Designation: D 3262 – 06

An American National Standard

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

This standard is issued under the fixed designation D 3262; 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 gravity-flow systems for conveying sanitary sewage, storm water, and some industrial wastes. Both glass-fiber-reinforced thermosetting-resin pipe (RTRP) and glass-fiber-reinforced polymer mortar pipe (RPMP) are fiberglass pipes.

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

1.2 Although this specification is suited primarily for pipes to be installed in buried applications, it may be used to the extent applicable for other installations such as, but not limited to, jacking, tunnel lining and sliplining rehabilitation of existing pipelines.

NOTE 2—There is no similar or equivalent ISO standard.

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

1.4 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 problems, 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:* [2]

C 33 Specification for Concrete Aggregates

D 638 Test Method for Tensile Properties of Plastics

D 695 Test Method for Compressive Properties of Rigid Plastics

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D 883 Terminology Relating to Plastics

D 1600 Terminology for Abbreviated Terms Relating to Plastics

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

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins

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

D 3567 Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings

D 3681 Test Method for Chemical Resistance of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe in a Deflected Condition

D 3892 Practice for Packaging/Packing of Plastics

D 4161 Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals

F 412 Terminology Relating to Plastic Piping Systems

F 477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

2.2 *AWWA Standard:*

Standard C-950, Glass-Fiber Reinforced Thermosetting Resin Pipe[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *General*—Unless otherwise indicated, definitions are in accordance with Terminology D 883 or Terminology F 412, and abbreviations are in accordance with Terminology D 1600.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *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.

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[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.

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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 Water Works Association (AWWA) 6666 W. Quincy Ave., Denver, CO 80235

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)*—fiberglass pipe with aggregate.

3.2.6 *reinforced thermosetting resin pipe (RTRP)*—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 reinforcement, or both, applied to the exterior surface of the pipe structural wall.

4. Classification

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

NOTE 3—All possible combinations of types, liners, grades, 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 type, liner, grade, and stiffness of pipe to be used under the installation and operating conditions that will exist for the project in which pipe is to be used.

4.2 *Designation Requirements*—The pipe materials designation code shall consist of the standard designation, ASTM D 3262, followed by type, liner, and grade indicated in 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 D 3262, three numerals, and a capital letter.

NOTE 4—Examples of the designation codes are as follows: *(1)* ASTM D 3262-1-1-3-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 having a minimum pipe stiffness of 9 psi (62 kPa). *(2)* ASTM D 3262-4-2-6-C for glass–fiber–reinforced epoxy resin pipe with an unreinforced thermoset liner, no surface layer, 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 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 and Manufacture

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

5.2 *Wall Composition*—The basic structural wall composition shall consist of a 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 with a sizing compatible with the resin used.

5.2.3 *Aggregate*—A siliceous sand conforming to the requirements of Specification C 33, except that the requirements for gradation shall not apply.

5.3 *Liner and Surface Layer*—A 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 detail 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.

TABLE 1 General Designation Requirements for Fiberglass Sewer Pipe

Designation Order	Property	Cell Limits[A]					
1	Type	1 glass-fiber-reinforced thermosetting polyester[B] resin mortar (RPMP polyester[B])		2 glass-fiber-resin-reinforced thermosetting polyester[B] resin (RTRP polyester[B])	3 glass-fiber-reinforced thermosetting epoxy resin mortar (RPMP epoxy)		4 glass-fiber-reinforced thermosetting epoxy resin (RTRP epoxy)
2	Liner	1 reinforced thermoset liner		2 non-reinforced thermoset liner	3 thermoplastic liner		4 no liner
3	Grade	1 polyester[B] resin surface layer—reinforced	2 polyester[B] resin surface layer—nonreinforced	3 polyester[B] resin and sand surface layer non-reinforced	4 epoxy resin surface layer—reinforced	5 epoxy resin surface layer—non-reinforced	6 no surface layer
4	Pipe stiffness psi (kPa)	A 9 (62)		B 18 (124)	C 36 (248)		D[A,B] 72 (496)

[A] This 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.

[B] For the purposes of this specification, polyester includes vinyl ester resins.

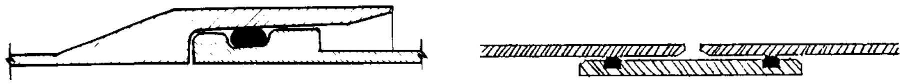

FIG. 1 Typical Joints

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.

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:

5.4.2.4.1 *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.

5.4.2.4.2 *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.

