Designation: D 2997 – 9901

An American National Standard

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

This standard is issued under the fixed designation D 2997; 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 machine-made glass-fiber-reinforced thermosetting-resin pressure pipe manufactured by the centrifugal casting process. Included are a classification system and requirements for materials, mechanical properties, dimensions, performance, test methods, and marking.

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

NOTE 2—Pipe covered by this specification has been found suitable for conveying gases, petroleum products, or corrosive fluids.

NOTE 3—For the purposes of this standard, polymer does not include natural polymers.

1.2 The values given in parentheses are for information only.

NOTE ~~3~~4—There is no similar or equivalent ISO standard.

1.3 The following precautionary caveat pertains only to the test method portion, Section 7, 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.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 33 Specification for Concrete Aggregates[2]

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[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 Systems and Chemical Equipment.

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

D 618 Practice for Conditioning Plastics ~~and Electrical Insulating Materials~~ for Testing[3]
D 883 Terminology Relating to Plastics[3]
D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure[4]
D 1599 Test Method for Short-Term Hydraulic ~~Failure~~ Pressure of Plastic Pipe, Tubing, and Fittings[4]
D 1600 Terminology for Abbreviated Terms Relating to Plastics[3]
D 2105 Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube[4]
D 2143 Test Method for Cyclic Pressure Strength of Reinforced, Thermosetting Plastic Pipe[4]
D 2310 Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe[4]
D 2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading[4]
D 2992 Practice for Obtaining Hydrostatic Design or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings[4]
D 3567 Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings[4]
F 412 Terminology Relating to Plastic Piping Systems[4]

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:* Descriptions of Terms Specific to This Standard:

3.2.1 *aggregate*, *n*—a siliceous sand conforming to the requirements of Specification C 33, except that the requirements for gradation shall not apply.

3.2.2 *centrifugal casting*, *n*—a manufacturing process used to produce tubular goods by applying resin and reinforcement to the inside of a mold that is rotated and heated, subsequently polymerizing the resin system. The outside diameter (OD) of the finished pipe is fixed by the inside diameter (ID) of the mold tube. The inside diameter of the pipe is determined by the amount of material introduced into the mold.

3.2.3 *fiberglass pipe*, *n*—a tubular product containing glassfiber 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.

3.2.4 *liner*, *n*—the inner portion of the wall at least 0.005 in. (0.13 mm) in thickness, as determined in 7.4 which does not contribute to the strength in the determination of the hydrostatic design basis.

3.2.5 *reinforced ~~plastic~~ polymer mortar pipe (RPMP)*, *n*—a fiberglass pipe with aggregate.

3.2.6 *reinforced thermosetting resin pipe (RTRP)*, *n*—a fiberglass pipe without aggregate.

3.2.7 *reinforced wall thickness*, *n*—the total wall thickness minus the liner or exterior surface resin layer thickness, or both.

4. Classification

4.1 *General*—Pipe meeting this specification is classified by type, grade, class, and hydrostatic design basis in accordance with Classification D 2310, and by a secondary cell classification system that defines the basic mechanical properties of the pipe. These types, grades, classes, hydrostatic design basis categories, and cell classification designations are as follows:

4.1.1 *Types: —Type II*

Centrifugally cast pipe.

4.1.2 *Grades: —Grade 1*

Glass-fiber-reinforced epoxy-resin pipe.

Grade 2—Glass-fiber-reinforced polyester-resin pipe.

Grade 3—Glass-fiber reinforced polydicyclopentadiene-resin pipe.

Grade 8—Glass-fiber-reinforced polyester-resin mortar pipe.

Grade 9—Glass fiber reinforced epoxy resin mortar pipe.

4.1.3 *Classes:—Class A*

No liner.

Class B—Polyester-resin liner, nonreinforced.

Class C—Epoxy-resin liner, nonreinforced.

Class D—Polydicyclopentadiene-resin liner, nonreinforced.

4.1.4 *Hydrostatic Design Basis*—Two methods of classifying the hydrostatic design basis of the pipe are provided. Pipe meeting this specification may be classified using either the cyclic test method or the static test method, or both, and the designations are shown in Table 1. Appendix X1 explains how to use the design basis categories shown in Table 1.

