Designation: D7087 – 05a (Reapproved 2010)

Standard Test Method for An Imaging Technique to Measure Rust Creepage at Scribe on Coated Test Panels Subjected to Corrosive Environments[1]

This standard is issued under the fixed designation D7087; 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 the measurement of rust creepage area from a scribe line on painted/coated flat test panels after exposure to corrosive environments. This test method has the advantage of simplicity and ease of use. Expensive equipment is not required, and the results are more accurate than visual evaluation but not as precise as advanced digital imaging.

1.2 This test method uses visual imaging software to determine the area damaged by rust creepage from the scribe.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses 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. Referenced Documents

2.1 *ASTM Standards:*[2]

B117 Practice for Operating Salt Spray (Fog) Apparatus

D1014 Practice for Conducting Exterior Exposure Tests of Paints and Coatings on Metal Substrates

D1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

D4585 Practice for Testing Water Resistance of Coatings Using Controlled Condensation

D4587 Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings

D5894 Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)

D6695 Practice for Xenon-Arc Exposures of Paint and Related Coatings

G85 Practice for Modified Salt Spray (Fog) Testing

3. Significance and Use

3.1 This test method provides a means of evaluating and comparing development of corrosion at scribe on painted/coated flat test panels after exposure to corrosive environments.

4. Apparatus

4.1 *Transparent Plastic Sheet*—Use transparent plastic sheet with thickness approximately 0.085 mm (0.0034 in. or 3.4 mil). The sheet material must be transparent enough for easy tracing and must be sufficiently absorbent to provide good ink adhesion.[3]

4.2 *Tracing Pen*—A black permanent marker with ultrafine tip approximately 0.5 mm (0.02 in.) in diameter.

4.3 *Ruler*—Any transparent ruler with 1-mm black divisions. This length shall be shorter than either length or width of glass surface of scanner.

4.4 *Computer and Scanning System*—Any computer and compatible scanning system is applicable. A computer with at least 32 MB of RAM is recommended.[4] A flat bed scanner with 1200 dpi optical, 1200×2400 dpi hardware resolution is suggested. The scanner must have a feature where it selects the best possible resolution required for scanning. There is no need to calibrate or change settings while scanning.

4.5 *Image Software*—Use any image software capable of reading an image file generated from the computer and scanning system, calibrating length, and integrating area rapidly and accurately.

[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 D01.25 on Evaluation of Weathering Effects.

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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] The transparent plastic sheet material of one-gallon size zipper freezer bag without surface texture was found acceptable in round robin testing.

[4] A PC compatible computer with the Windows 95, Windows 98, Windows ME, Windows NT, Windows 2000 or Windows XP operating system is applicable.

5. Specimen Scribing

5.1 Scribe test specimens in accordance with Test Method D1654, section on Preliminary Treatment of Test Specimens. The panels should be scribed in a single straight line.

6. Exposure of Test Specimens

6.1 Prior to exposure, measure the width of the scribe. Record this information.

6.2 Expose test specimens in accordance with any of the following Practices B117, D1014, D4585, D4587, D5894, D6695, and G85, or any other applicable test method, as agreed upon between the producer and the user. The exposure cycle, length of test and evaluation intervals shall be agreed upon prior to exposure of specimens.

7. Procedure – Evaluation of Scribed Specimens

7.1 *Prepare Specimens for Evaluation*—Prepare the scribed specimens in accordance with Test Method D1654.

7.2 *Quantification*—Quantify the corrosion or loss of paint extending from a scribe mark, that is, manual tracing followed by an imaging analysis.

7.2.1 *Creepage Area Tracing Technique*—Trace the rust creepage area based on the procedure described in 7.2.1.1 and 7.2.1.2.

7.2.1.1 *Marking Test Specimen*—Place the ruler immediately below and parallel to the scribe line ab of the test panel (refer to Fig. 1 for geometry terms). Use the tracing pen to mark points g and h on the test panel so that gh is the center line that represents 80 % of the scribe line. Mark points i, j, k, and l with the pen on the borderline of creepage area such that lines ig and kh are perpendicular to the scribe line (See Fig. 1). Remove the ruler.

7.2.1.2 *Area Tracing*—Place a single sheet of the transparent plastic that is 50 % larger than the panel over the entire corroded side of the scribed panel. Do not stretch the plastic sheet and ensure there are no folds or creases. Press the sheet tightly against the panel and fold the excess around the back of the panel. To avoid any sliding, tape the plastic sheet to the back of the panel.

