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Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates[1]

This standard is issued under the fixed designation D 4787; 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 that may be used to allow the detection of discontinuities in nonconductive linings or other non-conductive coatings applied to concrete substrates.

1.2 Discontinuities may include pinholes, internal voids, holidays, cracks, and conductive inclusions.

1.3This practice describes detection of discontinuities utilizing a low voltage wet sponge holiday detector and a high voltage pulsating or continuous dc spark tester. Linings with thickness in excess of 20 mils must be tested utilizing high voltage spark testing equipment.

1.3 This practice describes detection of discontinuities utilizing a high voltage spark tester using either pulsed or continuous dc voltage.

NOTE 1—For further information on discontinuity testing refer to NACE Standard RP0188-88 or Practice D 5162.

1.4 This practice describes procedures both with and without the use of a conductive underlayment.

1.5 The values stated in the inch-pound SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *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 a specific hazard statement, see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*

D149Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies ASTM Standards: [2]

D 5162Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates

G 62 Test Methods for Holiday Detection in Pipeline Coatings

2.2 *NACE Standards:* [3]

RP0188-88 Discontinuity (Holiday) Testing of Protective Coatings

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *discontinuity*—a localized lining site that has a dielectric strength less than a determined test voltage.

3.1.2*conductive underlayment*—a continuous layer applied to the prepared concrete surface prior to the application of a nonconductive lining layer(s) that will allow high voltage spark testing for discontinuities in the lining. conductive underlayment, *n*—a continuous layer applied to the prepared concrete surface prior to the application of a nonconductive lining layer(s) that will allow high voltage spark testing for discontinuities in the lining, as it will conduct the current present when the spark is generated.

3.1.2 *current sensitivity*, *n*—some high voltage testers have adjustable current sensitivity that can be used to prevent low levels of current flow activating the audible alarm. The alarm sensitivity control sets the threshold current at which the audible alarm

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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] Available from National Association of Corrosion Engineers, P.O. Box 218340, Houston, TX 77218.

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

sounds. If the high voltage can charge the lining, a small amount of current will flow while this charge is established. If the lining contains a pigment that allows a low-level leakage current to flow from the probe while testing the threshold current can be set so that the alarm does not sound until this current is exceeded, that is, when a holiday or flaw is detected. Increasing the current threshold setting makes the instrument less sensitive to this low level current flow, decreasing the current threshold setting makes the instrument more sensitive to current flow.

3.1.3 ~~*spark-over*—the distance a spark, from a high voltage tester, will jump across a space from a grounded surface at a specific electrical voltage.~~ discontinuity, *n*—a localized lining site that has a dielectric strength less than a determined test voltage.

3.1.4 ~~*high voltage spark tester*—an electrical device (in excess of 800V) used to locate discontinuities in a nonconductive protective coating applied to a conductive substrate.~~ high voltage spark tester, *n*—an electrical device (producing a voltage in excess of 500 V) used to locate discontinuities in a nonconductive protective coating applied to a conductive substrate. The high voltage is applied to the coating or lining using an exploring electrode and any current resulting from the high voltage passing through a discontinuity in the coating or lining is passed to the device via a signal return cable (also known as a ground or earth wire).

3.1.5 ~~*low voltage tester*—a low voltage wet sponge electrical detector used to locate discontinuities in nonconductive linings applied to conductive substrates.~~

~~3.1.5.1*Discussion*—This test instrument is not suitable for testing linings in excess of 20 mils.~~ holiday, *n*—small faults or pinholes that permit current to flow through the conductive substrate, also known as a discontinuity.

3.1.6 ~~*test voltage*—that electrical voltage established which will allow a discontinuity at the thickest lining location site to be tested, but which will not damage the lining.~~

~~3.1.6.1*Discussion*—The test voltage must always be set well below the dielectric breakdown strength of the lining. This voltage should be recommended by the lining manufacturer. The dielectric breakdown voltage strength of a solid can be determined by Test Method D149.~~ spark-over, *n*—the distance a spark, from a high voltage tester, will jump across a space from a grounded surface at a specific electrical voltage.

3.1.7 *telegraphing*, *n*—current traveling through a moisture path across the surface of the coating to a discontinuity, giving an erroneous indication of a fault.

3.1.8 *test voltage*, *n*—that electrical voltage established which will allow a discontinuity at the thickest lining location site to be tested, but which will not damage the lining. Table 1 is based on the minimum voltage for a given thickness determined by the breakdown voltage of air, which is typically 4 kV/mm (~100 V/mil) and the maximum voltage to prevent damage assuming a dielectric strength of 6 kV/mm (~150 V/mil).

Alternatively the test voltage can be calculated using the following expression:

$$V = M\sqrt{Tc}$$

where:

V = test voltage,
Tc = coating or lining thickness, and
M = a constant dependant on the thickness range and the units of thickness as follows:

Coating Thickness Units	Coating Thickness Range	M Value
mm	<1.00 (1000 µm)	3294
mm	>1.00 (1.000 µm)	7843
mil	<40.0	525
mil	>40.0	1250

Examples:

1) For a lining of 500 µm, Tc = 0.5 and M = 3294

Therefore

$$V = 3294\sqrt{0.5} = 3294 * 0.707 = 2329\ V\ (3.3\ kV)$$

2) For a lining of 20 mil, Tc = 20 and M = 525

Therefore

$$V = 525\sqrt{20} = 525 * 4.472 = 2347\ V\ (3.3\ kV)$$

3) For a lining of 1500 µm, Tc = 1.5 and M = 7843

Therefore

$$V = 7843\sqrt{1.5} = 7843 * 1.224 = 9599\ V\ (9.6\ kV)$$

4) For a lining of 60 mil, Tc = 60 and M = 1250

Therefore

$$V = 1250\sqrt{60} = 1250 * 7.745 = 9681\ V\ (9.7\ kV)$$

TABLE 1 Suggested Voltages for High Voltage Spark Testing

Total Dry Film Thickness		Suggested Inspection, V
mm	mils	
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

4. Summary of Practice

4.1 This practice allows for high ~~and low~~ voltage electrical detection of discontinuities in new linings applied to concrete substrates through the utilization of a continuous conductive underlayment applied to the prepared concrete surface prior to the application of the nonconductive lining layer(s) or by determining the conductivity of the concrete substrate to be tested. The conductivity of concrete varies, depending on moisture content, type, density, and location of rebars. Test the conductivity of the concrete by attaching the ~~ground wire~~ signal return cable to rebar or other metallic ground permanently installed in the concrete. If ~~a metallic ground~~ the concrete is ~~not available, the ground wire shall~~ sufficiently grounded a signal return cable may be placed ~~directly~~ with its electrical contact against the ~~bare concrete surface and weighted with~~structure and held in place using a ~~damp cloth or paper sand-filled~~ wet sand bag. If the test indicates the concrete provides an insufficient ~~ground, a~~ signal return the test cannot be conducted. A conductive underlayment will be required if a continuity test is to be conducted and it is not practical to add this conductive layer for the purpose of the test.

5. Significance and Use

5.1 The electrical conductivity of concrete is primarily influenced by the presence of moisture. Other factors, which affect the electrical continuity of concrete structures, include the following:

5.1.1 Presence of metal rebars,

5.1.2 Cement content and type,

5.1.3 Aggregate types,