Designation: G 80 – 88 (Reapproved 1998)

AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
Reprinted from the Annual Book of ASTM Standards. Copyright ASTM

# Standard Test Method for Specific Cathodic Disbonding of Pipeline Coatings[1]

This standard is issued under the fixed designation G 80; 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 an accelerated procedure for simultaneously determining comparative characteristics of insulating coating systems applied to steel 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 may or may not receive cathodic protection. It is intended for use with samples of coated pipe taken from commercial production and is applicable to such samples when the coating is characterized by function as an electrical barrier.

1.2 This test method is specific with no options. For alternative methods of test see Test Methods G 8.

1.3 The values stated in SI units are to be regarded as the standard.

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:*

G 8 Test Methods for Cathodic Disbonding of Pipeline Coatings[2]

G 12 Test Method for Nondestructive Measurement of Film Thickness of Pipeline Coatings on Steel[2]

G 16 Practice for Applying Statistics to Analysis of Corrosion Data[3]

## 3. Summary of Test Method

3.1 The coating on the test specimen is subjected to electrical stress in a highly conductive, alkaline electrolyte. Electrical stress is obtained by means of a sacrificial magnesium anode. The coating is perforated before starting the test.

3.2 After the test period is concluded, results are determined by physical examination and comparing the loosened or disbonding coating at the perforations in the immersed area with loosened or disbonded coating at a new test hole in the coating made in an area that was not immersed.

## 4. Significance and Use

4.1 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 more or less moisture-bearing and constitutes an effective electrolyte. Damage to pipe coating is almost unavoidable during transportation and construction. Normal soil potentials as well as applied cathodic protection potentials may cause loosening of the coating, beginning at holiday edges, in some cases increasing the apparent size of the holiday. Holidays may also be caused by such potentials. While apparently loosened coating and cathodic holidays may not result in corrosion, this test provides accelerated conditions for loosening to occur and therefore gives a measure of resistance of coatings to this type of action.

4.2 The effects of the test are evaluated by physical examination 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 electrically stressed area propagates from the holiday to a boundary where the loosened coating leaves off for the more effective contact or bond attributed to an original condition throughout the specimen before electrical stressing was applied. Assumptions associated with test results include:

4.2.1 That attempting to loosen or disbond the coating at a new test hole made in the coating in an area that was not immersed represents maximum adhesion or bond as measured by the lifting technique used, and that the same lifting technique can be used at a test hole that was immersed, thereby providing a means of comparing relative resistance to lifting.

4.2.2 That any relatively lesser bonded area at the immersed test holes in the coating was caused by electrical stressing and was not attributable to any anomaly in the application process. Ability to resist disbondment is a desired quality on a comparative basis, but disbondment per se in this test is not necessarily an adverse indication. The virtue of this test is that all dielectric type coatings now in common use will disbond to some degree thus providing a means of comparing one coating with another. Bond strength is more important for proper functioning of some coatings than others and the same measured disbondment for two different coating systems may not represent equivalent loss of corrosion protection.

4.2.3 That the current density appearing in this test is much greater than that usually required for cathodic protection in natural, inland soil environments.

4.2.4 That there is no impact on test results caused by

---

[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.48 on Durability of Nonmetallic Materials.

Current edition approved Nov. 25, 1988. Published January 1989. Originally published as G 80 – 83. Last previous edition G 80 – 83.

[2] *Annual Book of ASTM Standards*, Vol 06.02.

[3] *Annual Book of ASTM Standards*, Vol 03.02.

interaction among multiple test samples in the test vessel. It is suggested that if interference is suspected, clarification may be obtained by testing a single sample in the test vessel.

## 5. Apparatus

5.1 *Apparatus*:

5.1.1 *Test Vessel*—A nonconducting material shall be used for the vessel or as a lining in a metallic vessel. Dimensions of the vessel shall permit the following requirements:

5.1.1.1 Test specimens shall be suspended vertically in the vessel with at least 25.4 mm (1-in.) clearance from the bottom.

