittings shall be 2, 3, 4, 6, 8, 10, 12, 14, and 16-in. (50, 80, 100, 150, 200, 250, 300, 350 and 400-mm) nominal sizes, as specified, and shall have dimensions suitable for joining to the pipe and enabling the pipe and fitting joint to meet the requirements of this specification. For purposes of this specification, fittings shall include couplings and flanges.

6.1.4 *Flanges*—Flanges shall conform to the bolt hole sizes and pattern for 150-lb steel flanges in accordance with ANSI B16.5.

7. Performance Requirements

7.1 *Joint Strength*—Pipe, fittings, adhesive, and joints shall show no porosity or other evidence of failure when tested in accordance with 9.2.2.

7.2 *Hydrostatic Strength*—Pipe, fittings, adhesive, and joints shall withstand a hydrostatic pressure of 300 psi (2068 kPa) without any indication of porosity, delamination, splitting, or other evidence of failure when tested in accordance with 9.2.3.

7.3 *Impact Resistance*—Pipe and fittings shall show no porosity or visual evidence of damage that would affect serviceability when tested in accordance with 9.2.4.

7.4 *Boil Resistance*—Pipe and fittings shall show no evidence of delamination or other impairment and shall have a weight gain no greater than 1.0 % when tested in accordance with 9.2.5.

7.5 *External Load Resistance*—When tested as specified in 9.2.6, the pipe shall show no visual evidence of cracking, crazing, or other damage that could allow leakage of fuel

TABLE 1 Dimensions of Pipe

NOTE 1—Nominal pipe diameters of 14 (350 mm) and 16 in. (406.4 mm) are available and approved with 14.000 (355.6 mm) and 16.000 (406.4 mm) outside diameters or inside diameters.

Nominal Pipe Diameter		Outside Diameter		Tolerance, Type I and Type Ia		Tolerance, Type II	
in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
2 ± 0.30	(50)	2.375	(60.32)	±0.060 -0.018	(±1.52 -0.46)	±0.012	(±0.30)
3	(75)	3.500	(88.90)	±0.060 -0.018	(±1.52 -0.46)	±0.012	(±0.30)
4	(100)	4.500	(114.30)	±0.060 -0.018	(±1.52 -0.46)	±0.015	(±0.38)
6	(150)	6.625	(168.28)	±0.066 -0.028	(±1.68 -0.71)	±0.025	(±0.64)
8	(200)	8.625	(219.08)	±0.086 -0.040	(±2.28 -1.02)	±0.025	(±0.64)
10	(250)	10.750	(273.05)	±0.108 -0.048	(±2.74 -1.22)	±0.025	(±0.64)
12	(300)	12.750	(323.05)	±0.128 -0.056	(±3.25 -1.42)	±0.025	(±0.64)
14	(350)	14.000	(355.60)	±0.145 -0.064	(±3.68 -1.63)	±0.035	(±0.89)
16	(400)	16.000	(406.40)	±0.165 -0.074	(±4.19 -1.88)	±0.035	(±0.89)

through the pipe wall at 5 % deflection and no visual evidence of delamination, rupture, or other structural damage at 10 % deflection.

7.6 Degradation Resistance:

7.6.1 *Pipe and Fittings*—Pipe and fittings exposed to JP-5 and JP-5/JP-8 ST fuels, in accordance with 9.2.7, shall exhibit no visual evidence of deterioration as a result of exposure to the fuels and shall have short-time rupture strengths of not less than 90 % of the short-time rupture strengths of unexposed pipe and fittings when tested in accordance with 9.2.7.1.

7.6.2 *Fuels*—JP-5 and JP-5/JP-8 ST fuels contained within pipe and fittings in accordance with 4.2 and 4.3, shall not vary from control samples of the fuels in thermal stability and existent gum properties when tested, as specified, in accordance with 9.2.7.2.

7.6.3 *Hydrostatic Proof Test*—Pipe and fittings shall withstand a hydrostatic pressure of 225 psi (1551 kPa) without any indication of porosity when tested in accordance with 9.2.8.

8. Workmanship

8.1 *Pipe and Fittings*—The pipe and fittings shall be free from all defects including delaminations, cracks, indentations, bubbles, pinholes, porosity, and resin-rich and resin-starved areas which, due to their nature, degree, or extent, detrimentally affect the strength and serviceability of the pipe and fittings. The liner, if used in the pipe or fittings, shall be free of cracks, chips, or other damage.

