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Standard Test Methods for Holiday Detection of Coatings used to Protect Pipelines[1]

This standard is issued under the fixed designation G62; 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 These test methods cover the apparatus and procedures for detecting pinholes and holidays in coatings used to protect pipelines.

1.2 Method A is designed to detect pinholes and holidays in thin-film coatings from 0.025 mm to 0.254 mm (1 mils to 10 mils) in thickness using ordinary tap water and an applied voltage of less than 100 V d-c. It is effective on films up to 0.508 mm (20 mils) thickness if a wetting agent is used with the water.

1.3 Method B is designed to detect pinholes and holidays in thick-film coatings >0.508 mm (20 mils) This method can be used on any thickness of pipeline coating and utilizes applied voltages between 3.4 and 35 kV d-c.

1.4 The values stated in SI units to three significant decimals are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *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.*

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A742/A742M Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

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:*

3.1.1 *holiday, n*—an interruption in the normal physical structure or configuration of a coating such as cracks, laps, seams, inclusions, porosity, discontinuities, or areas of low coating thickness.

3.1.2 *mil, n*—0.001 in.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dielectric strength, n*—the maximum voltage an insulating material can withstand without undergoing electrical breakdown. It is typically tested in accordance with Test Method D149.

3.2.2 *electrical breakdown, n*—a process that occurs when an insulating material, subjected to high enough voltage, suddenly becomes an electrical conductor and electrical current flows through it.

3.2.3 *electrode, n*—a conductive surface that is charged by the Holiday Detector and placed against the coating to be tested. Common electrode configurations include sponges for low voltage detectors and brushes and springs for high voltage detectors.

3.2.4 *high voltage voltmeter, n*—a device capable of measuring the voltage between the electrode and the ground connection of a High Voltage Holiday Detector. When used with a Pulse DC High Voltage Holiday Detector, the High Voltage Voltmeter shall be a peak reading voltmeter.

3.2.5 *holiday detector, n*—a highly sensitive electrical device designed to detect holidays, pinholes, voids, and thin spots in a coating having a relatively high-electrical resistance applied to a surface of low electrical resistance such as steel pipe.

[1] These test methods are under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and are the direct responsibility of Subcommittee D01.48 on Durability of Pipeline Coating and Linings.

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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.

4. Summary of Test Methods

4.1 Both methods rely on electrical contact being made through a pipeline coating because of a holiday or a low-resistance path created by metal particles or thin spots in the coating. This electrical contact will activate an alarm alerting the operator of the incidence of a holiday.

4.2 In Method A, the applied voltage is 100 V d-c or less.

4.3 In Method B, the applied voltage is 3.4 kV d-c to 35 kV d-c.

5. Significance and Use

5.1 *Method A*—Low voltage holiday detection is used to locate holidays and pinholes in thin-film coatings (up to 0.508 mm (20 mils) using a sponge wetted with tap water (and a wetting agent for coatings thicker than 10 mils). The water carries the current from the electrode through the holiday to the conductive substrate. The detector is grounded to the coated substrate. When the detector senses this flow of current it alarms.

5.2 *Method B*—High voltage holiday detection is used to locate holidays and pinholes in thick-film coatings (greater than 20 mils), but can be used on coatings as low as 10 mils thick. A test voltage is selected and set. A charged Electrode is placed in contact with the coating, and the Detector is grounded to the coated substrate. When Electrical Breakdown occurs, electric current flows between the Detector's electrode and the conductive substrate and emits an audible alarm.

5.3 This standard does not apply to holiday detection of tape wraps used to protect pipe or coatings containing conductive raw materials such as conductive pigments and extenders.

5.4 The thickness of a coating applied to ductile iron pipe, fittings, or other iron castings may vary substantially due to the inherent roughness of the substrate. For these applications, consult the coating manufacturer for their recommended test voltage setting when using Method B. The coating manufacturer's recommended test voltage setting may be subject to approval by the owner.

NOTE 1— Use of voltage settings lower than those listed in this standard may increase the likelihood of non-detection.

