Designation: G 55 – 88 (Reapproved 1998)

AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428

Standard Test Method for Evaluating Pipeline Coating Patch Materials[1]

This standard is issued under the fixed designation G 55; 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 provides an accelerated means of determining the relative sealing abilities of pipeline patching materials that are used to seal holidays in pipeline coatings on steel pipe. This test method is intended for utilization of specimens of pipeline coatings on small-diameter pipe, for representing coatings used for buried or submerged service, and where the purpose of the coating is to provide an electrical barrier between the steel pipe and its environment.

1.2 This test method is not intended for evaluating patch materials that are overlapped upon themselves.

1.3 The values stated in SI units are to be regarded as the standard.The values given in parenthes 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. Summary of Test Method

2.1 Patched pipeline coating specimens are suspended in an aqueous, alkaline, low-resistivity electrolyte. The specimens are individually connected to a magnesium anode or rectifier at a point external to the electrolyte. The coated, patched pipeline specimens are sealed at the base and at all other areas except the patch boundaries, such that the only paths for current flow are at the boundaries of the patches. Current flow in each patch area is averaged from monthly readings taken for one year.

3. Significance and Use

3.1 Holidays in pipeline coatings may be repaired by circumferential wrapping with a suitable pipe wrap tape. However, this technique is not always practicable and patching may be required. The effectiveness of a patch material depends upon its adhesion to the original pipeline coating to effect sealing.

3.2 The results of this accelerated test have been found to yield comparative data useful for the selection of patching materials. The user is cautioned against the use of this method for absolute material properties characterization.

3.3 This procedure provides an accelerated method by exposing the patch to a severe radius of curvature on small-diameter pipe. The specimen is also exposed to a stress voltage in the presence of a highly conductive electrolyte.

4. Apparatus

4.1 *Test Vessel*—A cylindrical glass battery jar (or equivalent), approximately 300 mm (12 in.) in diameter and 300 mm in height. One magnesium anode shall be contained in each battery jar, with a maximum of eight pipe specimens, and with each specimen measuring about 25 mm (1 in.) in diameter by approximately 300 mm in length of coated pipe. (See 4.3 and Fig. 1 and Fig. 2.)

4.2 *Suspension*—The suspension ring for supporting the pipe specimens shall be an electrically nonconductive circular disk, measuring approximately 300 mm (12 in.) in diameter and approximately 5 mm (3⁄16 in.) in thickness. (See 6.4.) Drill a 15-mm (½-in.) diameter hole through the center of the ring for external extension of the anode lead wire. Drill eight suspension holes, about 45 mm (1¾ in.) in diameter, through the suspension ring for the pipe specimens; these holes shall be centered 110 mm (4½ in.) from the center of the suspension ring and evenly spaced around the ring at 45° increments as measured from the center of the suspension ring.

4.3 *Potential*—A high-purity magnesium anode shall be used, weighing approximately 2.3 kg (5 lb), and having an open-circuit potential of approximately 1.7 d-c V relative to a copper-copper sulfate electrode, and complete with a factory-sealed lead wire. The magnesium anode may be replaced by a controlled d-c voltage from a rectifier, and then maintaining the potential between the specimen having the least current flow and a copper-copper sulfate reference cell (with the cell being properly immersed in the electrolyte) at 1.50 ± 0.05 d-c V. (See Note 1.) The anode should be composed of a suitable nonconsumable material.[2] This option will avoid the precipitation of magnesium salts on the specimens.

NOTE 1—The potential of the magnesium anode will approximate this range over the life of the test. If a calomel electrode is used for the

---

[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 D01.48on Deterioration of Pipeline Coatings and Linings.

Current edition approved May 27, 1988. Published July 1988. Originally published as G 55 – 77. Last previous edition G 55 – 83.