(a) Orient the panel so that the scribe line is vertical and directly in front. With one hand, hold the panel and the plastic sheet, and with the other hand, trace the creepage or undercutting outline on the sheet using the pen. The tracing must be made smoothly and continuously by holding the pen at about a 75° angle to the surface with the upper end of pen away from creepage. Position the pen so that only the tip is in contact with the surface and is at the point where the raised creepage area begins. Halfway through the tracing, rotate the panel and the plastic 180 degrees and complete the tracing on the other side of the scribe. Ensure that the plastic does not move during the rotation. Make sure the traced lines at both ends of scribe line are connected. The traced line must have uniform intensity and good continuity.

(b) On the plastic sheet, mark points i, j, k, and l on the outside edge of the traced line. A typical trace of creepage area developed around the scribe line (ab) and marking points i, j, k, and l for area integration are shown in Fig. 1. Note that scribe line ab should not be traced. Remove the plastic sheet from the panel. With the tracing pen, use a ruler to draw lines cd and ef on the plastic sheet.

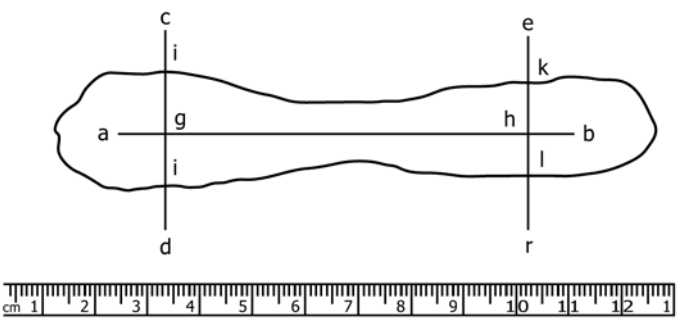

FIG. 1 The Scanned Trace and Markings for Area Integration of Creepage Area Around the Scribe Line.

NOTE 1—Stain beyond the creepage area should not be traced.

NOTE 2—The tracing must be conducted carefully under good light condition and by an operator with good eyesight.

NOTE 3—The intensity and continuity of traced line may be examined with a magnifying glass or an optical microscope.

NOTE 4—For some people, orienting the panel with scribe line horizontally may be easier. Trace the bottom side of the creepage area first and then trace the topside of creepage area later. Make sure the traced lines at both ends of the scribe line are connected.

7.2.2 *Trace Scanning*—Place the transparent plastic sheet with the traced creepage or undercutting area with marked points i, j, k, and l and lines cd and ef onto the glass of the flatbed scanner. Place a ruler next to the trace area with the dimension markings facing the light source. Back the tracing and the ruler with a sheet of white paper or cardstock. Scan the image that must include all the traced line and the ruler. Save this image as a .xxx file in the computer with a unique filename.

7.2.3 *Imaging and Integrating Creepage Area*—Use image software capable of capturing and opening image file of trace. Calibrate distance by selecting a known length with the ruler image (Fig. 1) such as 40 mm or 50 mm to obtain number of pixels per mm, choose threshold for line contrast, then click inside the region (ijlk) to be integrated to obtain rust creepage area by following the instructions provided with the software.

7.2.4 *Obtaining Creepage Area and Mean Creepage*—Integrate the scanned area based on 7.2.4.1 and obtain mean creepage based on 7.3 or 7.4.

7.2.4.1 *Integrating Total Rust Creepage Area at Scribe*—Integrate the total traced area in mm^2 including creepage area at both sides of selected center scribe line (A_{ijlk}). The area being integrated is the area INSIDE the traced line.

7.3 *Calculating Mean Creepage (Including Area of Original Scribe Line)*—Calculate mean creepage as follows:

$$C = A_{ijlk}/(2L) \quad (1)$$

where:

C = mean creepage in mm,
A_{ijlk} = integrated area inside the boundary of ijlk by tracing and imaging, and
L = length of scribe line from which creepage (or undercutting) is extended and area is integrated.

7.4 *Calculating the Net Mean Creepage (Excluding Area of Original Scribe Line)*—Calculate the net mean creepage as follows:

$$C_{net} = (A_{ijlk} - A_0)/(2L) \quad (2)$$

where:

C_{net} = net mean creepage in mm,
A_{ijlk} = integrated area inside the boundary of ijlk by tracing and imaging,
A_0 = integrated area of scribe line before exposure, and
L = length of scribe line from which creepage (or undercutting) is extended and area is integrated.