8.2 Examination:

8.2.1 *Sampling*—A sufficient quantity of pipe, fittings, and adhesive kits, in accordance with accepted statistical practice and as agreed upon between the purchaser and the seller, shall be selected from each lot or shipment and examined to determine conformance with this specification. In the case of no prior agreement, random samples selected by the testing laboratory shall be deemed adequate.

8.2.2 *Pipe and Fittings*—Sample pipe and fittings selected shall be examined for the following defects: incorrect dimensions; ends of pipe not cut at right angles to the axis; exposed fibers or nonuniform surface on bore of pipe or fittings; cracked or chipped liner (if used); bubbles, pinholes, delaminations, cracks, indentations, resin-rich or resin-starved areas in the outer wall that will affect the strength and performance of the product; and incorrect or missing identification marking. Any sample pipe or fitting having one or more of the defects listed shall be considered a defective unit.

8.2.3 *Dimensions*—Pipe and fitting dimensions shall be determined in accordance with the applicable sections of Practice D 3567.

8.2.4 *Adhesive*—Sample adhesive kits selected shall be examined for missing adhesive components and instructions for use, and missing or incorrect identification marking. Any sample adhesive kit having one or more of the defects listed shall be considered a defective unit.

9. Test Methods

9.1 *Sampling*—A sufficient quantity of pipe, fittings, and adhesive kits, in accordance with accepted statistical practice and as agreed upon between the purchaser and the seller, shall be selected from each lot or shipment and tested to determine

conformance with this specification. In the case of no prior agreement, random samples selected by the testing laboratory shall be deemed adequate.

9.2 *Tests*—Sample pipe, fittings, and adhesive kits selected shall be subjected to the tests in accordance with 9.2 through 9.2.8. Any sample failing to pass any of these tests shall be considered a defective unit.

9.2.1 *Test Conditions*—Unless otherwise specified in the test method, test specimens shall be conditioned for not less than 48 h in a room maintained at 60 to 90°F (15 to 32°C) and tested at the same temperature range. Unless otherwise specified, the test pressure in the individual test methods shall have a tolerance of +10 –0 psig (68.9 kPa) and –0 psig (0 kPa).

9.2.2 *Joint Strength*—Joint assemblies containing the pipe, fittings, and adhesive shall be fabricated. The adhesive shall be applied and cured as under field conditions in accordance with the manufacturer's printed instructions. The completed test section shall be either an assembly containing the pipe and each kind of fitting to be furnished under a contract, or simply one fitting joined between two pieces of pipe. When a section containing just one fitting is used, then similar test sections containing the other kinds of fittings to be furnished must also be tested. If the test section containing the one fitting is used, the longest end-to-end dimension shall be 18 in. (457 mm) or seven times the outside diameter of the pipe, whichever is greater, but no longer than 84 in. (2.1 m). If the test section contains more than one fitting, the pipe length between fittings shall be 6 in. (152 mm) or three times the outside diameter of the pipe, whichever is greater. The test section shall be subjected to a hydrostatic pressure of 275 psig (1896 kPa) at 150°F (65°C) for 168 h. The liquid medium shall be water and shall contain a soluble fluorescent dye. Observations with an ultraviolet lamp shall be made each 24 h for porosity or other evidence of failure of the pipe, fittings, or joints. Pipe, fittings, adhesive, and joints shall show no evidence of failure or porosity as required in 7.1.

9.2.3 *Hydrostatic Strength*—The test consists of filling a pipe and fitting test assembly, bonded with the adhesive to be furnished, with fresh water containing a soluble fluorescent dye at room temperature and cycling the pressure between 0 and 300 psig (2068 kPa) for 1000 cycles. The assembly shall contain one or more of the fittings to be furnished under a contract. The minimum test assembly size shall be 6 ft (1.8 m) if one fitting is tested. If multiple fittings are tested in the assembly, the pipe length between fittings shall be 2 ft (0.6 m), minimum. Approximately 5 to 10 s shall be used to apply the 300-psig pressure followed by a 30-s dwell at that pressure and then immediate removal of the pressure followed by a 30-s dwell at zero pressure. The specimen shall have failed the test if it cannot maintain the 300-psig pressure before the completion of the 1000 pressure cycles. If the 1000 pressure cycles are completed, the specimen shall be pressurized to 300 psig for 2 h, at the end of which time the specimen shall be examined with an ultraviolet lamp for porosity. The pressure shall then be removed and the specimen emptied of water and visually examined for other evidence of failure. Pipe, fittings, adhesive, and joints shall conform to the requirements in 7.2.

