Designation: D5685 – 11

An American National Standard

Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings[1]

This standard is issued under the fixed designation D5685; 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 "fiberglass" (glass-fiber-reinforced thermosetting-resin) fittings for use with filament wound or centrifugally cast fiberglass pipe, or both, in sizes 1 in. through 24 in. for pipe manufactured to Specification D2996 or D2997, or both.

1.2 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.

1.3 The following safety hazard caveat pertains only to the test method portion, Section 7, of this specification:

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 and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—The term "fiberglass pipe" as described in Section 3 of this specification applies to both reinforced thermosetting resin pipe (RTRP) and reinforced polymer mortar pipe (RPMP).

NOTE 2—For the purposes of this standard, ploymer does not include natural polymers.

NOTE 3—There is no known ISO equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

D883 Terminology Relating to Plastics

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

D2143 Test Method for Cyclic Pressure Strength of Reinforced, Thermosetting Plastic Pipe

D2310 Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

D2992 Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings

D2996 Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

D2997 Specification for Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

D3567 Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings

D4024 Specification for Machine Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges

F412 Terminology Relating to Plastic Piping Systems

F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

2.2 *ANSI Standard:*

B16.5 Steel Pipe Flanges, Flanged Valves and Fittings[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *General*—Definitions are in accordance with Terminology D883 or F412. Abbreviations are in accordance with Terminology D1600, unless otherwise indicated. The abbreviation for fiberglass pipe is RTRP and the abbreviation for fiberglass fittings is RTRF.

3.1.2 *"fiberglass" pipe*—tubular product containing glass fiber reinforcements embedded in or surrounded by cured thermosetting resin. The composite structure may contain aggregate, granular or platelet fillers, thixotropic agents, pigments, or dyes. Thermoplastic or thermosetting liners or coatings may be included.

3.1.3 *reinforced thermosetting resin pipe*—fiberglass pipe without aggregate (RTRP).

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

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

3.1.4 *reinforced polymer mortar pipe*—fiberglass pipe with aggregate (RPMP).

3.1.5 *reinforced thermosetting resin fitting*—fiberglass fitting without aggregate (RTRF).

3.1.6 *reinforced polymer mortar fitting*—fiberglass fitting with aggregate (RPMF).

4. Classification

4.1 This specification covers fiberglass fittings defined by type (method of manufacture), grade (general resin type), class (general liner type), catagory (configuration of joining system), and pressure rating (a single letter disignating the pressure class and method of manufacture).

4.2 *Types:*

4.2.1 *Type 1*—Filament-wound fittings manufactured by winding continuous fibrous-glass strand roving or roving tape, either preimpregnated or impregnated during winding, onto a mandrel, or a liner corresponding to the fitting shape.

4.2.2 *Type 2*—Compression molded fittings made by applying external pressure and heat to a molding compound that is confined within a closed mold.

4.2.3 *Type 3*—Resin transfer molded fittings manufactured by pumping a thermosetting resin into glass reinforcements that have been cut to size and clamped between matched molds.

4.2.4 *Type 4*—Centrifugally cast fittings made by applying resin and reinforcement to the inside of a mold that is rotating and heated, subsequently polymerizing the resin system.

4.2.5 *Type 5*—Contact molded fittings made by applying resin and reinforcement to a mold or to mitered filamentwound stock or centrifugally cast pipe stock. This procedure shall also cover “spray-up” fittings which are made by spraying resin and reinforcement on a mold or over mitered pipe wound stock. “Contact molding” includes both hand lay-up and spray-up manufacturing processes.

4.2.6 Fittings of Type 1 through Type 5 which require thrust blocking or external axial restraint when installed shall have the letter “R” appended to the type of designation. (For instance, a contact molded fitting requiring thrust blocking when installed would be designated a type “5R”.)

4.3 *Grades:*

4.3.1 *Grade 1*—Epoxy-resin.

4.3.2 *Grade 2*—Polyester-resin.

4.3.3 *Grade 3*—Phenolic-resin.

4.3.4 *Grade 4*—Vinylester resin.

4.3.5 *Grade 7*—Furan resin.

4.4 *Classes:*

4.4.1 *Class A*—No liner.

4.4.2 *Class B*—Polyester-resin liner (nonreinforced).

4.4.3 *Class C*—Epoxy-resin liner (nonreinforced).

