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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials¹

This standard is issued under the fixed designation G 26; 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.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This practice covers the basic principles and operating procedure for water- or light-exposure apparatus, or both, employing a xenon-arc light source.

NOTE 1—This practice combines the practices previously referred to as G 26 and G 27. Practice G 27, for Operating Xenon-Arc Type Apparatus for Light Exposure of Nonmetallic Materials², has been discontinued since it is now covered in this edition of G 26 under Test Methods C and D.

1.2 This practice does not specify the exposure conditions best suited for the material to be tested, but is limited to the method of obtaining, measuring, and controlling the conditions and procedures of the exposure. Sample preparation, test conditions, and evaluation of results are covered in ASTM methods or specifications for specific materials.

1.3 This practice includes four test methods:

1.3.1 *Test Method 1*—Continuous exposure to light and intermittent exposure to water spray.

1.3.2 *Test Method 2*—Alternate exposure to light and darkness and intermittent exposure to water spray.

1.3.3 *Test Method 3*—Continuous exposure to light without water spray. Exposure conditions are characteristic of those specified by AATCC Test Method 16E 1976.

1.3.4 *Test Method 4*—Alternate exposure to light and darkness without water spray. Exposure conditions characteristic of those natural conditions experienced when exposing are in accordance with Practice G 24.

1.4 The values stated in SI units are to be regarded as the standard. The inch-pound equivalents of the SI units may be approximate.

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.*

2. Referenced Documents

2.1 ASTM Standard:

D 859 Test Methods for Silica in Water²

D 1293 Test Methods for pH of Water²

D 4517 Test Method for Low-Level Total Silica in High Purity Water by Flameless Atomic Absorption³

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

G 24 Practice for Conducting Natural Light Exposures Under Glass⁵

2.2 AATCC Standard:

Method 16 Colorfastness to Light⁶

2.3 CIE Standard:

No. 20 Recommendations for the Integrated Irradiance and the Spectral Distribution of Simulated Solar Radiation for Testing Purposes⁷

2.4 ISO Standard:

Gray Scale⁸

3. Significance and Use

3.1 Several types of apparatus with different exposure conditions are available for use. No single operating procedure for light-exposure apparatus with and without water can be specified as a direct simulation of natural exposure. This practice does not imply expressly or otherwise an accelerated weathering test.

3.2 Since the natural environment varies 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 natural weathering test until the degree of quantitative correlation has been established for the material in question.

3.3 Variations in results may be expected among instruments of different types or when operating conditions among similar type instruments vary within the accepted limits of this practice. Therefore, no reference should be made to results from use of this practice unless accompanied by the report form shown in Fig. 1 or unless otherwise specified in a referenced procedure.

³ Annual Book of ASTM Standards, Vol 11.02.

⁴ Annual Book of ASTM Standards, Vol 14.02.

⁵ Annual Book of ASTM Standards, Vol 06.01.

⁶ Available from The Secretary, American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

⁷ Available from Secretary, U.S. National Committee, CIE, National Institute of Standards and Technology, Gaithersburg, MD 20899.

⁸ Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

¹ This practice is under the jurisdiction of ASTM Committee G-3 on Durability of Nonmetallic Materials and is the direct responsibility of Subcommittee G03.03 on Simulated and Controlled Environmental Tests.

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² Annual Book of ASTM Standards, Vol 11.01.



Laboratory _____
 Material _____
 G 26 Test Method No. _____
 Reference Standard Used: _____
 Other ASTM Test No. _____ Method No. _____
 Exposure Apparatus: ASTM Type _____
 Mfr. Model _____ Serial No. _____
 Light Source: Water-Cooled _____ W, Air-Cooled _____ W
 Method Used to Regulate Wattage to Lamp _____
 Optical Filters: Type _____ Age _____ h
 Spectral Irradiance: _____ W/m² at _____ nm
 Irradiation Units: _____ kJ/m² How Monitored: _____
 Elapsed Exposure Time: _____ h
 Exposure Conditions: Program _____ h
 Light _____ min Dark _____ min
 Black-Panel Temperature _____ °C (°F)
 Air Temperature _____ °C (°F)
 Dry Bulb Temperature _____ °C (°F) _____ °C (°F)
 Relative Humidity _____ % _____ %
 Specimen Water Spray _____ min cycle _____ min cycle
 Specimen Nonspray _____ min cycle _____ min cycle
 Specimen Spray Water Type: _____
 Specimen Spray Nozzle Type: Mfg. Designation _____
 Specimen Relocation Procedure During Exposure: _____
 Identify properties to be determined on test specimens and identify test procedures or methods used for property measurement.
 Operator/Date: _____
 Supervisor/Date: _____
 Company: _____

