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# Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials[1]

This standard is issued under the fixed designation G 152; 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 open flame 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 G 151 describes performance criteria for all exposure devices that use laboratory light sources. This practice replaces Practice G 23, which describes very specific designs for devices used for carbon-arc exposures. The apparatus described in Practice G 23 is covered by this practice.

1.2 Test specimens are exposed to filtered open flame carbon arc light under controlled environmental conditions. Different filters are described.

1.3 Specimen preparation and evaluation of the results are covered in methods or specifications for specific materials. General guidance is given in Practice G 151 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.~~Practice D 5870.

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.

1.6 This practice is technically similar to ISO 4892-4.

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## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

D 3980 ~~Practice for Interlaboratory Testing of Paint and Related Materials~~ Practice for Interlaboratory Testing of Paint and Related Materials[3]

D 5870 Practice for Calculating Property Retention Index of Plastics

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

G 23 Practice for Operating Light~~—~~-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials[0]

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

G 151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices ~~That~~that Use Laboratory Light Sources

2.2 *CIE Standard:*

CIE- *Publ.* No. 85: Recommendations for the Integrated Irradiance and the Spectral Distribution of Simulated Solar Radiation for Testing Purposes[4]

2.3 *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*~~

[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] Withdrawn.

[4] Available from American National Standards ~~Institute (ANSI),~~Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

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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]

## 3. Terminology

3.1 *Definitions*— The definitions given in Terminology G 113 are applicable to this practice.

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 G 113.

## 4. Summary of Practice

4.1 Specimens are exposed to repetitive cycles of light and moisture under controlled environmental conditions.

4.1.1 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:

4.2.1 Light source 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.

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5.2 *Cautions*—Refer to Practice G 151 for full cautionary guidance applicable to all laboratory weathering devices. Variation in results may be expected when operating conditions are varied within the accepted limits of this practice. No reference, therefore, 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. 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 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*—Open flame carbon arc light sources typically use three or four pairs of carbon rods, which contain a mixture of rare-earth metal salts and have a metal coating such as copper on the surface. An electric current is passed between the carbon rods which burn and give off ultraviolet, visible, and infrared radiation. The carbon rod pairs are burned in sequence, with one pair burning at any one time. Use carbon rods recommended by the device manufacturer.

6.1.1 *Filter Types*— Radiation emitted by the open flame carbon arc contains significant levels of very short wavelength UV (less than 260 nm) and must be filtered. Two types of glass filters are commonly used. 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 G 151.

6.1.2 None of these ~~fibers~~filters changes the spectral power distribution of the open flame carbon arc to make it match daylight in the long wavelength UV or the visible light regions of the spectrum.

6.1.3 The following factors can affect the spectral power distribution of open flame 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 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 the composition of the metallic salts used in he carbon rods can affect the spectral power distribution.

6.1.4 *Spectral Irradiance*:

6.1.4.1 *Spectral Irradiance of Open Flame Carbon Arc with Daylight Filters*~~—Daylight filters are used to reduce the short wavelength UV irradiance of the open flame carbon arc in an attempt to provide simulation of the short wavelength UV region of daylight. Although these filters are specified in many tests because of historical precedent, they transmit significant radiant energy below 300 nm (the typical cut-on wavelength for terrestrial sunlight) and may result in aging processes not occurring outdoors.~~—Daylight filters are used to reduce the short wavelength UV irradiance of the open flame carbon arc in an attempt to provide simulation of the short wavelength UV region of daylight. [5]The data in Table 1 is representative of the spectral irradiance received by a test specimen mounted in the specimen plane of an open flame carbon arc equipped with daylight filters.

NOTE 2—The typical spectral irradiance for open-flame carbon arc with daylight filters was obtained using a borosilicate glass filter.

6.1.4.2 *Spectral Irradiance of Open Flame Carbon Arc With Window Glass Filters*—Window glass filters use a heat resistant glass to filter the open flame carbon arc in a simulation of sunlight filtered through single strength window glass.[6] The data in Table 2 is representative of the spectral irradiance received by a test specimen mounted in the specimen plane of an open flame carbon arc equipped with window glass filters.

