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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

G62 Test Methods for Holiday Detection in Pipeline Coatings

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

2.2 *NACE ~~Standard:~~Standard Practices:*[3]

~~RP0188–88~~SP0188–2006 Discontinuity (Holiday) Testing of Protective Coatings

SP0274–2011 High Voltage Electrical Inspection of Pipeline Coatings

SP0490–2007 Holiday Detection of Fusion Bonded Epoxy

2.3 *ISO Standard:*[4]

ISO 29601 Paints and varnishes. Corrosion protection by protective paint systems. Assessment of porosity in a dry film

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.

[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~~standard's Document Summary page on the ASTM website.

[3] Available from NACE International (NACE), 1440 South Creek Dr., Houston, TX 77084-4906, http://www.nace.org.

[4] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

4. Significance and Use

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

4.2 Electrical testing to determine the presence and number of discontinuities in a coating film is performed on a nonconductive coating 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 coating film thickness, design, and service conditions.

4.3 The low voltage wet sponge test equipment is generally used for determining the existence of discontinuities in coating films having a total thickness of 0.5 mm (20 mil) or less. High voltage spark test equipment is generally used for determining the existences of discontinuities in coating films having a total thickness of greater than 0.5 mm (20 mil).

4.4 Coatings that are applied at a thickness of less than 0.5 mm (20 mil) may be susceptible to damage if tested with high voltage spark testing equipment. Consult the coating manufacturer for proper test equipment and inspection voltages.

4.5 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 selecting 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. Suggested starting voltages are provided in Table 1.

4.6 The coating manufacturer shall be consulted to obtain the following information, which would affect the accuracy of this test to determine discontinuities:

4.6.1 Establish the length of time required to adequately dry or cure the applied coating film prior to testing. Solvents retained in an uncured coating film may form an electrically conductive path through the film to the substrate.

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

4.7 This practice is intended for use with new ~~linings~~coatings applied to metal substrates. Its use on a coating previously exposed to an immersion condition has often resulted in damage to the coating and has produced erroneous detection of discontinuities due to permeation or moisture absorption of the coating. 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 due to contamination. The use of a high voltage tester on previously exposed coatings has to be carefully considered because of possible spark-through, which will damage an otherwise sound coating. Although a low voltage tester can be used without damaging the coating, it may also produce erroneous results.

5. Test Methods

TEST METHOD A—LOW VOLTAGE WET SPONGE TESTING

5.1 ~~*Apparatus:*~~ 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~~manufacturer's circuit design. It is used to locate discontinuities in a nonconductive coating 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.

5.1.2 Low *Voltage Wet Sponge Tester*—a sensitivity device with the operating voltage being of little importance other than being part of the particular electronic circuit design.

5.1.3 Wet *Sponge Type Instruments*—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.

5.1.3.1 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 coating discontinuity is detected. Generally this equipment is capable of being recalibrated in the field by the user.

5.1.3.2 *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 film and the conductive substrate at the point of coating film 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 recalibrated in the field by the user.

5.2 ~~*Procedure:*~~ Procedure:

5.2.1 Sufficient drying or curing of the coating shall be allowed prior to conducting a test. The length of time required shall be obtained from the coating manufacturer. Solvents retained in the coating film could produce erroneous indicators.

TABLE 1 Suggested Voltages for High Voltage Spark Testing

Total Dry Film Thickness		Suggested Inspection, V
mm	mil	
~~Total Dry Film Thickness~~		~~Suggested Inspection, V~~
~~mm~~	~~mil~~	
0.500–0.590	19.7–23.2	2700
0.600–0.690	23.6–27.2	3300
0.700–0.790	27.6–31.1	3900
0.800–0.890	31.5–35.0	4500
0.900–0.990	35.4–39.0	5000
1.000–1.090	39.4–42.9	5500
1.100–1.190	43.3–46.9	6000
1.200–1.290	47.2–50.8	6500
1.300–1.390	51.2–54.7	7000
1.400–1.490	55.1–58.7	7500
1.500–1.590	59.1–62.6	8000
1.600–1.690	63.0–66.5	8500
1.700–1.790	66.9–70.5	9000
1.800–1.890	70.9–74.4	10000
1.900–1.990	74.8–78.3	10800
2.000–2.090	78.7–82.3	11500
2.100–2.190	82.7–86.2	12000
2.200–2.290	86.6–90.2	12500
2.300–2.390	90.6–94.1	13000
2.400–2.490	94.5–98.0	13500
2.500–2.590	98.4–102.0	14000
2.600–2.690	102.4–105.9	14500
2.700–2.790	106.3–109.8	15000
2.800–2.890	110.2–113.8	15500
2.900–2.990	114.2–117.7	16000
3.000–3.090	118.1–121.7	16500
3.100–3.190	122.0–125.6	17000
3.200–3.290	126.0–129.5	17500
3.300–3.390	129.9–133.5	18000
3.400–3.490	133.9–137.4	18500
3.500–3.590	137.8–141.3	19000
3.600–3.690	141.7–145.3	19500
3.700–3.790	145.7–149.2	20000
3.800–3.890	149.6–153.1	21000
3.900–3.990	153.5–157.1	21800
4.000–4.190	157.5–165.0	22500
4.200–4.290	165.4–168.9	23000
4.300–4.390	169.3–172.8	24000
4.400–4.490	173.2–176.8	25000
4.500–4.590	177.2–180.7	25800
4.600–4.690	181.1–184.6	26400
4.700–4.790	185.0–188.6	26800
4.800–4.890	189.0–192.5	27400
4.900–4.990	192.9–196.5	28000
5.000–5.290	196.9–208.3	28500
5.300–5.500	208.7–216.5	29000
5.600–8.000	220.5–307.1	30000

5.2.2 The surface shall be clean, dry, and free of oil, dirt and other contaminates. Measure the film thickness of the coating with a nondestructive dry film thickness gage. If the coating film exceeds 0.5 mm (20 mil), use the procedures for high voltage spark testing described in Test Method B, High Voltage Spark Testing.

5.2.3 Test the instrument for sensitivity in accordance with 5.3.

5.2.4 Attach the signal return wire from the instrument terminal to the metallic substrate and ensure a good electrical contact.

5.2.5 Attach the exploring sponge lead to the other terminal.

5.2.6 Wet the sponge with a solution consisting of tap water and a low sudsing wetting agent, combined at a ratio of not more than ½ fluid oz of wetting agent to 1 gal water. An example of a low sudsing wetting agent is one used in photographic development. The sponge shall be wetted sufficiently to barely avoid dripping of the solution while the sponge is moved over the coating. The wetting agent residue must be removed prior to executing repairs to the coating.

5.2.7 Sodium chloride (salt) shall not be added to the wetting solution because of the potential erroneous indications of discontinuities. The salt, after drying on the coated surface, may form a continuous path of conductivity across the surface. It will also interfere with intercoat adhesion of additional coats.

5.2.8 Contact a bare spot on the conductive substrate with the wetted sponge to verify that the instrument is properly connected. This procedure shall be repeated periodically during the test.