



Designation: D 3361 – 01

Standard Practice for Unfiltered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings¹

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1. Scope

1.1 This practice covers the selection of test conditions for accelerated exposure testing of coatings and related products in unfiltered open-flame carbon-arc devices conducted according to Practice G 151. This practice also covers the preparation of test specimens, the test conditions suited for coatings, and the evaluation of test results.

NOTE 1—Previous versions of this practice referenced carbon-arc devices described by Practice G 23, which described very specific equipment designs. Practice G 23 has been withdrawn and replaced by Practice G 151, which describes performance criteria for all exposure devices that use laboratory light sources.

1.2 This practice covers unfiltered open-flame carbon-arc exposures of paints and related coatings, and covers the exposure cycle that has been commonly referred to as the “dew cycle.” Practice D 822 describes filtered open-flame carbon-arc devices, and Practice D 5031 describes enclosed carbon-arc exposures. The radiation from an unfiltered open-flame carbon arc produces shorter wavelengths and higher levels of short wavelength radiation than either filtered open-flame or enclosed carbon arcs.

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 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 822 Practice for Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Light- and Water-Exposure Apparatus³
- D 823 Test Methods for Producing Films of Uniform Thickness of Paint, Varnish, Lacquer, 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 3980 Practice for Interlaboratory Testing of Paint and Related Materials⁶
- D 4214 Test Methods for Evaluating Degree of Chalking of Exterior Paint Films³
- D 5031 Practice for Conducting Tests on Paint and Related

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 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.

Coatings and Materials Using Enclosed Carbon-Arc Light and Water Exposure Apparatus³

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

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

G 23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water 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 169 Guide for Application of Basic Statistical Methods to Weathering Tests¹⁰

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 2—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 an unfiltered open-flame carbon arc is significantly different from that produced in light and water exposure devices using other carbon-arc configurations or other light sources. The type and rate of degradation and the performance rankings produced by

exposures to unfiltered open-flame carbon-arcs can be much different from that produced by exposures to other types of laboratory light sources. Typically, exposures conducted according to this practice will produce degradation faster than similar exposures conducted according to Practice **D 822** or **D 5031** and may cause different types of degradation.

4.2.2 Interlaboratory comparisons are valid only when all laboratories use the same type of carbon-arc 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.^{11,12} 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. Significant factors include regulation of line voltage, freedom from salt or other deposits from water, temperature and humidity control, and conditions of the electrodes.

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 filtered open-flame carbon-arc apparatus with automatic humidity control that conforms to the requirements defined in Practice **G 151**.

5.2 Do not place any filters between the open flame carbon arc and the test specimens.

6. Hazards

6.1 **Warning**—In addition to other precautions, never look directly at the carbon arc because UV radiation can damage the eye. Most carbon-arc machines are equipped with door safety switches, but users of old equipment must be certain to turn off the power to the carbon arc before opening the test-chamber door.

6.2 This light source generates ozone and nitrous oxides. Vent exhaust from the exposure device to the atmosphere.

6.3 The burning carbon rods used in these devices become very hot during use. Make sure to allow at least 15 min for the arcs to cool after the device is turned off before attempting to change the carbon rods.

6.4 Carbon residue and ash are known respiratory irritants. Wear an appropriate high-efficiency dust respirator, gloves, and safety glasses when handling or changing carbon rods. Make sure to wash any carbon residue from hands or arms prior to eating or drinking.

⁷ Annual Book of ASTM Standards, Vol 08.03.

⁸ Annual Book of ASTM Standards, Vol 14.02.

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

¹⁰ Annual Book of ASTM Standards, Vol 14.04.

¹¹ 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.

¹² Ketola, W., and Fischer, R., "Characterization and Use of Reference Materials in Accelerated Durability Tests," *VAMAS Technical Report No. 30*, NIST, June 1997.