



# Standard Practice for Determining Dimensions of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings<sup>1</sup>

This standard is issued under the fixed designation D3567; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

## 1. Scope

1.1 This practice covers the determination of outside diameter, inside diameter, total wall thickness, reinforced wall thickness, liner thickness (where applicable), and length dimensions of “fiberglass” (glass-fiber-reinforced thermosetting resin) pipe. Included are procedures for measuring tapered dimensions and taper angles for pipe intended to be joined by tapered socket fittings, and procedures for gaging internal and external threads.

1.2 This practice also includes procedures for determining dimensions for fiberglass pipe fittings.

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

NOTE 1—There is no similar or equivalent ISO standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

**D4166 Test Method for Measurement of Thickness of Non-magnetic Materials by Means of a Digital Magnetic Intensity Instrument** (Withdrawn 2008)<sup>3</sup>

<sup>1</sup> This practice 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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<sup>2</sup> 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.

<sup>3</sup> The last approved version of this historical standard is referenced on www.astm.org.

### 2.2 ANSI Standard:

**B 2.1 Pipe Threads (Except Dryseal)**<sup>4</sup>

### 2.3 API Standard:

**API 5B Threading, Gaging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads**<sup>5</sup>

## 3. Terminology

### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *deviation from straightness*—the maximum deviation from a straight line exhibited by a pipe specimen divided by the length of the specimen.

3.1.2 *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.

3.1.3 *laying length of fittings*—the actual increase in the length of a line afforded by the fitting when installed.

3.1.4 *liner and exterior surface layer thicknesses*—the inner and outer portions of the wall used to enhance chemical and water resistance; they may have a different composition than the reinforced wall and the thicknesses of these internal and external surfaces may be measured when their boundary limits are visually identifiable and if they are each at least 0.005 in. (0.10 mm) in thickness.

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

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

## 4. Significance and Use

4.1 This practice provides for determining the physical dimensions of fiberglass pipe and fittings. This practice is

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

<sup>5</sup> Available from American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005-4070, http://api-ec.api.org.

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

suitable for determination of dimensional compliance with product specifications.

## 5. Conditioning

5.1 Test conditions for measurements shall be in accordance with appropriate product specification(s).

## 6. Total Wall Thickness—Pipe and Fittings

6.1 *Apparatus*—Calipers, optical comparators described in Section 7, ultrasonic thickness meters, or other gages such as the digital magnetic intensity instrument described by Test Method D4166, with graduations of 0.01 in. (0.025 mm) or less that produces a thickness measuring accuracy of within 5 %, may be used for measuring thicknesses of 0.20 in. (5.1 mm) or greater. For thicknesses less than the above, use a micrometer or other gage with graduations of 0.001 in. (0.025 mm) and an accuracy of within 5 %. Use a cylindrical tubing micrometer or spherical anvil micrometer with a radius end where the diameter of the pipe is small and a measuring error of 5 % or less would be exceeded without its use.

6.2 *Procedure*—Make a series of at least four readings at random selected locations, approximately equally spaced around the circumference. The location of the measurements should be taken some distance in from the pipe ends if the end thickness would be expected to be greater than other regions of the pipe.

NOTE 2—Take care to ensure that the measurements are not made at either a tapered or belled pipe end.

NOTE 3—Take care to avoid misalignment of the anvil with the longitudinal axis of the specimen when using cylindrical anvil micrometers that may bridge specimen surface curvature or indentations and give falsely high readings.

6.3 *Calculation*—Calculate the average total wall thickness of the four or more thicknesses taken.

6.4 *Report*—The report shall include the following:

- 6.4.1 Observed minimum and maximum wall thickness, and
- 6.4.2 Calculated average total wall thickness.

## 7. Reinforced Wall Thickness and Liner Thicknesses—Pipe and Fittings

7.1 *Sampling*—When performed on finished pipe or fittings, this procedure will usually destroy or damage the part. When this procedure is to be used for quality control or sampling, it is intended for use on samples taken from the excess of the fabrication, such as the ends of pipe or fittings, or both. If the procedure requires destructively testing the pipe or fittings, the requirements shall be agreed upon between the buyer and the seller.

