Designation: D 1654 – 08

Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments[1]

This standard is issued under the fixed designation D 1654; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the treatment of previously painted or coated specimens for accelerated and atmospheric exposure tests and their subsequent evaluation in respect to corrosion, blistering associated with corrosion, loss of adhesion at a scribe mark, or other film failure.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B 117 Practice for Operating Salt Spray (Fog) Apparatus
D 610 Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
D 714 Test Method for Evaluating Degree of Blistering of Paints
D 822 Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
D 870 Practice for Testing Water Resistance of Coatings Using Water Immersion
D 1014 Practice for Conducting Exterior Exposure Tests of Paints and Coatings on Metal Substrates
D 1735 Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
D 2247 Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity
D 2803 Guide for Testing Filiform Corrosion Resistance of Organic Coatings on Metal
D 4141 Practice for Conducting Black Box and Solar Concentrating Exposures of Coatings
D 4585 Practice for Testing Water Resistance of Coatings Using Controlled Condensation
D 4587 Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
D 5894 Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
D 6695 Practice for Xenon-Arc Exposures of Paint and Related Coatings
D 7087 Test Method for An Imaging Technique to Measure Rust Creepage at Scribe on Coated Test Panels Subjected to Corrosive Environments
E 3 Guide for Preparation of Metallographic Specimens
G 85 Practice for Modified Salt Spray (Fog) Testing
G 87 Practice for Conducting Moist SO_2 Tests

2.2 *ANSI Standard:* [3]

B94.50 Single-Point Cutting Tools, Basic Nomenclature and Definitions for

3. Terminology

3.1 *paint removal material*, *n*—a device or substance that is used to remove loose coating around a scribe.

3.2 *rust creepage or undercutting*, *n*—corrosion of a substrate that occurs around a damaged area of a coated material.

3.3 *scribe*, *n*—a linear, intentionally prepared damaged area on a coated material that extends down to the substrate.

3.4 *scribing tool*, *n*—a tool used to prepare a scribe on a coated material.

3.5 *zone of corrosion*, *n*—area of corrosion of a substrate.

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[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.

Current edition approved Nov. 1, 2008. Published December 2008. Originally approved in 1959. Last previous edition approved in 2005 as D 1654 – 05.

[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] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

4. Significance and Use

4.1 This method provides a means of evaluating and comparing basic corrosion performance of the substrate, pretreatment, or coating system, or combination thereof, after exposure to corrosive environments.

5. Apparatus

5.1 *Scribing Tools*:

5.1.1 *Lathe Tool Type*—High speed tool steel or tungsten carbide thread cutting lathe tool bit with a cutting tip having a 60° included angle. ANSI B94.50, Style E has been found to meet these requirements. (See Fig. 1.) The tool bit is typically mounted in a holder such as a wooden file handle to facilitate the scribing operation.

5.1.2 *Pencil Type*—Pencil shaped device, with a high speed tool steel or tungsten carbide scribing tip. Typically the gripping surface is knurled. The tip may be replaceable or permanent.

5.1.3 *Motorized Circular Blade*—A motor fitted with a 1 to 2 mm wide circular cutting device.

5.1.4 *Other Types*—Other types of scribing instruments which use a knife type blade such as a scalpel, razor blade, box cutter knife, or other sharp pointed tool are acceptable if agreed upon between the producer and the user.

5.2 *Straightedge*—Any straightedge of sufficient length and rigidity to guide the scribing tool in a straight line.

5.3 *Paint Removal Materials*—The following materials can be used to remove the coating around the scribe.

5.3.1 *Spatula.*

5.3.2 *Knife or similar instrument*—the sharpness of blade shall be agreed upon between purchaser and seller.

5.3.3 *Paint Stripper or strong solvent.*

5.3.4 *Materials for removal by air*:

5.3.4.1 *Air Source*—A source of compressed air capable of delivering at least 4.72 L/s (10 ft^3/min) at 552 kPa (80 psi).

