Designation: D 5894 – 96

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)[1]

This standard is issued under the fixed designation D 5894; 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 *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:*

D 610 Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces[2]

D 714 Test Method for Evaluating Degree of Blistering of Paints[3]

D 1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments[3]

D 4587 Practice for Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light-and-Water Exposure Apparatus[3]

G 53 Practice for Operating Light-and-Water Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials[4]

G 85 Standard Practice for Modified Salt Spray (Fog) Testing[5]

3. Summary of Practice

3.1 The test specimens are exposed to alternating periods of one week in a fluorescent UV/condensation chamber and one week in a cyclic salt fog/dry chamber. The fluorescent UV/condensation cycle is 4-h UV at 60°C and 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.

4. Significance and Use

4.1 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.

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

4.3 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 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.

4.4 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.

4.5 This practice is best used to compare the relative

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[1] This practice is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.27 on Accelerated Testing.

Current edition approved Jan. 10, 1996. Published March 1996.

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

[3] *Annual Book of ASTM Standards*, Vol 06.01.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

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

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.

4.6 This practice has been found useful for air-dry industrial maintenance paints on steel[6,7,8,9] but its applicability has not yet been assessed for galvanized substrates.

5. Apparatus

5.1 *Fluorescent UV-Condensation Exposure Chamber*, complying with Practice G 53.

5.2 *UVA-340 Fluorescent Lamps*.

5.3 *Salt Fog/Dry Cabinet*, complying with Practice G 85, Annex.

6. Test Specimens

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

6.2 Follow the guidelines of Practice G 85 and Practice D 4587 on the preparation of specimens for the needs of those particular exposures.

6.3 Unless otherwise agreed, flat specimens should be 75 × 150 mm.

6.4 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.

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

7. Procedure

7.1 *Fluorescent UV-Condensation Exposure*:

7.1.1 Start the exposure in the fluorescent UV-condensation chamber rather than the salt fog/dry chamber.

NOTE 1—It has been found that in certain cases the exposure must start in the fluorescent UV 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.

7.1.2 Perform the fluorescent UV-condensation exposure in compliance with Practices D 4587 and G 53.

7.1.3 Program a cycle of 4-h UV at 60°C ± 3°C and 4-h condensation at 50°C ± 3°C.

7.1.4 Use UVA-340 fluorescent lamps.

7.1.5 Expose the specimens for a total of 168 h in the fluorescent UV-condensation chamber before transferring them to the fog/dry chamber.

7.1.6 Other cycles and lamps are acceptable if agreed upon prior to the test, and reported in compliance with Section 9.

7.2 *Cyclic Salt Fog/Dry Exposure*:

7.2.1 Perform the cyclic salt fog/dry exposure according to Practice G 85, Annex A5.

7.2.2 Program a fog/dry cycle of 1-h fog at ambient temperature and 1-h dry-off at 35 ± 2°C.

7.2.3 Prepare the salt solution with 0.05 % sodium chloride and 0.35 % ammonium sulfate by weight.

7.2.4 Expose the specimens for a total of 168 h in the fog/dry chamber before transferring them back to the fluorescent UV-condensation chamber.

7.2.5 Other cycles, temperatures, and electrolytes are acceptable if agreed upon prior to the test, and reported in compliance with Section 9.

NOTE 2—Higher temperatures usually produce faster degradation, but possibly at the expense of realism. Longer fog/dry cycles (for example, 2-h fog, 2-h dry) have been found to produce slower degradation.

7.3 *Specimen Rotation*—When moving the specimens from one chamber to another, reposition the specimens so that over the course of the test each specimen spends equal amounts of time in each area of the chamber: edges, center, top, bottom. This will help minimize variation in degradation due to variations in conditions within the chamber.

7.4 *Evaluation of Corrosion*—Methods that may be useful for evaluating the corrosion of the specimens are Test Methods D 610, D 714, and D 1654. Practice D 4587 also references a number of other standards that may be used for evaluating the appearance change of the specimens.

8. Periods of Exposure

8.1 Use one of the following methods to determine the duration of the exposure under this practice:

8.1.1 A mutually agreed upon specified number of total hours,

8.1.2 The exposure required to produce a mutually agreed upon amount of change in either the test specimens or an agreed upon standard specimen, and

8.1.3 If no information is available as to an appropriate exposure duration, expose the specimens for a total of 1008 h, or until significant differences in performance between specimens become apparent.

9. Report

9.1 Report the following information:

9.1.1 Test cycle,

9.1.1.1 UV/condensation cabinet cycle (for example, 4-h UV at 60°C and 4-h condensation at 50°C),

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[6] 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.

[7] 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.

[8] 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.

[9] Boocock, S. K., "A Report on SSPC Programs to Research Performance Evaluation Methods," *Journal of Protective Coatings and Linings*, October 1994, pp. 51–58.

9.1.1.2 Fog/dry cabinet cycle (for example, 1-h fog at ambient temperature and 1-h dry-off at 35°C),

9.1.1.3 Hours spent in each cabinet before transfer from one cabinet to the other (for example, 168 h in the fog/dry cabinet and 168 h in the UV/condensation cabinet),

9.1.1.4 The total hours of exposure,

9.1.2 Manufacturer and model of fluorescent UV/condensation apparatus,

9.1.3 Manufacturer's designation and wavelength of peak emission for fluorescent lamps,

9.1.4 Manufacturer and model of modified salt spray apparatus,

9.1.5 Electrolyte solution (for example, 0.05 % sodium chloride and 0.35 % ammonium sulfate by weight), and

9.1.6 Other information required in Practice G 85, Section 9 and D 4587, Section 9.

10. Precision and Bias

10.1 A cooperative test program is underway in ASTM Subcommittee D01.27 to develop a precision and bias statement for this practice.

11. Keywords

11.1 accelerated aging/testing—paints; corrosion; cyclic corrosion; rust; salt spray; ultraviolet