



# Standard Practice for Conditioning Electrical Insulating Materials for Testing<sup>1</sup>

This standard is issued under the fixed designation D 6054; 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 approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers procedures for conditioning electrical insulating materials (although not necessarily to equilibrium) prior to testing and the conditions under which they shall be tested. In general the physical and electrical properties of electrical insulating materials are influenced by temperature and relative humidity in a manner that materially affects test results. In order that reliable comparisons may be made of different materials and between different laboratories, it is necessary to standardize the humidity and temperature conditions to which specimens of these materials are subjected prior to and during testing.

1.2 This practice is similar to Practice D 618.

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:

D 618 Practice for Conditioning Plastics for Testing<sup>2</sup>

D 709 Specification for Laminated Thermosetting Materials<sup>3</sup>

D 1711 Terminology Relating to Electrical Insulation<sup>3</sup>

D 5032 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Glycerin Solutions<sup>4</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 *room temperature, n*—a temperature in the range from 20 to 30°C.

3.1.2 *standard laboratory atmosphere, n*— an atmosphere having a temperature of  $23 \pm 2^\circ\text{C}$  and a relative humidity of  $50 \pm 5\%$ .

3.1.2.1 *Discussion*—Where closer tolerances on atmospheric conditions are required,  $\pm 1^\circ\text{C}$  on temperature or  $\pm 2\%$  on relative humidity, or both, may be specified.

3.1.3 *standard laboratory temperature, n*— a temperature of  $23 \pm 2^\circ\text{C}$ .

3.1.4 For definitions of other terms relating to electrical insulating materials, refer to Terminology D 1711.

## 4. Significance and Use

4.1 Conditioning of specimens may be undertaken: (1) for the purpose of bringing the material into equilibrium with normal or average room conditions; (2) simply to obtain reproducible results; or (3) to subject the material to abnormal conditions of temperature or humidity in order to predict its service behavior. However, it is not within the scope of this practice to define procedures for determining aging characteristics of electrical insulating materials.

4.2 The conditioning procedures prescribed in this practice are designed to obtain reproducible results and may give values somewhat different from values under equilibrium at normal conditions, depending upon the particular material and test. To ensure substantial equilibrium under normal conditions of humidity and temperature, however, may require many days or weeks depending upon thickness and type of material and its previous history. Consequently, conditioning for reproducibility must of necessity be used for general purchase and product control tests.

4.3 Any reference to this practice must include the information needed for designating the conditioning procedure (and testing procedure, if applicable), as defined in Section 7, or one of the standard conditioning procedures to be followed, as defined in Section 8.

## 5. Sampling

5.1 Sample in accordance with the ASTM or other test method or specification for the specific properties to be determined.

## 6. Test Specimens

6.1 Prepare test specimens of the quantity and type specified in the referencing standard for the properties to be determined.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D-9 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.12 on Electrical Tests.

Current edition approved Feb. 10, 1997. Published August 1997.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 08.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 10.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 10.02.

## 7. Designations for Conditioning

### 7.1 Designation for Conditioning Prior to Test:

7.1.1 Conditioning of test specimens may be designated as follows:

7.1.1.1 A number indicating in hours the duration of conditioning,

7.1.1.2 A number indicating in degrees Celsius the conditioning temperature, and

7.1.1.3 A number indicating percent relative humidity, when relative humidity is controlled, a word to indicate immersion in a liquid, or “Des” to indicate desiccation.

7.1.2 Separate the numbers from each other by slant marks. Denote a series of conditions by use of a plus (+) sign between successive conditions.

7.1.3 Use temperature and relative humidity tolerances as specified in Section 3 or Table 1, unless different tolerances are specified, in which case include the tolerances with the numbers indicating temperature or relative humidity. Desiccation may be achieved by exposure of the specimens in a desiccator in the presence of anhydrous calcium chloride or silica gel or any other equivalent desiccant or apparatus.

7.1.4 The specified times for nominal conditioning temperatures in air of 50°C or less are minimum times. For higher conditioning temperatures and for conditioning in a liquid, both the minimum and maximum times must be specified in the referencing standard.

