



Designation: D 4587 – 01

Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings¹

This standard is issued under the fixed designation D 4587; 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 the selection of test conditions for accelerated exposure testing of coatings and related products in fluorescent UV and condensation devices conducted according to Practices G 151 and G 154. This practice also covers the preparation of test specimens, and the evaluation of test results. Table 1 describes commonly used test conditions.

NOTE 1—Previous versions of this practice referenced fluorescent UV devices described by Practice G 53, which described very specific equipment designs. Practice G 53 has been withdrawn and replaced by Practice G 151, which describes performance criteria for all exposure devices that use laboratory light sources, and by Practice G 154, which gives requirements for exposing nonmetallic materials in fluorescent UV devices.

NOTE 2—ISO 11507:1997 also describes fluorescent UV-condensation exposures of paints and coatings.

1.2 *This standard does not purport to address all of the safety problems 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 358 Specification for Wood to Be Used As Panels in Weathering Tests of Coatings²
- D 523 Test Method for Specular Gloss³
- D 609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products³
- D 610 Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces²
- D 659 Method of Evaluating Degree of Chalking of Exterior Paints⁴

- D 660 Test Method for Evaluating Degree of Checking of Exterior Paints³
- D 662 Test Method for Evaluating Degree of Erosion of Exterior Paints³
- D 714 Test Method for Evaluating Degree of Blistering of Paints³
- D 772 Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints³
- D 823 Test Methods for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels³
- D 1005 Test Methods for Measurement of Dry Film Thickness of Organic Coatings Using Micrometers³
- D 1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base³
- D 1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base³
- D 1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely Illuminated Opaque Materials³
- D 1730 Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting⁵
- D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates³
- D 2616 Test Method for Evaluation of Visual Color Difference With a Gray Scale³
- D 3359 Test Methods for Measuring Adhesion by Tape Test³
- D 3980 Practice for Interlaboratory Testing of Paint and Related Materials⁶
- D 4214 Test Methods for Evaluating Degree of Chalking of Exterior Paint Films³
- D 5870 Practice for Calculating Property Retention Index of Plastics⁷
- E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method⁸

¹ 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.

Current edition approved July 10, 2001. Published September 2001. Originally published as D 4587 – 86. Discontinued June 2000 and reinstated as D 4587 – 01.

² Annual Book of ASTM Standards, Vol 06.02.

³ Annual Book of ASTM Standards, Vol 06.01.

⁴ Discontinued 1989; see 1990 Annual Book of ASTM Standards, Vol 06.01.

⁵ Annual Book of ASTM Standards, Vol 02.05.

⁶ Discontinued 1998; see 1997 Annual Book of ASTM Standards, Vol 06.01.

⁷ Annual Book of ASTM Standards, Vol 08.03.

⁸ Annual Book of ASTM Standards, Vol 14.02.

TABLE 1 Test Cycles Commonly Used for Fluorescent UV–Condensation Exposure Testing of Paints and Related Coatings^A

| Cycle Number | Cycle Description | 340 nm Irradiance ^B | Black Panel Temperature ^C | Typical Uses ^D |
|--------------|--|--|--|--|
| 1 | 8 h UV 4 h condensation Repeated continuously | 0.72 W/(m ² ·nm) dark period | 70 ± 2.5 °C (158 ± 5 °F) 50 ± 2.5 °C (122 ± 5 °F) | Automotive coatings ^E |
| 2 | 4 h UV 4 h condensation Repeated continuously | 0.77 W/(m ² ·nm) dark period | 60 ± 2.5 (140 ± 5 °F) 50 ± 2.5 (122 ± 5 °F) | Industrial maintenance coatings ^F |
| 3 | 4 h UV 20 h condensation Repeated continuously | 0.77 W/(m ² ·nm) dark period | 60 ± 2.5 (140 ± 5 °F) 50 ± 2.5 (122 ± 5 °F) | Exterior wood coatings |
| 4 | 8 h UV 4 h condensation Repeated continuously | 0.77 W/(m ² ·nm) dark period | 60 ± 2.5 (140 ± 5 °F) 50 ± 2.5 (122 ± 5 °F) | General metal coatings |

^A The cycles described are not listed in any order indicating importance, and are not necessarily recommended for the applications listed. Additional exposure cycles are described in Practice G 154.

^B The irradiance set point given is typical for devices operated without irradiance control. Other irradiance levels may be used, but must be described in the report.