[2] *Annual Book of ASTM Standards*, Vol 04.02.
[3] *Annual Book of ASTM Standards*, Vol 08.01.
[4] *Annual Book of ASTM Standards*, Vol 08.04.

TABLE 1 Hydrostatic Design Basis Categories

Cyclic Test Method		Static Test Method	
Designation	Hoop Stress, psi (MPa)	Designation	Hoop Stress, psi (MPa)
A	2 500 (17.2)	Q	5 000 (34.5)
B	3 150 (21.7)	R	6 300 (43.4)
C	4 000 (27.6)	S	8 000 (55.2)
D	5 000 (34.5)	T	10 000 (68.9)
E	6 300 (43.4)	U	12 500 (86.2)
F	8 000 (55.2)	W	16 000 (110)
G	10 000 (68.9)	X	20 000 (138)
H	12 500 (86.2)	Y	25 000 (172)
		X	31 500 (217)

4.1.5 *Mechanical Properties*—Table 2 presents a cell classification system for identifying the mechanical properties of pipe covered by this specification.

NOTE 4~~5~~—All possible combinations covered by the preceding classification system may not be commercially available.

4.1.6 *Designation Code*—The pipe designation code shall consist of the abbreviation RTRP or RPMP, followed by the type and grade in Arabic numerals, the class and static or cyclic hydrostatic design basis level in capital letters, and four Arabic numbers identifying, respectively, the cell classification designations of the short-term rupture strength, longitudinal tensile strength, tensile modulus, and pipe stiffness. Thus, a complete pipe designation code shall consist of four letters, two numerals, two letters, and four numerals.

4.1.6.1 *Example*—RTRP-21CA-1334. Such a designation would describe a centrifugally cast, glass-fiber-reinforced, epoxy pipe having a nonreinforced epoxy liner; a long-term cyclic pressure strength level exceeding 2500 psi (17.2 MPa); a short-term rupture strength exceeding 4000 psi (27.6 MPa); a longitudinal tensile strength exceeding 16 000 psi (110 MPa); a longitudinal tensile modulus exceeding 1.5 by 10^6 psi (10 300 MPa); and a pipe stiffness of 72 psi (496 kPa).

NOTE 5~~6~~—Although the *Form and Style for ASTM Standards* manual requires that the type classification be roman numerals, it is recognized that few companies have stencil-cutting equipment for this style of type, and it is therefore acceptable to mark the product type in arabic numbers.

5. Materials

5.1 *General*—The resins, reinforcements, colorants, fillers, and other materials, when combined as a composite structure, shall produce a pipe that shall be classified in accordance to this specification based on performance.

6. Requirements

6.1 *Workmanship*—The pipe shall be free from all defects, including indentations, delaminations, bubbles, pinholes, foreign inclusions, and resin-starved areas which, as a result of their nature, degree, or extent, detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in color, opacity, density, and other physical properties. The pipe shall be round and straight, and the bore of the pipe shall be smooth and uniform. All pipe ends shall be cut at right angles to the axis of the pipe, and any sharp edges removed.

6.2 *Dimensions and Tolerances*:

6.2.1 *Outside Diameter*—The outside diameter and tolerances of pipe meeting this specification shall conform to the requirements in Table 3, when determined in accordance with 7.4.

6.2.2 *Wall Thickness*—The minimum wall thickness of pipe furnished under this specification shall not at any point be less than 87.5 % of the nominal wall thickness published in the manufacturer's literature, current at the time of purchase, when measured in accordance with 7.4.

TABLE 2 Physical Property Requirements

Designation Order Number	Mechanical Property	Cell Limits						
		0[A]	1	2	3	4	5	6
1	Short time rupture strength hoop tensile stress, min, psi (MPa)	—	4 000 (27.6)	12 000 (82.7)	22 000 (152)	30 000 (207)	40 000 (276)	50 000 (345)
2	Longitudinal tensile strength, min, psi (MPa)	—	2 000 (13.8)	8 000 (55.2)	16 000 (110)	22 000 (152)	30 000 (207)	40 000 (276)
3	Longitudinal tensile modulus, min, psi × 10^6 (MPa)	—	0.6 (4 100)	1.3 (9 000)	1.5 (10 300)	1.9 (13 100)	2.5 (17 200)	3.0 (20 700)
4	Pipe stiffness at 5 % deflection, psi (kPa)	—	9 (62)	18 (124)	36 (248)	72 (496)	144 (993)	288 (1 986)

[A] 0 = Unspecified.

