



IPC-TM-650 TEST METHODS MANUAL

1.0 Scope This method describes a procedure for determining the ability of rigid insulating materials to resist breakdown parallel to laminations (or in the plane of the material) when subjected to extremely high voltages at standard AC power frequencies of 50-60Hz.

As for most electrical properties, values obtained on most materials are highly dependent on the moisture content and tests using different conditioning cannot be compared. Tests in other mediums, e.g., air are generally impractical due to its relatively low breakdown.

This method is based on the test technique described as ASTM D229.

2.0 Applicable documents

ASTM D229 Standard Method of Testing Rigid Sheet and Plate Materials Used for Electrical Insulation

ASTM D149 Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

3.0 Test Specimens

3.1 Number Four specimens shall be tested. When specified, two shall be in the machine direction and two in the transverse direction for reinforced materials.

3.2 Form Specimens shall be approximately 3.0 inch X 2.0 inch X thickness and shall be prepared by shearing or sawing the specimen from the test sample. Two holes 0.188 inch in diameter are to be drilled along the center line of the 3.0 inch dimension and midway between the edges in the 2.0 inch dimension, with a spacing of 1.0 inch \pm .01 inch center to center.

3.3 Location The specimens may be cut from any location in the sheet (except from the outer 1.0 inch of full size sheets).

3.4 Foil Clad Material Foil clad material shall have all metal cladding removed by etching and shall be thoroughly cleaned prior to conditioning or testing.

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4.0 Apparatus/Materials

4.1 High voltage breakdown tester (generally 50KV minimum) with current rating of .5KVA up to 10KV and 5KVA above 10KV and a motorized control capable of a 500 volts/second rate of rise.

4.2 Oil tank filled with insulating oil¹ capable of exceeding the requirements of the specification.

4.3 Tapered pin electrode fixture utilizing two American Standard #3 pins. (Note spherical ends on the pins are permitted and recommended to reduce likelihood of breakdown in the oil.)

4.4 High voltage test leads (leads rated in excess of machine capacity are recommended).

4.5 Constant temperature water bath, capable of 50°C \pm 2°C, filled with distilled water.

4.6 Beaker or pan filled with ambient temperature distilled water.

4.7 Racks for supporting specimens in the 50°C water bath (with all specimen surfaces exposed).

4.8 Timer 0-60 seconds.

4.9 Lint free paper towels.

5.0 Procedure

5.1 Preconditioning Unless otherwise specified the specimen shall be conditioned for 48 hours (+2 hours -0 hours) in distilled water maintained at 50°C \pm 2°C.

Following this step the specimen shall be immersed in ambient temperature distilled water for 30 minutes minimum, 4 hours maximum, to allow the specimens to achieve temperature equilibrium without a substantial change in moisture content.

1. Insulating Oil: Transfer oil such as Shell Dial Ax may be used. Use of dibutyl phthalate is acceptable but it may cause failure of the adhesives used for plastic tanks.

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5.2 Test Condition The test shall be performed at ambient temperature (23°C ± 5°C). Relative humidity is not significant as the tests are performed under oil.

5.3 Equipment Set Up

5.3.1 Adjust the transformer on the high voltage tester (manually for most models) to the position which will allow for the necessary voltage to be achieved with adequate current capacity for breakdown.

5.3.2 Set the machine for testing using a 500 volt per second rate of rise.

5.4 Test

5.4.1 Remove a preconditioned specimen from the ambient temperature water and wipe dry with a lint free paper towel.

5.4.2 Insert the first specimen into the fixture (inserting the tapered pins from opposite sides) and immerse in the oil bath.

5.4.3 Attach leads (if not permanently wired) so that one high voltage lead is connected to one tapered pin electrode and the ground lead is connected to the other tapered pin electrode.

5.4.4 Operate the tester such that the voltage is applied with a 500 volts per second rate of rise and observe the specimen until an electrical breakdown occurs.

5.4.5 Record the voltage at which breakdown occurs, using the meter memory device if available. *Note:* If the breakdown appears to be in the oil and no specimen damage is obvious it is recommended that the same sample be retested. If the specimen still will not breakdown due to breakdown of the oil, the oil should be filtered or replaced.

5.4.6 Determine the starting voltage and steps for the remaining specimens from the same sample from Table 1.

5.4.7 Change the high voltage tester to manual (or programmed stepped) operation, remove a specimen from the water bath, wipe dry, and insert the second specimen.

5.4.8 Set the voltage to the 50% value (plus or minus the value of one step) and apply the voltage for 60 seconds.

5.4.9 If no breakdown occurs increase the voltage in steps

Table 1 Voltage increments for Step by Step Test

Breakdown Voltage (KV)	Increment KV
less than 12.5	0.5
over 12.5 to 25	1.0
over 25 to 50	2.5
over 50 to 100	5
over 100	10

per Table 1 until the material breaks down or the breakdown capacity of the machine or oil is reached. Record the breakdown voltage to the nearest kilovolt or record "N. B." if there is no breakdown of the material. *Note:* If the minimum value required by the material specification is not exceeded, but material breakdown does not occur, it is necessary to replace or filter the oil.

5.4.10 Repeat steps 5.4.7-5.4.9 for the remaining specimens from the sample.

5.5 Calculation

5.5.1 Average the values for the three specimens tested using the stepped technique and round to the nearest kilovolt. Even if some specimens do not break down, the maximum individual voltages will be used to calculate an average. *Note:* If the accuracy of the meter on the machine is not within 5% for all values in the range, apply a correction obtained from the last machine calibration to each reading to determine the actual value for the dielectric breakdown.

5.6 Report

5.6.1 Report the average value of the dielectric breakdown (if all specimens actually breakdown), e.g., 85KV average.

5.6.2 Report the average with a plus after the value if one or two specimens do not break down, e.g., 82 + KV average 2NB.

5.6.3 Report the minimum value at which the oil broke down, if no actual specimen breakdowns are obtained, e.g., 75 + KV N.B.

5.6.4 Report any anomalies in the test or any variations from prescribed procedures or tolerances.

6.0 Notes

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6.1 The dielectric breakdown of the material may be adversely affected if the drilling process used to produce the holes is inadequate. Use of a sharp high speed drill is recommended to prevent burning the material or producing rough holes.

6.2 This test requires voltages which are life threatening. The High Voltage Tester must be installed and operated in accordance with the manufacturer's instructions. If the test chamber is not totally enclosed, with a safety interlock, extreme care must be exercised in performance of the test.