



Designation: D3517 – 19

Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe¹

This standard is issued under the fixed designation D3517; 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 machine-made fiberglass pipe, 8 in. (200 mm) through 156 in. (4000 mm), intended for use in water conveyance systems which operate at internal gage pressures of 450 psi (3103 kPa) or less. Both glass-fiber-reinforced thermosetting-resin pipe (RTRP) and glass-fiber-reinforced polymer mortar pipe (RPMP) are fiberglass pipes. The standard is suited primarily for pipes to be installed in buried applications, although it may be used to the extent applicable for other installations such as, but not limited to, jacking, tunnel lining and slip-lining rehabilitation of existing pipelines.

NOTE 1—For the purposes of this standard, polymer does not include natural polymers.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

NOTE 2—There is no known ISO equivalent to this standard.

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

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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 and Chemical Equipment.

Current edition approved Aug. 1, 2019. Published August 2019. Originally approved in 1976. Last previous edition approved 2014 as D3517 – 14. DOI: 10.1520/D3517-19.

2. Referenced Documents

2.1 ASTM Standards:²

- C33/C33M Specification for Concrete Aggregates
- D638 Test Method for Tensile Properties of Plastics
- D695 Test Method for Compressive Properties of Rigid Plastics
- D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- D883 Terminology Relating to Plastics
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D2290 Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe
- D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
- D2584 Test Method for Ignition Loss of Cured Reinforced Resins
- D2992 Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
- D3567 Practice for Determining Dimensions of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
- D3892 Practice for Packaging/Packing of Plastics
- D4161 Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
- F412 Terminology Relating to Plastic Piping Systems
- F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

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.

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

2.2 ISO Standard:

ISO 1172 Textile Glass Reinforced Plastics—Determination of Loss on Ignition³

2.3 NSF Standard:

Standard No. 61 Drinking Water System Components⁴

3. Terminology

3.1 Definitions:

3.1.1 *General*—Definitions are in accordance with Terminology **D883** and Terminology **F412** and abbreviations are in accordance with Terminology **D1600**, unless otherwise indicated.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *fiberglass pipe*—a 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.

3.2.2 *flexible joint*—a joint that is capable of axial displacement or angular rotation, or both.

3.2.3 *liner*—a resin layer, with or without filler, or reinforcement, or both, forming the interior surface of the pipe.

3.2.4 *qualification test*—one or more tests used to prove the design of a product. Not a routine quality control test.

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

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

3.2.7 *rigid joint*—a joint that is not capable of axial displacement or angular rotation.

3.2.8 *surface layer*—a resin layer, with or without filler, or reinforcements, or both, applied to the exterior surface of the pipe structural wall.

4. Classification

4.1 *General*—This specification covers fiberglass pressure pipe defined by raw materials in the structural wall (type) and liner, surface layer material (grade), operating pressure (class), and pipe stiffness. **Table 1** lists the types, liners, grades, classes, and stiffnesses that are covered.

NOTE 3—All possible combinations of types, liners, grades, classes, and stiffnesses may not be commercially available. Additional types, liners, grades, and stiffnesses may be added as they become commercially available. The purchaser should determine for himself or consult with the manufacturer for the proper class, type, liner, grade and stiffness of pipe to be used under the installation and operating conditions that will exist for the project in which the pipe is to be used.

4.2 *Designation Requirements*—The pipe materials designation code shall consist of the standard designation, ASTM D3517, followed by type, liner, and grade in Arabic numerals, class by the letter C and two or three Arabic numerals, and pipe

stiffness by a capital letter. **Table 1** presents a summary of the designation requirements. Thus, a complete material code shall consist of ASTM D3517. . . three numerals, C . . . and two or three numerals, and a capital letter.

NOTE 4—Examples of the designation are as follows: (1) ASTM D3517-1-1-3-C50-A for glass-fiber reinforced aggregate and polyester resin mortar pipe with a reinforced thermoset liner and an unreinforced polyester resin and sand surface layer, for operation at 50 psi (345 kPa), and having a minimum pipe stiffness of 9 psi (62 kPa), (2) ASTM D3517-4-2-6-C200-C for glass-fiber reinforced epoxy resin pipe with a non-reinforced thermoset liner, no surface layer, for operation at 200 psi (1380 kPa), and having a minimum pipe stiffness of 36 psi (248 kPa).