6.1.4.3 *Spectral Irradiance of Open Flame Carbon arc With Extended UV filters* —Filters that transmit more short wavelength UV are sometimes used to accelerate test results. Although this type of filter has been specified in many tests because of historical precedent, they transmit significant radiant energy below 300 nm (the typical cut-on wavelength for terrestrial sunlight) and may result in aging processes not occurring outdoors.[5] The spectral irradiance for an open flame carbon arc with extended UV filters shall comply with the requirements of Table 3.

NOTE ~~2—The~~ 3—The most commonly used type of ~~daylight~~extended UV filters are made from Potash-Lithia glass and are commonly known as Corex D filters.

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 radiation source, may provide for means of controlling temperature and relative humidity. When required, provision shall be made for the spraying of water on the test specimen or for the formation of condensate on the exposed face of the specimen.

6.2.1 The radiant source(s) shall be located with respect to the specimens such that the irradiance at the specimen face complies with the requirements in Practice G 151.

6.3 *Instrument Calibration*—To ensure standardization and accuracy, the instruments associated with the exposure apparatus, for example, timers, thermometers, wet bulb sensors, dry bulb sensors, humidity sensors, UV sensors, radiometers, require periodic calibration to ensure repeatability of test results. Whenever possible, calibration should be traceable to national or international standards. Calibration schedule and procedure should be in accordance with manufacturer's instructions.

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[5] Fischer, R., Ketola, W., Murray, W., "Inherent Variability in Accelerated Weathering Devices," *Progress in Organic Coatings,* Vol 19 (1991), pp. 165–179.

[6] Ketola, W., Robbins, J. S., "UV Transmission of Single Strength Window Glass," *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.

**TABLE 1 Typical Relative Ultraviolet Spectral Power Distribution of Open-Flame 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 | | |
| 290 ≤ λ ≤ 320 | 2.9 | 5.8 |
| 320 < λ ≤ 360 | 20.4 | 40.0 |
| 360 < λ ≤ 400 | 76.7 | 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 of open flame 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 open flame 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 carbon-arc devices for specific spectral power distribution data for the open flame carbon-arc and filters used.

[D] The benchmark solar radiation data is defined in ASTM G 177 and is for atmospheric conditions and altitude chosen to maximize the fraction of short wavelength solar UV. While this data is provided for comparison purposes only, a laboratory accelerated light source with daylight filters to provide a spectrum that is a close match to this the benchmark 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 (290-400 nm) is 9.8 % and the visible irradiance (400-800 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 open flame 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 open flame carbon-arc devices.

**TABLE 2 Typical U Reltavtiolvet Spectral Power Distribution o for Open Flame Carbon- Arc w With Window Glass FiltersA,B (Representative Data)**

Ultraviolet Wavelength Region
Spectral Bandp ass
W avelength λin nm

Irradiance as a Percentage of Total Irradiance from 300 to 400 nm

| Bandpass (nm) | Typical Percent[C] Open Flame Carbon Arc with Window Glass Filters[A] | Window Glass Filtered Solar Radiation Percent[D] Estimated Window Glass Filtered Sunlight[B] |
|---|---|---|
| 250–270 | 0 % | 0 % |
| 271–290 | 0 % | 0 % |
| 291–300 | 0 % | 0 % |
| 301–320 | 2.1 % | 0.1–1.5 % |
| 321–340 | 8.1 % | 9.4–14.8 % |
| 341–360 | 13.2 % | 23.2–23.5 % |
| 361–380 | 27.3 % | 29.6–32.5 % |
| 381–400 | 49.3 % | 30.9–34.5 % |