4.4.4 *Class D*—Phenolic resin liner (nonreinforced).

4.4.5 *Class E*—Polyester-resin liner (reinforced).

4.4.6 *Class F*—Epoxy-resin liner (reinforced).

4.4.7 *Class G*—Phenolic resin liner (reinforced).

4.4.8 *Class H*—Thermoplastic-resin liner (specify).

4.4.9 *Class I*—Furan-resin liner (reinforced).

4.4.10 *Class J*—Vinylester resin liner (nonreinforced).

4.4.11 *Class K*—Vinylester resin liner (reinforced).

4.5 *Joint Categories (Method of Joining):*

4.5.1 *Category 1*—Taper-to-taper adhesive-bonded joint fittings manufactured with a tapered socket to be used in conjunction with a pipe or fitting with a matching spigot section and a suitable adhesive. This joining method provides an interference fit over the entire length of the bond line.

4.5.2 *Category 2*—Straight-taper adhesive-bonded joint fitting manufactured with a tapered socket to be used with a pipe or fitting with an untapered spigot section and a suitable adhesive. This joining method provides an interference fit at the bottom of the socket.

4.5.3 *Category 3*—Straight adhesive bonded joint fitting manufactured with an untapered socket for use with a pipe or fitting with an untapered spigot and a suitable adhesive. This joining provides no interference fit.

4.5.4 *Category 4*—Butt and strap joint made by a contact molding process which involves hand lay-up with glass-woven roving or chopped strand mat, or both, which is saturated with resin.

4.5.5 *Category 5*—Flanged fittings are available as all outlets flanged or as flange-by-joint specified in this specification. Flanges are in compliance with Specification D4024.

4.5.6 *Category 6*—Elastomeric (gasket) sealed joints with sealant manufactured in compliance with Specification F477 for joints which have integral longitudinal restraint and do not require thrust blocking or external longitudinal restraint.

4.5.7 *Category 7*—Elastomeric (gasket) sealed joints with seals manufactured in compliance with Specification F477 for joints which require thrust blocking or external longitudinal restraint.

4.6 *Pressure Rating*—Pressure rating shall be categorized by a single letter designation. Pressure designations are shown in Table 1. The pressure ratings are applicable for the temperature at which the fittings were tested and for lower temperatures down to −50°F (−46°C). When agreed upon between purchaser and manufacturer, pressure ratings determined by tests conducted following Practice D2992 are acceptable.

4.7 *Designation Code*—The fitting designation code shall consist of the abbreviation RTRF or RPMF followed by the type, grade, and class in Arabic numerals and the pressure rating category as a capital letter.

NOTE 4—An example is RTRF 21A2E. This designation describes a

TABLE 1 Pressure Categories

Designation	Pressure Rating[A] , psig (kPa)
A	25 (172)
B	50 (345)
C	100 (690)
D	150 (1034)
E	200 (1380)
F	250 (1724)
G	300 (2068)
H	400 (2759)
I	500 (3448)
J	1000 (6896)

[A] Pressure ratings are applicable only for the temperature at which the fittings were tested and for lower temperatures.

(Type 2) compression molded fitting with a (Grade 1) epoxy-resin without a liner (Class A), which is joined with a (Category 2) taper-to-taper adhesive joining system and has a 200 psig (1380 kPa) pressure rating.

NOTE 5—Fittings with identical classification from different manufacturers may not be interchangeable due to non-standardization of pipe or socket diameter, socket length, taper angle, or combination thereof.

5. Materials

5.1 Fittings manufactured in accordance with this specification shall be composed of reinforcement embedded in or surrounded by cured thermosetting-resin. The composite structure may contain granular or platelet fillers, thixotropic agents, pigments, or dyes.

5.2 The resins, fiberglass reinforcements, and other materials, when combined into a composite structure, shall produce a fitting that will meet the performance requirements of this specification.

6. Requirements

6.1 *Workmanship*—The fittings shall be free of all defects including indentations, delaminations, bubbles, pin holes, foreign inclusions, and resin starved areas, which, due to their nature, degree, or extent, detrimentally affect the strength and serviceability of the fitting. The fitting shall be as uniform as commercially practicable in color, opacity, and other physical properties.