5.4.2.4.3 *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 supplemental restraining elements.

5.4.2.7 *Threaded joints*.

NOTE 6—Other types of joints may be added as they become commercially available.

NOTE 7—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 used with this pipe shall conform to the requirements of Specification F 477, except that composition of the elastomer shall be as agreed upon between the purchaser and the supplier for the particular exposure to oily or aggressive chemical environments.

6. *Requirements* Requirements

6.1 *Workmanship*—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.

6.1.1 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 ⅛ 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.

6.1.2 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*—The pipe shall be supplied in the nominal diameters shown in Table 2 or Table 3. The 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 stiffness, 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 ±¼ 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 *Chemical Requirements*:

6.3.1 *Long-Term*—Pipe specimens, when tested in accordance with 8.2.1, shall be capable of being deflected, without failure, at the 50 year strain level given in Table 4 when exposed to 1.0 *N* sulfuric acid.

NOTE 8—See Appendix X1 for derivation of the minimum sewer pipe chemical requirements given in Table 4.

NOTE 9—The calculations in Table 4 and Appendix X1 assume that the neutral axis is at the pipe wall midpoint. For pipe wall constructions that produce an altered neutral axis position, it is necessary to evaluate results and establish requirements substituting $2y$ for t. (y is the maximum distance from the neutral axis to the pipe surface.)

6.3.2 *Control Requirements*—Test pipe specimens periodically in accordance with 8.2.2, following the procedure of 8.2.2.1, or alternatively, the procedure of 8.2.2.2.

6.3.2.1 When the procedure of 8.2.2.1 is used, the following three criteria must be met: (a) the average failure time at each strain level must fall at or above the lower 95 % confidence limit of the originally determined regression line, (b) no specimen-failure times may be sooner than the lower 95 % prediction limit of the originally determined regression line, and (c) one third or more of the specimen-failure times must be on or above the originally determined regression line.

NOTE 10—Determine the lower 95 % confidence limit and the lower 95 % prediction limit in accordance with Annex A1.

6.3.2.2 When the alternative procedure of 8.2.2.2 is used, failure shall not occur in any specimen.

6.4 *Stiffness*—Each length of pipe shall have sufficient strength to exhibit the minimum pipe stiffness ($F/\Delta y$) specified

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

Inch-Pound Series		SI Series			
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	
20	±0.25	800	795	816	±4.2
21	±0.25	900	895	918	
24	±0.25	1000	995	1020	
27	±0.27	1200	1195	1220	
30	±0.30	1400	1395	1420	
33	±0.33	1600	1595	1620	±5.0
36	±0.36	1800	1795	1820	
39	±0.39	2000	1995	2020	
42	±0.42	(2200)	2195	2220	
45	±0.45	2400	2395	2420	
48	±0.48	(2600)	2595	2620	±6.0
51	±0.51	2800	2795	2820	
54	±0.54	(3000)	2995	3020	
60	±0.60	3200	3195	3220	
66	±0.66	(3400)	3395	3420	
72	±0.72	3600	3595	3620	±7.0
78	±0.78	(3800)	3795	3820	
84	±0.84	4000	3995	4020	
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	...	...	...	...

[A] Inside diameters other than those shown shall be permitted by agreement between the purchaser and the supplier.
[B] Values are taken from International Standards Organization documents. Parentheses indicate non-preferred diameters.

in Table 5, when tested in accordance with 8.3. At deflection Level A in accordance with Table 6, there shall be no visible damage in the test specimen evidenced by surface cracks. At deflection Level B in accordance with Table 6, 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 11—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 6 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 5 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 that might affect performance of the installed pipe.

6.4.1 For other pipe stiffness levels, appropriate values for level A and level B deflections (Table 6) may be computed as follows:

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

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

6.4.2 Since products may have use limits of other than 5 % long-term deflection, Level A and Level B deflections (Table 6) may be proportionally adjusted to maintain equivalent in-use 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).

6.5 *Joint Tightness*:

6.5.1 All joints shall meet the laboratory performance requirements of Specification D 4161. Unrestrained joints shall be tested with a fixed end closure condition and restrained joints shall be tested with a free end closure condition. Rigid joints shall be exempt from angular deflection requirements of D 4161. Rigid joints typically include butt joints with laminated overlay, bell-and-spigot joints with laminated overlay, flanged, bell-and-spigot adhesive bonded and threaded.

