



Designation: D5288 – 21

Standard Test Method for Determining Tracking Index of Electrical Insulating Materials Using Various Electrode Materials (Excluding Platinum)¹

This standard is issued under the fixed designation D5288; 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 was developed using copper electrodes to evaluate the low-voltage (up to 600 V) tracking resistance of materials in the presence of aqueous contaminants.²

NOTE 1—At this time, only industrial laminates have been examined using this method, which was developed at the National Manufacturers Electrical Association (NEMA) laboratory located at the University of Cincinnati. It was found that a closer end point (less scatter) was obtained than with platinum electrodes, and materials tested tended to be ranked by resin system.

1.1.1 It is acceptable to consider other electrode materials for use with this test method depending upon the application of the insulating material.

1.2 This test method is similar to Test Method D3638, which determines the comparative tracking index of materials using platinum electrodes to produce the tracking on the specimen surface.

1.3 The values stated in metric (SI) units are the standard. The inch-pound equivalents of the metric units are approximate.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:³

D618 Practice for Conditioning Plastics for Testing

D1711 Terminology Relating to Electrical Insulation

D3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials

D3638 Test Method for Comparative Tracking Index of Electrical Insulating Materials

2.2 IEC Publication:⁴

IEC 60112 Standard Method for the Determination of the Proof and the Comparative Tracking Indices of Solid Insulating Materials, 2003

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method and associated with electrical and electronic insulating materials, use Terminology D1711.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *tracking index, TI, n*—an index for electrical insulating materials which is arbitrarily defined as the numerical value of that voltage which will cause failure by tracking when the number of drops of contaminant required to cause failure is equal to 50.

3.2.1.1 *Discussion*—This value is obtained from a plot of the number of drops required to cause failure by tracking versus the applied voltage.

3.2.2 *tracking index-copper electrodes, TI-Cu, n*—a tracking index test using copper electrodes.

3.2.2.1 *Discussion*—This test is comparable to *comparative tracking index*, Test Method D3638, with the following exceptions: (1) copper electrodes are used instead of platinum, and

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.

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² Mathes, K. N., "Surface Failure Measurements," in *Engineering Dielectrics Volume IIB Electrical Properties of Solid Insulating Materials: Measurement Techniques*, STP926, ASTM International, 1987.

³ 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.

⁴ Available from International Electrotechnical Commission (IEC), 3, rue de Varembe, 1st floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, <http://www.iec.ch>.

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

(2) the electrodes may have to be re-ground after every test because of the softness of copper.

4. Summary of Test Method

4.1 The surface of a specimen of electrical insulating material is subjected to a low-voltage alternating stress combined with a low current which results from an aqueous contaminant (electrolyte) which is dropped between two opposing copper electrodes every 30 s. The voltage applied across these electrodes is maintained until the current flow between them exceeds a predetermined value which constitutes failure. Additional specimens are tested at other voltages so that a relationship between applied voltage and number of drops to failure can be established through graphical means. The numerical value of the voltage which causes failure with the application of 50 drops of the electrolyte is arbitrarily called the tracking index. This value provides an indication of the relative track resistance of the material.

5. Significance and Use

5.1 Electrical equipment has the potential to fail as a result of electrical tracking of insulating material that is exposed to various contaminating environments and surface conditions. A number of ASTM and other tests have been designed to quantify behavior of materials, especially at relatively high voltages. This method is an accelerated test which, at relatively low test voltages, provides a comparison of the performance of insulating materials under wet and contaminated conditions. The Tracking Index-Copper Electrodes test is not related directly to the suitable operating voltage in service.

5.2 When organic electrical insulating materials are subjected to conduction currents between electrodes on their surfaces, many minute tree-like carbonaceous paths or tracks are developed near the electrodes. These tracks are oriented randomly, but generally propagate between the electrodes under the influence of the applied potential difference. Eventually a series of tracks spans the electrode gap, and failure occurs by shorting of the electrodes.