6.2 *Dimensions and Tolerances*—All flanged fittings shall conform to the center line to flange face dimensions, hole size and hole pattern, and tolerances of ANSI B16.5 short or long radius type, or otherwise as agreed upon between the manufacturer and purchaser. Fitting center line to end dimensions, taper angles, taper length, or combinations thereof, will vary for non-flanged joining systems and the individual manufacturers shall be consulted for dimensions. Dimensions shall be measured in accordance with 7.3.

NOTE 6—Fittings with short radii which are not in compliance with ANSI B16.5 radius tolerances may be available.

6.3 *Fittings and Connections Pressure Test Requirements*—Fittings, couplings, and connections shall meet the following qualification requirements when tested with restrained ends for Type 6 fittings, and unrestrained ends for other type fittings, in accordance with 7.4.1 for short term hydrostatic strength tests, and 7.4.2 for cyclic or static tests.

6.3.1 Each type of component and its field-jointed configuration shall be capable of sustaining a short-time hydrostatic pressure, of at least four times its cyclic-rated pressure or three times its static-rated pressure for 1 min without visible weeping or leakage.

6.3.2 Each component shall meet or exceed the cyclic or static-test requirements of 7.4.2.

6.4 *Glass Transition Temperature (Tg)*—The Tg for each resin used, as determined by some thermal analysis method, shall be no less than a minimum statistically significant value established by the manufacturer. Samples shall be taken from manufactured fittings when thermal analysis testing is accomplished by differential-scanning-chlorimeter (DSC). Test in accordance with 7.5.

6.5 Factory leak tests shall be conducted at a pressure of 1.5 times pressure rating and at a frequency determined by an agreement between the purchaser and the seller.

6.6 For individual orders, only those additional test and number of tests specifically agreed upon between the purchaser and the seller need be conducted.

7. Test Methods

7.1 *Conditioning*—When conditioning is required, and in all cases of disagreement, condition the test specimens in accordance with Procedure A of Practice D618.

7.2 *Test Conditions*—The tests may be conducted at ambient temperature and humidity conditions. When controlled environment testing is specified, tests shall be conducted in the Standard Laboratory Atmosphere of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 10 % relative humidity. When elevated temperature testing is specified, conduct the tests at the design temperature ± 5.4°F (3°C).

7.3 *Dimensions and Tolerances*—Measure fitting dimensions in accordance with applicable documents and Practice D3567. Measure flange dimensions with a micrometer or vernier calipers, or other suitable measuring devices accurate to within ±0.001 in. (0.02 mm). Diameters shall be determined by averaging a minimum of four measurements, equally spaced circumferentially.

7.4 *Pressure Tests:*

7.4.1 *Short-Term Hydrostatic Strength Test*—Short-term hydrostatic failure pressure tests to determine compliance with 6.3 performed at ambient temperature in accordance with Test Method D1599 using specimens and sizes as described in 7.4.3. Leaking past the gasket interface of flanged fittings and elastomeric sealed fittings is permissible during this test, provided the pressure is at least two times the rating when the leak occurs. The bolt torquing sequence of Specification D4024, Fig. 2 shall be used when testing flanged fittings. Fittings without flanges shall be tested with the pipe they are to be used with joined to the fitting. Bending or shape restraint during the test is permitted to the extent applicable to its anticipated installed conditions. This information shall be contained in the test report.

7.4.2 *Cyclic or Static Pressure Test:*

7.4.2.1 For cyclic pressure tests, the gage pressure at the peak pressure of the cycle shall be not less than 2 times the pressure rating of the fitting. The cycle amplitude pressure shall be at least 80 % of the selected peak pressure.

7.4.2.2 For static pressure tests, the gage pressure shall be no less than 2 times the fitting static pressure rating.

7.4.2.3 Test each component specimen as required above with unrestrained ends and in accordance with Test Methods D2143 for cyclic tests, or D1598 for static tests at the components temperature rating.

7.4.2.4 Each component specimen must withstand 168 h for static tests or 252,000 cycles for cyclic tests, without failure.