6.6 *Beam Strength*—The pipe shall have a minimum axial tensile elongation at failure of 0.25% and meet the following requirements. For pipe sizes up to 27 in., the pipe shall withstand, without failure, the beam loads specified in Table 7, when tested in accordance with 8.4. For pipe sizes larger than

TABLE 3 Nominal Outside Diameters (OD) and Tolerances

NOTE—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 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 −0.040	9.05	
10	10.750	+0.108 −0.048	11.10	±0.06 (10 through 14)
12	12.750	+0.128 −0.056	13.20	
14	14.000	+0.140 −0.062	15.30	
16	16.000	+0.160 −0.070	17.40	+0.05 −0.08 (16 through 24)
18	...	...	19.50	
20	...	...	21.60	
24	...	...	25.80	
30	...	...	32.00	+0.08 −0.06 (30 through 60)
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	...	...	...	...	+2.0	...
1400	...	...	...	1229	+2.0	-2.6
1600	...	...	...	1434	+2.0	-2.8
1800	...	...	...	1638	+2.0	-2.8
2000	...	...	...	1842	+2.0	-3.0
2200	...	...	...	2046	+2.0	-3.0
2400	...	...	...	2250	+2.0	-3.2
2600	...	...	...	2453	+2.0	-3.4
2800	...	...	...	2658	+2.0	-3.6
3000	...	...	...	2861	+2.0	-3.8
3200	...	...	...	3066	+2.0	-4.0
3400	...	...	...	3270	+2.0	-4.2
3600	...	...	...	3474	+2.0	-4.4
3800	...	...	...	3678	+2.0	-4.6
4000	...	...	...	3882	+2.0	-4.8
...	...	...	...	4086	+2.0	-5.0

TABLE 4 Minimum Sanitary Sewer Pipe Chemical Requirements ϵ_{SCV}

Pipe Stiffness, psi (kPa)	Minimum Strain					
	6 min	10 h	100 h	1000 h	10 000 h	50 years
9 (62)	0.97 (*t*/*d*)	0.84 (*t*/*d*)	0.78 (*t*/*d*)	0.73 (*t*/*d*)	0.68 (*t*/*d*)	0.60 (*t*/*d*)
18 (124)	0.85 (*t*/*d*)	0.72 (*t*/*d*)	0.66 (*t*/*d*)	0.61 (*t*/*d*)	0.56 (*t*/*d*)	0.49 (*t*/*d*)
36 (248)	0.71 (*t*/*d*)	0.60 (*t*/*d*)	0.55 (*t*/*d*)	0.51 (*t*/*d*)	0.47 (*t*/*d*)	0.41 (*t*/*d*)
72 (496)	0.56 (*t*/*d*)	0.48 (*t*/*d*)	0.44 (*t*/*d*)	0.41 (*t*/*d*)	0.38 (*t*/*d*)	0.34 (*t*/*d*)

Where: *t* and *d* are the nominal total wall thickness and the mean diameter (inside diameter plus *t*) as determined in accordance with 8.1, and ϵ_{SCV}= strain corrosion value.

TABLE 5 Minimum Stiffness at 5 % Deflection

Nominal Diameter, in.	Pipe Stiffness, psi (kPa)			
	Designation			
	A	B	C	D
8			36 (248)	72 (496)
10		18 (124)	36 (248)	72 (496)
12 and greater	9 (62)	18 (124)	36 (248)	72 (496)

TABLE 6 Ring Deflection Without Damage or Structural Failure

	Nominal Pipe Stiffness, psi			
	9	18	36	72
Level A	18 %	15 %	12 %	9 %
Level B	30 %	25 %	20 %	15 %

27 in., and alternatively for smaller sizes, adequate beam strength is demonstrated by tension and compression tests conducted in accordance with 8.4.1 for pipe wall specimens oriented in the longitudinal direction, using the minimum tensile and compressive strengths specified in Table 7.

7. Sampling

7.1 *Lot*—Unless otherwise agreed upon between the purchaser and the supplier, one lot shall consist of 100 lengths of each type, grade, and size of pipe produced.

7.2 *Production Tests*—Select one pipe at random from each lot and take one specimen from the pipe barrel to determine conformance of the material to the workmanship, dimensional, and stiffness requirements of 6.1, 6.2, and 6.4, respectively.

7.3 *Qualification Tests*—Sampling for qualification tests (see 7.5) is not required unless otherwise agreed upon between the purchaser and the supplier. Qualification tests, for which a certification and test report shall be furnished when requested by the purchaser, include the following:

7.3.1 Long-term chemical test.

7.3.2 Joint-tightness test (see 6.5).

7.3.3 Beam strength test.

7.4 *Control for Chemical Test*—Perform sampling and testing for the control requirements of the chemical test at least once annually, unless otherwise agreed upon between the purchaser and the supplier.

