



Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method)¹

This standard is issued under the fixed designation G 95; 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 test method covers accelerated procedures for simultaneously determining comparative characteristics of coating systems applied to steep pipe exterior for the purpose of preventing or mitigating corrosion that may occur in underground service where the pipe will be in contact with natural soils and will receive cathodic protection. They are intended for use with samples of coated pipe taken from commercial production and are applicable to such samples when the coating is characterized by function as an electrical barrier.

1.2 This test method is intended to facilitate testing of coatings where the test cell is cemented to the surface of the coated pipe specimen. This is appropriate when it is impractical to submerge or immerse the test specimen as required by Test Methods G 8, G 42, or G 80. Coating sample configuration such as flat plate and small diameter pipe may be used, provided that the test procedure remains unchanged.²

1.3 This test method allows options that must be identified in the report.

1.4 The values stated in SI units 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:³

¹ This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.48 on Durability of Pipeline Coating and Linings.

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² For other cathodic disbondment testing procedures, consult Test Methods G 8, G 42, and G 80.

³ 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.

G 8 Test Methods for Cathodic Disbonding of Pipeline Coatings

G 12 Test Method for Nondestructive Measurement of Film Thickness of Pipeline Coatings on Steel

G 42 Test Method for Cathodic Disbonding of Pipeline Coatings Subjected to Elevated Temperatures

G 62 Test Methods for Holiday Detection in Pipeline Coatings

G 80 Test Method for Specific Cathodic Disbonding of Pipeline Coatings

3. Summary of Test Method

3.1 The test method described subjects the coating on the test specimen to electrical stress in a highly conductive alkaline electrolyte. Electrical stress is obtained from an impressed direct-current system. An intentional holiday is to be made in the coating prior to starting of test.

3.1.1 Electrical instrumentation is provided for measuring the current and the potential throughout the test cycle. At the conclusion of the test period, the test specimen is physically examined.

3.1.2 Physical examination is conducted by comparing the extent of loosened or disbonded coating at the intentional holiday in the immersed area with extent of loosened or disbonded coating at a reference holiday made in the coating in an area that was not immersed.

4. Significance and Use

4.1 Damage to pipe coating is almost unavoidable during transportation and construction. Breaks or holidays in pipe coatings may expose the pipe to possible corrosion since, after a pipe has been installed underground, the surrounding earth will be moisture-bearing and will constitute an effective electrolyte. Applied cathodic protection potentials may cause loosening of the coating, beginning at holiday edges. Spontaneous holidays may also be caused by such potentials. This test method provides accelerated conditions for cathodic disbondment to occur and provides a measure of resistance of coatings to this type of action.

4.2 The effects of the test are to be evaluated by physical examinations and monitoring the current drawn by the test specimen. Usually there is no correlation between the two

methods of evaluation, but both methods are significant. Physical examination consists of assessing the effective contact of the coating with the metal surface in terms of observed differences in the relative adhesive bond. It is usually found that the cathodically disbanded area propagates from an area where adhesion is zero to an area where adhesion reaches the original level. An intermediate zone of decreased adhesion may also be present.

4.3 Assumptions associated with test results include:

4.3.1 Maximum adhesion, or bond, is found in the coating that was not immersed in the test liquid, and

4.3.2 Decreased adhesion in the immersed test area is the result of cathodic disbondment.

4.4 Ability to resist disbondment is a desired quality on a comparative basis, but disbondment in this test method is not necessarily an adverse indication of coating performance. The virtue of this test method is that all dielectric-type coatings now in common use will disbond to some degree, thus providing a means of comparing one coating to another.

4.5 The current density appearing in this test method is much greater than that usually required for cathodic protection in natural environments.

5. Apparatus

5.1 *Test Vessel*—A transparent plastic or glass tube that is centered over the intentional holiday and sealed to the test sample surface with a waterproof sealing material. The cylinder is to be 101.6 mm (4.0 in. nominal diameter) and of sufficient height to contain 127.0 mm (5.0 in.) of electrolyte. Fig. 1 and Fig. 2 apply to this entire section.

NOTE 1—Size of vessel shall remain unchanged. Sealing procedure must be altered to accommodate specimen having a diameter less than 101.60 mm (4 in.).

5.2 *Filter Tube*—Anode assembly shall be constructed utilizing an immersion tube with fritted disk. Length of the tube will be 180 mm (7 in.) and 8 mm (0.315 in.) in diameter. The fritted-disk section shall be 30 mm (1.18 in.) in diameter with a pore size of 10 to 15 μ m.