5.1.1.2 Each test specimen shall be separated from the other specimens, from the anodes and from the walls of the test vessel by at least 38.1 mm (1.500 in.).

5.1.1.3 Depth of electrolyte shall permit the test length of the specimen to be immersed as required in 7.4.

5.1.2 *Magnesium Anode*—The anode shall be made of a magnesium alloy having a solution potential of −1.45 to −1.55 V with respect to a $CuCuSO_4$ reference electrode in the electrolyte given in 6.1. It shall have a surface area not less than one third that of the total specimen area exposed to electrolyte (outside area exposed only). The anode shall be provided with a factory-sealed, 4107-cmil(14-gage Awg), minimum, insulated copper wire. Anodes without a factory seal may be used if the magnesium extends above the cover.

5.1.3 *Connectors*—Wiring from anode to test specimen shall be 4107-cmil (14-gage Awg), minimum, insulated copper. Attachment to the test specimen shall be by soldering, brazing, or bolting to the nonimmersed end, and the place of attachment shall be coated with an insulating material. A junction in the connecting wire is permitted, provided that it is made by means of a bolted pair of terminal lugs soldered or mechanically crimped to clean wire ends.

5.1.4 *Holiday Tools*—Holidays shall be made with conventional drills of the required diameter. A sharp-pointed knife with a safe handle is required for use in making physical examinations.

5.1.5 *High-Resistance Voltmeter*, for direct current, having an internal resistance of not less than 10 MΩ and having a range from 0.01 to 5 V for measuring potential to the reference electrode.

5.1.6 *Reference Electrode*, saturated $CuCuSO_4$ 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 $CuCuSO_4$ reference for reporting by adding −0.072 V to the observed reading.

5.1.7 *Thickness Gage*, for measuring coating thickness in accordance with Test Method G 12.

5.1.8 *Volt-Ohm-Meter*, for initial testing of apparent coating resistance.

5.1.9 *Metallic Electrode*, used temporarily with the volt-ohm-meter to determine apparent initial holiday status of the test specimen.

5.1.10 *Additional Connecting Wires*, 4107-cmil (14-gage Awg), minimum, insulated copper.

## 6. Materials

6.1 The electrolyte shall consist of potable tap water with the addition of 1 mass % of each of the following technical-grade salts, calculated on an anhydrous basis: sodium chloride, sodium sulfate, and sodium carbonate. Use freshly prepared solution for each test.

6.2 Materials for sealing the ends of coated pipe specimens may consist of bituminous products, waxy, epoxy, or other materials, including molded elastomer or plastic end caps.

6.3 Plywood or plastic material has been found suitable for the construction of test vessel covers and for the support through apertures of test specimens and electrodes. Wood dowels introduced through holes in the top ends of test specimens have been found suitable for suspending test specimens from the vessel cover.

## 7. Test Specimen

7.1 The test specimens shall be 60 mm (2.375 in.) O.D. Schedule 40 coated pipes prepared with their surface preparation and coatings procedure equivalent to that of production coated pipe, then cut and drilled as shown in Fig. 1. One end shall be plugged or capped and sealed.

7.2 Three test holes shall be made in the coating in each specimen, drilled 120° apart with one in the center and the other two at locations one-fourth the distance from top and bottom of the immersed test length. Each 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 diameter shall be not less than three times the coating thickness, but it shall never be smaller than 6.35 mm, (0.250 in.) in diameter. The steel wall of the pipe shall not be perforated. Record initial holiday diameter.

NOTE 1—Before making the holiday, see 7.6.

7.3 The end of the pipe which will protrude above the immersion line shall be provided with suitable supporting means and a separate wire connection for electrical purposes, soldered, brazed, or bolted to the pipe. The protruding end, including hanger and wire connections, shall be protected and sealed with an insulating coating material.