#### NOTE 1—Examples:

Condition 96/23/50—Condition 96 h at 23°C and 50 % relative humidity (standard laboratory atmosphere).

Condition 48/50/water—Condition 48 h at 50°C in water.

Condition 48/50/water + 96/23/50—Condition 48 h at 50°C in water; then condition 96 h at 23°C and 50 % relative humidity.

Condition 48/50 + Des—Condition 48 h at 50°C followed by desiccation.

Condition 48/23 ± 1/50 ± 2—Condition 48 h at 23 ± 1°C and 50 ± 2 % relative humidity.

### 7.2 Designation for Test Condition:

7.2.1 Test conditions may be designated as follows:

7.2.1.1 A capital letter “T” following the prior conditioning designation and separated therefrom by a colon,

7.2.1.2 A number indicating in degrees Celsius the test temperature, and

7.2.1.3 A number indicating the relative humidity in the test whenever relative humidity is controlled.

7.2.2 Separate the numbers from each other by a slant mark, and from the “T” by a dash. Use temperature and relative humidity tolerances as specified in Section 3 or Table 1, unless different tolerances are specified, in which case include the tolerances with the numbers indicating temperature or relative humidity.

#### NOTE 2—Examples:

Condition 24/180: T-180—Condition 24 h at 180°C; Test at 180°C. (See 7.1.4 relative to minimum and maximum conditioning times.)

Condition 96/35/90: T-35/90—Condition 96 h at 35°C and 90 % relative humidity; Test at 35°C and 90 % relative humidity.

## 8. Standard Procedures for Conditioning Prior to Test

8.1 *Procedure A*—Condition 40/23/50 for specimens 7 mm (0.25 in.) or less in thickness, 88/23/50 for specimens over 7 mm. Condition in the standard laboratory atmosphere. Provide air circulation on all sides of the specimens by placing them in suitable racks, hanging them from metal clips, or laying them on wide-mesh wire-screen frames with at least 25 mm between the screen and the bench or other supporting surface.

8.1.1 Procedure A is generally satisfactory and is recommended unless other procedures are specified.

8.1.2 If for any particular material or test a specific longer time of conditioning is required, the time shall be agreed upon by the interested parties. Shorter conditioning times may be used for thin specimens provided equilibrium is substantially obtained.

NOTE 3—This procedure differs from “Condition A” of Specification D 709 and of some MIL specifications, in that Condition A in those standards is defined as being “as received, no special conditioning”.

8.2 *Procedure B*—Condition 48/50 + Des—After conditioning at 50 ± 2°C for at least 48 h, remove the specimens from the oven and cool in a desiccator for at least 5 h for specimens 7 mm or less in thickness and at least 15 h for specimens over 7 mm in thickness, immediately prior to testing.

8.2.1 Procedure B is commonly used for the purpose of obtaining reproducible test results on thermosetting materials by means of a short-time conditioning period or where the specific effects of moderate drying are to be determined.

NOTE 4—This procedure is the same as Condition E-48/50 of Specification D 709 and of some MIL specifications.

8.3 *Procedure C*—Condition 96/35/90. The tolerances for this procedure are:

Time, h	±2
Temperature, °C	±1
Relative Humidity, %	±2

8.3.1 Procedure C is recommended wherever the specific effects of exposure to severe atmospheric moisture are to be determined.

8.3.2 It has been found that for certain tests and materials more reliable data are obtained in enclosures with circulating air, rather than still air. In such cases, use enclosures with circulating air.

8.4 *Procedure D*—Condition 24/23/water—Condition the specimens by immersion in distilled or deionized water for 24 ± ½ h at 23 ± 1°C.