5.3 As in other tracking test methods, for example, IEC 60112 and Test Method D3638, this test method specifies test procedures that are intended to promote the formation of surface discharges which will produce carbon tracks in a reproducible manner. Since these conditions rarely reproduce the actual conditions encountered in service, the results of tracking tests cannot be used to infer either direct or relative service behavior of a material in a specific design application. Tracking tests can be used for screening purposes only. Suitability is verified through testing of the material in actual end use or under conditions that closely simulate actual end use.

5.4 The use of copper electrodes in this type of test was developed at the University of Cincinnati, NEMA laboratory. It is felt by the members of the Industrial Laminates Section of NEMA that using copper electrodes gives a more realistic value for a tracking index, related to the resin system used to reinforce the substrate of a laminate. In general, tracking tests made with copper electrodes tend to give lower values than

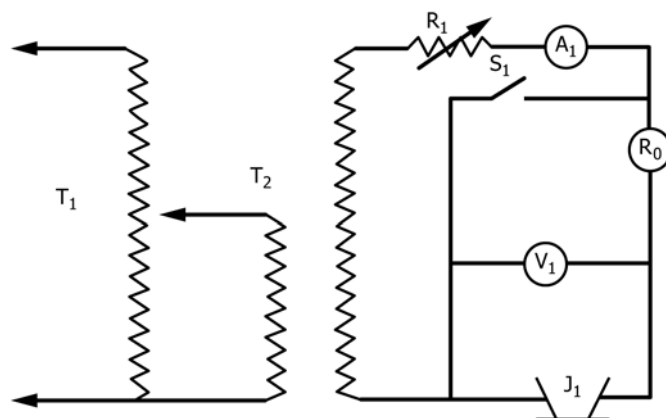


FIG. 1 Electrical Circuit Components

platinum electrodes in the same type of test. It is a fact that copper is more widely used than platinum for electrical conductors.⁵

6. Apparatus

6.1 The simplified electrical circuitry used in this test is illustrated in Fig. 1. For necessary information on the cleanliness of apparatus, see Annex A1. The essential components are:

6.1.1 *Variable Power Source*, consisting of a transformer-type supply, such as the combination T_1 and T_2 in Fig. 1, with a variable output of 0 to 1000 V, 60 Hz capable of maintaining a current of 1 A (1 kVA).

6.1.2 *Voltmeter* (V_1), capable of measuring the varying ac output of the power source. A 0- to 600-V voltmeter with an accuracy of at least $\pm 0.5\%$ of full scale.

6.1.3 *Ammeter* (A_1), with a range of 0 to 1 A ac and an accuracy of at least $\pm 10\%$ of full scale.

6.1.4 *Current Limiting Resistor* (R_1), continuously variable, wire wound, rated at greater than 1 A.

6.1.5 *Shorting Switch* (S_1), single-pole single-throw rated at 1000 V and greater than 1 A.

NOTE 2—The need for a shorting switch is optional. It is possible to couple the variable resistor with the autotransformer which gives an automatic setting of the current throughout the range of the instrument. Then whenever it is necessary to check the calibration of the instrument, the shorting action can be accomplished by a jumper wire placed across the electrodes. This coupling of the autotransformer with the variable resistor is another option.

6.1.6 *Over-current Relay* (R_0), shall not trip at currents up to 0.1 A, and the tripping time on short circuit shall be a minimum of 0.5 s (the current shall be limited on short circuit to 1 A, with a tolerance of $\pm 10\%$ at a power factor of 0.9 to 1.0).

NOTE 3—Some instruments have used a Heinemann breaker, which is probably the closest standard commercial breaker to that described in the

⁵ Middendorf, W. H. and Vemuri, R., "Report on Copper vs. Platinum Electrodes," 1990. Available from National Electrical Manufacturers Association (NEMA), 1300 N. 17th St., Suite 900, Arlington, VA 22209, <http://www.nema.org>.