NOTE 5—Although the “Form and Style for ASTM Standards” manual requires that the type classification be roman numerals, it is recognized that 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 and Manufacture

5.1 *General*—The thermosetting resins, glass fiber reinforcements, fillers, and other materials, when combined as a composite structure, shall produce piping products that meet the performance requirements of this specification.

5.2 *Wall Composition*—The basic structural wall composition shall consist of thermosetting resin, glass fiber reinforcement, and, if used, an aggregate filler.

5.2.1 *Resin*—A thermosetting polyester or epoxy resin, with or without filler.

5.2.2 *Reinforcement*—A commercial grade of glass fibers compatible with the resin used.

5.2.3 *Aggregate*—A siliceous sand conforming to the requirements of Specification **C33/C33M**, except that the requirements for gradation shall not apply.

NOTE 6—Fiberglass pipe intended for use in the transport of potable water should be evaluated and certified as safe for this purpose by a testing agency acceptable to the local health authority. The evaluation should be in accordance with requirements for chemical extraction, taste, and odor that are no less restrictive than those included in National Sanitation Foundation (NSF) Standard No. 61. The seal or mark of the laboratory making the evaluation should be included on the fiberglass pipe.

5.3 *Liner and Surface Layers*—Liner or surface layer, or both, when incorporated into or onto the pipe, shall meet the structural requirements of this specification.

5.4 *Joints*—The pipe shall have a joining system that shall provide for fluid tightness for the intended service condition. A particular type of joint may be restrained or unrestrained and flexible or rigid depending on the specific configuration and design conditions.

5.4.1 *Unrestrained*—Pipe joints capable of withstanding internal pressure but not longitudinal tensile loads.

5.4.1.1 *Coupling or Bell-and-Spigot Gasket Joints*, with a groove either on the spigot or in the bell to retain an elastomeric gasket that shall be the sole element of the joint to provide watertightness. For typical joint details see **Fig. 1**.

5.4.1.2 *Mechanical Coupling Joint*, with elastomeric seals.

5.4.1.3 *Butt Joint*, with laminated overlay.

5.4.1.4 *Flanged Joint*, both integral and loose ring.

5.4.2 *Restrained*—Pipe joints capable of withstanding internal pressure and longitudinal tensile loads..

5.4.2.1 Joints similar to those in **5.4.1.1** with supplemental restraining elements.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁴ Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, <http://www.nsf.org>.



TABLE 1 General Designation Requirements for Fiberglass Pressure Pipe

Designation Order	Property	Cell Limits (Note 1)
1	Type	<p>1 glass-fiber-reinforced thermosetting polyester (Note 2) resin mortar (RPMP polyester (Note 2)) reinforced thermoset liner</p> <p>2 glass-fiber-reinforced thermosetting polyester (Note 2) resin mortar (RTRP polyester (Note 2)) non-reinforced thermoset liner</p> <p>3 glass-fiber-reinforced thermosetting epoxy resin mortar (RPMP epoxy) thermoplastic liner</p> <p>4 glass-fiber-reinforced thermosetting epoxy resin (RTRP epoxy) no liner</p>
2	Liner	
3	Grade	<p>1 polyester (Note 2) resin surface layer—reinforced</p> <p>2 polyester (Note 2) resin surface layer—non-reinforced</p> <p>3 polyester (Note 2) resin and sand surface layer nonreinforced</p> <p>4 epoxy resin surface layer—reinforced</p> <p>5 epoxy resin surface layer—non-reinforced</p> <p>6 no surface layer</p>
4	Class (Note 3)	C50 C100 C150 C200 C250 C300 C350 C400 C450
5	Pipe Stiffness psi (kPa)	<p>A 9 (62)</p> <p>B 18 (124)</p> <p>C 36 (248)</p> <p>D 72 (496)</p>

NOTE 1—The cell-type format provides the means of identification and specification of piping materials. This cell-type format, however, is subject to misapplication since unobtainable property combinations can be selected if the user is not familiar with non-commercially available products. The manufacturer should be consulted.

NOTE 2—For the purposes of this standard, polyester includes vinyl ester resins.

NOTE 3—Based on operating pressure in psig (numerals).

