



Standard Test Method for Proof-Voltage Testing of Thin Solid Electrical Insulating Materials¹

This standard is issued under the fixed designation D 1389; 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 This test method covers a general procedure for proof-voltage testing of thin solid electrical insulating materials at commercial power frequencies. It is intended to apply principally to flat materials but is applicable, with modification, to any form that permits continuously passing the material between suitable electrodes.^{2,3}

1.2 On extremely thin materials (usually less than 0.05 mm (0.002 in.)), the test results may be influenced more by mechanical damage caused by conditions of test than by dielectric defects. Consequently, this test method is not recommended for use with extremely thin materials, unless prior determination has established that the test results are not influenced by mechanical damage.

1.3 While the equipment and procedures described in this test method relate specifically to tests made with power frequency ac voltages, similar equipment and procedures are used for proof-voltage tests using dc voltages. To the extent that it applies to dc tests, this test method can serve as a guide for persons making such tests. However, only tests made with power frequency ac voltages can be said to be in accordance with this test method.

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 the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see Section 7.

¹ This test method is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.12 on Electrical Tests.

Current edition approved March 1, 2004. Published March 2004. Originally approved in 1956. Last previous edition approved in 1997 as D 1389 – 97a.

² Bartnikas, R., Chapter 3, "High Voltage Measurements," *Electrical Properties of Solid Insulating Materials, Measurement Techniques*, Vol. IIB, *Engineering Dielectrics*, R. Bartnikas, Editor, ASTM STP 926, ASTM, Philadelphia, 1987.

³ Nelson, J. K., Chapter 5, "Dielectric Breakdown of Solids," *Electrical Properties of Solid Insulating Materials: Molecular Structure and Electrical Behavior*, Vol. IIA, *Engineering Dielectrics*, R. Bartnikas and R. M. Eichorn, Editors, ASTM STP 783, ASTM, Philadelphia, 1983.

2. Referenced Documents

2.1 *ASTM Standards*:⁴

D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

3. Terminology

3.1 *Definitions*:

3.1.1 *proof voltage test, n*—a test during which a specified voltage is applied to a specimen to determine whether breakdown will occur at that voltage. Fixed electrodes may be used, in which case the voltage is held for a specified time; or large area specimens may pass between roller, brush, or blade electrodes, in which case the speed is specified.

4. Summary of Test Method

4.1 In this test method, sheet insulating material is passed at a specified speed between roller electrodes with a specified ac voltage applied, so that all, or nearly all, of the area of the material is subjected to the specified voltage. The number of electrical breakdowns and their locations are determined.

4.2 The applied proof voltage may be selected as a percentage of the dielectric breakdown voltage, as determined in accordance with Test Method D 149, or as a multiple of the breakdown voltage for an air gap of equal thickness.

4.3 Unless the material being tested is known to have high resistance to partial discharges, the proof voltage is ordinarily selected to be below the visible corona level. If it is necessary to test at a voltage at which visible corona will be present, the degradation of the material resulting from exposure to corona should be weighed against the advantages of testing at the high voltage level.

4.4 Two values for the rate of movement of the material between the electrodes are given to facilitate handling of

⁴ 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.

different types of materials. The results obtained with the different speeds are not equivalent.

5. Significance and Use

5.1 Occasional dielectric defects may be found in commercially available and acceptable thin electric insulating materials. More often than not, these materials are used in multiple layers. The probability that occasional dielectric weak spots will coincide from layer to layer is very small but increases with the frequency of occurrence of these defects. The proof-voltage test serves to indicate the frequency of occurrence of dielectric defects and facilitates the isolation of areas where the defects are excessive.

5.2 Some uses of thin electrical insulating materials require the complete absence of any dielectric defects. The proof-voltage test serves to locate dielectric defects, making possible repair or replacement of the area involved as may be desirable.

5.3 In the absence of detected faults, this test method is nondestructive to the material being evaluated, except as discussed in 1.2 and 4.3.

5.4 A critical part of the apparatus and procedure is the sensitivity and speed of response of the fault detection device, usually a circuit breaker. The results obtained using different sets of apparatus may differ greatly, depending upon the characteristics of this component.