5.3.4.2 *Air Gun*—An air dusting gun and nozzle combination. The following configuration has been found to be successful:

Air Consumption, m^3/min (ft^3/min)	Pressure, kPa (psi)	Nozzle Diameter, mm (in.)
0.24 (8.4)	550 (80)	3.0 (0.12)

5.3.5 *Power Washer* capable of delivering 3500 psi.

5.4 *Scale*—Any rule with 1-mm divisions.

6. Preliminary Treatment of Test Specimens

6.1 *Scribed Specimens*:

6.1.1 Where specified or agreed upon, prepare each specimen for testing by scribing it in such a manner that the scribe can be exposed lengthwise when positioned in the test cabinet. This position will allow solution droplets to run lengthwise along the scribe.

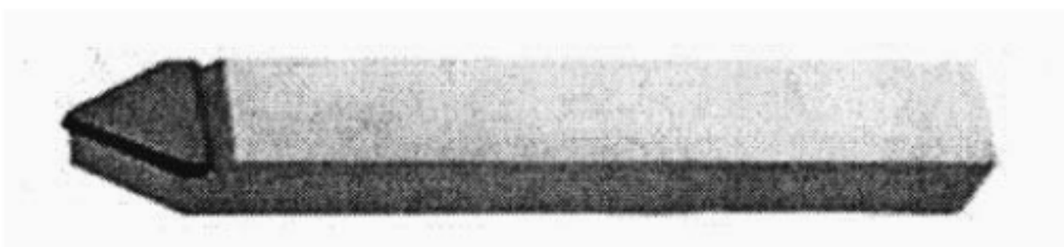

FIG. 1 Scribe Tool

6.1.2 Scribe the specimen by holding the tool at approximately a 70 to 90° angle to the surface with the upper end of tool holder inclined toward the operator. Position the tool so that only the tip is in contact with the surface. (See Fig. 2.) Pull the scribing tool to obtain a uniform V-cut through the coating that is being tested. The endpoints of the scribe shall be at least 1.25 cm (0.5 in.) from the edge of the panel. Inspect the tool frequently, using low power magnification, for dulling, chipping or wear and replace or repair as needed. The scribe should be of sufficient length to cover the significant test area, but should not contact the edge of the specimen. The scribe must penetrate all organic coating layers on the metal, leaving a uniformly bright line. The extent of scribe penetration through metal coatings, such as galvanize, should be agreed upon between the producer and user. The coil coating industry typically requires scribes to penetrate all organic coating layers but not penetrate the metal coating layers. The automotive industry typically requires scribes to penetrate all organic and metal coating layers. The pencil type may be less effective than the lathe tool type when scribing coating systems consisting of multiple layers of organic coatings or coating systems including metal layers. When scribing coating systems consisting of multiple layers of organic coatings or coating systems including metal layers the depth and quality of scribe technique should be evaluated using the cross section, castable plastic mount, polishing technique described in Practice E 3. Quality of the scribe technique may also be observed with the aid of low-power magnification. Note, mark, and describe defects, coding, and flaws that may affect results. If a motorized circular blade is used, position the test specimen to allow for a straight, linear cut at the desired length. The blade shall be positioned to a depth such that it is able to cut into the substrate. This type of blade will result in a rectangular cut rather than a V-cut.

6.1.3 One cut may not be sufficient to cut multi-layer protective coatings down to the metal. The use of more than one cut must be agreed to between all concerned parties prior to scribing, and the number of cuts must be recorded in the test documentation. When multiple cuts are needed, each cut must