5.3 *Impressed-Current Anode*—Anode shall be of the platinum wire type, 0.51 mm (0.020 in.) - 24 gage diameter. It shall be of sufficient length to extend outside the confines of the test cell and shall be connected to the wire from the power source with a bolted or compression fitting.

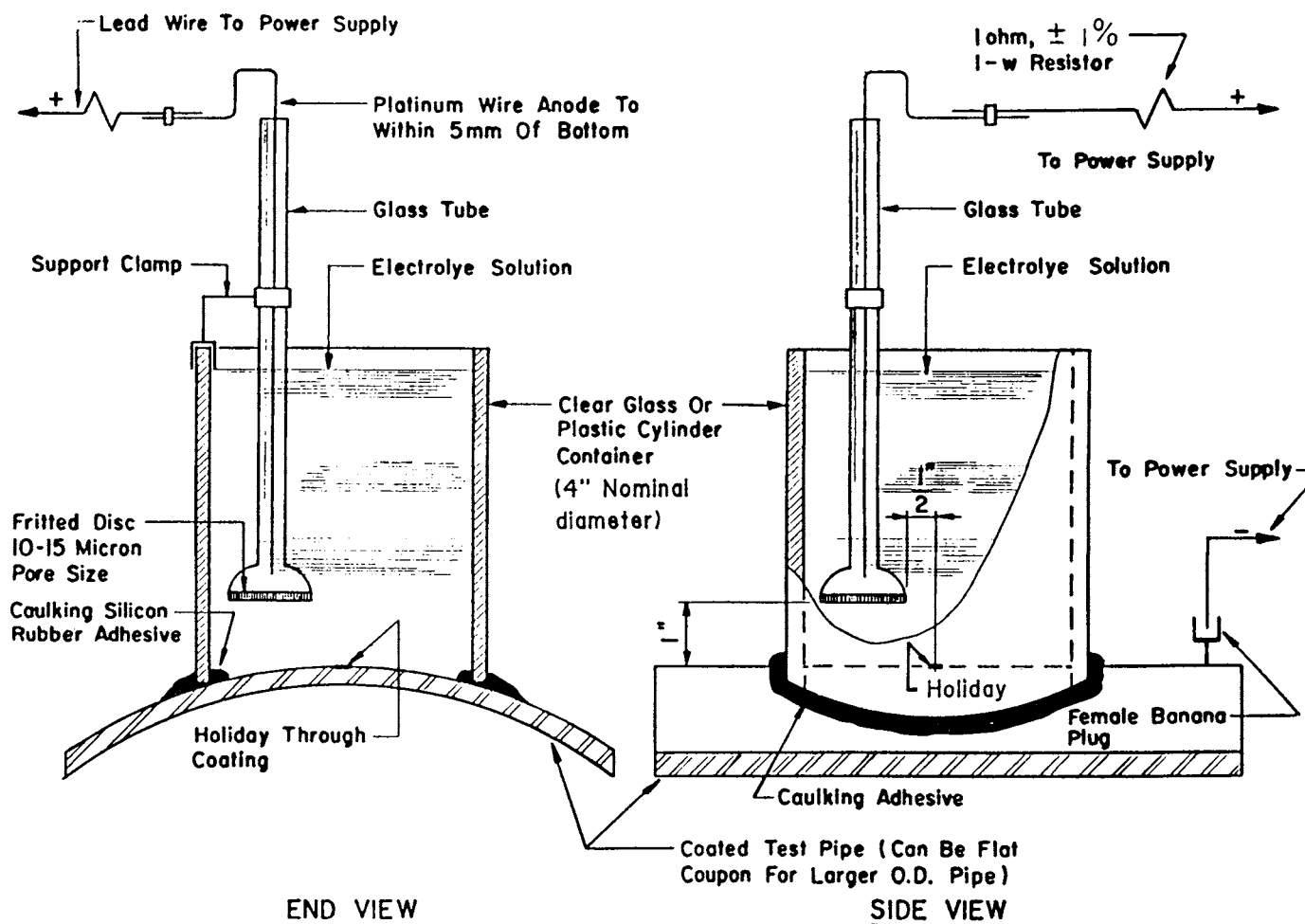
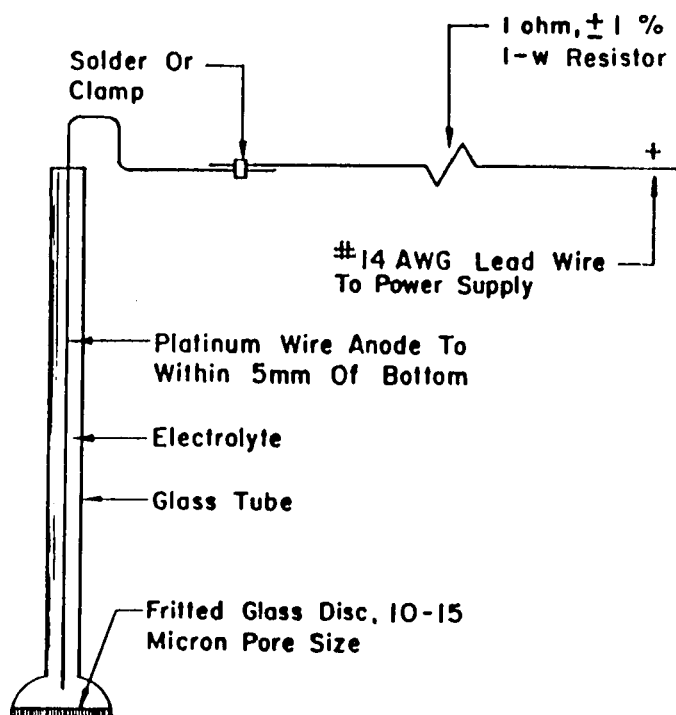