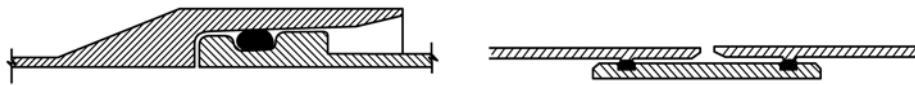


FIG. 1 Typical Joints

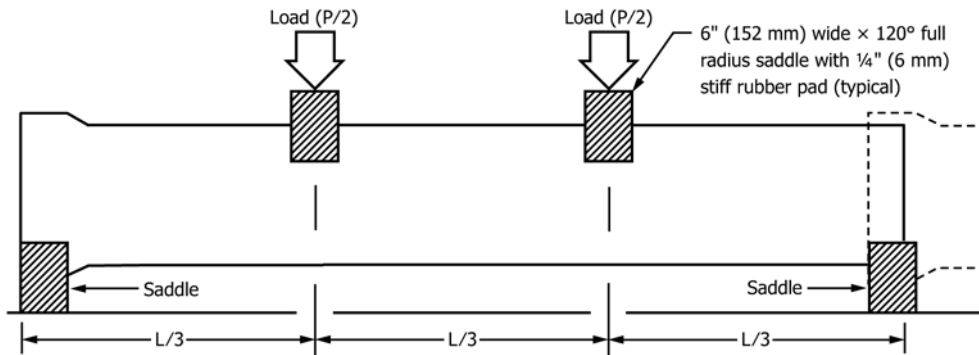


FIG. 2 Beam Strength—Test Setup

5.4.2.2 *Butt Joint*, with laminated overlay.

5.4.2.3 *Bell-and-Spigot*, with laminated overlay.

5.4.2.4 *Bell-and-Spigot*, adhesive-bonded joint: Three types of adhesive-bonded joints are permitted by this standard as follows:

(1) *Tapered bell-and-spigot*, an adhesive joint that is manufactured with a tapered socket for use in conjunction with a tapered spigot and a suitable adhesive.

(2) *Straight bell-and-spigot*, an adhesive joint that is manufactured with an untapered socket for use in conjunction with an untapered spigot and a suitable adhesive.

(3) *Tapered bell and straight spigot*, an adhesive joint that is manufactured with a tapered socket for use with an untapered spigot and a suitable adhesive.

5.4.2.5 *Flanged Joint*, both integral and loose ring

5.4.2.6 *Mechanical Coupling*, an elastomeric sealed coupling with a supplemental restraining elements.

5.4.2.7 *Threaded Joints*.

NOTE 7—Other types of joints may be added as they become commercially available.

NOTE 8—Restrained joints typically increase service loads on the pipe to greater than those experienced with unrestrained joints. The purchaser is cautioned to take into consideration all conditions that may be encountered in the anticipated service and to consult the manufacturer regarding the suitability of a particular type and class of pipe for service with restrained joint systems.

5.5 *Gaskets*—Elastomeric gaskets when used with this pipe shall conform to the requirements of Specification F477.

6. Requirements

6.1 Workmanship:

6.1.1 Each pipe shall be free from all defects including indentations, delaminations, bubbles, pinholes, cracks, pits, blisters, foreign inclusions, and resin-starved areas that due to 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.

6.1.2 The inside surface of each pipe shall be free of bulges, dents, ridges, and other defects that result in a variation of inside diameter of more than $\frac{1}{8}$ in. (3.2 mm) from that obtained on adjacent unaffected portions of the surface. No glass fiber reinforcement shall penetrate the interior surface of the pipe wall.

6.1.3 Joint sealing surfaces shall be free of dents, gouges, and other surface irregularities that will affect the integrity of the joints.

6.2 Dimensions:

6.2.1 *Pipe Diameters*—Pipe shall be supplied in the nominal diameters shown in Table 2 or Table 3. The pipe diameter tolerances shall be as shown in Table 2 or Table 3, when measured in accordance with 8.1.1.

6.2.2 *Lengths*—Pipe shall be supplied in nominal lengths of 10, 20, 30, 40, and 60 ft. (3.05, 6.10, 9.15, 12.19, and 18.29 m). The actual laying length shall be the nominal length ± 2 in. (± 51 mm), when measured in accordance with 8.1.2. At least 90 % of the total footage of any one size and class, excluding special order lengths, shall be furnished in the nominal lengths specified by the purchaser. Random lengths, if furnished, shall not vary from the nominal lengths by more than 5 ft (1.53 m) or 25 %, whichever is less.

6.2.3 *Wall Thickness*—The average wall thickness of the pipe shall not be less than the nominal wall thickness published in the manufacturer's literature current at the time of purchase, and the minimum wall thickness at any point shall not be less than 87.5 % of the nominal wall thickness when measured in accordance with 8.1.3.