TABLE 3 Outside Dimensions and Tolerances

Nominal Pipe Size, in.	in.	(mm)
1	1.315 ± 0.009	(33.401 ± 0.229)
1½	1.900 ± 0.009	(48.260 ± 0.229)
2	2.375 ± 0.012	(60.325 ± 0.305)
2½	2.875 ± 0.012	(73.025 ± 0.305)
3	3.500 ± 0.012	(88.900 ± 0.305)
4	4.500 ± 0.015	(114.300 ± 0.381)
6	6.625 ± 0.025	(168.275 ± 0.635)
8	8.625 ± 0.025	(219.075 ± 0.635)
10	10.750 ± 0.025	(273.050 ± 0.635)
12	12.750 ± 0.025	(323.850 ± 0.635)
14	14.000 ± 0.035	(355.600 ± 0.889)

6.2.3 *Liner Thickness*—Except for Class A unlined products, all other classes shall have a minimum liner thickness of 0.005 in. (5 mil), when measured in accordance with 7.4.

6.3 *Performance*—Pipe meeting this specification shall be categorized by a long-term static or cyclic hydrostatic design basis shown in Table 1, when tested in accordance with 7.5 and 7.6. Additionally, the pipe shall meet the applicable cell limit requirements for short-term rupture strength, longitudinal tensile strength, tensile modulus, and pipe stiffness described in Table 2, when tested in accordance with 7.7, 7.8, and 7.9.

7. Test Methods

7.1 *Conditioning*—Condition the test specimens at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity for not less than 48 h prior to test, in accordance with Procedure A of Practice D 618, for those tests where conditioning is required, and in all cases of disagreement.

7.2 *Test Conditions*—Conduct the tests in the Standard Laboratory Atmosphere of 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity, unless otherwise specified in the test specification.

7.3 *Sampling*—Samples of pipe to determine conformance of the material to be short-term rupture requirements shown in Table 2 shall be taken at random on a weekly basis or on each production run, whichever is the most frequent. The rate of sampling for the other tests listed shall be in accordance with the accepted statistical practice and as agreed upon between the purchaser and the seller.

NOTE 67—For individual orders, only those additional tests and number of tests specifically agreed upon between the purchaser and the seller need be conducted.

7.4 *Dimensions and Tolerances*—Determine in accordance with Practice D 3567.

7.5 *Long-Term Cyclic Pressure Strength*—Determine in accordance with Procedure A of Practice D 2992.

7.6 *Long-Term Static Pressure Strength*—Determine in accordance with Procedure B of Practice D 2992.

7.7 *Short-Term Rupture Strength*—Determine in accordance with Test Method D 1599.

7.8 *Longitudinal Tensile Properties*—Determine in accordance with Test Method D 2105.

7.9 *Pipe Stiffness*—Determine in accordance with Test Method D 2412. The reported stiffness shall be based on 5 % deflection.

8. Certification

8.1 When agreed upon in writing by the purchaser and the seller, a certification shall be made the basis of acceptance of the material. This shall consist of a copy of the manufacturer's test report or a statement by the seller accompanied by a copy of the test results, that the material has been sampled, tested, and inspected in accordance with the provisions of the specification. Each certification so furnished shall be signed by an authorized agent of the seller or the manufacturer.

8.2 When original identity cannot be established, certification can only be based on the sampling procedure provided by the applicable specification.

9. Marking

9.1 Each piece shall be marked at least once and at lengths of at least every 15 ft. Each piece of pipe shall be marked with the following information in such a manner that it remains legible under normal handling and installation practices:

9.1.1 Nominal pipe size (for example, 2 in.),

9.1.2 Identification of fiberglass pipes in accordance with the designation code given in Section 5,

9.1.3 This designation, D 2997, with which the pipe complies, and

9.1.4 Manufacturer's name (or trademark).

APPENDIX

(Nonmandatory Information)

X1. HYDROSTATIC DESIGN BASIS, CATEGORIES, SERVICE FACTORS, AND PRESSURE RATINGS

X1.1 Hydrostatic Design Basis

X1.1.1 The hydrostatic design basis is the estimated long-term hydrostatic strength on which service factors (1.0 or less) are applied to obtain a hydrostatic design stress. The long-term hydrostatic strength is obtained by Practice D 2992. In Practice D 2992, either Procedure A using data obtained in accordance with Test Method D 2143 or Procedure B using data obtained in accordance with Test Method D 1598 is used to determine the long-term hydrostatic strength extrapolated at 50 years.