FIG. 1 Report Form

4. Apparatus

4.1 Water-Cooled Type:⁹

4.1.1 The apparatus employed should utilize a water-cooled xenon-arc lamp as the source of radiation and should be one of the following general types, or their equivalent:

4.1.1.1 *Type A*—An exposure apparatus in which the source of radiant energy shall be a water-cooled xenon-arc vertically located at the central axis of either a 508-mm (20-in.) diameter vertical specimen rack, or of a 648-mm (25.5-in.) diameter inclined rack. Means shall be provided for automatic programming of temperature and cycles. Means shall be provided for adjustment of relative humidity. The specimen rack shall rotate at 1 ± 0.1 rpm.

NOTE 2—In the commercial descriptions of the four types, the term “cycle” is defined as each time interval of light, darkness, and water spray that is specified differently in accordance with the different testing methods.

4.1.1.2 *Type AH*—The exposure apparatus shall be identical to Type A except it shall have automatic humidity control.

4.1.1.3 *Type B*—An exposure apparatus in which the source of radiant energy shall be a water-cooled xenon-arc vertically located at the central axis of a 960-mm (37.75-in.) diameter specimen rack. Means shall be provided for automatic programming of temperature and cycles. Means may be provided for adjustment of humidity. The specimen rack shall rotate at 1 ± 0.1 rpm.

4.1.1.4 *Type BH*—The exposure apparatus shall be similar to Type B except it shall have automatic humidity control.

4.1.2 The xenon-arcs employed shall be of the “long arc” water-cooled type operated through suitable reactance transformers and electrical equipment from a 50 or 60-Hz power supply. They shall employ cylindrical inner and outer optical filters to direct the flow of cooling water and to simulate a designed spectral energy distribution.

4.1.2.1 For the purpose of this practice, the xenon-arc lamp shall consist of a quartz xenon burner tube and one of the following optical filter combinations as recommended by the manufacturer:

(a) Borosilicate glass inner and outer optical filter to simulate the spectral power distribution (SPD) of natural daylight throughout the actinic region.

(b) Infrared absorbing glass inner optical filter with quartz outer optical filter to simulate the SPD of natural daylight (300 to 1000 nm).

(c) Borosilicate glass inner optical filter with soda lime glass outer optical filter to simulate the SPD of natural daylight (actinic wavelengths) filtered through window glass.

(d) Infrared absorbing glass inner and outer optical filter to simulate the SPD of natural daylight (310 to 1000 nm) filtered through window glass.

(e) Quartz inner and outer optical filter to approximate sunlight intensities unfiltered by the earth's atmosphere.⁹

4.1.2.2 To prevent loss in levels of irradiance due to excessive solarization and to prevent possible breakage caused by stresses in optical filters exposed to high-intensity UV energy, inner optical filters shall be replaced periodically. Suggested intervals are 300 and 400 h for Types A and B, respectively. The outer optical filter shall be replaced after 1500 and 2000 h for Types A and B, respectively.

4.1.3 Distilled or deionized water should be recirculated past the burner at a flow rate sufficient to remove excess heat. Passing water through a cartridge demineralizer installed in the recirculation line just ahead of the lamp

⁹ Available from Atlas Electric Devices Co., 4114 N. Ravenswood Ave., Chicago, IL 60613 and from Suga Test Instruments Co., Ltd, 4-14, Shinjuku 5-chome, Shinjuku-Ku, Tokyo, 160, Japan.

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minimizes contamination of the quartz envelope of the burner. A heat-exchange unit should be used to cool the recirculated lamp water.

4.1.4 Since xenon-arc lamps, like all gas discharge lamps, will have a progressive drop in radiation output with continued use, and since optical filters will change in their transmission characteristics, provision shall be made in the apparatus (automatically or manually) for progressively increasing the wattage of the lamp to minimize changes in the intensity of the radiation at the face of the sample. The greatest change in both the xenon burner tube and optical filters occurs in the first 20 h of use. For this reason, burners and optical filters preaged by the instrument manufacturer are recommended for critical testing when a more rapidly changing rate of intensity is undesirable. For routine testing on a comparative basis, the 20 h of preaging may be omitted.

