



Standard Test Methods of Measuring Dimensions of Rigid Rods and Tubes Used for Electrical Insulation¹

This standard is issued under the fixed designation D668; 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 These test methods cover the measurement of the dimensions of all rigid rods and tubes used as electrical insulation, the limitations imposed being those of the size range of the more common forms of measuring instruments used.

1.2 Where the number of tests to be made or the specifications covering the rod or tube justify its use, it is acceptable to use an accurately calibrated “go-and-no-go” ring gage of suitable size.

1.3 *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:*²

[D374 Test Methods for Thickness of Solid Electrical Insulation](#) (Withdrawn 2013)³

[D1711 Terminology Relating to Electrical Insulation](#)

3. Terminology

3.1 *Definitions*—For definitions of terms used in these test methods refer to Terminology [D1711](#).

4. Significance and Use

4.1 These test methods are used to measure the dimensions of the rod or tube to determine conformance with specifications on full lengths or cut lengths. The measurements can also be

¹ These test methods are under the jurisdiction of ASTM Committee [D09](#) on Electrical and Electronic Insulating Materials and are the direct responsibility of Subcommittee [D09.07](#) on Flexible and Rigid Insulating Materials.

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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 The last approved version of this historical standard is referenced on www.astm.org.

used for manufacturing control, determination of uniformity, dimensional stability, and physical and electrical properties of the rods and tubes.

5. Conditioning

5.1 Condition specimens prior to testing for at least 48 h at 23 ± 1 °C and 50 ± 2 % relative humidity. Perform tests in air controlled at that temperature and humidity.

6. Method of Measurement

6.1 Make all diameter and wall thickness measurements for specimens with dimensions 300 mm (12 in.) and under in accordance with the procedure described in Test Methods [D374](#) as applicable. Close the micrometer or vernier caliper slowly on the specimen until contact is made without appreciable distortion of the specimen. The criterion of contact is the initial development of frictional resistance to movement of the specimen between the micrometer or caliper surfaces. Use a steel tape or steel scale for measurement of length and diameter greater than 300 mm (12 in.).

7. Length of Rods or Tubes 300 mm (12 in.) and Under in Length

7.1 *Apparatus*—A machinist's micrometer or vernier caliper of suitable size reading to 0.02 mm or 0.001 in.

7.2 *Test Specimens*—Specimens shall consist of rods or tubes 300 mm (12 in.) or shorter.

7.3 *Procedure*—Measure the length of the specimen to the nearest 0.02 mm or 0.001 in. Size permitting, make four measurements at points 90° apart around the circumference of the specimen.

7.4 *Report*—Report the average of the measurements taken as the length of the rod or tube.

8. Length of Rod or Tubes Over 300 mm (12 in.) in Length

8.1 *Apparatus*—Steel tape or steel scale of suitable length graduated in 0.5 mm or $\frac{1}{64}$ in.

8.2 *Test Specimens*—Specimens shall consist of rods or tubes over 300 mm (12 in.) in length, including full lengths.

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

8.3 *Procedure*—Measure the length of the specimen to the nearest 0.5 mm or 1/64 in. Size permitting, make four measurements at points 90° apart around the circumference of the specimen.

8.4 *Report*—Report the average of the measurements as the length of the rod or tube.

9. Diameter of Rods or Outside Diameter of Tubes 300 mm (12 in.) and Under in Outside Diameter

9.1 *Apparatus*—A machinist’s micrometer or vernier caliper reading to 0.02 mm or 0.001 in.

9.2 *Test Specimens*—Specimens shall consist of tubes 300 mm (12 in.) and under in outside diameter or rods of any diameter.

9.3 *Procedure*—Measure the outside diameter of the specimen to the nearest 0.02 mm or 0.001 in. Make four measurements at points 45° apart around the circumference at each end and at the middle of the specimen.

9.4 *Report*—Report the average of the twelve measurements as the outside diameter of the tube or the diameter of the rod.

9.4.1 In the case of tubes, report the variation in outside diameter as the difference between the maximum and minimum individual outside diameter readings, together with all measurements made.

NOTE 1—Rods having a diameter greater than 300 mm are generally commercially available and no standard test procedures have been developed for measuring dimensions of such rods.

10. Outside Diameter of Tubes Over 300 mm (12 in.) in Outside Diameter

10.1 *Apparatus*—A flat steel tape graduated in steps of 0.5 mm or 1/64 in.

10.2 *Test Specimen*—Specimens shall consist of tubes over 300 mm (12 in.) in outside diameter.

10.3 *Procedure*—Place the steel tape tightly around the outside of the tube at a right angle to the long axis, and measure the circumference to the nearest 0.5 mm or 1/64 in. Calculate the outside diameter by the following equation:

$$D = (\text{tape reading}/\pi) - 2t \quad (1)$$

where:

D = average outside diameter of tube, mm or in., and

t = thickness of tape, mm or in.

Make at least three measurements at three different locations on the tube.

10.4 *Report*—Report the average of all measurements as the outside diameter of the tube.

11. Inside Diameter of Tubes 300 mm (12 in.) and Under in Inside Diameter

11.1 *Apparatus*—The preferred option is to use a machinist’s inside micrometer or a vernier caliper of suitable size reading to 0.02 mm or 0.001 in. However, the use of a combination of a telescoping gage and a standard machinist’s outside micrometer is also acceptable (see 1.2).