[2] The sole source of supply of a nonconconsumable anode, Durachlor 51 anode, Type B, 18-in. with cable, known to the committee at this time is Duriron Co., P.O. Box 1145, Dayton, OH 45401. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

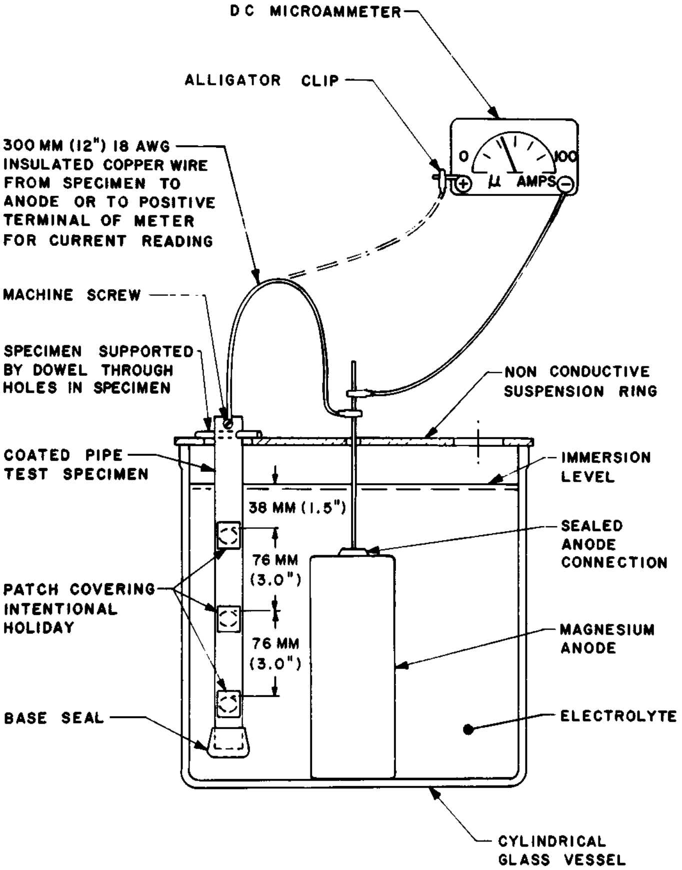


FIG. 1 Test Assembly for Evaluating Pipeline Coating Patch Materials

reference cell, the potential should be − 1.43 ± 0.05 d-c V.

4.4 *Electrolyte*—Use 1 % each by weight of anhydrous pure grades of sodium chloride, sodium sulfate, and sodium carbonate, dissolved in either distilled water or demineralized water. This electrolyte shall never be less alkaline than pH = 10.0 and should be within a resistivity range from 20 to 35 Ω · cm.

4.5 *Instruments*:

4.5.1 *Resistivity Meter*, capable of measuring 20 to 40Ω· cm in an aqueous solution.

4.5.2 *pH meter*, capable of measuring 0 to 14 pH.

4.5.3 *Thermometer*, ASTM Type 17C or equivalent, 19 to 27°C.

4.5.4 *Microammeters*, d-c, 0 to 100-µA and 0 to 500-µA.

4.5.5 *Voltmeter*, for direct current, having an internal resistance of not less than 10 MΩ and having a range from 0.01 to 5.0 V.

4.5.6 *Full-Wave Rectifier*, optional, 0 to 0.05 % ripple, capable of maintaining 1.50 ± 0.05 d-c V relative to a copper-copper sulfate cell, and having a capacity for at least 10 A of direct current.

5. Test Specimens

5.1 *Dimensions*—The specimen shall be steel pipe approximately 25 mm (1 in.) in diameter, approximately 300 mm (12 in.) in length, and previously coated with the desired original pipeline coating.

5.2 *Circuit Tap*—A 5-mm (3⁄16-in.) diameter hole shall be drilled or tapped (or a self-tapping screw may be used) at a point 13 mm (½ in.) below the top of each specimen. This tap is for a machine screw anode lead wire connection.