8. Report

8.1 Report the following information:

8.1.1 Rust creepage (also called undercutting) area of recommended traces in mm^2.

8.1.2 Mean creepage, C, calculated from Eq 1, or net mean creepage, C_{net}, calculated from Eq 2.

8.1.3 Type of specimen and its dimensions.

8.1.4 Length of scribe line around which creepage area is integrated.

8.1.5 Exposure test to which the specimen was subjected to.

8.1.6 Exposure cycle.

8.1.7 Duration or interval of exposure.

9. Precision and Bias

9.1 *Precision*—Interlaboratory round robin test results were obtained by six laboratories; in each laboratory, three weathered coated panels were traced in duplicate. For three samples with mean rust creepage of 2.2, 3.4, and 8.8 mm, within-laboratory relative standard deviation was found to be 4.3, 3.0, 1.8 %, respectively, and between-laboratories relative standard deviation was found to be 8.2, 10.4, and 2.2 %, respectively. Based on this, the following criteria should be used for judging the precision of results at the 95 % confidence level:

9.1.1 *Repeatability*—Two results for the mean creepage of 2.2, 3.4, and 8.8 mm obtained by the same operator should be considered suspect if they differ by more than 12.3, 8.3, and 4.9 %, respectively. In other words, the measurements for the mean creepage of 2.2, 3.4, and 8.8 mm should stay between 1.9 and 2.5 mm, 3.1 and 3.7 mm, and 8.4 and 9.2 mm, respectively.

9.1.2 *Reproducibility*—Two results, each the mean of duplicates, obtained by operators in different laboratories should be considered suspect if they differ by more than 22.9, 29.3, and 6.3 % respectively, for the mean creepage of 2.2, 3.4, and 8.8 mm. In other words, the measurements for the mean creepage of 2.2, 3.4, and 8.8 mm should stay between 1.7 and 2.7 mm, 2.4 and 4.4 mm, and 8.3 and 9.4 mm, respectively.

9.2 *Bias*—Bias cannot be determined as no reference material is available.

NOTE 5—The error increases as rust creepage area or mean creepage decreases. More data are available in the publication cited.[5]

NOTE 6—Some factors affecting precision are:
(a) Deviation of tracing line from actual outline of creepage area.
(b) Low adhesion of pen ink to plastic sheet.
(c) Discontinuity of tracing line.
(d) Low intensity of tracing line.
(e) Non-uniformity of tracing line.
(f) Distance not accurately calibrated.
(g) Sliding of transparent plastic sheet during tracing.
(h) Poor light condition.
(i) Poor operator eyesight.

10. Keywords

10.1 accelerated tests; coated panels; creepage area; imaging; outdoor exposure; quantification; rust creepage; undercutting; weathering

[5] "An Imaging Technique to Measure Rust Creepage at Scribes on Coated Test Panels," *Journal of Protective Coatings and Linings*, Vol. 19, No.1, p. 67, January 2002.

APPENDIXES

(Nonmandatory Information)

X1. DOWNLOADABLE FREE IMAGE SOFTWARE

X1.1 *Downloadable Free Image Software*—A downloadable free trial version of Scion Image software was used in the round robin testing. Upon publication of this standard the current version of the digital imaging program available was "Scion Image Beta 4.02." The operating procedure of this free software is described in X1.2 – X1.7.

X1.2 *Download Software*—Go to the website of "www.scioncorp.com" and click "Products" and then page down to "Software" and click "Scion Image Beta 4.02 Win." Run set up "WinB402.exe" file (it takes about 7 minutes to download, and save this file).

X1.3 *Open Image File*—Image file needs to be a .tif or .bmp type (you can save the image in one of those formats directly from the scanner). Two images are shown on computer monitor, one labeled "index color" and the other labeled "trace." Delete the "Index color image." The program does not work the same for it as the other image.

X1.4 *Set Scale and Length Calibration*—Under "Analyze," use the "measure line (dotted) tool" to determine the pixels in chosen number of mm on ruler, and then open the "set scale" window. Select "mm" in the box of "Units" and then enter the chosen length in the box of "known distance."

X1.5 *Analyze the Traced Area*—Under "Analyze," go to "Options," choose "Interior holes" and "Wand Auto-measure" and "Area," deselect "density."

X1.6 *Choose Threshold*—Under "Options," choose threshold; a default threshold will be selected that can be adjusted by putting mouse in LUT window. The threshold tool is automatically chosen.

X1.7 *Area Integration*—Select the "magic wand tool" and place inside the traced area A_{ijlk} toward the vertical borderline kl. The area (A_{ijlk}) is displayed in the chart (can also use "show results" under "Analyze" or "ctrl-2" to get the area).

X2. COMMERCIAL IMAGE SOFTWARE

X2.1 Use the particular image software to determine the area of the creepage by following the instruction provided with the image software.