



Designation: D5894 – 16

# Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)<sup>1</sup>

This standard is issued under the fixed designation D5894; 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 practice covers basic principles and operating practice for cyclic corrosion/UV exposure of paints on metal, using alternating periods of exposure in two different cabinets: a cycling salt fog/dry cabinet, and a fluorescent UV/condensation cabinet.

1.2 This practice is limited to the methods of obtaining, measuring, and controlling exposure conditions, and procedures. It does not specify specimen preparation nor evaluation of results.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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:*<sup>2</sup>

**D610 Practice for Evaluating Degree of Rusting on Painted Steel Surfaces**

**D714 Test Method for Evaluating Degree of Blistering of Paints**

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

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

**G85 Practice for Modified Salt Spray (Fog) Testing**

**G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials**

**G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests**

**G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources**

**G154 Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials**

## 3. Terminology

3.1 *Definitions*—The definitions given in Terminology **G113** are applicable to this practice.

## 4. Summary of Practice

4.1 The test specimens are exposed to alternating periods of one week in a fluorescent UV/condensation chamber followed by one week in a cyclic salt fog/dry chamber. The fluorescent UV/condensation cycle is 4-h UV at 0.89 W/(m<sup>2</sup> · nm) at 340 nm at 60°C followed by 4-h condensation at 50°C, using UVA-340 lamps. The fog/dry chamber runs a cycle of 1-h fog at ambient temperature and 1-h dry-off at 35°C. The fog electrolyte is a relatively dilute solution, with 0.05 % sodium chloride and 0.35 % ammonium sulfate.

## 5. Significance and Use

5.1 The outdoor corrosion of painted metals is influenced by many factors, including: corrosive atmospheres, rain, condensed dew, UV light, wet/dry cycling, and temperature cycling. These factors frequently have a synergistic effect on one another. This practice is intended to provide a more realistic simulation of the interaction of these factors than is found in traditional tests with continuous exposure to a static set of corrosive conditions.

5.2 Results obtained from this practice can be used to compare the relative durability of materials subjected to the specific test cycle used.

5.3 No single exposure test can be specified as a complete simulation of actual use conditions in outdoor environments. Results obtained from exposures conducted according to this practice can be considered as representative of actual outdoor

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee **D01** on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee **D01.27** on Accelerated Testing.

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<sup>2</sup> 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.

\*A Summary of Changes section appears at the end of this standard

exposures only when the degree of rank correlation has been established for the specific materials being tested. The relative durability of materials in actual outdoor service can be very different in different locations because of differences in UV radiation, time of wetness, temperature, pollutants, and other factors. Therefore, even if results from a specific artificial test condition are found to be useful for comparing the relative durability of materials exposed in a particular exterior environment, it cannot be assumed that they will be useful for determining relative durability for a different environment.

5.4 Even though it is very tempting, it is not recommended to calculate an “acceleration factor” relating  $x$  hours of laboratory exposure to  $y$  months of exterior exposure. Different materials and different formulations of the same material can have significantly different acceleration factors. The acceleration factor also varies depending on the variability in rate of degradation in the laboratory test and in actual outdoor exposure.

5.5 This practice is best used to compare the relative performance of materials tested at the same time in the same exposure device. Because of possible variability between the same type of exposure devices, it is not recommended to compare the amount of degradation in materials exposed for the same duration at separate times, or in separate devices running the same test condition. This practice should not be used to establish a “pass/fail” approval of materials after a specific period of exposure unless performance comparisons are made relative to a control material exposed simultaneously, or the variability in the test is rigorously quantified so that statistically significant pass/fail judgments can be made.

5.6 This practice has been found useful for air-dry industrial maintenance paints on steel<sup>3,4,5,6,7</sup> and zinc-rich primers but its applicability has not yet been assessed for highly UV-stabilized coating systems, such as for automotive applications.

## 6. Apparatus

6.1 *Fluorescent UV-Condensation Exposure Chamber*, complying with Practices **G151** and **G154**.

6.2 *UVA-340 Fluorescent Lamps*.