5.3 *Pipe Suspension Support Holes*—A 6-mm (¼-in.) diameter hole shall be drilled completely through both walls of the coated pipe specimen at a point 20 mm (¾ in.) from the top end of the specimen and located vertically beneath the circuit tap hole. A short length of wooden dowel pin about 5 mm (3⁄16 in.) in diameter shall be used as an insertion through the suspension holes to support and level the pipe specimen on the circular suspension ring when the suspension ring is mounted on the battery jar.

5.4 *Intentional Holidays*—A 4-fluted 13-mm (½-in.) diameter facing bit shall be used to drill intentional holidays through the original pipeline coating to the metal. Drilling such holidays shall be practiced on scrap pieces of small-diameter coated pipe, prior to drilling the holidays in the test specimens. Drilling shall not be any deeper than necessary into the metal of the pipe. Three holidays shall be prepared on each specimen in a vertical line directly underneath the circuit tap to correspond to electrolyte immersions of 38 mm (1½ in.), 114 mm (4½ in.), and 190 mm (7½ in.), as measured from the top of the holiday to the surface of the electrolyte. The thickness of the suspension ring shall be considered for its effect in elevating the pipe specimens in the electrolyte.

5.5 *Patches*—A square patch configuration of 25 by 25 mm (1 by 1 in.), evenly centered about the holiday, shall be lightly marked. This will provide a minimum patch overlap of 6 mm (¼ in.) as measured perpendicular to the center of each patch edge to the circumference of the holiday. The top and bottom edges of each patch shall be in the horizontal plane. Each marked patch area shall be lightly buffed with 120-grit sandpaper. A primer shall be applied using clean cotton on a stick to extend the primer to the edges of the marked patch area when specified by the manufacturer of the patch. The manufacturers' specified drying time shall be used for primers before application of the patch. Scissors or a knife shall be used to cut tape patches to size; tape patches shall be applied by a firm pressure of the thumb. Wax patches shall be applied by dripping or pouring the melted wax on the patch area to the desired patch thickness. Each mastic patch or each liquid patch shall be applied with a new, clean brush. The number of coats applied shall be recorded and the patch thickness shall be indicated. The balance of the circumferential band that is not covered by a patch is then covered either with the patch material under test or with another material that has been demonstrated to maintain an effective seal with the original pipeline coating. The base of each specimen shall be sealed with a material capable of preventing current flow at the base of the specimen. All prepared specimens shall be conditioned a minimum of 48 hours at room temperature prior to immersion in the electrolyte. Current leakage at the base seal shall be limited to not more than 1 µA.

5.6 *Wiring*—Individual 150-mm (6-in.) lengths of 18-gage insulated copper wire and small alligator clips shall be used for the electrical connection from the machine screw of the specimen to the lead wire of the anode.