11.2 *Test Specimen*—Specimen shall consist of tubes whose inside diameter is not over 300 mm (12 in.) nor under 3 mm (1/8 in.).

11.3 *Procedure*—Measure the inside diameter of the specimen to the nearest 0.02 mm or 0.001 in. Make four measurements at points 45° apart around the circumference at each end of the specimen.

11.4 *Report*—Report the average of the measurements taken as the inside diameter of the tube.

12. Inside Diameter of Tubes Over 300 mm (12 in.) in Inside Diameter

12.1 *Procedure*—Determine the average inside diameter by subtracting twice the average wall thickness from the average outside diameter. Determine the average wall thickness from an average of at least six measurements in accordance with Section 13.

13. Wall Thickness of Tubes

13.1 *Apparatus*—A ball foot micrometer or suitable vernier caliper reading to 0.02 mm or 0.001 in. shall be used for the measurement of tubes 8 mm (5/16 in.) and over in inside diameter. A dial micrometer reading to 0.02 mm or 0.001 in. shall be used for the measurement of tubes under 8 mm (5/16 in.) in inside diameter.

13.2 *Test Specimens*—Specimens shall consist of tubes of any length or diameter.

13.3 *Procedure*—Measure the wall thickness to the nearest 0.02 mm or 0.001 in. For tubes 8 mm (5/16 in.) and over in inside diameter, take four measurements at points 90° apart around the circumference at each end of the specimen. For tubes under 8 mm (5/16 in.) in inside diameter, measure the wall thickness by placing the specimen over a mandrel of slightly smaller diameter which is fixed in position at right angles relative to the spindle of the dial micrometer. Note a zero setting with the spindle against the pin. Then place the specimen over the pin and take readings at various points around the circumference of the specimen. Take at least four readings.

13.4 *Report*—Report the average of the measurements taken as the wall thickness of the tube.

14. Variation in Wall Thickness of Tubes

14.1 *Apparatus*—see 13.1.

14.2 *Test Specimens*—Specimens shall consist of tubes of any length or diameter.

14.3 *Procedure*—Measure the wall thickness to the nearest 0.02 mm or 0.001 in. For tubes 8 mm (5/16 in.) and over in inside diameter, make a series of measurements around each end of the specimen. For tubes under 8 mm (5/16 in.) in inside diameter, measure the variation in wall thickness by rotating the specimen around the mandrel and following the general procedure in accordance with 13.3 for tubes of this size.

14.4 *Report*—Report the difference between the maximum and minimum values as the variation in wall thickness. Also, report all measurements taken.

15. Warp

15.1 *Apparatus*—A horizontal flat surface and a rigid bar with plane surface firmly fixed at right angles to the flat surface, both being at least as long as the specimen. The height of the bar shall exceed half the diameter of the tube. Feeler gages of suitable thicknesses will also be required.

15.2 *Test Specimens*—Specimens shall consist of rods or tubes of any length or diameter.

15.3 *Procedure*—Place the specimen in the fixture. With the aid of feeler gages, measure the maximum distance between the rod or tube and the plane surface, rotating the specimen as necessary to locate the maximum. Measure to the nearest 0.02 mm or 0.001 in.

15.4 *Report*—Report warp or lack of straightness as the maximum distance measured in accordance with 15.3.

15.5 *Calculation*—Calculate the percentage warp based on a 1-m or 36-in. length as follows:

$$W_m = (1D/L^2) \times 100 \text{ or } W_{36} = (36D/L^2) \times 100 \quad (2)$$

where:

- W_m = percentage warp calculated to a 1-m length,
- D = maximum deviation of the rod or tube from the straight edge, m or in.,
- L = actual length of the rod or tube as determined in accordance with the procedure described in Section 7 or 8, m or in., and
- W_{36} = percentage warp calculated in a 36-in. length.

When it is desired to compare the actual deviation for any length with the permissible deviation for that length, use one of the following equations:

$$D_{xm}/D_m = L_{xm}^2/(1)^2 \text{ or } D_x/D_{36} = L_x^2/(36)^2 \quad (3)$$

where:

- D_{xm} = permissible deviation from the straight edge for the given length, m,
- D_m = permissible deviation for a 1-m length,
- L_{xm} = given length, m,
- D_x = permissible deviation from the straight edge for the given length, in.,
- D_{36} = permissible deviation for a 36-in. length, and
- L_x = given length, in.

NOTE 2—These requirements do not apply to cut pieces but only to rod or tube lengths as manufactured, unless otherwise agreed upon between the manufacturer and the purchaser.

16. Precision and Bias

16.1 These tests have been in use for many years, but no information has been presented to ASTM upon which to base a statement of precision. No activity has been planned to develop such information.

16.2 These test methods have no bias because the values for these measurements are determined solely in terms of these test methods themselves.

17. Keywords

17.1 dimensions; rigid rods; rigid tubes; wall thickness; warp

SUMMARY OF CHANGES

Committee D09 has identified the location of selected changes to this specification since the last issue, D668 – 99R04, that may impact the use of this specification. (Approved November 1, 2012.)

(1) Non-mandatory terms have been eliminated.

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