**TABLE 1 Standard Nonnormal Test Temperatures**

Test Temperatures, °C (°F)	Tolerance plus or minus, °C (°F)	Test Temperatures, °C (°F)	Tolerance plus or minus, °C (°F)
-70 (-94)	2.0 (3.6)	180 (356)	2.0 (3.6)
-55 (-67)	2.0 (3.6)	200 (392)	3.0 (5.4)
-40 (-40)	2.0 (3.6)	225 (437)	3.0 (5.4)
-25 (-13)	2.0 (3.6)	250 (482)	3.0 (5.4)
0 (32)	2.0 (3.2)	275 (527)	3.0 (5.4)
35 (95)	1.0 (1.8)	300 (572)	3.0 (5.4)
50 (122)	2.0 (3.6)	325 (617)	4.0 (7.2)
70 (158)	2.0 (3.6)	350 (662)	5.0 (9.0)
90 (194)	2.0 (3.6)	400 (752)	6.0 (10.8)
105 (221)	2.0 (3.6)	450 (842)	8.0 (14.4)
120 (248)	2.0 (3.6)	500 (932)	10.0 (18.0)
130 (266)	2.0 (3.6)	600 (1112)	12.0 (21.6)
155 (311)	2.0 (3.6)		

8.5 *Procedure E*—Condition 48/50/water + 1/23/water—Condition the specimens by immersion in distilled or deionized water for  $48 \pm \frac{1}{2}$  h at  $50 \pm 1^\circ\text{C}$ , and cool them by immersion in a sufficient quantity of distilled or deionized water to reduce the temperature to  $23^\circ\text{C}$  within 1 h.

NOTE 5—Procedures D and E have been found useful in ASTM electrical and mechanical tests, and are used extensively in MIL specifications.

8.6 *Procedure F*—Condition  $\frac{1}{23/96}$  (time as specified in the applicable material specification)—Condition the specimens in an atmosphere of  $96 \pm 1\%$  relative humidity at a temperature of  $23 \pm 1^\circ\text{C}$  for a period of time as specified in the applicable material specification.

8.6.1 Constant relative humidity can be obtained only by close temperature control. A procedure for maintaining close tolerances using aqueous glycerin solutions is described in Practice D 5032.

8.6.2 It has been found that for certain tests and materials more reliable data are obtained in enclosures with circulating air, rather than still air. In such cases, use enclosures with circulating air.

## 9. Tests at Normal Temperatures

9.1 Unless otherwise specified, test materials conditioned in the standard laboratory atmosphere in the same atmosphere.

9.2 Unless otherwise specified, test materials conditioned in accordance with Procedure B at room temperature conditions. Start the test as soon as possible but no more than  $\frac{1}{2}$  h after removal of the specimens from the desiccator.

9.3 Unless otherwise specified, test materials conditioned in accordance with procedures C and F in the same atmosphere.

9.4 Unless otherwise specified, wipe materials conditioned in accordance with Procedures D and E immediately with a damp cloth, then with a dry cloth, and test them at room temperature. Remove specimens from the water only as the

tests are ready to be conducted. Start the tests immediately and complete them as soon as possible.

## 10. Tests at Other Than Normal Temperatures

10.1 When tests are specified at one of the standard temperatures defined in Table 1, transfer the specimens to the specified test conditions within  $\frac{1}{2}$  h after completion of the preconditioning.

10.2 Hold the specimen at the test temperature for at least the time required to ensure equilibrium temperature, but, for elevated temperatures, not more than 5 h before conducting the test.

## 11. Report

11.1 In any report of an ASTM test method referencing this practice report the following information:

11.1.1 *For standard conditioning:*

11.1.1.1 Conditioning procedure (Section 8) specified and used, if applicable, or

11.1.1.2 Conditioning designation (Section 7) specified and used, if applicable, and

11.1.1.3 Conditioning time used, to the nearest  $\frac{1}{2}$  h, if not specified in the procedure.

11.1.2 *For test conditions:*

11.1.2.1 The temperature to the nearest degree Celsius, and the relative humidity (where applicable) to the nearest percent, in the vicinity of the specimen during the test, except that if the test extends longer than 30 min, report the ranges of temperature and relative humidity.

11.1.3 The actual range of temperature and relative humidity, if standard tolerances are not applied.

## 12. Keywords

12.1 conditioning; electrical insulation; humidity; relative humidity; temperature

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