X1.1.2 The long-term hydrostatic strength is the estimated tensile stress in the wall of the pipe in the hoop orientation due to internal hydrostatic pressure that will cause failure after 50 years (657×10^6 pressure cycles by Procedure A or 438 000 h of static pressure by Procedure B).

X1.2 Hydrostatic Design Basis Categories

X1.2.1 The hydrostatic design basis is obtained by categorizing the long-term strength in accordance with Table X1.1 or Table X1.2.

X1.3 Service (Design) Factor

X1.3.1 The service (design) factor is a number equal to 1.00 or less that takes into consideration all the variables and degree of safety involved in a fiberglass pressure piping installation, and is selected for the application on the basis of two general groups of conditions.

X1.3.2 The first group considers the manufacturing and testing variables, specifically normal variations in the material, manufacture, dimensions, good handling techniques, and in the evaluation procedures of this method. The second group considers the application or use, specifically installation, environment, temperature, hazard involved, life expectance desired, and the degree of reliability selected.

NOTE X1.1—It is not the intent of this specification to give service (design) factors. The service (design) factor should be selected by the design engineer after evaluating fully the service conditions and the engineering properties of the specific pipe material under consideration. Recommended service (design) factors will not be developed or issued by ASTM.

X1.4 Hydrostatic Design Stress

X1.4.1 The hydrostatic design stress is the estimated maximum tensile stress in the wall of the pipe in the circumferential orientation as a result of internal hydrostatic pressure that can be applied continuously with a high degree of certainty that failure will not occur. It is obtained by multiplying the hydrostatic design basis as determined by Procedure A or Procedure B by the service (design) factor.

X1.5 Pressure Rating

X1.5.1 The pressure rating is the estimated maximum pressure that the medium in the pipe can exert continuously with a high degree of certainty that failure of the pipe will not occur.

X1.5.2 The pressure rating for each diameter and wall thickness of pipe and fitting is calculated from the hydrostatic design stress for the specific pipe by means of the ISO formula:

$$S = P\,(D - t)/2t$$

TABLE X1.1 Hydrostatic Design Basis Categories by Procedure A

Hydrostatic Design Basis Category, psi (MPa)	Range of Calculated Values, psi (MPa)
2 500 (17.2)	2 400 to 3 010 (16.5 to 20.8)
3 150 (21.7)	3 020 to 3 820 (20.8 to 26.3)
4 000 (27.6)	3 830 to 4 790 (26.4 to 33.0)
5 000 (34.5)	4 800 to 5 900 (33.1 to 40.7)
6 300 (43.4)	6 000 to 7 500 (41.4 to 51.7)
8 000 (55.2)	7 600 to 9 500 (52.4 to 65.5)
10 000 (68.9)	9 600 to 11 900 (66.2 to 82.0)
12 500 (86.2)	12 000 to 15 200 (82.7 to 105)

TABLE X1.2 Hydrostatic Design Basis Categories by Procedure B

Hydrostatic Design Basis Category, psi (MPa)	Range of Calculated Values, psi (MPa)
5 000 (34.5)	4 800 to 5 900 (33.1 to 40.7)
6 300 (43.4)	6 000 to 7 500 (41.4 to 51.7)
8 000 (55.2)	7 600 to 9 500 (52.4 to 65.5)
10 000 (68.9)	9 600 to 11 900 (66.2 to 82.0)
12 500 (86.2)	12 000 to 15 200 (82.7 to 105)
16 000 (110)	15 300 to 18 900 (106 to 130)
20 000 (138)	19 000 to 23 000 (131 to 159)
25 000 (172)	24 000 to 29 000 (166 to 200)
31 500 (217)	30 000 to 38 000 (207 to 262)

where:
S = hoop stress,
P = internal pressure,
D = average outside diameter, and
t = minimum reinforced wall thickness.

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue, D 2997–99, that may impact this standard.

(*1*) Changed acronym, RPMP, definition from reinforced *plastic* mortar pipe to reinforced *polymer* mortar pipe.