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Designation: G153 – 13

Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials[1]

This standard is issued under the fixed designation G153; 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 basic principles and operating procedures for using enclosed carbon-arc light and water apparatus intended to reproduce the weathering effects that occur when materials are exposed to sunlight (either direct or through window glass) and moisture as rain or dew in actual use. This practice is limited to the procedures for obtaining, measuring, and controlling conditions of exposure. A number of exposure procedures are listed in an appendix; however, this practice does not specify the exposure conditions best suited for the material to be tested.

NOTE 1—Practice G151 describes performance criteria for all exposure devices that use laboratory light sources. This practice replaces Practice G23, which describes very specific designs for devices used for carbon-arc exposures. The apparatus described in Practice G23 is covered by this practice.

1.2 Test specimens are exposed to enclosed carbon arc light under controlled environmental conditions.

1.3 Specimen preparation and evaluation of the results are covered in various methods or specifications for specific materials. General guidance is given in Practice G151 and ISO 4892-1. More specific information about methods for determining the change in properties after exposure and reporting these results is described in ISO 4582.

1.4 The values stated in SI units are to be regarded as the standard.

1.5 *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.*

1.5.1 Should any ozone be generated from the operation of the light source, it shall be carried away from the test specimens and operating personnel by an exhaust system.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3980 Practice for Interlaboratory Testing of Paint and Related Materials (Withdrawn 1998)[3]

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

G23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials (Withdrawn 2000)[3]

G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

2.2 *ISO Standards:*

ISO 4582 Plastics—Determination of the Changes of Colour and Variations in Properties After Exposure to Daylight Under Glass, Natural Weathering or Artificial Light[4]

ISO 4892-1 Plastics—Methods of Exposure to Laboratory Light Sources, Part 1, General Guidance[4]

ISO 4892-4 Plastics—Methods of Exposure to Laboratory Light Sources, Part 4, Open-Flame Carbon Arc Lamp[4]

2.3 *CIE Standards:*

CIE-Publ. No. 85: Recommendations for the Integrated Irradiance and the Spectral Distribution of Simulated Solar Radiation for Testing Purposes[5]

3. Terminology

3.1 *Definitions*—The definitions that are applicable to this practice are provided in Terminology G113.

3.1.1 As used in this practice, the term *sunlight* is identical to the terms *daylight* and *solar irradiance, global* as they are defined in Terminology G113.

[1] This practice is under the jurisdiction of ASTM Committee G03 on Weathering and Durability and is the direct responsibility of Subcommittee G03.03 on Simulated and Controlled Exposure Tests.

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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.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from Secretary, U.S. National Committee, CIE, National Institute of Standards and Technology, Gaithersburg, MD 20899.

***A Summary of Changes section appears at the end of this standard**

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4. Summary of Practice

4.1 Specimens are exposed to repetitive cycles of light and moisture under controlled environmental conditions. Moisture usually is produced by spraying the test specimen with demineralized/deionized water or by condensation of water vapor onto the specimen.

4.2 The exposure condition may be varied by selection of the following:

4.2.1 Filter,

4.2.2 The type of moisture exposure,

4.2.3 The timing of the light and moisture exposure,

4.2.4 The temperature of light exposure, and

4.2.5 The timing of a light/dark cycle.

4.3 Comparison of results obtained from specimens exposed in same model of apparatus should not be made unless reproducibility has been established among devices for the material to be tested.

4.4 Comparison of results obtained from specimens exposed in different models of apparatus should not be made unless correlation has been established among devices for the material to be tested.

5. Significance and Use

5.1 The use of this apparatus is intended to induce property changes associated with the end use conditions, including the effects of sunlight, moisture, and heat. These exposures may include a means to introduce moisture to the test specimen. Exposures are not intended to simulate the deterioration caused by localized weather phenomena, such as atmospheric pollution, biological attack, and saltwater exposure. Alternatively, the exposure may simulate the effects of sunlight through window glass. Typically, these exposures would include moisture in the form of humidity.

NOTE 2—**Caution:** Refer to Practice G151 for full cautionary guidance applicable to all laboratory weathering devices.

5.2 Variation in results may be expected when operating conditions are varied within the accepted limits of this practice. Therefore, no reference shall be made to results from the use of this practice unless accompanied by a report detailing the specific operating conditions in conformance with Section 10.