6.2.4 *Squareness of Pipe Ends*—All points around each end of a pipe unit shall fall within $\pm \frac{1}{4}$ in. (± 6.4 mm) or ± 0.5 % of the nominal diameter of the pipe, whichever is greater, to a plane perpendicular to the longitudinal axis of the pipe, when measured in accordance with 8.1.4.

6.3 *Soundness*—Unless otherwise agreed upon between purchaser and supplier, test each length of pipe up to 96 in. (2400 mm) diameter hydrostatically without leakage or cracking, at

TABLE 2 Nominal Inside Diameters (ID) and Tolerances Inside Diameter Control Pipe

Inch-Pound Units		SI Units			
Nominal Diameter ^A , in.	Tolerance, in.	Nominal Metric Diameter ^B , mm	ID Range ^B , mm		Tolerance ^B on Declared ID, mm
			Minimum	Maximum	
8	±0.25	200	196	204	±1.5
10	±0.25	250	246	255	±1.5
12	±0.25	300	296	306	±1.8
14	±0.25	400	396	408	±2.4
15	±0.25	500	496	510	±3.0
16	±0.25	600	595	612	±3.6
18	±0.25	700	695	714	±4.2
20	±0.25	800	795	816	±4.2
21	±0.25	900	895	918	±4.2
24	±0.25	1000	995	1020	±5.0
27	±0.27	1200	1195	1220	±5.0
30	±0.30	1400	1395	1420	±5.0
33	±0.33	1600	1595	1620	±5.0
36	±0.36	1800	1795	1820	±5.0
39	±0.39	2000	1995	2020	±5.0
42	±0.42	(2200)	2195	2220	±6.0
45	±0.45	2400	2395	2420	±6.0
48	±0.48	(2600)	2595	2620	±6.0
51	±0.51	2800	2795	2820	±6.0
54	±0.54	(3000)	2995	3020	±6.0
60	±0.60	3200	3195	3220	±7.0
66	±0.66	(3400)	3395	3420	±7.0
72	±0.72	3600	3595	3620	±7.0
78	±0.78	(3800)	3795	3820	±7.0
84	±0.84	4000	3995	4020	±7.0
90	±0.90	...	...	...	...
96	±0.96	...	...	...	...
102	±1.00	...	...	...	...
108	±1.00	...	...	...	...
114	±1.00	...	...	...	...
120	±1.00	...	...	...	...
132	±1.00	...	...	...	...
144	±1.00	...	...	...	...
156	±1.00	...	...	...	...

^AInside diameters other than those shown shall be permitted by agreement between purchaser and supplier.

^BValues are taken from International Standards Organization documents. Parentheses indicate non-preferred diameters.

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the internal hydrostatic proof pressures specified for the applicable class in **Table 4**, when tested in accordance with **8.2**. For sizes over 96 in. (2400 mm), the frequency of hydrostatic leak tests shall be as agreed upon by purchaser and supplier.

6.4 Hydrostatic Design Basis:

6.4.1 Long-Term Hydrostatic Pressure—The pressure classes shall be based on long-term hydrostatic pressure data obtained in accordance with **8.3** and categorized in accordance with **Table 5**. Pressure classes are based on extrapolated strengths at 50 years. For pipe subjected to longitudinal loads or circumferential bending, the effect of these conditions on the hydrostatic design pressure, classification of the pipe must be considered.

6.4.2 Control Requirements—Test pipe specimens periodically in accordance with Practice **D2992**.

NOTE 9—Hydrostatic design basis (HDB—extrapolated value at 50 years) determined in accordance with Procedure A of Practice **D2992**, may be substituted for the Procedure B evaluation required by **8.3**. It is generally accepted that the Procedure A HDB value times 3 is equivalent to the Procedure B HDB value.

6.5 Stiffness—Each length of pipe shall have sufficient strength to exhibit the minimum pipe stiffness ($F/\Delta y$) specified in **Table 6**, when tested in accordance with **8.4**. At deflection level A per **Table 7**, there shall be no visible damage in the test

specimen evidenced by surface cracks. At deflection level B per **Table 7**, there shall be no indication of structural damage as evidenced by interlaminar separation, separation of the liner or surface layer (if incorporated) from the structural wall, tensile failure of the glass fiber reinforcement, and fracture or buckling of the pipe wall.