^C Temperature is at equilibrium for either an uninsulated or insulated black panel, although the response of the insulated black panel might be slower than that for the uninsulated black panel. Refer to Practice G 151 for more information about the construction and differences between uninsulated and insulated black panels.

^D Typical uses do not imply that results from exposures of these materials according to the cycle described will correlate to those from actual use conditions.

^E SAE J2020 describes the test used in many automotive specifications and requires use of a FS40 fluorescent UVB lamp.

^F Historical convention has established this as a very commonly used test cycle. This cycle may not adequately simulate the effects of outdoor exposure.

E 1347 Test Method for Color and Color Difference Measured by Tristimulus (filter) Colorimetry³

G 53 Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials⁹

G 113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials¹⁰

G 141 Guide for Addressing Variability in Exposure Testing on Nonmetallic Materials¹⁰

G 147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests¹⁰

G 151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices That Use Laboratory Light Sources¹⁰

G 154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials¹⁰

G 169 Guide for Application of Basic Statistical Methods to Weathering Tests¹⁰

2.2 *ISO Standard*:¹¹

ISO 11507:1997

2.3 *SAE Standard*:¹²

SAE J2020 Accelerated Exposure of Automotive Exterior Materials Using a Fluorescent UV Condensation Apparatus

3. Terminology

3.1 The definitions given in Terminology G 113 are applicable to this practice.

4. Significance and Use

4.1 The ability of a paint or coating to resist deterioration of its physical and optical properties caused by exposure to light,

heat, and water can be very significant for many applications. This practice is intended to induce property changes associated with end-use conditions, including the effects of sunlight, moisture, and heat. The exposure used in this practice is not intended to simulate the deterioration caused by localized weather phenomena such as atmospheric pollution, biological attack, and saltwater exposure.

4.2 *Cautions*—Variation in results may be expected when different operating conditions are used. Therefore, no reference to the use of this practice shall be made unless accompanied by a report prepared according to Section 10 that describes the specific operating conditions used. Refer to Practice G 151 for detailed information on the caveats applicable to use of results obtained according to this practice.

NOTE 3—Additional information on sources of variability and on strategies for addressing variability in the design, execution and data analysis of laboratory accelerated exposure tests is found in Guide G 141.

4.2.1 The spectral power distribution of light from fluorescent UV lamps is significantly different from that produced in light and water exposure devices using other light sources. The type and rate of degradation and the performance rankings produced in exposures to fluorescent UV lamps can be much different from those produced by exposures to other types of laboratory light sources.

4.2.2 Interlaboratory comparisons are valid only when all laboratories use the same design of fluorescent UV device, lamp, and exposure conditions.

4.3 Reproducibility of test results between laboratories has been shown to be good when the stability of materials is evaluated in terms of performance ranking compared to other materials or to a control.^{13,14} Therefore, exposure of a similar material of known performance (a control) at the same time as the test materials is strongly recommended. It is recommended

⁹ Discontinued 2000; see 1999 Annual Book of ASTM Standards, Vol 14.04.

¹⁰ Annual Book of ASTM Standards, Vol 14.04.

¹¹ Available from International Organization for Standardization, 1 Rue de Varembe, Case Postale 56, CH-1211, Geneva 20, Switzerland.

¹² Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

¹³ Fischer, R., "Results of Round Robin Studies of Light- and Water-Exposure Standard Practices," *Accelerated and Outdoor Durability Testing of Organic Materials*, ASTM STP 1202, ASTM, 1993.

¹⁴ Ketola, W., and Fischer, R., "Characterization and Use of Reference Materials in Accelerated Durability Tests," *VAMAS Technical Report No. 30*, NIST, June 1997.

that at least three replicates of each material be exposed to allow for statistical evaluation of results.

4.4 Test results will depend upon the care that is taken to operate the equipment according to Practice **G 154**. Significant factors include regulation of line voltage, temperature of the room in which the device operates, temperature control, and condition and age of the lamps.

4.5 All references to exposures in accordance with this practice must include a complete description of the test cycle used.

5. Apparatus

5.1 Use of fluorescent UV apparatus that conform to the requirements defined in Practices **G 151** and **G 154** is required to conform to this practice.

NOTE 4—A fluorescent UV apparatus that complied with Practice **G 53** also complies with Practice **G 154**.