6. Procedure

6.1 Place the anode in the bottom of the battery jar. Extend

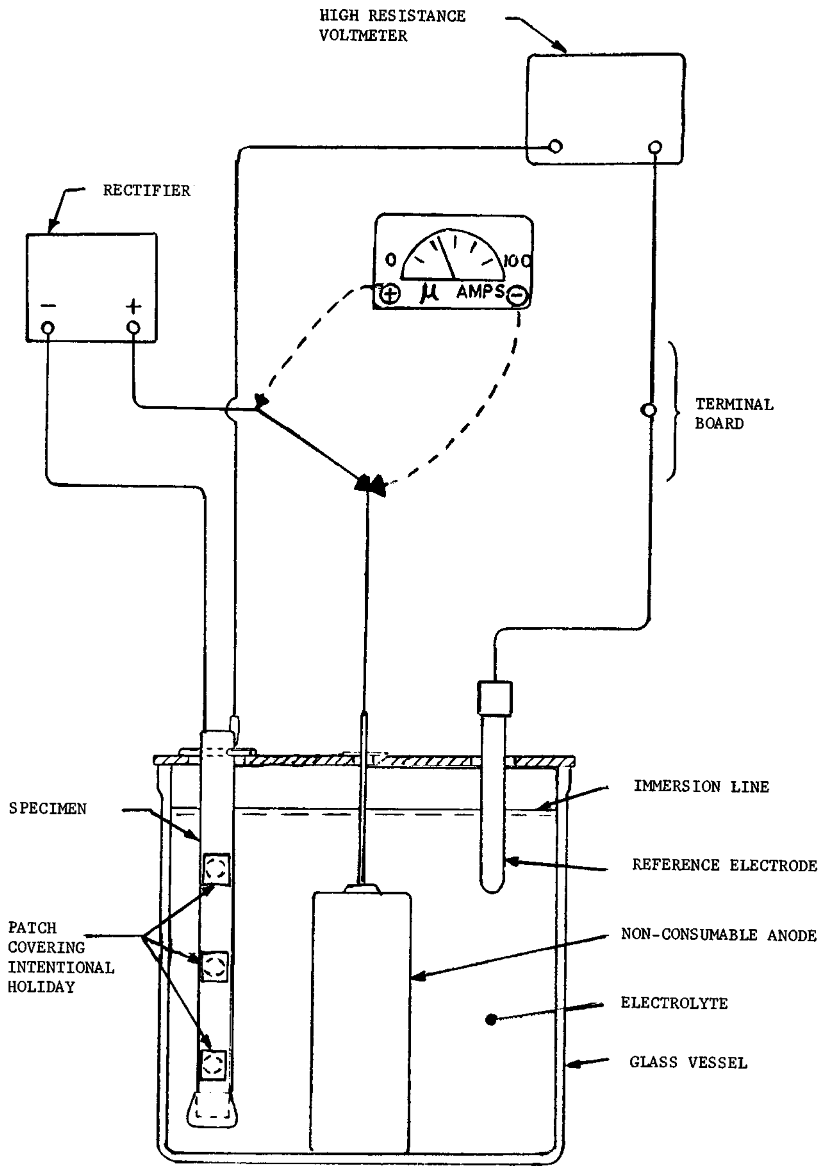


FIG. 2 Alternative Test Assembly for Evaluating Pipeline Coating Patch Materials

the anode lead wire vertically through the center of the suspension ring; then center the suspension ring on the battery jar.