9.2.4 *Impact Resistance*—Pipe and fittings shall be subjected to a falling ball test and a drop test in accordance with 9.2.4.1 and 9.2.4.2 and shall conform to the requirements in 7.3.

9.2.4.1 *Falling Ball Test*—A steel ball 2 in. (50 mm) in diameter and weighing approximately 1.2 lb (0.54 kg) shall be dropped squarely onto the surface of the pipe or fitting specimen with a free fall (which may be guided) from a height of 1 ft (0.3 m). The pipe specimen shall be a minimum of 2 ft (0.6 m) in length and the fitting specimen shall be the complete fitting. The ball may be caught or deflected after the hit so that the rebound does not hit the specimen. The specimen shall be full of water containing a soluble fluorescent dye, but not pressurized. The test shall be made at room temperature and the specimen shall be supported on a solid, flat support. Four drops shall be made on randomly selected areas of the pipe specimen, 90° clockwise from each other. One drop shall be made on the fitting specimen. The specimen shall then be pressurized to 225 psig (1551 kPa) and shall remain at this pressure for 168 h. At the end of this time, the specimen shall be examined for porosity with an ultraviolet lamp and then emptied and examined for evidence of damage.

9.2.4.2 *Drop Test*—Specimens of pipe and fittings shall be dropped onto a concrete floor from a height of 4 ft (1.2 m). The pipe specimen shall be a minimum of 2 ft (0.6 m) in length and the fitting specimen shall be the complete fitting. The test shall be conducted at room temperature. The specimen shall be empty and shall be dropped parallel to the floor. All bore center lines of the fitting specimen shall be horizontal when striking the floor. Following the drop, the specimen shall be examined for evidence of damage and then filled with water containing a soluble fluorescent dye and pressurized to 275 psig (1896 kPa). The specimen shall remain at this pressure for 168 h and then be examined for porosity with an ultraviolet lamp.

9.2.5 *Boil Resistance*—A test specimen 1.5 in. (38.5 mm) in length shall be cut from the sample pipe. Fittings shall be tested using either the whole fitting or a 1.5-in. length cut from the fitting. The test specimens shall be conditioned for 8 h at 200°F (93.3°C), desiccated, and an initial weighing made. The specimens shall be suspended in a boiling distilled water bath for 3 h. The specimens shall be removed one at a time, blotted dry of excess water, and weighed. This weighing shall be made within 1.5 min after removal from the bath. After weighing, the specimens shall be visually examined for delamination or other evidence of impairment and the percentage weight gain of the specimens shall be calculated as follows:

$$\text{Weight gain, \%} = \frac{(B - A)}{A} \times 100 \quad (1)$$

where:

A = initial weight, and

B = weight after immersion.

Tested specimens shall meet weight gain and visual inspection requirements in accordance with 7.4.

9.2.6 *External Load Resistance*—The pipe shall be tested in accordance with Test Method D 2412. The test specimens shall be visually examined at 5 % deflection for evidence of cracking, crazing, or other damage that could allow leakage of fuel through the pipe wall, and examined again at 10 % deflection

for evidence of delamination, rupture, or other structural damage. When tested as specified, the pipe shall meet visual inspection criteria in accordance with 7.5.

9.2.7 *Degradation Resistance*—Test specimens of pipe and fittings shall be filled with JP-5 and JP-5/JP-8 ST fuels and stored for 90 days at 75 ± 15°F (24 ± 8°C). If all nominal sizes of pipe are fabricated in the same way and with the same materials, only one size of pipe need be tested. Test specimens shall be obtained from samples of that size selected. If all nominal sizes of fittings are fabricated in the same way and with the same materials, only elbows and tees of one size need be tested. One end of the pipe test specimens shall be sealed utilizing the adhesive for joint assembly so that the adhesive will be in contact with the fuels. The JP-5 and JP-5/JP-8 ST fuels shall conform to MIL-T-5624. Following the 90-day storage period, the fuels shall be poured into stainless steel cans labeled with the type of fuel and the pipe or fitting from which the fuel was poured. The pipe, fittings, and fuels shall then be tested in accordance with 9.2.7.1 and 9.2.7.2.