Ultraviolet and Visible Wavelength Region Irradiance as a Percentage of Total Irradiance from 300 to 800 nm[E]
Ultraviolet and Visible Wavelength Region Irradiance as a Percentage of Total Irradiance from 300 to 800 nm[C]
Irradiance as a Percentage of Total Irradiance from 300 to 800 nm[E]
Irradiance as a Percentage of Total Irradiance from 300 to 800 nm[C]

| Bandpass (nm) | Open Flame Carbon Arc with Window Glass Filters[E] | Estimated Window Glass Filtered Sunlight[D] |
|---|---|---|
| λ < 300 | 0.1 | 0.0 |
| 300 ≤ λ ≤ 320 | 1.3 | ≤ 0.5 |
| 320 < λ ≤ 360 | 19.5 | 34.2 |
| 300–400 | 22.7–34.1 % | 9.0–11.1 % |
| 360 < λ ≤400 | 79.2 | 65.3–73.1 % |
| 401–700 | 51.1–67.3 % | 71.3–73.1 % |

*Data from 701 to 800 nm is not shown

[A] *Carbon Arc Data in* —This dable 2ta are for a theypical spectrral power distribution for ane ope in flame carbons arc withe g wiven bandpow glass filtexprs. Not enough sspectral data is a pvailable fore mentaninge oful analysis tho de tvelotp al specirradfication. Subce from 300 to 400 nm. Annex A1 sitatee G03.03 is ho working to d collect sufficiermnt data ine ordelar tio develop a spectralirradficationee.

[B] *Sunlight Data*—The sunlight data in Tas for globale 2 is brrased oian the rectae ongul a horizontegal surface with an air mass of 1.2, column of a spzonee 0.294 atm cm, 30 % rael powativer humidistry, altibtude 2100 m (atimons fopher oic prenssure ofla 787.8 me carbon ), arc with window gl ass filtn aeros and isol represented by an opticval thickness of 0.081 at 300 nlym and 0.62 at 400 nm. The range is pr destermined by multiplyinot enough d solatr irra avadilablnce by to dhev upper and lopwer limits for transmission of singlea strength window gfulass sampleeis used ficaor studies conducted by Subcommittee G03.02.[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 open flame carbon arc devices in which the spectral power distributions differ by as much as that allowed by the tolerances typical for window glass filters. Contact the manufacturer of the carbon arc devices for specific spectral power distribution data for the open flame carbon arc and filters used.

[D] The window glass filtered solar data is for a solar spectrum with atmospheric conditions and altitude chosen to maximize the short wavelength fraction of solar UV (defined in ASTM G177) that has been filtered by window glass. The glass transmission is the average for a series of single strength window glasses tested as part of a research study for ASTM Subcommittee G3.02.[6] While this data is provided for comparison purposes only, it is desirable for a laboratory accelerated light source with window glass filters to provide a spectrum that is a close match to this window glass filtered solar spectrum.

[EC] PrevioSus versions of thlis sght Dandtard us—Thed wi sundow glass filghtere d solar radiation data ba ised fronm Table 4 of CIE Publication number 85. See Appendix X2 f Nor more information comparing the solar radiation data used in this standard with that for CIE. 85, Tab gle 4.

[F] For thebenchmark window gla ss filtered solar spectrum, the UV irradiance (300-400 onm) is 8.2 % and t he visible iorradiazonce (400-800 nm) is 91.8 % expressedtal s a peurfacen witage of the tot al irrn adiance fro m 300 to 800 nm. The percentagess of UV and visible irradian 1.0, ceson samples exposed iumn opezone ofl 0.34 atme carbon arm, 1.42 c dm previces with wpindow gltass fible waters may vary due tpo the number, and reflect ane ae propertiesof sl repreci mens beingtexposed, by and the UV transmissi on ofpthe window glcass fil ters used. This is based ockn measurements made in xen on arc devicesf 0. Siml1 ar measurements have 500 not beenmade in open flame carbon arc devices.