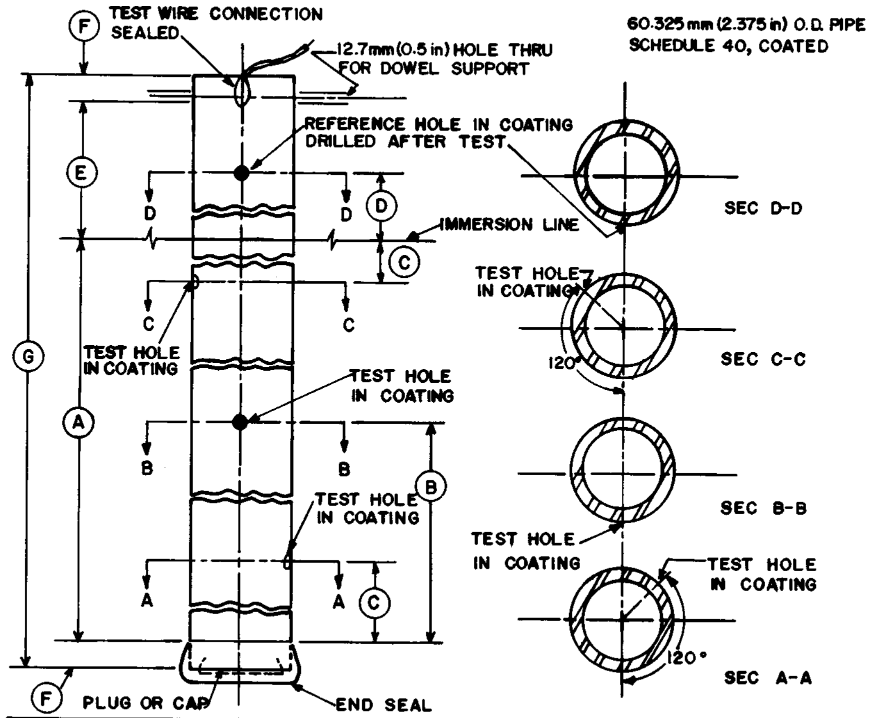
7.4 The specimen test area shall consist of the area between the edge of the bottom end seal and the immersion line for a distance of 490.22 mm ± 12.7 (19.300 ± .500 in) representing an area of 92,900 $mm^2$ (1 $ft^2$). The bottom end seal area shall not be considered part of the area tested.

7.5 Measure and record the minimum and maximum coating thickness in accordance with Test Method G 12, and the thickness where each holiday is made.

7.6 Verify the continuity of the coating and the effectiveness of the end cap seal before making artificial holidays as follows:

7.6.1 Immerse the test specimen and a metallic electrode in the electrolyte. Connect one terminal of the ohmmeter to the test specimen and the other terminal to the metallic electrode. Measure the apparent resistance in ohms, making two determinations: one with the specimen connected to the positive terminal of the ohmmeter, and one with the specimen connected to the negative terminal.

7.6.2 Disconnect the specimen from the ohmmeter but leave




| DIMEN. | MILLIMETERS | INCHES | |
|---|---|---|---|
| A | 490.22 ± 12.7 | 19.300 ± .500 | REQUIRED |
| B | 245.11 ± 12.7 | 9.650 ± .500 | |
| C | 120.65 ± 6.35 | 4.750 ± .250 | |
| D | 114.3 ± 6.35 | 4.500 ± .250 | |
| E | 233.363 MIN | 9.1875 MIN | |
| F | 19.05 MIN | 0.750 MIN | RECOM-MENDED |
| G | 762 MIN | 30 MIN | |
| | | | |

FIG. 1 Specimen

it immersed for 15 min. Then measure resistance again as in 7.6.1.

7.6.3 A significant decrease in either resistance reading after 15 min will indicate a flaw in the coating or end cap seal. Reject the specimen if the flaw is identified in the coating. If the flaw is in the end cap seal it may be repaired and the resistance remeasured as in 7.6.1 and 7.6.2.