5.2 Unless otherwise specified, the spectral power distribution of the fluorescent UV lamp shall conform to the requirements in Practice **G 154** for a UVA 340 lamp.

NOTE 5—Fluorescent UV exposures described in **SAE J2020** for automotive applications call for use of fluorescent UVB lamps.

5.3 Test Chamber Location:

5.3.1 Locate the apparatus in an area maintained between 18 and 27°C (65 and 80°F). Measure ambient temperature at a maximum distance of 150 mm (6 in.) from the plane door of the apparatus. Control of ambient temperature is particularly critical when one apparatus is stacked above another, because the heat generated from the lower unit can interfere with the operation of the units above.

5.3.2 Place the apparatus at least 300 mm (12 in.) from walls or other apparatus. Do not place the apparatus near a heat source such as an oven.

5.3.3 Ventilate the room in which the apparatus is located to remove heat and moisture.

6. Hazards

6.1 *Warning*—In addition to other precautions, never look directly at the fluorescent UV lamp because UV radiation can damage the eye. Turn the device off before removing panels for inspection.

7. Test Specimens

7.1 Apply the coating to flat (plane) panels with the substrate, method of preparation, method of application, coating system, film thickness, and method of drying consistent with the anticipated end use, or as mutually agreed upon between the producer and user.

7.2 Panel specifications and methods of preparation include but are not limited to Practices **D 609**, **D 1730**, or Specification **D 358**. Select panel sizes suitable for use with the exposure apparatus.

7.2.1 For specimens coated on insulating materials, such as foams, maximum specimen thickness is 20 mm in order to allow for adequate heat transfer for condensation.

7.3 Coat test panels in accordance with Practices **D 823**, then measure the film thickness in accordance with an appro-

appropriate procedure selected from Test Methods **D 1005**, **D 1186**, or **D 1400**. Nondestructive methods are preferred because panels so measured need not be repaired.

7.4 Prior to exposing coated panels in the apparatus, condition them at $23 \pm 2^\circ\text{C}$ ($73 \pm 3^\circ\text{F}$) and $50 \pm 5\%$ relative humidity for one of the following periods in accordance with the type of coating:

| | |
|--------------------------|--------|
| Baked coatings | 24 h |
| Radiation-cured coatings | 24 h |
| All other coatings | 7 days |

7.4.1 Other procedures for preparation of test specimens may be used if agreed upon by all interested parties.

7.5 Mount specimens in holders so that only the minimum specimen area required for support by the holder is covered. Do not use this covered area of the specimen as part of the test area.

7.6 Unless otherwise specified, expose at least three replicate specimens of each test and control material.

7.7 Follow the procedures described in Practice **G 147** for identification and conditioning and handling of specimens of test, control, and reference materials prior to, during, and after exposure.

7.8 Do not mask the face of a specimen for the purpose of showing on one panel the effects of various exposure times. Misleading results may be obtained by this method, since the masked portion of the specimen is still exposed to temperature and humidity cycles that in many cases will affect results.

7.9 Retain a supply of unexposed file specimens of all materials evaluated.

7.9.1 When destructive tests are run, it is recommended that a sufficient number of file specimens be retained so that the property of interest can be determined on unexposed file specimens each time exposed materials are evaluated.

NOTE 6—Since the stability of the file specimen may also be time dependent, users are cautioned that over prolonged exposure periods, or where small differences in the order of acceptable limits are anticipated, comparison of exposed specimens with the file specimen may not be valid. Nondestructive instrumental measurements are recommended whenever possible.

7.10 Specimens should not ordinarily be removed from the exposure apparatus for more than 24 h, then returned for additional tests, since this may not produce the same results on all materials as tests run without this type of interruption. When specimens are removed from the exposure apparatus for 24 h or more, then returned for additional exposure, report the elapsed time as noted under Section **10**.

8. Procedure

8.1 **Table 1** lists several exposure cycles that are used for fluorescent UV exposures of nonmetallic materials. Obtain agreement between all concerned parties for the specific exposure cycle used. Additional intervals and periods of condensation may be substituted upon agreement among the concerned parties.

NOTE 7—Each setpoint and its tolerances found in **Table 1** represent an operational control point for equilibrium conditions at a single location in the cabinet, which may not necessarily represent the uniformity of those conditions throughout the cabinet. ASTM Committee G03 is working to refine these tolerances and address the uniformity issue.