7.2 *Apparatus*—An optical scale comparator with a 7 to 10X magnification and having a reticle graduated as follows:

7.2.1 For products with liner measurements less than 0.050 in. (1.27 mm): 0.001-in. (0.025-mm) divisions or not more than 10 % of liner thickness, whichever is smaller.

7.2.2 For products with liner measurements 0.050 in. (1.27 mm) or larger: 0.005-in. (0.13-mm) divisions or smaller.

7.3 *Procedure*:

7.3.1 *Surface Preparation*—At the desired cross section of the pipe or fitting, make a sawcut at right angles to the inside

surface. Remove burrs and sand the cut surface smooth, using 200-grit (or finer) sandpaper. Thoroughly wash the sanded surface with clean water to remove resin and glass dust, then blot dry.

7.3.2 *Reinforced Wall and Liner Thickness*—Measure the cut surface of the pipe or fitting by setting a major scale division of the reticle at the apparent interface between the liner and reinforced wall. Make 6 measurements 60° apart as follows:

7.3.2.1 Read toward the outer surface of the pipe or fitting wall and observe the reinforced wall thickness.

7.3.2.2 Read toward the inner surface of the pipe or fitting wall and observe the liner thickness.

7.3.3 *Surface Layer Thickness*—If the product specification requires surface layer measurement, set a major scale division at the apparent interface between the coating and the reinforced wall. Make 6 measurements 60° apart by reading toward the outer surface of the pipe or fitting and observing the surface layer thickness.

7.3.4 *Nonreinforced Layers*, within the reinforced wall or combination reinforcement layers. If the product involves unreinforced layers or multiple reinforcement layers of different types, the amount and type of measurements shall be agreed upon between the buyer and the seller.

7.3.4.1 The thickness of these layers shall be determined by setting a major scale division of the reticle at the apparent interface and reading toward the next apparent interface. Make 6 measurements 60° apart.

7.4 *Calculations*—Calculate the average reinforced wall thickness and liner thickness by averaging the values obtained.

7.5 *Report*—The report shall include the following:

7.5.1 Observed minimum and maximum reinforced wall thickness,

7.5.2 Calculated average reinforced wall thickness,

7.5.3 Observed minimum and maximum liner thickness,

7.5.4 Calculated average liner thickness, and

7.5.5 Observations of exterior surface layer, nonreinforced layers, or other reinforced layer measurements within the reinforced wall when measured.

## 8. Average Outside Diameter Measurements

NOTE 4—The need for measurements and the location of the measurements should be evaluated since the outside surface of the pipe may not be smooth. Uneven surfaces or burrs will influence the accuracy of the outside diameter measurements.

8.1 *Apparatus*—A circumferential vernier wrap tape shall be used to determine the average outside diameter. The tape should be accurate to within  $\pm 0.02$  in. ( $\pm 0.4$  mm) on the circumference measured.

8.2 *Procedure*—Individually measure and record the outside diameter end-sealing surfaces or special OD control surfaces. Make the OD measurements near each end and at three intermediate locations. Take the OD measurement by placing the circumferential wrap tape around the pipe, making sure it is at right angles to the pipe axis. Average all five readings.

8.2.1 Calculate the diameter as follows:

$$D = C_{OD}/\pi \quad (1)$$

where:

$C_{OD}$  = average of the readings.

NOTE 5—For larger diameter piping, the weight of the piping may cause significant distortion. Take care in measurement and evaluation of the significance of this measurement. If significant product distortion due to weight occurs, the pipe may be measured when in the vertical position. Alternatively, the diameter may be measured as a reference from the mandril from which the pipe was made as follows:

$$d = (C_M/\pi + 2 \times \text{wall thickness}) \quad (2)$$

where:

$C_M$  = outside circumference of the mandril, in. (mm) and the wall thickness is as described in 6.3. The measurement intervals are as described in 8.2.