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**TABLE 3 Relative Spectral Power Distribution for Open Flame Carbon-Arc with Extended UV Filters[A,B]**

| Spectral Bandpass Wavelength λ in nm | Minimum Percent[C] | Benchmark Solar Radiation – Percent[D,E,F] | Maximum Percent[C] |
|---|---|---|---|
| λ < 290 | | | 4.9 |
| 290 ≤ λ ≤ 320 | 2.3 | 5.8 | 6.7 |
| 320 < λ ≤ 360 | 16.4 | 40.0 | 24.3 |
| 360 < λ ≤ 400 | 68.1 | 54.2 | 80.1 |

[A] Data in Table 3 are the irradiance in the given bandpass expressed as a percentage of the total irradiance from 250 to 400 nm. The manufacturer is responsible for determining conformance to Table 3. Annex A1 states how to determine relative spectral irradiance.

[B] The data in Table 3 are based on the rectangular integration of 24 spectral power distributions for open flame carbon-arcs with various lots of carbon rods and extended UV filters of various lots and ages. The spectral power distribution data is for filters within the aging recommendations of the device manufacturer. The minimum and maximum data are at least the three sigma limits from the mean for all measurements.

[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 open flame 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 carbon-arc devices for specific spectral power distribution data for the open flame carbon-arc and filters used.

[D] The ASTM benchmark solar radiation data is defined in ASTM G 177 and is for atmospheric conditions and altitude chosen to maximize the short wavelength UV fraction of solar UV. This data is provided for comparison purposes only.

[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 the standard with that for CIE 85 Table 4.

[F] For the benchmark solar spectrum, the UV irradiance (290-400 nm) is 9.8% and the visible irradiance (400-800 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 filtered open flame 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 open flame carbon-arc devices.

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6.4 *Thermometer*— Either insulated or uninsulated black or white panel thermometers may be used. Thermometers shall conform to the descriptions found in Practice G 151. The type of thermometer used, the method of mounting on specimen holder, and the exposure temperature shall be stated in the test report.

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6.4.1 The thermometer shall be mounted on the specimen rack so that its surface is in the same relative position and subjected to the same influences as the test specimens.

6.4.2 Some specifications may require chamber air temperature control. Positioning and calibration of chamber air temperature sensors shall be in accordance with the descriptions found in Practice G 151.

NOTE ~~3~~4—Typically, these devices control by black panel temperature only.

6.5 *Moisture*—The test specimens may be exposed to moisture in the form of water spray, condensation, or high humidity.

6.5.1 *Water Spray*— The test chamber may be equipped with a means to introduce intermittent water spray onto the front or the back of the test specimens, under specified conditions. The spray shall be applied so that the specimens are uniformly wetted. The spray system shall be made from corrosion resistant materials that do not contaminate the water used.

6.5.1.1 *Spray Water Quality*—Spray water must have a conductivity below 5 µS/cm, contain less than 1-ppm solids, and leave no observable stains or deposits on the specimens. Very low levels of silica in spray water can cause significant deposits on the surface of test specimens. Care should be taken to keep silica levels below 0.1 ppm. In addition to distillation, a combination of deionization and reverse osmosis can effectively produce water of the required quality. The pH of the water used should be reported. See Practice G 151 for detailed water quality instructions.

6.5.2 *Condensation*— A spray system designed to cool the specimen by spraying the back surface of the specimen or specimen substrate may be required when the exposure program specifies periods of condensation.

6.5.3 *Relative Humidity*—The test chamber may be equipped with a means to measure and control the relative humidity. Such instruments shall be shielded from the light source radiation.

6.6 *Specimen Holders*— Holders for test specimens shall be made from corrosion resistant materials that will not affect the test results. Corrosion resistant alloys of aluminum or stainless steel have been found acceptable. Brass, steel, or copper shall not be used in the vicinity of the test specimens.

6.6.1 The specimen holders typically, but not necessarily, are mounted on a revolving cylindrical rack which is rotated around the light source at a speed dependent on the type of equipment and which is centered both horizontally and vertically with respect to the exposure area in the specimen holders.

