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Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings[1]

This standard is issued under the fixed designation D4587; 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 G151 and G154. 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 G53, which described very specific equipment designs. Practice G53 has been withdrawn and replaced by Practice G151, which describes performance criteria for all exposure devices that use laboratory light sources, and by Practice G154, which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 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 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:*[2]

D358 Specification for Wood to Be Used as Panels in Weathering Tests of Coatings (Withdrawn 2014)[3]

D523 Test Method for Specular Gloss

D609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products

D610 Practice for Evaluating Degree of Rusting on Painted Steel Surfaces

D659 Method for Evaluating Degree of Chalking of Exterior Paints (Withdrawn 1990)[3]

D660 Test Method for Evaluating Degree of Checking of Exterior Paints

D662 Test Method for Evaluating Degree of Erosion of Exterior Paints

D714 Test Method for Evaluating Degree of Blistering of Paints

D772 Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints

D823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels

D1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers

D1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base (Withdrawn 2006)[3]

D1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base (Withdrawn 2006)[3]

D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials

D1730 Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

D2616 Test Method for Evaluation of Visual Color Difference With a Gray Scale

D3359 Test Methods for Measuring Adhesion by Tape Test

D3980 Practice for Interlaboratory Testing of Paint and Related Materials (Withdrawn 1998)[3]

D4214 Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

D5870 Practice for Calculating Property Retention Index of Plastics

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

[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.

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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 last approved version of this historical standard is referenced on www.astm.org.

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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,C]	Black Panel Temperature[D]	Typical Uses[E]
1	8 h UV 4 h condensation Repeated continuously	0.83 W/(m²·nm) dark period	70 ± 2.5ºC (158 ± 5ºF) 50 ± 2. ºC (122 ± 5ºF)	Automotive coatings[F]
2	4 h UV 4 h condensation Repeated continuously	0.89 W/(m²·nm) dark period	60 ± 2.5 (140 ± 5ºF) 50 ± 2.5 (122 ± 5ºF)	Industrial maintenance coatings[G]
3	4 h UV 20 h condensation Repeated continuously	0.89 W/(m²·nm) dark period	60 ± 2.5 (140 ± 5ºF) 50 ± 2.5 (122 ± 5ºF)	Exterior wood coatings
4	8 h UV 4 h condensation Repeated continuously	0.89 W/(m²·nm) dark period	60 ± 2.5 (140 ± 5ºF) 50 ± 2.5 (122 ± 5ºF)	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 G154.
[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] Previous editions of Practice D4587 contained non-mandatory irradiance set points in Table 1 that were commonly used in the industry. The previous set points were 0.72 and 0.77 W/(m² · nm) at 340 nm for UVA 340 lamps. The measurement data used to establish these set points was inaccurate, due to an error in calibration on the part of one manufacturer. It has been found that, for most users, the actual irradiance when running at the previous set points was 11 to 15 % higher than the indicated set point. The set points shown in this edition of D4587 do not change the actual irradiances that have been historically used by these users. However, for users of equipment made by another manufacturer, the irradiance control system did not have the measurement inaccuracies described above, so running at the new set points will represent a change in the actual irradiance of the test. If in doubt, users should consult the manufacturer of their device for clarification.
[D] 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 G151 for more information about the construction and differences between uninsulated and insulated black panels.
[E] 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.
[F] SAE J2020 describes the test used in many automotive specifications and requires use of a FS40 fluorescent UVB lamp.
[G] Historical convention has established this as a very commonly used test cycle. This cycle may not adequately simulate the effects of outdoor exposure.

E1347 Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry
G53 Practice for Operating Light-and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials (Withdrawn 2000)[3]
G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials
G141 Guide for Addressing Variability in Exposure Testing 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
G169 Guide for Application of Basic Statistical Methods to Weathering Tests

2.2 *ISO Standard:*[4]

ISO 11507:1997 Paints and Varnishes—Exposure of Coatings to Artificial Weathering—Exposure to Fluorescent UV and Water

2.3 *SAE Standard:*[5]

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

3. Terminology

3.1 The definitions given in Terminology G113 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 G151 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 G141.

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

[4] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.
[5] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://aerospace.sae.org.

materials or to a control.[6,7] 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 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 G154. 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 G151 and G154 is required to conform to this practice.

NOTE 4—A fluorescent UV apparatus that complied with Practice G53 also complies with Practice G154.

5.2 Unless otherwise specified, the spectral power distribution of the fluorescent UV lamp shall conform to the requirements in Practice G154 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 D609, D1730, or Specification D358. Select panel sizes suitable for use with the exposure apparatus.

7.2.1 For specimens coated on insulating materials, such as foams, quickly check the specimens during the condensation period to verify that visible condensation is occurring on the specimens. Perform this visual check once per week at least one hour after the start of condensation.

NOTE 6—If condensation is not occurring, the most likely cause involves inadequate room-air cooling; (*1*) the laboratory temperature is too high; (*2*) condensation temperature is set too low, or too close to room temperature; (*3*) thick specimens of insulating material may be preventing the room-air cooling necessary for condensation. For example, a 25 mm thick wood specimen may exhibit poor condensation with a condensation set point of 40°C and a lab temperature of 30°C; or (*4*) improper specimen mounting is allowing vapor to escape from the chamber.

7.3 Coat test panels in accordance with Practices D823, then measure the film thickness in accordance with an appropriate procedure selected from Test Methods D1005, D1186, or D1400. 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 ± 2°C (73 ± 3°F) and 50 ± 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 G147 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 7—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.

[6] 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.

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

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