NOTE 10—This is a visual observation (made with the unaided eye) for quality control purposes only and should not be considered a simulated service test. **Table 7** values are based on an in-use long-term deflection limit of 5 % and provide an appropriate uniform safety margin for all pipe stiffnesses. Since the pipe stiffness values ($F/\Delta y$) shown in **Table 6** vary, the percent deflection of the pipe under a given set of installation conditions will not be constant for all pipes. To avoid possible misapplication, take care to analyze all conditions which might affect performance of the installed pipe.

6.5.1 For other pipe stiffness levels, appropriate values for Level A and Level B deflections (**Table 7**) may be computed as follows:

$$\text{Level A at new PS} = \left(\frac{72}{\text{new PS}} \right)^{0.33} \quad (9) \quad (1)$$

$$\text{Level B at new PS} = \text{new Level A} \div 0.6$$

6.5.2 Since products may have use limits of other than 5 % long-term deflection, Level A and Level B deflections (**Table 7**) may be proportionally adjusted to maintain equivalent in-use

TABLE 3 Nominal Outside Diameters (OD) and Tolerances

NOTE 1—The external diameter of the pipe at the spigots shall be within the tolerances given in the table, and the manufacturer shall declare his allowable maximum and minimum spigot diameters. Some pipes are manufactured such that the entire pipe meets the OD tolerances while other pipes meet the tolerances at the spigots, in which case, if such pipes are cut (shortened) the ends may need to be calibrated to meet the tolerances.

Nominal Pipe Size, in.	Steel Pipe Equivalent (IPS) OD's, in.	Tolerance, in.	Cast Iron Pipe Equivalent OD's, in.	Tolerance, in.
8	8.625	+0.086	9.05	±0.06
10	10.750	-0.040	11.10	
12	12.750	+0.108	13.20	
14	14.000	-0.048	15.30	
16	16.000	+0.128	17.40	+0.05 -0.08
18	...	-0.062	19.50	
20	...	+0.160	21.60	
24	...	-0.070	25.80	
30	32.00	+0.08 -0.06
36	...	...	38.30
42	...	...	44.50
48	...	...	50.80
54	57.56	
60	61.61	

Metric Pipe Size, mm	Ductile Iron Pipe Equivalent, mm	Tolerance Upper, mm	Tolerance Lower, mm	International O.D., mm	Tolerance Upper, mm	Tolerance Lower, mm
200	220.0	+1.0	0.0	...	...	...
250	271.8	+1.0	-0.2	...	...	...
300	323.8	+1.0	-0.3	310	+1.0	-1.0
350	375.7	+1.0	-0.3	361	+1.0	-1.2
400	426.6	+1.0	-0.3	412	+1.0	-1.4
450	477.6	+1.0	-0.4	463	+1.0	-1.6
500	529.5	+1.0	-0.4	514	+1.0	-1.8
600	632.5	+1.0	-0.5	616	+1.0	-2.0
700				718	+1.0	-2.2
800				820	+1.0	-2.4
900				924	+1.0	-2.6
1000				1026	+2.0	-2.6
1200				1229	+2.0	-2.6
1400				1434	+2.0	-2.8
1600				1638	+2.0	-2.8
1800				1842	+2.0	-3.0
2000				2046	+2.0	-3.0
2200				2250	+2.0	-3.2
2400				2453	+2.0	-3.4
2600				2658	+2.0	-3.6
2800				2861	+2.0	-3.8
3000				3066	+2.0	-4.0
3200				3270	+2.0	-4.2
3400				3474	+2.0	-4.4
3600				3678	+2.0	-4.6
3800				3882	+2.0	-4.8
4000				4086	+2.0	-5.0

safety margins. For example, a 4 % long-term limiting deflection would result in a 20 % reduction of Level A and Level B deflections, while a 6 % limiting deflection would result in a 20 % increase in Level A and Level B deflection values. However, minimum values for Level A and Level B deflections shall be equivalent to strains of 0.6 and 1.0 % respectively (as computed by Eq X1.4 in Appendix X1 of Specification D3262).

6.5.3 For high stiffness pipes, 5 % deflection will likely be above the use limit and the adjusted level A test deflection. For very high stiffness pipes, 5 % deflection may also be greater than the adjusted level B test deflection. In such cases, the pipes may be damaged or fail prior to determining the pipe stiffness at 5 % deflection. Therefore, it is permitted to set the pipe stiffness test deflection equal to the adjusted level A