7.6.4 The lowest resistance after 15 min of immersion shall be not less than 1000 mΩ. A stable reading below 1000 MΩ may not indicate a flaw and the specimen may be used for test, but all resistance measurements shall be reported in the results.

## 8. Procedure

8.1 Immerse the test specimen in the electrolyte and connect it to the anode as shown in Fig. 1. Position the middle holiday so that it faces away from the anode. Space the anode with respect to test specimens as described in 5.1.1. Mark the correct immersion level of the test specimen with a grease pencil and maintain by daily additions of potable water as required. Perform the test at a room temperature of 21° to 25°C (70° to 77°F).

8.1.1 In order to ascertain that the test cell is functioning, measure the potential between test specimen and a reference electrode immediately after starting the test and immediately before terminating it. Use temporary connections and instrumentation, as shown in Fig. 1. The potential measured shall be −1.45 V to −1.55 V with respect to a $CuCuSO_4$ reference electrode. Use the instrument described in 5.1.5.

8.2 Duration of the test period shall be 60 days.

8.3 A physical examination shall be performed immediately upon termination of the test period as follows:

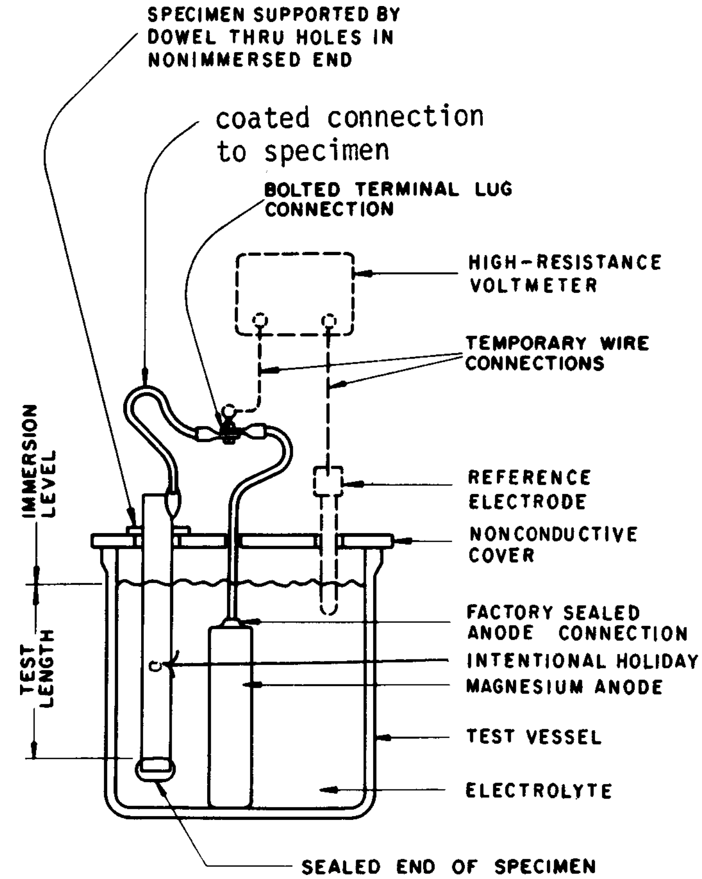
8.3.1 Examine the entire immersed area for any evidence of new holidays and loosening of coating at the edge of all holidays, including the artificial holidays.

8.3.2 Drill a new test hole in the coating in an area that was not immersed as shown in Fig. 1. Follow the same drilling procedure described in 7.2.

8.3.3 In order to gauge or calibrate the lifting technique, attempt to lift the coating at the new test hole with the point of a sharp knife after making cuts through the coating intersecting at the center of the hole. Inability or relative resistance to lifting or disbonding the coating shall be considered the adhered or bonded condition of the untested coating with respect to the lifting technique used.