FIG. 1 Typical Test Set Up



ANODE ASSEMBLY

FIG. 2 Anode Assembly

5.4 *Anode Assembly*—Anode shall be suspended inside the test vessel so that the tip of the anode assembly closest to the holiday is 25.4 mm (1 in.) above, and the edge of the anode assembly is 12.7 mm (½ in.) offset from the holiday.

5.5 *Reference Electrode*—Saturated Cu-CuSO₄ of conventional glass or plastic tube with porous plug construction, preferably not over 19.05 mm (0.750 in.) in diameter, having a potential of -0.316 V with respect to the standard hydrogen electrode. A saturated calomel electrode may be used, but measurements made with it shall be converted to the Cu-CuSO₄ reference for reporting by adding -0.072 V to the observed reading.

5.6 *Reference Electrode Placement*—Submerge the tip of the reference electrode 25.4 mm (1 in.) into the electrolyte.

5.7 *High-Impedance Multimeter*—For making direct-current and voltage measurements. Multimeter must have an internal resistance of not less than 10 M Ω and be capable of measuring current as low as 1 mA, and voltage up to 10 V.

5.8 *Direct-Current Power Supply*—Capable of supplying low-ripple voltage at 3.0, ±0.01, V, as measured between the test specimen and reference electrode.

5.9 *Precision Wire-Wound Resistor*—1 Ω, ±1 %, 1-W (minimum) to be used in the test cell circuit as a shunt for measuring current.

5.10 *Thickness Gage*—For measuring coating thickness in accordance with Test Method G 12.

5.11 *Holiday Detector*—For locating holidays in the coating of the test specimen in accordance with Test Methods G 62.

5.12 *Connections*—Wiring from current source to the specimen shall be by either soldering, brazing, or bolting to the non-immersed area of the specimen. A junction in the connection

wire is not desirable but, if necessary, may be made by means of a bolted pair of terminal lugs, soldering or mechanically crimping to clean wire ends.

5.13 *Additional Connecting Wires*—If additional wiring is necessary, it shall be stranded, insulated copper and not less than 1.75 mm (0.069 in. -14 gage) diameter.

5.14 *Holiday Tools*—A drill and a suitable drill bit that will accomplish drilling of test hole, as described under 8.2. A sharp-pointed knife, with a safe handle is required for use in making physical examination.

6. Reagent and Materials

6.1 The electrolyte shall consist of distilled or deionized water with the addition of 3 mass % of technical grade sodium chloride. Use freshly prepared solution for each test.

7. Test Specimen

7.1 During the coating operation, the applicator may be directed to cut a section of coated pipe of sufficient length for laboratory evaluation of the coating. Precautions are to be taken when cutting the pipe so that spatter will not harm the coating where testing will be done. Wet rags shall be placed on each side of the torch-cut area to minimize thermal changes and spatter damage to the coating. Test sample shall be taken at least 76.2 mm (3 in.) from any torch-cut edge. Special precautions are to be taken so that coating is not damaged in handling, transporting, or further cutting. The test specimens may be a cut coupon, flat plate, or a ring specimen. The test may also be performed on an actual inservice pipeline, or any other appropriate coated surface.