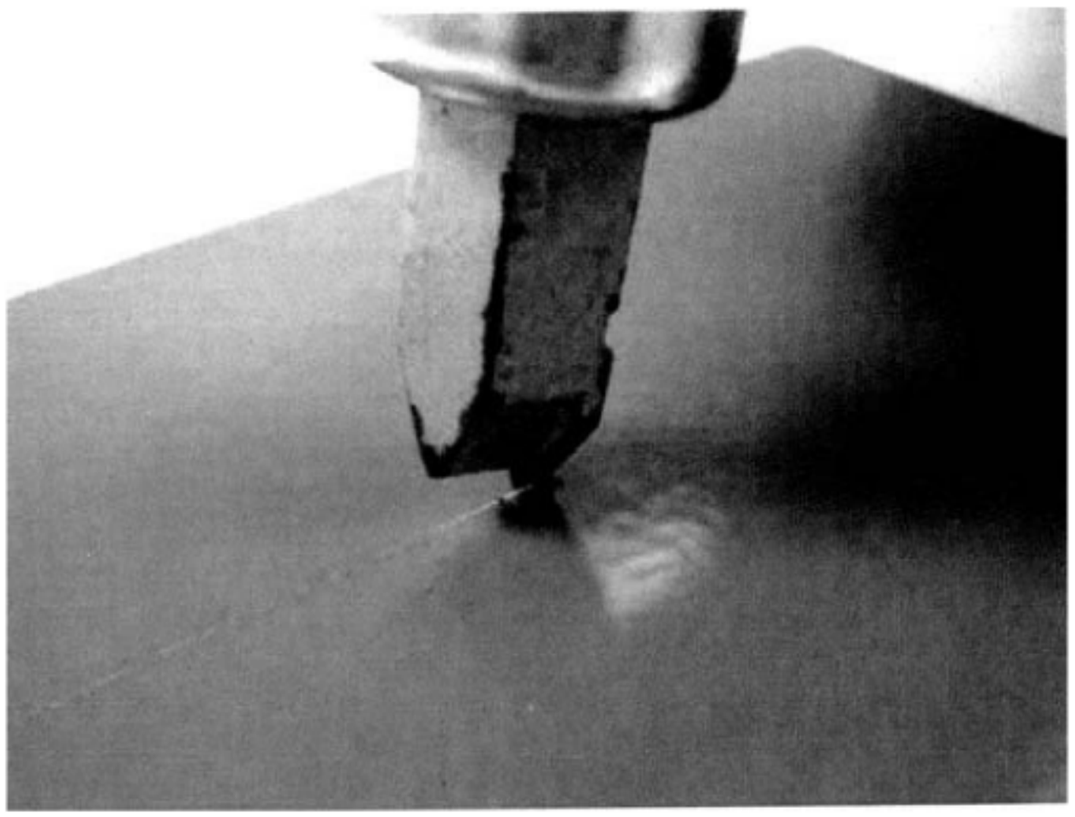

FIG. 2 Scribing Tool in Action

be done in the same direction. If a motorized blade is being used, it may be necessary to clean out residual materials of the scribe with a pencil-type scriber.

6.1.4 Scribe lines other than those of a single, straight nature may be used if agreed upon between the producer and the user.

6.1.5 Wipe off the panel with a dry rag, or blow with air to remove any metal flakes from the scribing process.

6.1.6 The width of the scribe (w) shall be recorded.

6.2 *Cut Edges*—Cut edges of panels may be exposed during testing, or protected by wax, tape, or other means as agreed upon between the producer and the user. If left unprotected, method of shearing panel edges should be agreed upon between the producer and user, noting whether edges are oriented in the "burr up" or "burr down" configuration.

6.3 *Deformation*—Deformation of test panels prior to exposure, if desired, should be agreed upon between the producer and user.

7. Exposure of Test Specimens

7.1 Expose test specimens in accordance with one or more of the following test methods or practices: B 117, D 822, D 870, D 1014, D 1735, D 2247, D 2803, D 4141, D 4585, D 4587, D 5894, D 6695, G 85, G 87, or any other applicable test method, as agreed upon between the producer and the user. The length of test and evaluation intervals should be agreed upon prior to exposure of specimens.

8. Procedure A—Evaluation of Rust Creepage for Scribed Specimens

8.1 Rinse each specimen after completion of the exposure period, using a gentle stream of water at a temperature up to 45°C (110°F). Remove coating along scribe with one of the following methods such that all corrosion of the substrate (that is, rust creepage or undercutting) can be observed using one of the following methods.

8.1.1 *Method 1 (Scraping)*—Scrape the specimen vigorously with and instrument described in 5.3.1.

8.1.2 *Method 2 (Knife)*—Pick off the loose or lifted coating with a knife described in 5.3.2.

8.1.3 *Method 3 (Paint Stripper)*—Soak the panels in paint stripper or suitable solvent as described in 5.3.3 until the coating around the scribe is removed, or can be removed with a spatula.