4.1.5 Many nonmetallic materials are selectively absorbing. The energy that a molecule absorbs depends upon the wavelength of the incident radiation.¹⁰ It is desirable to monitor the level of irradiance of the photochemically effective wavelengths if intercomparisons are to be made among samples not exposed simultaneously. Samples may then be exposed to known amounts of irradiation, the time integral of irradiance.

4.1.5.1 Where radiometers capable of monitoring discrete portions of a continuous spectrum are available, exposure to a mutually agreed-upon level of irradiation may be specified as the exposure interval in place of a time interval.

(a) When using the optical filter combination described in 4.1.2.1 (a), the suggested minimum spectral irradiance levels are:

- .2 W/m²/nm band at 320 nm
- .35 W/m²/nm band at 340 nm
- .5 W/m²/nm band at 380 nm
- .75 W/m²/nm band at 420 nm

(b) When using the optical filter combination described in 4.1.2.1 (c), the suggested minimum spectral irradiance levels are:

- .2 W/m²/nm band at 340 nm
- .45 W/m²/nm band at 380 nm
- .7 W/m²/nm band at 420 nm

(c) Operating at the suggested minimum levels approximates the average daily solar irradiance under ideal conditions. It is about half of the maximum values for total irradiance on a horizontal plane when the sun is at 90° altitude as reported in CIE No. 20. When irradiance is monitored and periodic manual adjustment of wattage is made to compensate for changes of intensity, no lamp assembly should be used that cannot maintain the minimum level of irradiance within a 10 % tolerance at the monitored wavelength. Irradiation expressed as joules per square metre is the product of irradiance × exposure time in seconds.

4.1.5.2 Xenon-arc type equipment not having a radiometer shall be operated with periodic increases in wattage to minimize any drift in levels of irradiation. Such intervals shall be established by the parties concerned or follow the suggested schedule below in 4.1.5.2 (a).

NOTE 3—The use of suggested wattage steps does not imply that irradiance will be maintained at levels equivalent to those obtained when employing a light monitor. They are intended as a guide to minimize the reduction of UV intensity with maximum lamp longevity when using either Test Method A or C for 2.5, 6, or 6.5-kW lamps, respectively.

(a) The following are the suggested wattage settings for each exposure interval of a 2500-W xenon burner tube based upon the average performance of xenon burner tubes with borosilicate filters:

Time, h	Power, W
0 to 20	1600
20 to 200	1800
200 to 400	2000
400 to 600	2250
600 to 800	2500
800 to 1000	2600
1000 to 1200	2800
1200 to 1500	3000

(b) The following are the suggested wattage settings for each exposure interval of a 6000-W xenon burner tube based upon the performance of xenon burner tubes with borosilicate filters in Test Method A:

Time, h	Power, W
0 to 20	min
20 to 100	4750
100 to 250	5000
250 to 400	5250
400 to 550	5500
550 to 700	6000
700 to 850	6500
850 to 1000	7000

(c) The following are the suggested wattage settings for each exposure interval of a 6500-W xenon burner tube based upon the average performance of xenon burner tubes with borosilicate filters in Test Method A:

Time, h	Power, W
0 to 20	min
20 to 100	5500
100 to 200	6000
200 to 500	6200
500 to 1000	6500
1000 to 1500	7000
1500 to 2000	7500
2000 and over	8500

4.1.6 Specimens should be mounted on a rack rotating about the lamp at a distance such that the location of each specimen assures that the irradiance incident on its surface does not vary by more than 5 % from the average. Figure 2 illustrates a rack meeting this condition.

4.1.7 Any apparatus that does not comply with the condition of 4.1.6 shall not have a variation in irradiance exceeding 10 % of the average, and may require specimen rearrangement during exposure, in accordance with the test procedure, in order to minimize the variability in radiant exposure.

4.1.8 Testing temperatures should be measured and regulated on the basis of a black panel thermometer unit mounted on the specimen rack so that the face of the unit is in the same relative position and is subjected to the same influences as the test specimens. The black panel thermometer unit should consist of a stainless steel panel about 70 by 50 by 0.95 mm (2.750 by 5.875 by 0.0375 in.), to which a stainless steel bimetallic dial-type thermometer is mechani-

¹⁰ Hawkins, W.L., ed., "Polymer Stabilization," Wiley-Interscience, 1972. p. 166.