5.2.1 It is recommended that a similar material of known performance, a control, be exposed simultaneously with the test specimen to provide a standard for comparative purposes. It is best practice to use control materials known to have relatively poor and good durability. It is recommended that at least three replicates of each material evaluated be exposed in each test to allow for statistical evaluation of results.

6. Apparatus

6.1 *Laboratory Light Source*—Enclosed carbon arc light sources typically use carbon rods which contain a mixture of metal salts. An electric current is passed between the carbon rods which burn and give off ultraviolet, visible, and infrared radiation. Use carbon rods recommended by the device manufacturer.

6.1.1 *Filter*—The most commonly used filters are borosilicate glass globes which fit around the carbon burners. Other filters may be used by mutual agreement by the interested parties as long as the filter type is reported in conformance with the report section in Practice G151.

6.1.2 The emission spectra of the enclosed carbon arc shows strong emission in the long wavelength ultraviolet region. Emissions in the visible, infrared, and short wavelength ultraviolet below 350 nm generally are weaker than in sunlight (see Table 1).

6.1.3 The following factors can affect the spectral power distribution of enclosed carbon arc light sources:

6.1.3.1 Differences in the composition and thickness of filters can have large effects on the amount of short wavelength UV radiation transmitted.

6.1.3.2 Aging (solarization) of filters can result in changes in filter transmission. The aging properties of filters can be influenced by the composition. Aging of filters can result in a significant reduction in the short wavelength UV emission of a burner.

6.1.3.3 Accumulation of dirt or other residue on filters can affect filter transmission.

6.1.3.4 Differences in chemical composition of carbons.

6.1.4 *Spectral Irradiance for Enclosed Carbon with Daylight Filters*—The data in Table 1 are representative of the spectral irradiance received by a test specimen mounted in the specimen plane.

6.2 *Test Chamber*—The design of the test chamber may vary, but it should be constructed from corrosion resistant material, and in addition to the radiant source, may provide for means of controlling temperature and relative humidity. When

TABLE 1 Typical Relative Spectral Power Distribution for Enclosed Carbon-Arc with Daylight Filters[A,B]

Spectral Bandpass Wavelength λ in nm	Typical Percent[C]	Benchmark Solar Radiation Percent[D,E,F]
λ < 290	0.0	
290 ≤ λ ≤ 320	0.1	5.8
320 < λ ≤ 360	19.9	40.0
360 < λ ≤ 400	80.1	54.2

[A] Data in Table 1 are the irradiance in the given bandpass expressed as a percentage of the total irradiance from 290 to 400 nm. Annex A1 states how to determine relative spectral irradiance.

[B] The data in Table 1 is representative and is based on the rectangular integration of the spectral power distributions enclosed carbon arcs with daylight filters. There is not enough data available to establish a meaningful specification.

[C] For any individual spectral power distribution, the calculated percentage for the bandpasses in Table 1 will sum to 100 %. Test results can be expected to differ between exposures using enclosed carbon arc devices in which the spectral power distributions differ by as much as that allowed by the tolerances typical for daylight filters. Contact the manufacturer of the enclosed carbon-arc devices for specific spectral power distribution data for the enclosed carbon-arc and filters used.

[D] The benchmark solar radiation data is defined in ASTM G177 and is for atmospheric conditions and altitude chosen to maximize the short wavelength UV fraction of solar UV. While this data is provided for comparison purposes only, it is desirable for a laboratory accelerated light source with daylight filters to provide a spectrum that is a close match to this solar spectrum.

[E] Previous versions of this standard used solar radiation data from Table 4 of CIE Publication Number 85. See Appendix X2 for more information comparing the solar radiation data used in this standard with that for CIE 85 Table 4.

[F] For the benchmark solar spectrum, the UV irradiance (290 to 400 nm) is 9.8 % and the visible irradiance (400 to 800 nm) is 90.2 % expressed as a percentage of the total irradiance from 290 to 800 nm. The percentages of UV and visible irradiances on samples exposed in enclosed carbon-arc devices may vary due to the number and reflectance properties of specimens being exposed. This is based on measurements in xenon-arc devices but similar measurements have not been made in enclosed carbon-arc devices.

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