



Standard Practice for Accelerated Weathering Test Conditions and Procedures for Bituminous Materials (Xenon-Arc Method)¹

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1. Scope

1.1 This practice covers test conditions and procedures for xenon-arc exposures according to Practices [G151](#) and [G155](#) for bituminous roofing and waterproofing materials. (See Terminology [G113](#).)

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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:²

[D1669/D1669M](#) Practice for Preparation of Test Panels for Accelerated and Outdoor Weathering of Bituminous Coatings

[D1670/D1670M](#) Test Method for Failure End Point in Accelerated and Outdoor Weathering of Bituminous Materials

[G113](#) Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

[G141](#) Guide for Addressing Variability in Exposure Testing of Nonmetallic Materials

[G147](#) Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests

[G151](#) Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

[G155](#) Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

[G169](#) Guide for Application of Basic Statistical Methods to Weathering Tests

3. Summary of Test Method

3.1 Thin films of bitumen are uniformly applied to aluminum panels. Shingles and similar products are cut to size and exposed to specified cycles of temperature, light, and water. A choice of two test cycles is given along with options for determining the period of exposure and evaluating results.

4. Significance and Use

4.1 Tests conducted according to this practice are used to compare the weathering characteristics of bituminous materials versus a control material of known outdoor durability. It is not possible to establish a single relationship that is applicable to all materials between time in accelerated tests conducted according to this practice and time in natural weathering because (1) there are geographical climatic variations, local weather variations, and variations in local pollutants, and (2) the relation between accelerated and natural weathering is material dependent with differences in acceleration factors between materials as well as for different formulations of the same material. Guide [G141](#) provides guidance regarding variability in outdoor and accelerated weathering tests and about the use of control materials.

NOTE 1—It is recommended that outdoor weathering be used to validate the laboratory accelerated test in terms of performance ranking.

NOTE 2—This practice can be used for other than bituminous materials, but the significance and use have not been evaluated.

5. Apparatus

5.1 The xenon-arc apparatus used shall conform to the requirements defined in Practices [G151](#) and [G155](#).

5.2 *Filters*—Daylight filter as described in Practice [G155](#).

5.3 *Radiometer*—The use of a radiometer to monitor and control the amount of radiant energy received at the specimen is required. The use of the radiometer shall comply with the requirements in Practice [G151](#).

¹ This practice is under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and is the direct responsibility of Subcommittee D08.02 on Steep Roofing Products and Assemblies.

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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.

6. Test Specimens

6.1 Unless otherwise agreed upon, test specimens shall be approximately 70 by 150 mm [$2\frac{3}{4}$ by $5\frac{7}{8}$ in.]. Bituminous materials with adequate flow resistance shall be applied as uniform coatings on aluminum panels in accordance with Practice **D1669/D1669M**. Fabricated materials such as bituminous roofing, shingles, and similar products shall be cut to size and their weather surfaces exposed. Bituminous materials that are too flexible to sustain their own weight when exposed in a vertical position are permitted to be mounted on aluminum panels using stainless steel or other non-rusting clips.

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

6.1.2 Other test specimen sizes are permitted to be used to provide sufficient material for postexposure testing when desired.

6.1.3 Follow the procedures described in Practice **G147** for identification, conditioning, and handling of specimens of test and control materials before, during, and after exposure.

6.1.4 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.

7. Procedure

7.1 Proceed in accordance with Section 9 of Practice **G155**.

7.2 Water Purity:

7.2.1 The purity of water used for specimen spray is very important. Without proper treatment to remove cations, anions, organics, and particularly silica, exposed panels will develop spots or stains that may not occur in exterior exposures.

7.2.2 Follow the requirements for water purity described in Practice **G151**.

7.2.3 When specimens are found to have deposits or stains after exposure in the apparatus, the water purity must be checked to determine if it meets the requirements of **7.2.2**. On some occasions, exposed specimens can be contaminated by deposits from bacteria that can grow in the purified water used for specimen spray. When bacterial contamination is detected, the entire system used for specimen water spray must be flushed with chlorine and thoroughly rinsed before resuming exposures.

