



Designation: D 1499 – 99

Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Plastics¹

This standard is issued under the fixed designation D 1499; 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 specific procedures and test conditions that are applicable for exposure of plastics in filtered open-flame carbon-arc devices conducted in accordance with Practices G 151 and G 152. This practice also covers the preparation of test specimens, the test condition suited for plastics, and the evaluation of test results.

NOTE 1—Previous versions of this practice allowed use of both filtered open-flame and enclosed carbon-arc devices, and referenced carbon-arc devices in Practice G 23, which described very specific equipment designs. Practice G 23 is being replaced by Practice G 151, which describes performance criteria for all exposure devices that use laboratory light sources, and by Practice G 152, which gives requirements for exposing nonmetallic materials in filtered open-flame carbon-arc devices. Practice G 23 will be balloted for withdrawal before December 2000.

1.2 This practice does not cover enclosed carbon-arc exposures of plastics, which had been allowed in Practice D 1499. Enclosed carbon-arc exposures of nonmetallic materials are described in Practice G 153. Practice D 5031 describes enclosed carbon-arc exposures of paints and related coatings.

NOTE 2—Subcommittee D20.50 is developing a new standard describing exposures of plastics in enclosed carbon-arc devices, and which will reference Practice G 153.

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.*

NOTE 3—This practice is technically equivalent to ISO 4892-4.

2. Referenced Documents

2.1 ASTM Standards:

- D 3980 Practice for Interlaboratory Testing of Paint and Related Materials²
- D 5031 Practice for Conducting Tests on Paints and Related Coatings and Materials Using Enclosed Carbon-Arc Light and Water Exposure Apparatus²

D 5870 Practice for Calculating Property Retention Index of Plastics³

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method⁴

G 23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials⁴

G 113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials⁴

G 141 Guide for Addressing Variability in Exposure Testing on Nonmetallic Materials⁴

G 147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests⁴

G 151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices That Use Laboratory Light Sources⁴

G 152 Practice for Operating Open-Flame Carbon-Arc Light Apparatus for Exposure of Nonmetallic Materials⁴

G 153 Practice for Operating Enclosed Carbon-Arc Light Apparatus for Exposure of Nonmetallic Materials⁴

G 155 Practice for Operating Xenon-Arc Light Apparatus for Exposure of Nonmetallic Materials⁴

2.2 ISO Standard:⁵

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

3. Terminology

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

4. Significance and Use

4.1 The ability of a plastic material to resist deterioration of its electrical, mechanical, 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

¹ This practice is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.50 on Permanence Properties.

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² *Annual Book of ASTM Standards*, Vol 06.01.

³ *Annual Book of ASTM Standards*, Vol 08.03.

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

⁵ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

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

by localized weather phenomena, such as, atmospheric pollution, biological attack, and saltwater exposure.

4.2 Caution—Variation in results may be expected when operating conditions are varied within the accepted limits of this practice. Therefore, no reference to the use of this practice shall be made unless accompanied by a report prepared in accordance with Section 9 that describes the specific operating conditions used. Refer to Practice G 151 for detailed information on the caveats applicable to use of results obtained in accordance with this practice.

NOTE 4—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.

4.3 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.^{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 in accordance with Practice G 152. Significant factors include regulation of line voltage, freedom from salt or other deposits from water, temperature and humidity control, and conditions of the electrodes.

5. Apparatus

5.1 Use filtered open-flame carbon-arc apparatus that conforms to the requirements defined in Practices G 151 and G 152.

5.2 Unless otherwise specified, the spectral power distribution of the filtered open-flame carbon-arc shall conform to the requirements in Practice G 152 for carbon-arc with daylight filters.

6. Test Specimen

6.1 The size and shape of specimens to be exposed will be determined by the specifications of the particular test method used to evaluate the effects of the exposure on the specimens; the test method shall be determined by the parties concerned. Where practical, it is recommended that specimens be sized to fit specimen holders and racks supplied with the exposure apparatus. Unless supplied with a specific backing as an integral part of the test, specimens shall be mounted so that only the minimum specimen area required for support by the holder shall be covered. This unexposed surface must not be used as part of the test area.

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

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, Warren D. Ketola and Douglas Grossman, eds., American Society for Testing and Materials, Philadelphia, 1993.

⁷ Ketola, W., and Fischer, R., "Characterization and Use of Reference Materials in Accelerated Durability Tests," *VAMAS Technical Report No. 30*, available from NIST, Gaithersburg, MD.

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

6.4 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.

6.5 Since the thickness of a specimen may markedly affect the results, thickness of test and control specimens shall be within $\pm 10\%$ of the nominal dimensions.

NOTE 5—This is especially important when mechanical properties are being investigated.

6.6 Incident energy at the extremes of the specimen exposure area in older equipment may be only 60 to 70 % of that at the center. If the irradiance at any position within the exposure area is less than 90 % of the peak irradiance, follow one of the procedures outlined in Practice G 152 to ensure either equal radiant exposure or compensation for differences in radiant exposure.

6.7 Retain a supply unexposed file specimens of all material evaluated.

6.7.1 When destructive tests are run, ensure that sufficient file specimens are retained so that the property of interest can be determined on unexposed file specimens each time exposed materials are evaluated.

6.8 Specimens should not be removed from the exposure apparatus for more than 24 h and then returned for additional tests, since this does 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 and then returned for additional exposure, report the elapsed time in accordance with Section 9.

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. Instrumental measurements are recommended whenever possible.

7. Procedure

7.1 Practice G 152 lists several exposure cycles that are used for filtered open-flame carbon-arc exposures of nonmetallic materials. Obtain mutual agreement between all concerned parties for the specific exposure cycle used. Additional intervals and methods of wetting, by spray or condensation, or both, may be substituted upon mutual agreement between the concerned parties.

7.1.1 By historical convention, the following exposure cycle has been commonly used for plastics.

7.1.1.1 Continuous light with equilibrium uninsulated black panel temperature controlled to $63 \pm 3^\circ\text{C}$ ($145 \pm 9^\circ\text{F}$), consisting of the following alternating intervals:

7.1.1.2 102 minutes light only followed by 18 minutes of light with water sprayed on the test specimens.

7.1.1.3 Unless otherwise specified in devices which allow for control of relative humidity, maintain relative humidity at a $50 \pm 5\%$ equilibrium during the light-only interval.

NOTE 7—The equilibrium black panel temperature is obtained without