9.2.7.1 *Pipe and Fittings*—The test specimens from which the fuels were removed shall be examined for visual evidence of deterioration from contact with the fuels and then shall be tested in accordance with Test Method D 1599 to determine their short-time rupture strengths. The same test shall be performed on similar test samples maintained in the same room during the 90-day storage period, but not in contact with the test fuels. The percent difference between the rupture strengths of the exposed and unexposed specimens shall be determined. Visual inspections and rupture strengths shall meet the criteria of 7.6.1.

9.2.7.2 *Fuels*—The JP-5 and JP-5/JP-8 ST fuels removed from the pipe and fitting test specimens shall be tested for thermal stability in accordance with Test Method D 3241 and for existent gum in accordance with Test Methods D 381. The same tests shall also be performed on JP-5 and JP-5/JP-8 ST fuels which had been stored in stainless steel cans in the same room as the filled pipe and fitting specimens during the 90-day storage period. The thermal stability and existent gum properties of the exposed and unexposed fuels shall be compared and must comply with 7.6.2.

9.2.8 *Hydrostatic Proof Test*—The pipe and fittings shall be filled with water and pressurized to 275 psig (1896 kPa). The test shall be conducted at room temperature. The pipe and fittings shall remain under pressure for not less than 5 min and then shall be examined for porosity while still under pressure. The pipe and fittings tested shall conform to the requirements of 7.6.3.

10. Inspection

10.1 Inspection of the material shall be made as agreed upon between the purchaser and the supplier as part of the purchase order.

10.2 *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless the purchaser disapproves. The purchaser shall have the right to perform any

of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

NOTE 2—In U.S. Federal contracts the contractor is responsible for inspection.

11. Certification

11.1 Unless otherwise specified on the purchase contract, a certificate of compliance from an independent commercial laboratory or factory inspection agency acceptable to the purchaser will be accepted as proof that the requirements in 7.1 to 7.5 for the destructive tests specified in 9.2.2 to 9.2.6 (joint strength, impact resistance, boil resistance, beam strength, and cycling resistance) have been met. The certificate of compliance shall be accompanied by a certification from the manufacturer that the tests have been performed on products manufactured from the same materials and by the same manufacturing processes as the items being offered, and that any proposed changes in material or processes will be promptly reported to the purchaser. The purchaser reserves the right to require additional testing and certification when such changes are made or when otherwise deemed necessary.

12. Product Marking

12.1 *Pipe*—Each length of pipe shall be marked at intervals of not more than 15 ft (6 m). Each marking shall include at

least the manufacturer's name or trademark, the nominal pipe size, and the type of reinforced plastic pipe. The type of reinforced plastic pipe may be designated in accordance with Classification D 2310 or some other easily identifiable system. The marking shall be of a contrasting color and a type that remains legible under normal handling and installation procedures.

12.2 *Fittings*—Each fitting shall be marked with at least the manufacturer's name or trademark and the nominal size. The marking shall be of a contrasting color and a type that remains legible under normal handling and installation procedures.

12.3 *Adhesive*—Each container shall be marked with at least the manufacturer's name or trademark, adhesive component type, expiration date, special storage conditions, handling precautions, and instructions for use (if a separate instruction sheet is not included in the adhesive kit).

13. Packaging

13.1 Unless otherwise specified in the contract or order, the preservation, packing, and marking shall be in accordance with Practice D 3951.

14. Keywords

14.1 beam strength; boil resistance; centrifugally cast; cycling resistance; epoxy resins; filament wound; impact resistance; jet fuel; joint strength; molded

SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification. For the convenience of the user, Committee D-20 has highlighted those changes that may impact the use of this specification. This section may include descriptions of the changes or the reasons for the changes, or both.

D 5677 – 00:

(1) Added Note 1 on ISO equivalency.

(2) Updated 3.1.1 to reference correct Section of Specification F 1173.

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