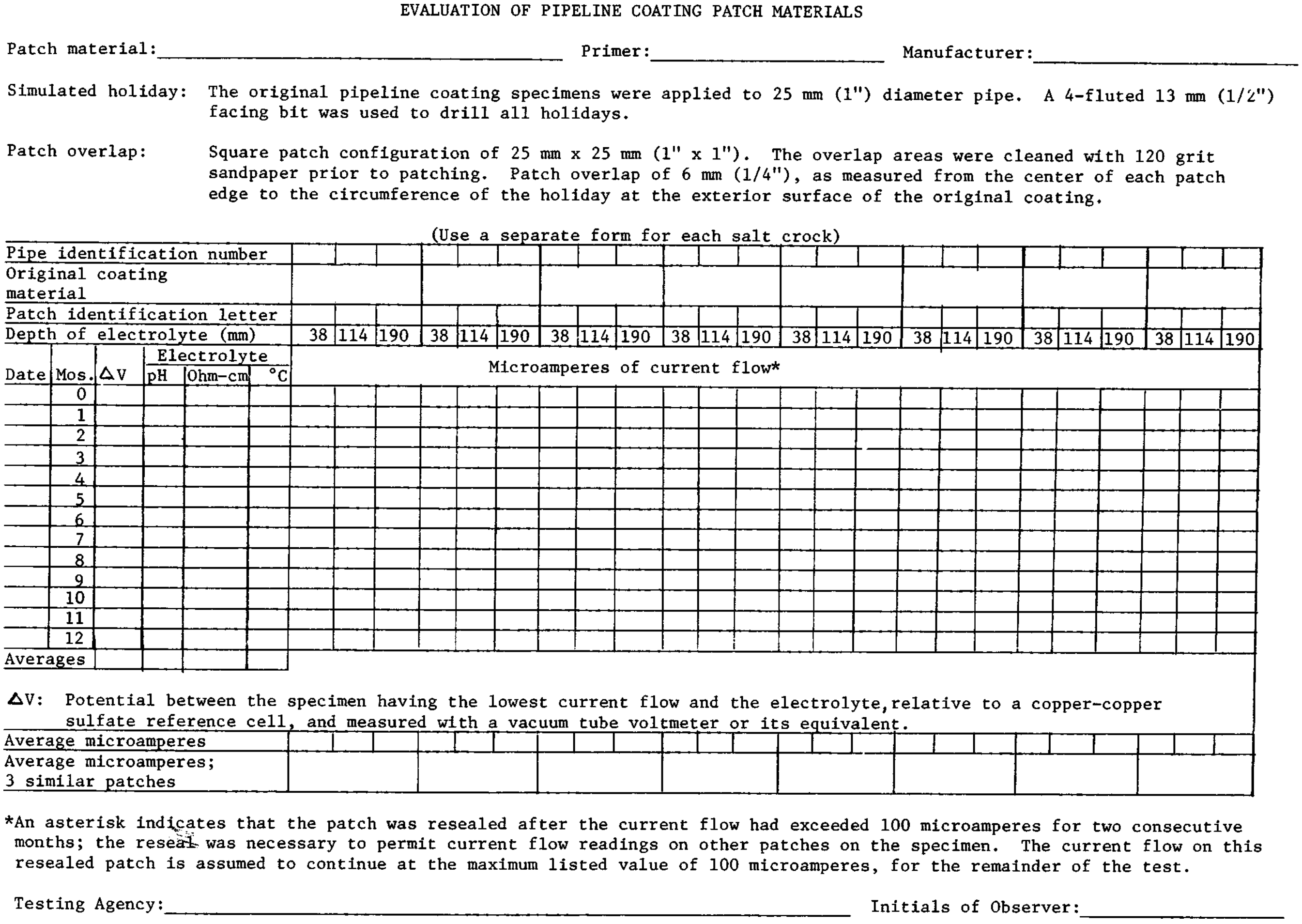
6.2 Mount each patched pipe specimen through one of the large holes in the suspension ring, with patches facing out, until the wooden dowel pin in the suspension hole of the specimen is supported by the suspension ring. When all specimens have been suspended into the battery jar, pour the room temperature electrolyte into the battery jar to a point 32 mm (1¼ in.) above the topmost patch. The electrolyte will then be the required height above each patched holiday. Mark and maintain this level of electrolyte by additions of distilled water or demineralized water. Maintain the assembly at room temperature for the entire test.

6.3 *Wiring*—Use alligator clips to connect the 150-mm (6-in.) length of 18-gage insulated copper wire from the machine screw in the patched specimen to the lead wire of the anode.

6.4 *Data*—See the suggested report (Fig. 3) for the collection of data. Record the data at the start of the test exposure as 0 month test duration. Record the data (microamperes of current flow, pipe to electrolyte potential relative to a copper-copper sulfate reference cell, and the electrolyte with respect to pH, resistivity, and temperature) each month for 12 consecutive months. Select a date for taking data within ±2 calendar days of the day of the month that the initial data were recorded (for example, a test beginning on the 19th day of a particular month should have successive monthly data taken between the 17th and 21st days of the next 12 months).

6.5 *Current Flows*:

6.5.1 Determine current flows by temporarily disconnecting the 18-gage insulated wire from the anode, connecting the positive lead from a 0 to 100 microammeter (d-c) to the patched specimen, and connecting the negative lead to the wire from the anode, external to the battery jar. If there is a measurable current flow for a patched specimen (1 μA or more), remove that specimen from the battery jar, taking care not to allow the specimen to contact the edge of the hole in the



EVALUATION OF PIPELINE COATING PATCH MATERIALS

Patch material:________________________ Primer:______________ Manufacturer:______________

Simulated holiday: The original pipeline coating specimens were applied to 25 mm (1") diameter pipe. A 4-fluted 13 mm (1/2") facing bit was used to drill all holidays.

