



Designation: D3638 – 21^{ε1}

Standard Test Method for Comparative Tracking Index of Electrical Insulating Materials¹

This standard is issued under the fixed designation D3638; 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.

^{ε1} NOTE—Subsections 7.1.1, 7.1.2, and 9.4 were corrected editorially in January 2022.

1. Scope*

1.1 This test method evaluates in a short period of time the low-voltage (up to 600 V) track resistance or comparative tracking index (CTI) of materials in the presence of aqueous contaminants.

1.2 The values stated in metric (SI) units are to be regarded as standard. The inch-pound equivalents of the metric units are approximate.

1.3 This test method is technically equivalent to the version of IEC Publication 112 cited in 2.2. However, the 2007 version of IEC 60112 Fourth Edition yields numerical CTI values that are very likely to differ significantly from 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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 Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

D1711 Terminology Relating to Electrical Insulation

D6054 Practice for Conditioning Electrical Insulating Mate-

rials for Testing (Withdrawn 2012)³

2.2 *IEC Publications:*⁴

IEC 112 Method for the determination of the proof and the comparative tracking indices of solid insulating materials

IEC 60112 Method for the determination of the proof and the comparative tracking indices of solid insulating materials

IEC 60664-1 Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests, 2020 Edition 3.0

2.3 *ANSI/UL Publication:*⁵

ANSI/UL 840 Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment. January 6, 2005, 3rd edition

3. Terminology

3.1 *Definitions:*

3.1.1 *track, n*—a partially conducting path of localized deterioration on the surface of an insulating material.

3.1.2 *tracking, n*—the process that produces tracks as a result of the action of electric discharges on or close to an insulation surface.

3.1.3 *tracking, contamination, n*—tracking caused by scintillations that result from the increased surface conduction due to contamination.

3.1.4 *tracking resistance, n*—the quantitative expression of the voltage and the time required to develop a track under the specified conditions.

3.1.5 For other terminology, refer to Terminology **D1711**.

3.2 *Definitions of Terms Specific to This Standard:*

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 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.

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

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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

3.2.1 *comparative tracking index, 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*—The voltage value is obtained from a plot of the number of drops required to cause failure by tracking versus the applied voltage.

3.2.2 *failure, n*—an attribute of an electrical circuit containing an electrical-current-sensing device that rapidly decreases the applied voltage to zero if the current in the circuit exceeds a predetermined limit.

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) dropped between two opposing electrodes every 30 s. The voltage applied across these electrodes is maintained until the current between them exceeds a predetermined value, constituting a failure. Additional specimens are tested at other voltages to establish a relationship between applied voltage and number of drops to failure 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 comparative tracking index. This index provides an indication of the relative track resistance of the material.

5. Significance and Use

5.1 Electrical equipment can fail as a result of electrical tracking of insulating material that is exposed to various contaminating environments and surface conditions. 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 comparative tracking index 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. Even-

tually a series of tracks spans the electrode gap, and failure occurs by shorting of the electrodes.

5.3 The conditions specified herein are intended to produce a condition conducive to the formation of surface discharges and possible subsequent tracking. Test conditions are chosen to accelerate a process that is reproducible. Consequently, they rarely reproduce the varied conditions found in actual service. Therefore, while tracking tests serve to differentiate materials under given conditions, results of tracking tests cannot be used to infer either direct or comparative service behavior of an application design. Rather, the results provide a tool for judging the suitability of materials for a given application. The suitability can only be verified through testing the design in actual end use or under conditions which simulate end use as closely as possible.

5.4 The results have been used for insulation coordination of equipment with rated voltage up to 1000 Vac or 1500 Vdc connected to low-voltage supply systems (higher voltages permitted in internal circuits). The complete principles of insulation coordination involve the consideration of the combination of clearances, creepage distances, and the properties of solid insulation used to constitute the insulation system. Users of these results need to consider the overvoltage levels and the methods of control which will be utilized and establish the pollution degree to which the product insulation system will be expected to be subjected.

NOTE 1—See IEC 60664-1:2020, Table F.5 (Creepage Distances to Avoid Failure Due to Tracking) and UL 840, Table 9.1 (Minimum Acceptable Creepage Distances) as examples for the use of comparative tracking index results as part of insulation coordination.

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 as follows:

6.1.1 *Variable Power Source*, consisting of a transformer type supply, such as the combination T1 and T2 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 (V1)*, capable of measuring the varying a-c output of the power source up to 600 V with an accuracy of at least $\pm 2.5\%$ of full scale.

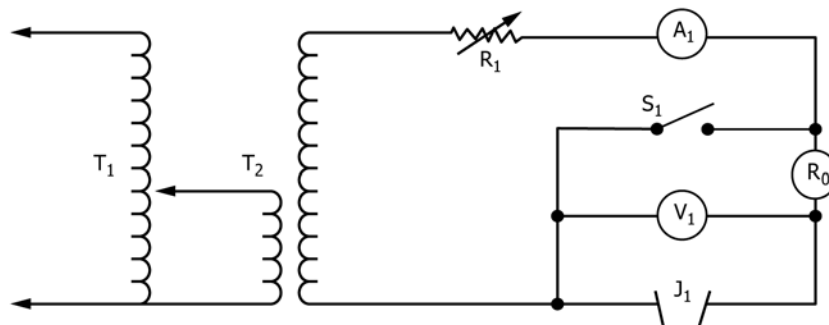


FIG. 1 Electrical Circuit Components