7.5 For individual orders, conduct only those additional tests and numbers of tests specifically agreed upon between the purchaser and the supplier.

8. Test Methods

8.1 *Dimensions*:

8.1.1 *Diameters*:

8.1.1.1 *Inside Diameter*—Take inside diameter measurements at a point approximately 6 in. (152 mm) from the end of the pipe section using a steel tape or an inside micrometer with graduations of 1⁄16 in. (1 mm) or less. Make two 90° opposing measurements at each point of measurement and average the readings.

8.1.1.2 *Outside Diameter*—Determine in accordance with Test Method D 3567.

8.1.2 *Length*—Measure with a steel tape or gage having graduations of 1⁄16 in. (1 mm) or less. Lay the tape or gage on or inside the pipe and measure the overall laying length of the pipe.

8.1.3 *Wall Thickness*—Determine in accordance with Test Method D 3567.

8.1.4 *Squareness of Pipe Ends*—Rotate the pipe on a mandrel or trunnions and measure the runout of the ends with a dial indicator. The total indicated reading is equal to twice the distance from a plane perpendicular to the longitudinal axis of the pipe. Alternatively, when the squareness of the pipe ends is rigidly fixed by tooling, the tooling may be verified and reinspected at intervals frequent enough to assure that the squareness of the pipe ends is maintained within tolerance.

8.2 *Chemical Tests*—Test the pipe in accordance with Test Method D 3681.

8.2.1 *Long-Term*—To find if the pipe meets the requirements of 6.3.1, determine at least 18 failure points in accordance with Test Method D 3681.

8.2.1.1 *Alternative Qualification Procedure*—Test four specimens each at the 10 and 10 000-h minimum strains given in Table 4 and test five specimens each at the 100 and 1000-h minimum strains given in Table 4. Consider the product qualified if all 18 specimens are tested without failure for at least the prescribed times given in Table 4 (that is, 10, 100, 1000, or 10 000 h respectively).

8.2.2 *Control Requirements*—Test at least six specimens in accordance with one of the following procedures and record the results:

8.2.2.1 Test at least three specimens at each of the strain levels corresponding to the 100- and 1000-h failure times from the product's regression line established in 8.2.1.

8.2.2.2 When the alternate method of 8.2.1.1 is used to qualify the product, test at least three specimens each at the 100 and 1000-h minimum strains given in Table 4 for at least 100 and 1000-h respectively.

TABLE 7 Beam Strength Test Loads

Nominal Diameter, in.	Beam Load (*P*)		Minimum Longitudinal Tensile Strength, per Unit of Circumference		Minimum Longitudinal Compressive Strength, per Unit of Circumference	
	lbf	(kN)	lbf/in.	(kN/m)	lbf/in.	(kN/m)
8	800	(3.6)	580	(102)	580	(102)
10	1200	(5.3)	580	(102)	580	(102)
12	1600	(7.1)	580	(102)	580	(102)
14	2200	(9.8)	580	(102)	580	(102)
15	2600	(11.6)	580	(102)	580	(102)
16	3000	(13.3)	580	(102)	580	(102)
18	4000	(17.8)	580	(102)	580	(102)
20	4400	(19.6)	580	(102)	580	(102)
21	5000	(22.2)	580	(102)	580	(102)
24	6400	(28.5)	580	(102)	580	(102)
27	8000	(35.6)	580	(102)	580	(102)
30	. . .	. . .	580	(102)	580	(102)
33	. . .	. . .	640	(111)	640	(111)
36	. . .	. . .	700	(122)	700	(122)
39	. . .	. . .	780	(137)	780	(137)
42	. . .	. . .	800	(140)	800	(140)
45	. . .	. . .	860	(150)	860	(150)
48	. . .	. . .	920	(161)	920	(161)
51	. . .	. . .	980	(171)	980	(171)
54	. . .	. . .	1040	(182)	1040	(182)
60	. . .	. . .	1140	(200)	1140	(200)
66	. . .	. . .	1260	(220)	1260	(220)
72	. . .	. . .	1360	(238)	1360	(238)
78	. . .	. . .	1480	(260)	1480	(260)
84	. . .	. . .	1600	(280)	1600	(280)
90	. . .	. . .	1720	(301)	1720	(301)
96	. . .	. . .	1840	(322)	1840	(322)
102	. . .	. . .	1940	(340)	1940	(340)
108	. . .	. . .	2060	(360)	2060	(360)
114	. . .	. . .	2180	(382)	2180	(382)
120	. . .	. . .	2280	(400)	2280	(400)
132	. . .	. . .	2520	(440)	2520	(440)
144	. . .	. . .	2740	(480)	2740	(480)
156	...	...	2964	(519)	2964	(519)