7.4.3 *Test Specimens and Sample Size Requirements for Pressure Tests*—Test specimens shall include at least one fitting in each configuration, for example, 45° and 90° elbow, tee, flange, coupling (includes integral coupling) etc., joined to pipe sections at least 18 in. (0.5 m) long or 2 diameters, whichever is longer, using the joining method, design, and adhesive intended for field assembly. Specimen diameters for test in each configuration shall include the maximum product size in each pressure class and for each method of manufacture. In addition, smaller sizes in the pressure rating shall be tested as follows:

Product Size Range Nominal, in.[A]	Test Size, Nominal, in.
1, 1½, 2, 2½, 3	3
4, 6	6
8,10,12	12
14,16	16

[A] In each range of size, the manufacturer may elect to test a smaller product size to qualify only the smaller size.

7.4.4 *Requalification Tests for Fittings, Couplings, Connections, and Adhesives*—The qualification tests in 6.3 shall be repeated after any change in manufacturing process, construction, or type of materials.

NOTE 7—Fiberglass fittings short-term hydrostatic strength at ambient temperature is not necessarily greater than its short-term hydrostatic strength at all higher temperatures.

7.5 *Glass Transition Temperature*—Determine by using the procedure in Annex A1.

8. Marking

8.1 Mark each fitting with the following information:

8.1.1 The designation "ASTM D5685" with which the fitting complies,

8.1.2 Identification of the fitting in accordance with the designation code in 4.2,

8.1.3 Nominal fitting size,

8.1.4 Manufacturer's name (or trademark) and product designation, and

8.1.5 Pressure rating (cyclic or static), psig.

8.2 All required markings shall be legible and applied so as to remain legible under normal handling and installation practices.

9. Keywords

9.1 centrifugally cast; compression molded; contact molded; degree of cure; epoxy-resin; filament-wound; furan-resin; glass transition temperature; percent extractable material; polyester-resin; pressure-rating; transfer molded

ANNEX

(Mandatory Information)

A1. METHOD OF TEST FOR THE DETERMINAITON OF DEGREE OF CURE BY DIFFERENTIAL SCANNING CALORIMETRY (DSC)

A1.1. Scope

A1.1.1 This test determines whether the degree of cure of a fiberglass fitting test specimen meets the quality control requirements determined by statistical analysis of typical production products.

A1.2. Terminology

A1.2.1 *Definition:*

A1.2.1.1 *glass transition temperature*—the midpoint of the inflection temperature at the DSC curve (heat flow versus temperature).

A1.3. Apparatus

A1.3.1 *Differential Scanning Calorimeter (DSC).*

A1.4. Test Specimens

A1.4.1 *Size*—The size of the specimen is limited by the size of the DSC sample pan. All specimens can be a chip or filed into a fine powder to provide easy weighing and uniform contact with the pan.

A1.4.2 *Location*—For any given fitting, a sample should be taken 0 to 10 mils (0 to 0.025 m) from the outer surface, as well as 0 to 10 mils from the inner surface. If the fitting has a liner, a specimen should be taken from the liner, as well as the inner and outer edges of the overwrap.

A1.5. Procedure

A1.5.1 The maximum heating rate is 41°F (23°C)/min. The Tg is dependent upon heating rate, therefore a consistent heating rate must be used for all testing.

A1.5.2 Run the scan from room temperature to at least 22°F (12°C) above the expected glass transition temperature and no more than 482°F (250°C).

A1.5.3 Obtain the Tg_1 (midpoint of the inflection in the DSC curve).

A1.5.4 If the Tg is not within 9°F (16°C) of statistically significant value, cool down the DSC and run another sample again from room temperature to 54°F (30°C) above Tg_1 to obtain Tg_2.

A1.5.5 The values Tg_1 and Tg_2 obtained with the test sample should be compared to those statistically significant values obtained from typical production product. The measured and typical values should be within 9°F (16°C).

A1.6. Report

A1.6.1 Report the following information:

A1.6.1.1 Complete identification of the specimens, including material, manufacturer's name, and lot number.

A1.6.1.2 Fitting dimensions, including nominal size, minimum reinforced wall thickness, and average outside diameter of reinforced wall. Unreinforced thickness (that is, liner) shall also be reported.

A1.6.1.3 Number of specimens tested and where the specimens were taken from the fitting.

A1.6.1.4 Heat-up rate for DSC initial temperature and final temperature for both scans.

A1.6.1.5 Record glass transition temperature (inflection value) for the first scan as Tg_1.

A1.6.1.6 Record glass transition temperature (inflection value) for the second scan as Tg_2, if applicable.

A1.6.1.7 Date of test.