8.3 *Report*—When outside diameter measurements are appropriate, the report shall include the minimum, maximum, and average outside diameter.

## 9. Out-of-Round Measurements

9.1 *Apparatus*—A caliper, micrometer, or similar instrument capable of measuring the OD within  $\pm 0.25\%$  of nominal shall be used.

9.2 *Procedure*—Using a micrometer or vernier calipers, take a series of outside diameter measurements at intervals spaced as in 8.2. Determine the maximum and minimum diameter by three measurements  $120^\circ$  apart at each interval.

NOTE 6—For large diameter piping, the weight of the piping may cause significant distortion. Take care in measurement and evaluation of the significance of this measurement. If significant product distortion due to weight occurs, the pipe may be measured when in the vertical position. Alternatively, with the pipe in a horizontal position, measure the pipe diameter both vertically and horizontally and then remeasured after rotating the pipe  $45^\circ$ . Calculate the difference between the horizontal and vertical measurements in each case. The difference will be the average out-of-roundness. The measurement intervals are as described in 9.2.

9.3 *Calculations*—Calculate out-of-roundness as follows:

9.3.1 Subtract the minimum outside diameter from the average outside diameter and subtract the average outside diameter from the maximum.

9.4 *Report*—The report shall include the following:

9.4.1 The average plus tolerance (maximum outside diameter – average outside diameter), and

9.4.2 The average negative tolerance (average outside diameter – minimum outside diameter).

## 10. Inside Diameter

10.1 Calculate the average inside diameter as follows:

$$d = D - 2t_a \quad (3)$$

where:

$d$  = average inside diameter, in.,

$D$  = average outside diameter, in., as determined in Section 8, and

$t_a$  = average total wall thickness, in., as determined in Section 6.

## 11. Pipe Taper Angle Measurement

11.1 *Apparatus*—Depending on requirements and availability of equipment, the following apparatus may be used:

11.1.1 *For Procedure A:*

11.1.1.1 *Telescoping Sleeve Gage*, for checking conformance to a taper angle tolerance, accurate within  $\pm 0.001$  in. (0.025 mm). For a given pipe size and tolerance specification, the inside diameter of the outer sleeve shall be 0.020 in. (0.51 mm) below the minimum outside diameter of the pipe under test. The inside diameter of the inner sleeve shall be such that when both sleeves are in place on the taper, the taper angle may be calculated by measuring the spacing between the sleeves and relating the relative inside diameter differences of the sleeves.

11.1.2 *For Procedure B:*

11.1.2.1 *Vernier Calipers*, accurate to within 0.001 in. (0.025 mm). These may also be used by comparing actual differences in diameter at specific distances on the taper.

11.2 *Procedure:*

11.2.1 *Procedure A*—Seat the inner sleeve on the end of the taper to ensure that it is parallel and concentric with the pipe. Then slide the outer sleeve forward as far as it will go. Measure the distance between the two sleeves and calculate the taper angle accordingly.

11.2.2 *Procedure B*—Scribe two circumferential marks on the taper as far apart as possible, but at least  $\frac{1}{4}$  in. (6 mm) from the small end of the taper. Measure the exact distance between these marks within 0.01 in. (0.25 mm). Using calipers, measure the actual outside diameter at each of the scribe marks. Make four measurements  $45^\circ$  apart.

11.3 *Calculations*—Using the actual diameters at the points measured and the distances between the points, calculate the taper angle,  $a$ , as follows:

$$\sin a = [(D_2 - D_1)/2]/L \quad (4)$$

where:

$D_2$  = large diameter observed,

$D_1$  = smaller diameter observed, and

$L$  = distance between the two diameters measured along the tapers.

NOTE 7—When measuring the distance between sleeve gages, use the tangent instead of the sine, but at angles less than  $5^\circ$  this difference is not significant.

11.4 *Report*—The report shall include the following:

11.4.1 Apparatus used,

11.4.2 Average  $D_1$ ,

11.4.3 Average  $D_2$ ,

11.4.4 The value of  $L$ , and

11.4.5 Taper angle as calculated in 11.3, in terms of degrees to the nearest  $0.1^\circ$ .

## 12. Length of Pipe

12.1 *Apparatus*—A steel tape, with  $\frac{1}{16}$ -in. (1-mm) or finer graduations.