Patch overlap: Square patch configuration of 25 mm x 25 mm (1" x 1"). The overlap areas were cleaned with 120 grit sandpaper prior to patching. Patch overlap of 6 mm (1/4"), as measured from the center of each patch edge to the circumference of the holiday at the exterior surface of the original coating.

(Use a separate form for each salt crock)

Pipe identification number																													
Original coating material																													
Patch identification letter																													
Depth of electrolyte (mm)						38	114	190	38	114	190	38	114	190	38	114	190	38	114	190	38	114	190	38	114	190	38	114	190
			Electrolyte			Microamperes of current flow*																							
Date	Mos.	ΔV	pH	Ohm-cm	°C																								
	0																												
	1																												
	2																												
	3																												
	4																												
	5																												
	6																												
	7																												
	8																												
	9																												
	10																												
	11																												
	12																												
Averages																													

ΔV: Potential between the specimen having the lowest current flow and the electrolyte, relative to a copper-copper sulfate reference cell, and measured with a vacuum tube voltmeter or its equivalent.

Average microamperes																								
Average microamperes; 3 similar patches																								

*An asterisk indicates that the patch was resealed after the current flow had exceeded 100 microamperes for two consecutive months; the reseal was necessary to permit current flow readings on other patches on the specimen. The current flow on this resealed patch is assumed to continue at the maximum listed value of 100 microamperes, for the remainder of the test.

Testing Agency:______________________________ Initials of Observer:______________

FIG. 3 Suggested Form for Collecting and Summarizing Data

suspension ring. Gently rinse the specimen with either demineralized water or distilled water (at room temperature) to remove all traces of electrolyte. Then, with the microammeter connected in series from the patched specimen to the anode, slowly lower the patched specimen into the electrolyte and note the current flow just below, and then just above, each patch. The difference in microamperes is the amount of current flow that is being transmitted by that particular patch.

6.5.2 Record only 100 µA when the current flow for a patch exceeds 100 µA. When 100 µA has been recorded for two consecutive readings, remove the patch, clean the patch area, and then permanently patch the area with a material capable of sealing the holiday for the remainder of the test. The current flow data for the original patch is assumed to continue at the maximum value of 100 µA for the remainder of the test. The resealing will permit the continuance of accurate readings of the current flows for the remaining test patches on that pipe specimen. The 0 to 500 d-c microammeter can be used as necessary during the first month of failure of one or more patches on a pipe specimen, when the total current flow of a pipe specimen exceeds 100 µA.

7. Report

7.1 The report shall be a copy of the data collection form (Fig. 3) with all computations completed. The averages are obtained by adding all of the numbers accumulated in a column (initial reading plus 12 monthly readings), and dividing the summation by 13. Determine average values for the microamperes of current flow for each patch, the pipe to electrolyte potential, and for the pH, resistivity, and temperature of the electrolyte. The summary section also provides space for a listing of the average current flow for each set of three patches.

8. Precision and Bias

8.1 Precision data are limited to the comparison of the three samples of any one patch material sealing the holidays on any one original pipeline coating. These data are based on limited information, but statistically have been shown, by round-robin testing by four laboratories, to provide a reasonable basis for comparing the sealing abilities of various patching materials and various pipeline coatings.

8.2 The average values of triplicate samples of the same materials, excluding values of 0 µA, by the same worker should not be considered suspect unless they differ by more than a factor of 2. For example, an average value of 20 µA for one set requires a second set of the same materials to be between 10 to 40 µA for the same worker.

8.3 The average values of triplicate samples of the same materials, excluding values of 0 µA, reported by one laboratory should not be considered suspect unless they differ from similar data from another laboratory by a factor of 3. For example, an average value of 20 µA for one laboratory requires a value in the range of 7 to 60 µA for the same materials in another laboratory.

9. Keywords

9.1 barrier; coatings; holiday; patches; pipeline; seals