6. Apparatus

6.1 *Low-Voltage Holiday Detector*—A test device having an electrical energy source of less than 100 V d-c, such as a battery; an exploring electrode equipped with a cellulose sponge dampened with an electrically conductive liquid such as tap water; an audio indicator to signal a defect in a high-electrical resistance coating on a metal substrate; and a ground wire connecting the detector with the low-resistance metal surface.

6.2 *High-Voltage Holiday Detector*—A test device having an electrical energy source of 3.4 kV d-c to 35 kV d-c; an exploring electrode consisting of a wire brush, coil-spring, or conductive silicon electrode capable of traversing along the pipeline coating; and an audio indicator to signal a defect in a high-electrical resistance coating on a metal substrate. A ground wire connects the detector with the low-resistance metal surface.

6.3 *High Voltage Voltmeter*—A peak reading voltmeter capable of measuring the voltage difference between the electrode (or part of the High Voltage Holiday Detector electrically continuous with, and at the same voltage as, the electrode), and the ground connection.

7. Reagents and Materials

7.1 *Tap Water,* plain or with a wetting agent.

NOTE 2—Ordinary tap water will suffice to wet the sponge electrode when inspecting coatings up to 0.254 mm (10 mils) in thickness. On films between 0.254 mm and 0.508 mm (10 mils and 20 mils), a non-sudsing type wetting agent added to the water is recommended to allow for faster penetration of the liquid into pinholes.

8. Test Specimen

8.1 The test specimen shall be a representative length of production-coated pipe or polymeric precoated corrugated steel pipe.

9. Calibration and Verification of Operation

9.1 *Method A*—Low-voltage holiday detectors shall be calibrated annually by the equipment manufacturer, their authorized agent, or accredited calibration laboratory approved by the manufacturer and verified for proper operation prior to each use with respect to sensitivity by having the alarm activated when a selected resistance, having a ½ W rating, is placed across its terminals. A common factory setting for sensitivity is 100 000 Ω. Many units can be reset to any predetermined sensitivity value in this manner.

9.2 *Method B*—High-Voltage Holiday Detectors.

9.2.1 *Calibration*—High voltage detectors shall be calibrated annually by the equipment manufacturer, their authorized agent, or accredited calibration laboratory approved by the manufacturer in a controlled environment using a documented process. A Certificate of Calibration showing traceability to a National Metrological Institute shall be retained with the instrument.

9.2.2 *Verification*—Verification of the (a) output voltage and (b) overall function shall be performed before and after each period of use, if the detector has been dropped, or if the electrode or coating thickness changes.

9.2.2.1 *Two-point Verification of Output Voltage*—Ensure that the detector is properly grounded, and that the electrode to be used for testing is connected and in contact with the coating to be tested. Connect the ground connect from the High Voltage Voltmeter to the ground connector of the detector. Turn the detector on, set the voltage based on the expected/measured low coating thickness, and activate the voltage output. While the voltage output is activated, place the electrode of the High Voltage Voltmeter against the detector's electrode. The measured voltage on the High Voltage Voltmeter shall be within 10 % of the desired test voltage. If required, adjust the test voltage setting on the detector and reverify. Repeat this procedure based on the expected/measured high coating thickness.

NOTE 3— Some High Voltage Holiday Detectors contain an integrated High Voltage Voltmeter and means of adjusting the test voltage at the electrode automatically, thereby performing the above steps automatically.

9.2.2.2 *Functional Verification*—Locate a known holiday in the coating, where a small area (less than 1 mm [40 mils] diameter) of the substrate is exposed. Ensuring the Detector is properly grounded, place the electrode on the coating at least 25 mm (1 in.) away from the known Holiday. Turn on the Detector, activate the voltage output, and sweep the electrode across the known defect according to the procedure in Section 11. Ensure that the alarm activates when the electrode passes the known holiday.

10. Procedure for Method A

10.1 Use the low-voltage holiday detector conforming to that described in 6.1.

10.2 Assemble the wand and electrode according to the manufacturer's instructions.

10.3 Dampen the sponge electrode with tap water and place it between the clamps at the end of the wand, then tighten the clamps to secure the sponge electrode. Clip the ground wire to some point where the metal surface is bare. To verify operation, touch the electrode to a second point where the surface is bare and verify the audible signal is activated.