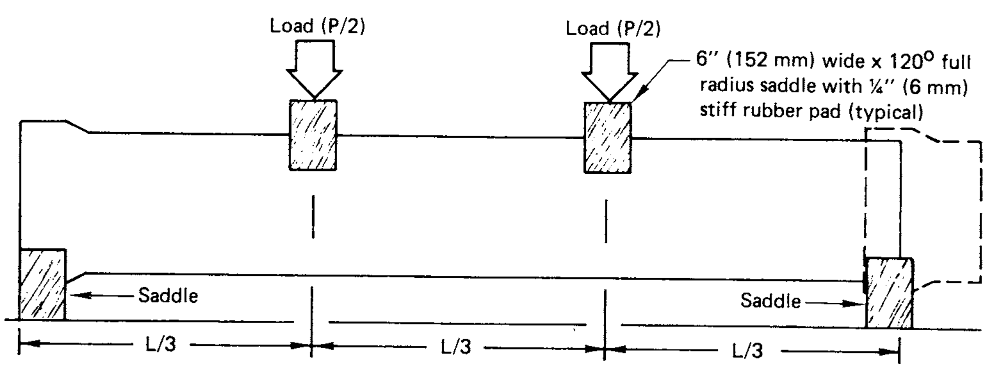

FIG. 2 Beam Strength—Test Setup

8.2.2.3 The control test procedures of 8.2.2.2 may be used as an alternative to the reconfirmation procedure described in Test Method D 3681 for those products evaluated by the alternative qualification procedure of 8.2.1.1.

8.3 *Stiffness*—Determine the pipe stiffness ($F/\Delta y$) at 5 % deflection for the specimen, using the apparatus and procedure of Test Method D 2412, with the following exceptions permitted:

8.3.1 Measure the wall thickness to the nearest 0.01 in. (0.25 mm).

8.3.2 Load the specimen to 5 % deflection and record the load. Then load the specimen to deflection Level A in accordance with Table 6 and examine the specimen for visible damage evidence by surface cracks. Then load the specimen to deflection Level B in accordance with Table 6 and examine for evidence 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, fracture, or buckling of the pipe wall. Calculate the pipe stiffness at 5 % deflection.

8.3.3 For production testing, only one specimen need be tested to determine the pipe stiffness.

8.3.4 The maximum specimen length may be 12 in. (305 mm) or the length necessary to include stiffening ribs if they are used, whichever is greater.

NOTE 12—As an alternative to determining the pipe stiffness using the apparatus and procedure of Test Method D 2412 the supplier may submit to the purchaser for approval a test method and test evaluation based on Test Method D 790 accounting for the substitution of curved test specimens and measurement of stiffness at 5 % deflection.

8.4 *Beam Strength*—Place a 20-ft (6.1-m) nominal length of pipe on saddles at each end. Hold the ends of the pipe round during the test. Apply the beam load for the diameter of pipe shown in Table 7 simultaneously to the pipe (see Fig. 2). Maintain the loads for not less than 10 min with no evidence of failure. The testing apparatus shall be designed to minimize stress concentrations at the loading points.

8.4.1 As an alternative to 8.4, adequate beam strength shall be shown by determining longitudinal tensile strength in accordance with Test Method D 638, except the provisions for maximum thickness shall not apply, and longitudinal compressive strength in accordance with Test Method D 695, on pipe wall specimens oriented in the longitudinal direction.

9. Packaging, Marking, and Shipping

9.1 Mark each length of pipe that meets or is part of a lot that meets the requirements of this specification at least once in letters not less than ½ in. (12 mm) in height and of bold-type style in a color and type that remains legible under normal handling and installation procedures. The marking shall include the nominal pipe size, manufacturer's name or trademark, this ASTM specification number D 3262, type, liner, grade, and stiffness in accordance with the designation code in 4.2.