8.1.4 *Method 4 (Air Blow-Off)*—Holding the nozzle, as described in 5.3.4, at approximately a 45° angle, blow along the entire scribe line, disturbing the surface adjacent to the scribe adjacent to the scribe mechanically by the air nozzle to ensure an opening for the air blast.

8.1.5 *Method 5 (Power Washer)*—Using a power washer described in 5.3.5, remove the coating around the scribe.

8.1.6 Other methods can be used to remove loose material around the scribe if agreed upon between purchaser and seller.

NOTE 1—The above methods may not be appropriate in all cases, such as for interim ratings in continuing tests.

NOTE 2—For all methods, complete the removal of loose coating with 15 min of specimen removal from the exposure cabinet. If removal cannot be completed within the prescribed time, immerse the specimens in water at room temperature or store in a plastic bag to avoid any drying effect.

TABLE 1 Rating of Failure at Scribe (Procedure A)

Representative Mean Creepage From Scribe		
Millimetres	Inches (Approximate)	Rating Number
Zero	0	10
Over 0 to 0.5	0 to 1/64	9
Over 0.5 to 1.0	1/64 to 1/32	8
Over 1.0 to 2.0	1/32 to 1/16	7
Over 2.0 to 3.0	1/16 to 1/8	6
Over 3.0 to 5.0	1/8 to 3/16	5
Over 5.0 to 7.0	3/16 to 1/4	4
Over 7.0 to 10.0	1/4 to 3/8	3
Over 10.0 to 13.0	3/8 to 1/2	2
Over 13.0 to 16.0	1/2 to 5/8	1
Over 16.0 to more	5/8 to more	0

8.2 *Rating*—Only areas of the substrate that are discolored due to corrosion should be considered. Record the maximum and minimum creepage from the scribe, and note whether or not the maximum is an isolated spot. The mean can be determined by making at least 6 measurements of the width of the zone of corrosion uniformly distributed along the scribe, ignoring 3 mm (0.125 in.) of each end of the scribe. Determine the arithmetic mean, and use the following equation to determine rust creepage (c):

$$c = \frac{w_c - w}{2} \quad (1)$$

where:

w_c = mean overall width of the corrosion zone and
w = width of the original scribe.

As an alternative, use Test Method D 7087. Record creep values in millimetres, inches, or rating numbers as prescribed in Table 1, as agreed upon between producer and user. Loss of paint that does not extend down to the substrate and result in corrosion can be rated using the same procedure, but should not be considered as scribe creepage, undercutting, or corrosion. If this is the case, not the coat(s) removed.

9. Procedure B—Evaluation of Unscribed Areas

9.1 Use photographic blister standards given in Practice D 714 to describe the results of the exposure test with respect to blisters, and Practice D 610 to describe the results of the exposure with respect to rusting

10. Procedure C—Evaluation of Unprotected Edges

10.1 If paint creepage from cut edges is tested, rate the corrosion or loss of paint extending from a cut edge in the same manner described for scribes in Procedure A.

11. Procedure D—Evaluation of Formed Areas

11.1 If tested samples contain bends, dimples, or other formed areas of interest, rate the extent of failure at these areas separately in the same manner described in Procedure B, or as agreed upon between the producer and user.

12. Report

12.1 The report shall include the following information, unless otherwise agreed upon between the producer and user:

12.1.1 All pertinent information regarding the conduct of each corrosion test, as prescribed in the specifications for each test,

12.1.2 Methods of scribing, shearing, or forming, or combination thereof, or test specimens.

12.1.3 Method of removal of loose coating.

12.1.4 Rust creepage.

12.1.5 If applicable, the extent of the removal of loose paint around scribe that did not extend down to the substrate, noting which coat(s) were removed.

13. Precision and Bias

13.1 *Precision*—Since this is a method of evaluation based on measurements after various tests, the statement of precision applicable to each specific method of exposure to corrosive environments applies.

14. Keywords

14.1 blistering; corrosion; creepage; edge/scribe; paints/related coatings/materials; rust; undercutting