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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Operating Light- and Water-Exposure Apparatus (Unfiltered Open-Flame Carbon-Arc Type) for Testing Paint, Varnish, Lacquer, and Related Products Using the Dew Cycle¹

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1. Scope

1.1 This practice covers the specific variations in test conditions that are applicable when Method 2 in Practice G 23 is employed for the exposure of paint and related coatings and materials using the dew cycle with unfiltered open-flame carbon arc.

NOTE 1—Another procedure for exposing these products is covered by Practice D 822 in which specimens are subjected to radiation from the filtered open-flame carbon arc. The filters in Practice D 822 remove some of the shorter wavelength ultraviolet radiation not normally received at the earth's surface.

1.2 *This standard does not purport to address all of the safety problems, 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 523 Test Method for Specular Gloss²
- D 609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products²
- D 610 Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces³
- D 660 Test Method for Evaluating Degree of Checking of Exterior Paints²
- D 661 Test Method for Evaluating Degree of Cracking of Exterior Paints²
- D 662 Test Method for Evaluating Degree of Erosion of Exterior Paints²
- D 714 Test Method for Evaluating Degree of Blistering of Paints²
- D 772 Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints²

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.

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² Annual Book of ASTM Standards, Vol 06.01.

³ Annual Book of ASTM Standards, Vol 06.02.

- D 822 Practice for Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Light- and Water-Exposure Apparatus²
- D 823 Test Methods for Producing Films of Uniform Thickness of Paint, Varnish, Lacquer, and Related Products on Test Panels²
- D 1005 Test Methods for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers²
- D 1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base²
- D 1212 Test Methods for Measurement of Wet Film Thickness of Organic Coatings²
- D 1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base²
- D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials²
- D 1730 Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting⁴
- D 1731 Practices for Preparation of Hot-Dip Aluminum Surfaces for Painting⁴
- D 1732 Practices for Preparation of Magnesium Alloy Surfaces for Painting⁴
- D 2092 Practices for Preparation of Zinc-Coated (Galvanized) Steel Surfaces for Painting³
- D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates²
- D 2616 Test Method for Evaluation of Visual Color Difference with a Gray Scale²
- D 4214 Test Methods for Evaluating Degree of Chalking of Exterior Paint Films²
- D 4587 Practice for Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light-and-Water Exposure Apparatus²
- E 97 Test Method for Directional Reflectance Factor, 45-deg 0-deg, of Opaque Specimens by Broad-Band Filter Reflectometry⁵
- G 23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure

⁴ Annual Book of ASTM Standards, Vol 02.05.

⁵ Discontinued; see 1992 Annual Book of ASTM Standards, Vol 14.02.

of Nonmetallic Materials⁶

G 26 Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials⁶

3. Significance and Use

3.1 Organic coatings on exterior exposure are subjected to attack by degrading elements of the weather, particularly ultraviolet light, oxygen, and water. This practice may be used for evaluating the behavior of films exposed in apparatus that produces ultraviolet radiation, high temperatures, and water condensation on the films. However, light sources, such as the carbon arc, that emit a significant amount of radiation at wavelengths shorter than those in natural sunlight, may cause results that lead to unrealistic evaluations of weathering properties.

3.2 This test method produces failure of films at a very rapid rate because the test is run without filters. The unfiltered carbon arc produces light that does not exist at the earth's surface. Failure caused by this light may bear no relationship to failures in natural sunlight. It is essential to have a control material of known performance of a similar vehicle type in every test. Other ASTM Practices that can be operated in a way to produce wavelength spectra with lesser amounts of short wavelength UV include Practices D 822, D 4587, and G 26.

3.3 Substrates that have good thermal insulating properties should not be used because sufficient condensation cannot be obtained.

3.4 As no single light exposure apparatus, with or without water, can be specified as a direct simulation of natural exposure, this practice does not imply expressly, or otherwise, a specific correlation with outdoor exposure. It has, however, been useful in some instances.

3.5 Since climatic conditions vary with respect to time, geography, and topography, it may be expected that the effects of natural exposure will vary accordingly. All materials are not affected equally by the same environment. Results obtained by use of this practice should not be represented as equivalent to those of any outdoor weathering test unless the degree of quantitative correlation has been established for the material in question.

3.6 Variations in results may be expected when operating conditions among similar type instruments vary within accepted limits of this standard procedure.

4. Apparatus

4.1 *Type EH Apparatus* (open-flame carbon arc), of Practice G 23, without filters.⁷

5. Hazards

5.1 **Warning**—Never look directly at the carbon arc because ultraviolet radiation can damage the eye. Most carbon arc apparatus machines are equipped with door safety switches,

but users of old equipment must be certain to turn the operate switch off before opening the test chamber door.

5.2 This light source generates ozone and nitrous oxides. Exhaust from the cabinet should be vented to the atmosphere.

6. Test Specimens

6.1 Unless otherwise agreed upon, choose panels that meet the applicable base panel requirements specified in Practices D 609, D 1730, D 1731, D 1732, or D 2092. Select panel sizes suitable for exhibiting the failure mode to be observed.

6.2 Apply the coatings to flat panels with the base panel material, 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 the user.

6.3 Unless otherwise agreed upon, coat test panels in accordance with Test Methods D 823 and measure the film thickness in accordance with an appropriate procedure selected from Test Methods D 1005, D 1186, D 1212, or D 1400. Nondestructive methods are preferred because panels so measured do not need to be repaired.

6.4 Unless otherwise specified, before exposing coated panels in the apparatus, condition them at $73.5 \pm 3.5^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) 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 min

7. Procedure

7.1 Mount the test specimens vertically both above and below the horizontal center line of the source of radiation. Rotate the specimens from upper to lower rack to provide uniform exposure conditions over their surface. Specimens should be exposed approximately as many hours in the top rack as in the bottom rack, but need not be inverted.

7.2 Operate in accordance with Practice G 23. The black panel temperature shall reach a maximum of $145 \pm 9^\circ\text{F}$ ($63 \pm 5^\circ\text{C}$) during the light-on-without-water-spray period of the test cycle and the equilibrium relative humidity of the air in the test chamber shall be $50 \pm 5\%$. The chamber temperature shall be $90 \pm 5^\circ\text{F}$ ($32 \pm 3^\circ\text{C}$) during the light-off-with-water-spray period of the test and the relative humidity of the air shall be $95 \pm 5\%$.

7.3 The water from the rack spray shall strike the back of the test specimens so that the only water on the face of the panels is from the dew formation caused by the chilled water on the back of the panels. The temperature of the water shall be $45 \pm 4^\circ\text{F}$ ($7.2 \pm 2^\circ\text{C}$). The water should have less than 20 ppm of solids.

7.4 Operate the apparatus on a cycle of 60 min dark with water-back spray and 60 min light without water spray.

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 (light and dark hours),

8.1.2 Number of total hours of exposure required to produce a mutually agreed upon amount of change in either the test specimen or an agreed upon standard sample.

⁶ Annual Book of ASTM Standards, Vol 14.02.

⁷ Apparatus and carbon arcs from the Atlas Electric Devices Co., 4114 N. Ravenswood Ave., Chicago, IL 60613, and from Suga Test Instruments Co., Ltd., 5-14-14, Shinjuko, Shinjuko-ko, Tokyo 160, Japan, have been found suitable for this purpose.