9.2 Prepare pipe for commercial shipment in such a way as to ensure acceptance by common or other carriers.

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

10. Keywords

10.1 fiberglass pipe; pressure pipe; RTRP; RPMP; strain corrosion

ANNEX

(Mandatory Information)

A1. CALCULATIONS OF LOWER CONFIDENCE (LCL) AND LOWER PREDICTION (LPL) LIMITS

A1.1 The following equations are used:

$$h_{LCL} = (a + bf_0) - ts\sqrt{\frac{(f_0 - F)^2}{U} + \frac{1}{N}}$$

$$h_{LPL} = (a + bf_0) - ts\sqrt{\frac{(f_0 - F)^2}{U} + \frac{1}{N} + 1}$$

where all symbols are as defined in Annex A1 and Annex A3 of Practice D 2992 except:

f_0 = log of stress (strain) level of interest

NOTE A1.1—Of the expected failures at stress (strain) f_0, 97.5 % will occur after h_{LPL}. The average failure time at stress (strain) f_0 will occur later than h_{LCL}97.5 % of the time.

APPENDIXES

(Nonmandatory Information)

X1. STRAIN CORROSION PERFORMANCE REQUIREMENTS

X1.1 From Molin and Leonhardt, the expression for bending strain is given as:

$$\epsilon_b = D_f(t/d)(\delta v/d) \quad (X1.1)$$

With the common acceptance that these pipes must be capable of withstanding 5 % deflection long-term, the maximum installed bending strain may be expressed as:

$$\epsilon_b \max = (0.05)(D_f)(t/d) \quad (X1.2)$$

Using the AWWA C 950 long-term bending factor of safety of 1.50, the minimum strain corrosion performance extrapolated to 50 years must be:

$$\epsilon_{scv} \geq (0.075)(D_f)(t/d) \quad (X1.3)$$

X1.2 The shape factor, D_f, is dependent on both the pipe stiffness and the installation (backfill material, backfill density, compaction method, haunching, trench configuration, native-soil characteristics, and vertical loading, for example). Assuming conservatively, installations achieved by tamped compaction with inconsistent haunching that will limit long-term deflections to 5 %, the following values of D_f have been selected to be realistic, representative, and limiting. Substituting these values in the above equation for ϵ_{scv}yields the minimum required strain corrosion performance at 50 years given in Table 4 and below:

Pipe Stiffness, (psi)	D_f	Minimum ϵ_{scv} Performance
9	8.0	0.60 (*t/d*)
18	6.5	0.49 (*t/d*)
36	5.5	0.41 (*t/d*)
72	4.5	0.34 (*t/d*)

NOTE X1.1—Products may have use limits of other than 5 % long-term deflection. In such cases the requirements should be proportionally adjusted. For example, a 4 % long-term limiting deflection would result in a 50 year requirement of 80 % of Table 4, while a 6 % limiting deflection would yield a requirement of 120 % of Table 4.

X1.3 *Alternative Strain Corrosion Test Requirements:*

X1.3.1 At 0.1 h (6 min), the required strain corrosion performance is based on the Level B deflections from Table 6 as follows:

$$\epsilon \text{ test} \geq Df\left[\frac{t}{d + \delta V/2}\right]\left[\frac{\delta V}{d + \delta V/2}\right] \quad \text{(X1.4)}$$

or

$$\epsilon \text{ test} \geq Df\,(t/d)\,(\delta V/d)\left(\frac{1}{1 + \delta V/2d}\right)^2 \quad \text{(X1.5)}$$

Df for parallel plate loading is 4.28. Making the other substitutions yield:

Pipe Stiffness (psi)	Level B $\delta v/d$ (%)	Minimum Test Strain at 6 Minutes
9	30	0.97 (*t/d*)
18	25	0.85 (*t/d*)
36	20	0.71 (*t/d*)
72	15	0.56 (*t/d*)

X1.3.2 The minimum strain values at 10, 100, 1000, and 10 000 h given in Table 4 are defined by a straight line connecting the points at 6 min and 50 years on a log-log plot.

X2. INSTALLATION

X2.1 This specification is a material performance and purchase specification only and does not include requirements for engineering design, pressure surges, bedding, backfill, or the relationship between earth cover load and the strength of the pipe. Experience has shown, however, that successful performance of this product depends upon the proper type of bedding and backfill, pipe characteristics, and care in the field construction work. The purchaser of the fiberglass pipe specified herein is cautioned that he must properly correlate the field requirements with the pipe requirements and provide adequate inspection at the job site.

X3. RECOMMENDED METHODS OF DETERMINING GLASS CONTENT

X3.1 Determine glass content as follows:

X3.1.1 By ignition loss analysis in accordance with Test Method D 2584 or ISO 1172.

X3.1.2 As a process control, by weight of the glass fiber reinforcement applied by machine into the pipe structure.