6.3 *Salt Fog/Dry Cabinet*, complying with Practice **G85** Annex 5, Dilute Electrolyte Cyclic Fog/Dry Test.

<sup>3</sup> Skerry, B. S. and Simpson, C. H., “Combined Corrosion/Weathering Accelerated Testing of Coatings for Corrosion Control,” Presented at Corrosion 91, The National Association of Corrosion Engineers (NACE) Annual Conference 1991, and available from NACE, P.O. Box 218340, Houston, TX 77218.

<sup>4</sup> Simpson, C. H., Ray, C. J., and Skerry, B. S., “Accelerated Corrosion Testing of Industrial Maintenance Paints Using a Cyclic Corrosion Weathering Method,” *Journal of Protective Coatings and Linings*, Vol 8, No. 5, May 1991, pp. 28–36.

<sup>5</sup> Cleveland Society for Coatings Technology, “Correlation of Accelerated Exposure Testing and Exterior Exposure Sites,” *Journal of Coatings Technology*, Vol 66, No. 837, October 1994, pp. 49–61.

<sup>6</sup> Boocock, S. K., “A Report on SSPC Programs to Research Performance Evaluation Methods,” *Journal of Protective Coatings and Linings*, October 1994, pp. 51–58.

<sup>7</sup> Cleveland Society for Coatings Technology, “Correlation of Accelerated Exposure Testing and Exterior Exposure Sites Part II: One-Year Results,” *Journal of Coatings Technology*, Vol 68, No 858, July 1996, pp. 47–61.

## 7. Test Specimens

7.1 The composition and preparation of the substrate, specimen preparation, and the number of specimens shall be agreed upon prior to testing.

7.2 Follow the guidelines of Practice **G85** and Practice **D4587** on the preparation of specimens for the needs of those particular exposures.

7.2.1 Follow the guidelines of Practice **G147** on conditioning and handling of specimens.

7.3 Unless otherwise agreed, flat specimens shall be 75 by 150 mm.

7.4 Expose at least one control specimen with every test. The control specimen should have known durability and be of similar composition to the test specimens. It is preferable to have two control materials: one of higher durability and one of lower durability.

7.5 It is recommended that at least three replicates of each specimen be tested, to compensate for variation within the chambers and variation between specimens.

## 8. Procedure

8.1 *Fluorescent UV-Condensation Exposure:*

8.1.1 Start the exposure in the fluorescent UV-condensation chamber.

NOTE 1—It has been found that in certain cases the exposure must start in the fluorescent UV/condensation device in order to get realistic rusting and staining as well as faster corrosion. It is thought that the initial UV damage to the coating allows the subsequent salt fog to produce a more realistic corrosion attack on the substrate.

8.1.2 Perform the fluorescent UV-condensation exposure in compliance with Practice **G151** and **G154**, and Cycle 2 of Practice **D4587**.

8.1.3 For irradiance-controlled devices and unless otherwise specified, set the irradiance level to  $0.89 \text{ W}/(\text{m}^2 \cdot \text{nm})$  at 340 nm; the maximum allowable deviation from the set point at the control point indicated by the readout of the calibrated control sensor during equilibrium operation is  $\pm 0.02 \text{ W}/(\text{m}^2 \cdot \text{nm})$  for irradiance. If mutually agreed upon by all parties, use of non-irradiance controlled devices is permitted, but use of these devices must be included in the test report.

8.1.4 Program a UV/condensation cycle of 4-h UV at 60°C followed by 4-h condensation at 50°C. The temperatures specified refer to the uninsulated black panel control sensor in the chamber, as described in Practice **G154**. The maximum allowable deviation from the set point at the control point indicated by the readout of the calibrated control sensor during equilibrium operation is  $\pm 2.5^\circ\text{C}$  for temperature.

8.1.5 Use UVA-340 fluorescent lamps.

8.1.6 Expose the specimens for 21 cycles, in the fluorescent UV-condensation chamber before transferring them to the fog/dry chamber. These 21 cycles equal a total of 168 h (1 week).

8.1.7 Other cycles and lamps are acceptable if agreed upon prior to the test, and reported in compliance with Section 10.

8.2 *Cyclic Salt Fog/Dry Exposure:*