6.6.2 Specimen holders may be in the form of an open frame, leaving the back of the specimen exposed, or they may provide the specimen with a solid backing. Any backing used may affect test results and shall be agreed upon in advance between the interested parties.

6.7 *Apparatus to Assess Changes in Properties*—Use the apparatus required by the ASTM or other standard that describes determination of the property or properties being monitored.

## 7. Test Specimen

7.1 Refer to Practice G 151.

## 8. Test Conditions

8.1 Any exposure conditions may be used, as long as the exact conditions are detailed in the report. Appendix X1 lists some representative exposure conditions. These are not necessarily preferred and no recommendation is implied. These conditions are provided for reference only.

## 9. Procedure

9.1 Identify each test specimen by suitable indelible marking, but not on areas to be used in testing.

9.2 Determine which property of the test specimens will be evaluated. Prior to exposing the specimens, quantify the appropriate properties in accordance with recognized ASTM or international standards. If required, for example, destructive testing, use unexposed file specimens to quantify the property. See ~~ISO 4582~~Practice D 5870.for detailed guidance.

9.3 *Mounting of Test Specimens* —Attach the specimens to the specimen holders in the equipment in such a manner that this specimens are not subject to any applied stress. To assure uniform exposure conditions, fill all of the spaces, using blank panels of corrosion resistant material if necessary.

NOTE ~~4~~5—Evaluation of color and appearance changes of exposed materials must be made based on comparisons to unexposed specimens of the same material, which have been stored in the dark. Masking or shielding the face of test specimens with an opaque cover for the purpose of showing the effects of exposure on one panel is not recommended. Misleading results may be obtained by this method, since the masked portion of the specimen is still exposed to temperature and humidity that in many cases will affect results.

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9.4 *Exposure to Test Conditions* —Program the selected test conditions to operate continuously throughout the required number of repetitive cycles. Maintain these conditions throughout the exposure. Interruptions to service the apparatus and to inspect specimens shall be minimized.

9.5 *Specimen Repositioning*—Periodic repositioning of the specimens during exposure is not necessary if the irradiance at the positions farthest from the center of the specimen area is at least 90 % of that measured at the center of the exposure area. Irradiance uniformity shall be determined in accordance with Practice G 151.

9.5.1 If irradiance at positions farthest from the center of the exposure area is between 70 and 90 % of that measured at the center, one of the following three techniques shall be used for specimen placement.

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9.5.1.1 Periodically reposition specimens during the exposure period to ensure that each receives an equal amount of radiant exposure. The repositioning schedule shall be agreed upon by all interested parties.

9.5.1.2 Place specimens only in the exposure area where the irradiance is at least 90 % of the maximum irradiance.

9.5.1.3 To compensate for test variability, randomly position replicate specimens within the exposure area which meets the irradiance uniformity requirements as defined in 9.5.1.

9.6 *Inspection*—If it is necessary to remove a test specimen for periodic inspection, take care not to handle or disturb the test surface. After inspection, the test specimen shall be returned to the test chamber with its test surface in the same orientation as previously tested.

9.7 *Apparatus Maintenance*—The test apparatus requires periodic maintenance to maintain uniform exposure conditions. Perform required maintenance and calibration in accordance with manufacturer's instructions.

9.8 Expose the test specimens for the specified period of exposure. See Practice G 151 for further guidance.

9.9 At the end of the exposure, quantify the appropriate properties in accordance with recognized ASTM or international standards and report the results in conformance with Practice G 151.

NOTE ~~5~~6—Periods of exposure and evaluation of test results are addressed in Practice G 151.

## 10. Test Report

10.1 The test report shall conform to Practice G 151.

## 11. Precision and Bias

11.1 *Precision*:

11.1.1 The repeatability and reproducibility of results obtained in exposures conducted according to this practice will vary with the materials being tested, the material property being measured, and the specific test conditions and cycles that are used. In round-robin studies conducted by Subcommittee G03.03, the 60° gloss values of replicate PVC tape specimens exposed in different