Designation: D 3517 – 01

An American National Standard

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

This standard is issued under the fixed designation D 3517; 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 fiberglass pipe, 8 in. (200 mm) through 144 in. (3700 mm), intended for use in water conveyance systems which operate at internal gage pressures of 250 psi (1.72 MPa) 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, sliplining and 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 similar or equivalent ISO 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 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]

D 638 Test Method for Tensile Properties of Plastics[3]

D 695 Test Method for Compressive Properties of Rigid Plastics[3]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[3]

D 883 Terminology Relating to Plastics[3]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[3]

D 2290 Test Method for Apparent Tensile Strength of Ring or Tubular Plastics and Reinforced Plastics by Split Disk Method[4]

D 2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading[4]

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins[5]

D 2992 Practice for Obtaining Hydrostatic 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]

D 3892 Practice for Packaging/Packing of Plastics[6]

D 4161 Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals[4]

F 412 Terminology Relating to Plastic Piping Systems[4]

F 477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe[4]

2.2 *ISO Standard:*

ISO 1172 Textile Glass Reinforced Plastics—Determination of Loss on Ignition[7]

2.3 *NSF Standard:*

Standard No. 14 for Plastic Piping Components and Related Materials[8]

3. Terminology

3.1 *Definitions:*

[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] *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.

[5] *Annual Book of ASTM Standards,* Vol 08.02.

[6] *Annual Book of ASTM Standards,* Vol 08.03.

[7] Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

[8] Available from the National Sanitation Foundation, P.O. Box 1468, Ann Arbor, MI 48106.

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

3.1.1 *General*—Definitions are in accordance with Terminology D 833 and Terminology F 412 and abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

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

3.2.2 *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.

3.2.3 *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.

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 D 3517, 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 D 3517. . . three numerals, C . . . and two or three numerals, and a capital letter.

NOTE 4—Examples of the designation are as follows: *(1)* ASTM D 3517-1-1-3-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 D 3517-4-2-6-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 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 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 E-type glass fibers with a finish 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.

TABLE 1 General Designation Requirements for Fiberglass Pressure Pipe

Designation Order	Property	Cell Limits (Note 1)								
1	Type	1 glass-fiber-reinforced thermosetting polyester (Note 2) resin mortar (RPMP polyester (Note 2))		2 glass-fiber-reinforced thermosetting polyester (Note 2) resin (RTRP polyester (Note 2))		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 (Note 2) resin surface layer—reinforced	2 polyester (Note 2) resin surface layer—non-reinforced	3 polyester (Note 2) resin and sand surface layer nonreinforced		4 epoxy resin surface layer—reinforced	5 epoxy resin surface layer—non-reinforced	6 no surface layer		
4	Class (Note 3)	C50	C75	C100	C125	C150	C175	C200	C225	C250
5	Pipe Stiffness psi (kPa)	A 9 (62)		B 18 (124)		C 36 (248)		D 72 (496)		

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).

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 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.

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

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 Couplings.*.

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

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.

5.4.2.5 *Flanged*.

5.4.2.6 *Mechanical*.

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

5.5 *Gaskets*—Elastomeric gaskets when used with this pipe shall conform to the requirements of Specification F 477.

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 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.

6.1.3 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 ±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 *Soundness*—Unless otherwise agreed upon between purchaser and supplier, test each length of pipe up to 54 in. (1370 mm) diameter hydrostatically without leakage or cracking, at the internal hydrostatic proof pressures specified for the applicable class in Table 4, when tested in accordance with 8.2. For sizes over 54 in., 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 D 2992.

NOTE 8—Hydrostatic design basis (HDB-extrapolated value at 50 years) determined in accordance with Procedure A of Practice D 2992, 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

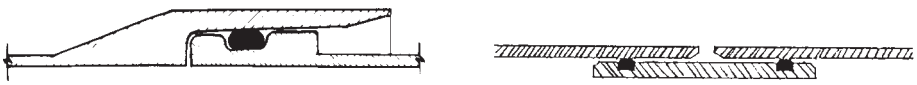

FIG. 1 Typical Joints

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	. . .	. . .	. . .	. . .

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

failure of the glass fiber reinforcement, and fracture or buckling of the pipe wall.

NOTE 9—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:

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

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

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 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 D 3262).

6.6 *Hoop-Tensile Strength*—All pipe manufactured under this specification shall meet or exceed the hoop-tensile strength shown for each size and class in Table 8, when tested in accordance with 8.5.

6.6.1 *Alternative Requirements*—When agreed upon between the purchaser and the supplier, the minimum hoop-tensile strength shall be as determined in accordance with 8.5.1.

6.7 *Joint Tightness*—The pipe joint shall meet the Laboratory Performance Requirements section of Specification D 4161. Restrained rigid joints (see 5.4.2.2, 5.4.2.3, 5.4.2.4, and 5.4.2.5) shall be exempt from angular deflection requirements.