10.4 The detector is now ready to operate by passing the dampened sponge over the coated surface at a speed not to exceed 0.3 m/s (1 ft⁄s). When a holiday is detected, the electrode can be turned on end to locate the exact spot. Demarcate the location of the holiday/pinhole using a removable product such as chalk or painter's tape.

11. Procedure for Method B

11.1 Use a high-voltage holiday detector conforming to that described in 6.2.

11.2 Assemble the detector unit as required by the manufacturer and connect the electrode wand and grounding cable to the detector unit.

11.3 Measure the thickness of the coating in the area to be tested in accordance with Practice D7091.

11.4 Select the test voltage.

11.4.1 The test voltage shall be 1.5 the dielectric strength of air at the measured Dry Film Thickness as calculated using Paschen's law, plus 1500V. For air at standard atmospheric temperature and pressure, that voltage can be calculated as[3]:

$$V = 1500 + 1.5 * \left[170 + 2.48d + 58\sqrt{d} \right] (microns) \quad (1)$$

$$V = 1500 + 1.5 * \left[170 + 63.0d + 293\sqrt{d} \right] (mils) \quad (2)$$

where:

V = the test voltage, and d equals the coating thickness.

11.4.2 A voltage setting lookup table for common coating thickness values developed based on the formulas above is provided in Appendix X1.

11.4.3 A voltage setting of 1.5 times the dielectric strength of air ensures that factors such as debris on the surface of the electrode or coating, local variations in coating thickness, and imperfections in the electrode are less likely to result in a failure to detect a Holiday. If efforts are made to account for those factors, and there is agreement among all interested parties, a lower test voltage can be acceptable. For example, a lower voltage setting may be necessary when the calculated voltage is near the Dielectric Strength of the coating, or the calculated voltage at the measured Dry Film Thickness exceeds the capabilities of available holiday detection equipment.

11.4.4 The voltage setting selected is based on the actual average dry film thickness. If the thickness of the coating varies substantially, then the use of multiple voltage settings may be required during inspection. For example, if the thickness of the coating on the pipe spool (applied in the shop) is different than the thickness of the coating applied to the girth weld area in the field, then the voltage setting should be adjusted based on actual thicknesses.

11.4.5 It is critical that the test voltage does not exceed the Dielectric Strength of the coating or Electrical Breakdown may occur through the coating, damaging it. For most common coatings this is not a concern.

11.5 Ground the test specimen.

11.6 Prior to making the inspection, ensure that the coated surface is dry. Dryness is critical in a high voltage test. Take care to keep the electrode at least 12.7 mm (½ in.) from any bare sheared or slit edge.

11.7 Turn on the holiday detector.

11.7.1 **Warning—**Because of the high voltages involved, do not touch the ground wire and the metal part of the electrode at the same time if the instrument is on.

11.8 Traverse the electrode over the test specimen at a rate not to exceed 0.3 m⁄s (1 ft⁄s), ensuring that the electrode contacts the entire coated area. The detector will signal if it passes any void, pinhole, or area of the coating that may be thinner than the minimum allowable thickness. When a holiday is detected by the audible alarm, the electrode can be repositioned or a pinhole locator (containing a wooden handle) used to determine the exact holiday area by observing the origin of the spark jump.

11.9 If a holiday is detected, the electrode may be passed over the area slowly in different orientations to locate the holiday for repair.

11.10 Demarcate the location of the holiday/pinhole using a removable product such as chalk or painter's tape.

11.11 *Testing of Repaired Area:*

11.11.1 Sufficient curing of the repair coating shall be allowed prior to retesting. The length of time required shall be obtained from the coating manufacturer.

11.11.2 Only those areas of repair shall be retested. Areas of repair shall be retested until no holidays are detected.

12. Report

12.1 The report shall include the following:

12.2 Complete identification of the specimen including names and code number of the coating, pipe diameter, source, production data, and production run number. For polymeric

[3] https://www.researchgate.net/publication/288833755_Arc_Breakdown_in_Air_over_Very_Small_Gap_Distances