8. Procedure

8.1 Verify the coating integrity in the area to be tested in accordance with Test Methods G 62. Discard specimen found to contain holidays. Measure and record the maximum and minimum coating thickness measured in the area subjected to test in accordance with Test Method G 12.

8.2 One intentional holiday shall be made in each specimen to be tested. The holiday shall be drilled so that the angular cone point of the drill will fully enter the steel where the cylindrical portion of the drill meets the steel surface. The drill shall be 3.2 mm (0.125 in.) in diameter.

8.3 Electrical connection is then made to the test specimen, (see 5.12).

8.4 Attach the test cylinder to the test specimen, (see 5.1). Take care to ensure that the cylinder satisfactorily fits the curvature of the pipe sample and that it is centered over the intentional holiday.

8.5 Add the electrolyte solution to the specified level in the test cylinder. Record the pH of the solution. Check the level of the electrolyte each day and maintain by adding distilled or deionized water.

8.6 Place the fritted glass filter tube into the electrolyte solution as described in 5.4. Support the fritted glass filter tube.

8.7 Insert the platinum anode into the fritted glass tube, down to within 5 mm (2 in.) of the bottom.

8.8 Attach the positive lead of the current source to the platinum anode and the negative lead to the cathode (pipe). A

potential of 3 V DC with respect to a copper-copper sulphate reference electrode is to be impressed across the test cell.

8.9 Conduct the test at a room temperature of 21 to 25°C (70 to 77°F). Tests to be run for a period of 90 days.

8.10 At least twice each week, place a reference CuSO₄ electrode in the electrolyte between the anode and the holiday. Read the voltage and adjust the power supply output, if required, so that a negative 3 V DC potential is maintained between the reference electrode and the test sample.

9. Examination

9.1 At the end of the 90 day test period, disassemble the cell and rinse the test area with warm tap water. Immediately wipe the sample dry and visually examine the entire test area for any evidence of unintentional holidays and loosening of coating at the edge of all holidays, including the intentional holiday, and record coating condition, for example, color, blisters, cracking, crazing, adhering deposits, etc.

9.2 Drill a new reference holiday in the coating in an area that was not immersed. Follow the same drilling procedure as described in 8.2.

9.3 Make radial 45° cuts through the coating intersecting at the center of both the intentional holiday and the reference holiday with a sharp, thin-bladed knife. Take care to ensure that coating is cut completely through to the steel substrate.

9.4 Attempt to lift the coating at both the reference holiday and the intentional holiday with the point of a sharp, thin-bladed knife. Use the bond at the reference holiday as a reference for judging the quality of the bond at the intentional holiday. Measure and record the total area of disbonded coating at the intentional holiday.

10. Report

10.1 The report of results shall include the following.

10.1.1 Complete identification of the test specimen, including:

- 10.1.1.1 Name and code number of the coating,
- 10.1.1.2 Size and wall thickness of pipe,
- 10.1.1.3 Applicator, production date, and production run number of coating,
- 10.1.1.4 Minimum-maximum coating thickness, average thickness, and the thickness at the holiday,
- 10.1.1.5 Size of initial holidays,
- 10.1.1.6 Dates of starting and termination of test,
- 10.1.1.7 Cell diameter and depth of electrolyte,
- 10.1.1.8 Salt composition and concentration,
- 10.1.1.9 Cell voltage,
- 10.1.1.10 Length of test period, and
- 10.1.1.11 Other data that may be pertinent.

10.2 Report the test results by measuring the total area of disbondment by planimeter, square counting, or other precise method. Subtract the initial holiday area and calculate an equivalent circle diameter.⁴

11. Precision and Bias

11.1 *Precision*—For between-laboratory testing data is within $\pm 25\%$ of the mean for represented samples. Samples were taken from one length of production run coated 16 in. pipe.

11.2 *Bias*—No statement of bias is made since samples were all obtained from one length of pipe and all participating laboratories utilized equipment and procedures as outlined in this test method.

12. Keywords

12.1 anode; attached cell; cathodic; disbondment; electrical stress; electrolyte; salt bridge

⁴ Equivalent circle diameter is calculated by $ECD = (A/0.785)^{1/2}$, where A = area corrected for holiday area.

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