5.5 It is essential that the fault detector respond only to fault currents, and that fault currents above a pre-defined value should always make the fault detector respond. The design, adjustment, and operation of the apparatus should be such as to avoid both erroneous functioning and erroneous nonfunctioning of the detector resulting from charging currents, magnetizing currents, corona currents, imbalance of circuit impedances, or component malfunction.

5.6 The proof-voltage test may be used as a manufacturing control test and as an acceptance test to guarantee a minimum level of dielectric defects.

5.7 If this test method is used as an acceptance test, take care that the factors discussed in 5.4 and 5.5 have been

considered, and if more than one set of apparatus is to be used, that comparable results are obtained from them.

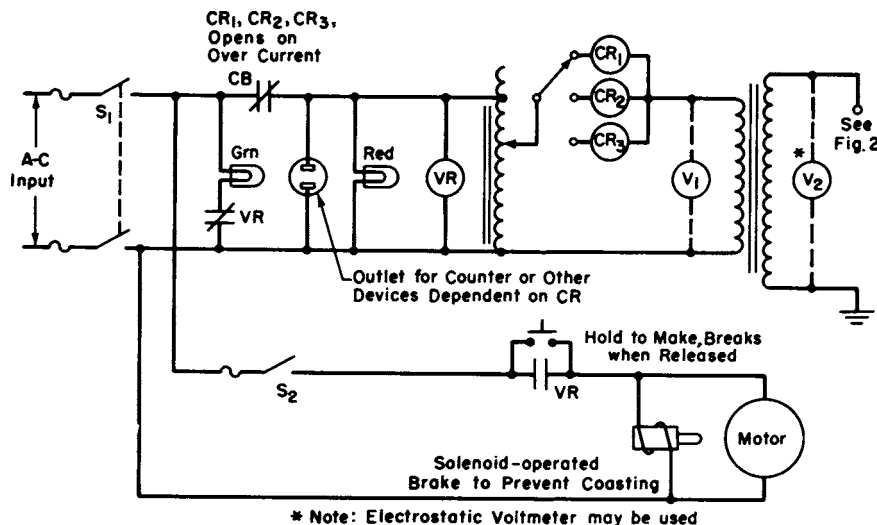
6. Apparatus

6.1 *General Requirements*—The test voltage must conform to the requirements of Test Method D 149, relative to its variation from nominal value, wave-shape, and accuracy and method of measurement. As related to this specific test method, some design details that are useful are described in 6.2-6.5, and in Fig. 1.

6.2 *System Considerations*—Departure from a sinusoidal wave form may arise either at the voltage source or in the load circuit. Excessive distortion due to load current can usually be avoided if the overall impedance drop through the apparatus at rated current and voltage is less than 10 % of the rated voltage, and provided the ratio of test voltage to rated voltage is not too small; the lower limit of this ratio can be determined by test. The apparatus should be of such size and design that fault currents at breakdown produce visually observable ruptures. The magnitude of the fault current required will depend on the material being tested.

6.3 *Transformer*—The desired test voltage is readily obtained from a step-up transformer energized from an adjustable voltage source. The transformer must be of such size and design that its continuous duty rating is consistent with the requirements as specified in 6.1. Standard 5 kVA or larger distribution transformers 14400/13200 to 120/240 or 240/480 V with less than 5 % impedance drop are readily available and their use is suggested.

6.4 *Fault Detector*—Fault detection shall be provided by an automatic circuit-breaking device with non-automatic reset. In order to provide detection of the smallest defects, to prevent pitting of the electrodes, and to provide maximum protection of the other electrical elements, the fault detector should be as sensitive and as fast-acting as possible. On the other hand, the task of visually locating dielectric punctures in some types of materials may be difficult if the fault current is interrupted too quickly. Therefore, the current setting and the response time of



Symbols: CB-Circuit Breaker; CR-Current Relay; VR-Voltage Relay.

FIG. 1 Elementary Schematic Diagram of Typical Electrical Test Apparatus