12.2 *Procedure*—Lay the pipe specimen on a flat surface and in a straight line. Observe the length within the nearest  $\frac{1}{16}$  in. (1 mm).

12.3 *Report*—The report shall include the length of each specimen measured.

### 13. Laying Lengths of Fittings

13.1 *Apparatus*—Two good quality commercial steel scales calibrated in  $\frac{1}{16}$ -in. (1-mm) increments.

#### 13.2 Procedure:

NOTE 8—Because of the wide variety of fittings and joining types, specific procedures to cover every possible case cannot be written. As a result, the following general techniques may have to be modified to include a specific configuration or adapter.

#### 13.2.1 Elbows and Branch Fittings:

13.2.1.1 Insert a steel scale into one opening of the fitting so that the inner edge of the scale is along the centerline of the pipe when it is joined to the fittings. Repeat this procedure in the other leg of the fitting until the end of the second scale touches the inner edge of the first scale. Record the reading on the second scale at the mouth of the fitting as overall length, *A*. Now subtract from this overall length the socket or makeup length, *X*, as measured, or as specified by the manufacturer. The difference, *L*, is the laying length of the fitting. See Fig. 1.

#### 13.2.2 Straight-Line Fittings:

13.2.2.1 Measure the overall length of the fitting. Subtract from this the makeup lengths on both sides, as specified by the manufacturer. The difference is the laying length of the fitting.

13.3 *Report*—The report shall include laying lengths of each specimen measured.

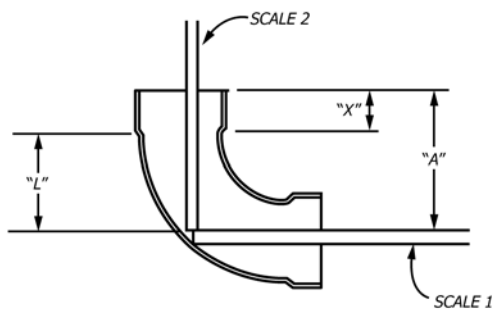


FIG. 1 Measurement for Calculation of Laying Length

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### 14. Gaging Threads

14.1 Measure threads using American National Standard tapered pipe thread gages conforming to ANSI B2.1 or API EUE 8 round (API 5B) dimensions. In gaging external taper threads, screw up the ring gage tight by hand on the external thread. In gaging internal taper threads, screw up the plug gage tight by hand into the fitting.

14.2 *Gaging Chamfered, Countersunk, or Recessed Threads*—When the internal thread is chamfered, countersunk, or recessed the notch should be flush with the bottom of the chamfer, which shall be considered the intersection of the chamfer cone and the pitch cone of the thread. Usually this depth is equal to one-half thread from the face of the fitting.

14.3 Estimate the difference between the gaging face of the ring gage and the face of the fitting (external threads) or the difference between the notch of the plug gage and the end of the thread (internal threads) to the nearest  $\frac{1}{8}$  turn, after correction has been made for any variation in the gage from basic dimensions.

### 15. Straightness

15.1 *Apparatus*—A plane horizontal surface, a drawn line or string, and a metal rule with  $\frac{1}{16}$ -in. (1.6-mm) or finer calibration.

15.2 *Procedure*—Place the pipe section on the plane surface and allow it to come to rest. At a distance of half the outside diameter above the pipe surface, stretch the drawn line or string from one pipe end to the other and draw it taut while in contact with both ends. Holding the ruler horizontally, determine the maximum distance between the pipe and the line. Pipe with a nonuniform curvature will not necessarily show the maximum reading at the center.

15.3 *Report*—The report shall include the specimen length and the maximum deviation from straightness.

### 16. Keywords

16.1 diameter; dimensions; fiberglass; fittings; gaging threads; liner thickness; out-of-round; pipe; straightness; taper angle; wall thickness