8.3.4 Record the condition found at the new test hole.

8.3.5 Determine if the coating has been loosened at the immersed test holes by attempting to lift the coating with the point of a sharp knife after making cuts through the coating




NOTE 1—Test hole made in non-immersed area after testing not shown.

**FIG. 2 Test Assembly**

intersecting at the holiday or point of inspection using the same technique applied in 8.3.3.

8.3.6 Classify coating that can be lifted or disbonded more readily than at the new test hole as unsealed area. Measure the unsealed area.

NOTE 2—The use of a transparent film having a grid laid out in small squares such as 2.54 mm (0.1 in) on a side has been found useful. The film is placed against the unsealed area and the boundary of the unsealed area is traced on the grid. The area is then obtained by counting the squares within the bounded area.

## 9. Data Sheet and Report (see Fig. 3)

9.1 Complete identification of the test specimen, including:

9.1.1 Name and code number of the coating,

9.1.2 Size and wall thickness of pipe,

9.1.3 Source, production date, and production run number,

9.1.4 Minimum-maximum coating thickness, average thickness and the thickness at the holiday,

9.1.5 Size of initial holidays,

9.1.6 Resistance measurements verifying continuity of the coating and effectiveness of the end cap seal as required in Sec. 7.6,

9.1.7 Dates of starting and terminating test, and

9.1.8 Other information that may be pertinent.

9.2 Tally of areas that have been found unsealed on the terminal date. Report areas in square millimeters (square inches) or millimeters (inches) of equivalent circle diameter.

NOTE 3—Equivalent circle diameter (ECD) is obtained from the following formula:

$$>ECD = \left(\frac{A}{0.785}\right)1/2< \qquad (1)$$

where:

$A$ = area of holiday, $mm^2$ ($in.^2$)

## 10. Precision

10.1 No statement of precision can be made for tests of single specimens. For evaluation of the results of more than one specimen representing the same product the statistical methods given in Practice G 16 may be used.

NOTE 4—Variation in results may be due to differences between specimens as well as in execution of the tests. Variation of more than 12.7 mm (0.5 in) in equivalent circle diameter of presumably like specimens may be due to causes other than execution.

## 11. Keywords

11.1 anode; cathodic; disbondment; electrical stress; electrolyte; equivalent diameter

DATA SHEET AND REPORT

SPECIFIC CATHODIC DISBONDING OF PIPELINE COATINGS

1. Specimen No.______ Report No.______ Initials______ Date______

2. Pipe:

______mm (in.) O.D.______mm (in.) Wall______mm (in.) Length

Mfgr.______ API______

3. Coating:

Name, No. ______

Mfgr.______

Application method ______

Applicator ______

Thickness, mm (in.)

Max___ Min___ Av.___ At holidays Top___ Middle___ Bottom___

4. Condition found at new test hole made in the non-immersed area after test concluded:

Mark applicable case:

___No lifting or disbonding

___Some lifting or disbonding: ______mm² (in.²) ______ECD

5. Test:

Date started______ Date finished______

Test area______mm² (in²)

| | Top | Middle | Bottom | Average |
|---|---|---|---|---|
| Initial holiday dia. mm (in.) | | | | |
| Final unsealed area mm² (in.²) | | | | |
| (—) Initial holiday area mm² (in.²) | | | | |
| = Net disbonded area mm² (in.²) | | | | |
| Disbonded Equivalent Circle Diameter mm (in.) | | | | |

6. Preliminary verification

Verification of coating continuity before starting test per Sec. 7.6

| Trial | Polarity | Megohms | |
|---|---|---|---|
| | | Initial | After 15 Min. |
| Initial | Plus | | |
| | Minus | | |
| Final | Plus | | |
| | Minus | | |

**FIG. 3 Form for Presenting Data for One Specimen**

*The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 100 Barr Harbor Drive, West Conshohocken, PA 19428.*