Designation: D5162 – 21

Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates[1]

This standard is issued under the fixed designation D5162; 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 practice covers procedures for determining discontinuities using two types of test equipment:

1.1.1 *Test Method A*—Low Voltage Wet Sponge, and

1.1.2 *Test Method B*—High Voltage Spark Testers.

1.2 This practice addresses metallic substrates. For concrete surfaces, refer to Practice D4787.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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]

D4787 Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates

D7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *discontinuity, as used in this standard, n*—a flaw, void, crack, thin spot, foreign inclusion, or contamination in the coating film that significantly lowers the dielectric strength of the coating film; a discontinuity may also be identified as a holiday or pinhole.

3.1.2 *holiday, as used in this standard, n*—a term that identifies a discontinuity.

3.1.3 *holiday detector, as used in this standard, n*—a device that locates discontinuities in a nonconductive coating film applied to an electrically conductive surface.

3.1.4 *pinhole, as used in this standard, n*—a film defect characterized by small pore like flaws in the coating which, when extended entirely through the film, will appear as a discontinuity; a pinhole in the finish coat may not appear as a discontinuity.

4. Significance and Use

4.1 A coating/lining is applied to a metallic substrate to prevent corrosion or reduce product contamination, or both. The degree of coating continuity required is dictated by service conditions. Discontinuities in a coating/lining are frequently very minute and may not be readily visible. This practice provides a procedure for electrical detection of discontinuities in nonconductive coating systems.

4.2 Electrical testing to determine the presence and number of discontinuities in a coating/lining is performed on a nonconductive coating/lining applied to an electrically conductive surface. The allowable number of discontinuities should be determined prior to conducting this test since the acceptable quantity of discontinuities will vary depending on film thickness, design, and service conditions.

4.3 The low voltage wet sponge test equipment is generally used for detecting discontinuities in coatings/linings having a total thickness of 0.5 mm (20 mil) or less. High voltage spark test equipment is generally used for detecting discontinuities in coatings/linings having a total thickness of greater than 0.5 mm (20 mil).

4.3.1 Coatings/linings less than 0.5 mm (20 mil) in thickness may be susceptible to damage if tested with high voltage

[1] This practice is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.46 on Industrial Protective Coatings.

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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.

spark testing equipment. However, coatings/linings greater than 0.25 mm (10 mil) and less than 0.5 mm (20 mil) may be tested with high voltage spark test equipment provided the voltage is calculated and set correctly, and the coating manufacturer approves its use.

4.4 To prevent damage to a coating film when using high voltage test instrumentation, total film thickness and dielectric strength in a coating system shall be considered in determining the appropriate voltage for detection of discontinuities. Atmospheric conditions shall also be considered since the voltage required for the spark to gap a given distance in air varies with the conductivity of the air at the time the test is conducted. Table X1.1 in Appendix X1 contains suggested voltages for high voltage spark testing of low dielectric strength coatings/linings.

4.5 The coating manufacturer shall be consulted to obtain the following information that can affect the accuracy of this test to determine discontinuities:

4.5.1 Establish the length of time required to adequately dry or cure the applied coating/lining prior to testing. Solvents retained in an uncured coating/lining may form an electrically conductive path through the film to the substrate and may be a fire hazard.

4.5.2 Determine whether the coating/lining contains electrically conductive fillers or pigments that may affect the normal dielectric properties.

4.6 This practice is intended for use with new coatings/linings applied to metal substrates. Its use on a lining previously exposed to an immersion condition has often resulted in damage to the lining and has produced erroneous detection of discontinuities due to permeation or moisture absorption of the lining. Deposits may also be present on the surface causing telegraphing (current traveling through a moisture path to a discontinuity, giving an erroneous indication) or current leakage across the surface of the coating/lining due to contamination. The use of a high voltage tester on previously exposed coatings/linings must be carefully considered because of possible spark-through that will damage an otherwise sound coating/lining. Although a low voltage tester can be used without damaging the coating/lining, it may also produce erroneous results.

5. Test Methods

TEST METHOD A—LOW VOLTAGE WET SPONGE TESTING

5.1 *Apparatus:*

5.1.1 *Low Voltage Holiday Detector*—An electronic device powered by a self-contained battery with voltages ranging from 5 to 90 V dc, depending on the equipment manufacturer's circuit design. It is used to locate discontinuities in a nonconductive coating/lining applied to a conductive substrate. Operation includes the use of an open-cell sponge electrode wetted with a solution for exploring the coating surface, a signal return connection, and an audible or visual indicator, or both, for signaling a point of coating discontinuity. A number of commercially available, industry-accepted, instruments are available. The following electronic principle describes two types of devices generally used; others may be available but are not described in this practice.

5.1.1.1 *Lightweight, Self-Contained, Portable Devices*—Based on the electrical principle of an electromagnetic sensitive relay or a solid-state electronic relay circuit that energizes an audible or visual indicator when a discontinuity is detected. Generally, this equipment is capable of being adjusted by the user.

5.1.1.2 *Lightweight, Self-Contained, Portable Devices*—Also based on the principle of an electronic relaxation oscillator circuit that reacts significantly to the abrupt drop in electrical resistance between the high dielectric value of the coating/lining and the conductive substrate at the point of a discontinuity. This results in a rise in oscillator frequency as well as in the audible signal from the device. Generally, this equipment is incapable of being adjusted by the user.

5.1.2 *Low Sudsing, Non-ionic Wetting Agent.*

5.2 *Verifying Operation of Detector (instrument):*

5.2.1 The instrument shall be tested for sensitivity prior to initial use and periodically thereafter, in accordance with the equipment manufacturer's instructions.

5.2.2 Test the battery for proper voltage output. Refer to the manufacturer's instructions.

5.2.3 Switch the instrument to the "on position," if applicable.

5.2.4 Wet the sponge with a wetting solution consisting of tap water and a wetting agent (see 5.4.6).

5.2.5 Connect the signal return wire to the instrument ground output terminal.

5.2.6 Touch the signal return wire clip to the wetted sponge. The instrument should signal in accordance with the instrument manufacturer's instructions.

5.2.7 If the instrument should fail to signal, it shall be considered defective.

5.3 *Instrument Calibration:*

5.3.1 The instrument shall be calibrated by the manufacturer or accredited calibration laboratory at the frequency required by the manufacturer. A certificate of calibration may be required.

5.4 *Procedure:*

5.4.1 Sufficient drying or curing of the coating/lining shall be allowed prior to conducting a test. The length of time required shall be obtained from the coating manufacturer.

5.4.2 The surface shall be dry, and free of oil and other contaminants. Measure the film thickness of the coating with a nondestructive dry film thickness gage in accordance with Practice D7091. If the average thickness of the coating film for the area being inspected exceeds 0.5 mm (20 mil) use the procedures for high voltage spark testing described in Test Method B, High Voltage Spark Testing.

5.4.3 Test the instrument for sensitivity in accordance with 5.3.

5.4.4 Attach the signal return (ground) wire from the instrument terminal to the metallic substrate and ensure a good electrical contact.

5.4.5 Attach the exploring sponge lead to the other terminal.