6.8 *Longitudinal Strength*:

6.8.1 *Beam Strength*—For pipe sizes up to 27 in. the pipe shall withstand, without failure, the beam loads specified in Table 9, when tested in accordance with 8.6.1. For pipe sizes larger than 27 in., and alternatively for smaller sizes, adequate beam strength is demonstrated by tension and compression tests conducted in accordance with 8.6.2 and 8.6.3, respectively, for pipe wall specimens oriented in the longitudinal

TABLE 3 Nominal Outside Diameters (OD) and Tolerances

Outside Diameter Control Pipe				
Nominal Pipe Size, in.	Steel Pipe Equiv. (IPS) OD's, in.	Tolerance, in.	Cast Iron Pipe Equivalent OD's, in.	Tolerance, in.
8	8.625	+0.086 −0.040	9.05	±0.06
10	10.750	+0.108 −0.048	11.10	±0.06
12	12.750	+0.128 −0.056	13.20	±0.06
14	14.000	+0.140 −0.062	15.30	+0.05 −0.08
16	16.000	+0.160 −0.070	17.40	+0.05 −0.08
18	. . .	. . .	19.50	+0.05 −0.08
20	. . .	. . .	21.60	+0.05 −0.08
24	. . .	. . .	25.80	+0.05 −0.08
30	. . .	. . .	32.00	+0.08 −0.06
36	. . .	. . .	38.30	+0.08 −0.06
42	. . .	. . .	44.50	+0.08 −0.06
48	. . .	. . .	50.80	+0.08 −0.06
54	. . .	. . .	57.56	+0.08 −0.06
60	. . .	. . .	61.61	+0.08 −0.06

Metric Pipe Size, mm	D.I. Pipe Equiv., mm	Tolerance, mm	Int'l OD, mm	Tolerance, mm
200	222	−3.0, +1.0	1.02 × nominal plus 4	+2.0, −2.0
250	274	−3.1, +1.0	1.02 × nominal plus 4	+2.1, −2.0
300	326	−3.3, +1.0	1.02 × nominal plus 4	+2.3, −2.0
350	378	−3.4, +1.0	1.02 × nominal plus 4	+2.4, −2.0
400	429	−3.5, +1.0	1.02 × nominal plus 4	+2.5, −2.0
500	532	−3.8, +1.0	1.02 × nominal plus 4	+2.8, −2.0
600	635	−4.0, +1.0	1.02 × nominal plus 4	+3.0, −2.0
700	738	−4.3, +1.0	1.02 × nominal plus 4	+3.3, −2.0
800	842	−4.5, +1.0	1.02 × nominal plus 4	+3.5, −2.0
900	945	−4.8, +1.0	1.02 × nominal plus 4	+3.8, −2.0
1000	1048	−5.0, +1.0	1.02 × nominal plus 4	+4.0, −2.0
1100	1152	−5.3, +1.0	1.02 × nominal plus 4	+4.3, −2.0
1200	1255	−5.5, +1.0	1.02 × nominal plus 4	+4.5, −2.0
1400	1462	−6.0, +1.0	1.02 × nominal plus 4	+5.0, −2.0
1600	1668	−7.4, +1.0	1.02 × nominal plus 4	+5.5, −2.0
1800	1875	−8.2, +1.0	1.02 × nominal plus 4	+6.0, −2.0
2000	2082	−9.0, +1.0	1.02 × nominal plus 4	+6.5, −2.0
2200 to 4000	. . .	. . .		increase (+) tol. 0.5 each 200 mm

TABLE 4 Hydrostatic-Pressure Test

Class	Hydrostatic Proof Pressure, gage, psi (kPa)
C50	100 (689)
C75	150 (1034)
C100	200 (1379)
C125	250 (1723)
C150	300 (2068)
C175	350 (2412)
C200	400 (2757)
C225	450 (3102)
C250	500 (3445)

TABLE 5 Long-Term Hydrostatic Pressure Categories

Class	Minimum Calculated Values of Long-Term Hydrostatic Pressure gage, psi (kPa)
C50	90 (621)
C75	135 (931)
C100	180 (1241)
C125	225 (1551)
C150	270 (1862)
C175	315 (2172)
C200	360 (2482)
C225	405 (2792)
C250	450 (3103)

TABLE 6 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 7 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 %

direction, using the minimum tensile and compressive strength specified in Table 9.

6.8.2 *Longitudinal Tensile Strength*—All pipe manufactured under this specification shall meet or exceed the longitudinal tensile strength shown for each size and class in Table 10, when tested in accordance with 8.6.2.

NOTE 10—The values listed in Table 10 are the minimum criteria for products made to this standard. The values may not be indicative of the axial strength of some products, or of the axial strength required by some installation conditions and joint configurations.

6.8.3 Conformance to the requirements of 6.8.1 shall satisfy the requirements of 6.8.2 for those pipe sizes and classes where the minimum longitudinal tensile strength values of Table 9 are equal to the values of Table 10. Conformance to the requirements of 6.8.2 shall satisfy the longitudinal tensile strength requirements of 6.8.1.

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, and strength requirements of 6.1, 6.2, 6.5, and 6.6, respectively. Unless otherwise agreed upon between purchaser and supplier, all pipes (up to 54-in. (1370-mm) diameter) shall meet the soundness requirements of 6.3.

7.3 *Qualification Tests*—Sampling for qualification tests (see section 3.2.4) 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 Hydrostatic Pressure Test*.

7.3.2 *Joint-Tightness Test* (See 6.7).

7.3.3 *Longitudinal-Strength Test*, including:

7.3.3.1 Beam strength and

7.3.3.2 Longitudinal tensile strength.

7.4 *Control Tests*—The following test is considered a control requirement and shall be performed as agreed upon between the purchaser and the supplier:

7.4.1 *Soundness Test*—60-in. (1520-mm) diameter pipe and larger.

7.4.2 Perform the sampling and testing for the control requirements for hydrostatic design basis at least once every two years.

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 1⁄16in. (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 squareness of pipe ends is rigidly fixed by tooling, the tooling may be verified and reinspected at frequent enough intervals to ensure that the squareness of the pipe ends is maintained within tolerance.

8.2 *Soundness*—Determine soundness by a hydrostatic proof test procedure. Place the pipe in a hydrostatic pressure testing machine that seals the ends and exerts no end loads. Fill