7.2.4 The temperature of water used for specimen spray shall be $7.2 \pm 3^\circ\text{C}$ [$45 \pm 5^\circ\text{F}$].

7.2.5 When the water purity requirements above are met and there is disagreement between parties on the extent of problems caused by stain or deposit, run referee tests in at least one other laboratory that can meet the water quality requirements described in **7.2**.

7.3 Unless otherwise specified, operate the apparatus continuously with the device programmed to control irradiance at 340 nm at $0.35 \text{ W}/(\text{m}^2\cdot\text{nm})$ and operating according to the conditions described in Cycle A or Cycle B. Unless otherwise specified, place specimens in an exposure area where irradiance is at least 90 % of the maximum irradiance measured within the exposure area. In devices with rotating specimen

racks, fill any empty spaces with blank metal panels in order to properly maintain the conditions within the exposure area.

NOTE 3—Information about the exposure areas that meet the 90 % irradiance uniformity requirement is available from the manufacturers of the exposure devices.

7.3.1 During equilibrium operation, the maximum allowable deviation from the desired irradiance at 340 nm is $\pm 0.02 \text{ W}/(\text{m}^2\cdot\text{nm})$ and the maximum allowable deviation from the desired uninsulated black panel temperature is $\pm 2.5^\circ\text{C}$. During equilibrium conditions, when the meter or sensor indicating irradiance or black panel temperature shows a value that is outside the limits described above, discontinue the test and correct the cause of the problem before continuing.

7.3.1.1 *Cycle A-1*—51-min light-only exposure with device programmed to produce an uninsulated black panel temperature of 60°C at equilibrium conditions. This is followed by a 9-min period with the light on and with water sprayed on the front of the specimens.

7.3.1.2 *Cycle A-2*—The same as Cycle A-1, except that water is sprayed on both the front and back surfaces of the specimens.

7.3.1.3 *Cycle B-1*—60 min with light on and water sprayed on the front of the specimens, 90 min light-only exposure, 120 min with light on and water sprayed on the front of the specimens, 990 min light-only exposure, 180 min of cold exposure. Program the device to produce an uninsulated black panel temperature of 60°C at equilibrium conditions during the light-only periods.

7.3.1.4 *Cycle B-2*—The same as Cycle B-1, except that water is sprayed on both the front and back surfaces of the specimens.

NOTE 4—Typically water is sprayed only on the front surface of the specimens. Some users operate their equipment so that water is sprayed on both the front and back surfaces. Results between exposures conducted with these two types of water spray may differ.

7.3.1.5 For the cold exposure, panels shall be placed in a freezer that is controlled at -18°C [0°F]. During equilibrium operation, the maximum allowable deviation from this temperature is $\pm 5^\circ\text{C}$ [$\pm 9^\circ\text{F}$]. The time to transfer test specimens from the xenon-arc device to the freezer or from the freezer back to the xenon arc device (including any time used for inspection of the test specimens) shall not exceed 15 min. This time shall not be included as part of the 24 h exposure cycle.

7.3.2 Some users use equipment capable of controlling chamber air temperature or relative humidity, or both. When chamber air temperature is controlled, program the device to control chamber air temperature at 44°C . For exposures in which relative humidity is controlled, it is recommended that the device be programmed to control at 50 % RH. When chamber air temperature or relative humidity, or both, are controlled, the setting of these parameters must be included in the test report.

7.3.2.1 When chamber air temperature is controlled, the maximum allowable deviation from the desired temperature is $\pm 2^\circ\text{C}$. When the relative humidity is controlled, the maximum allowable deviation from the desired relative humidity during equilibrium conditions is $\pm 10\%$ RH. During equilibrium conditions, when the meter or sensor indicating chamber air

temperature or relative humidity indicates a value outside the limits described above, discontinue the test and correct the cause of the problem before continuing.

NOTE 5—Historically, tests run according to this practice have been run without controlling humidity or chamber air temperature. Tests run with humidity or chamber air temperature controlled at the recommended value may produce different results.

8. Period of Exposure and Evaluation of Test Results

8.1 The duration of the exposure under this practice shall be one of the following:

8.1.1 A mutually agreed upon number of 24-h cycles of operation in accordance with either Cycle A or Cycle B,

8.1.2 The number of 24-h cycles required to produce a mutually agreed upon minimum amount of change in the test specimen, or

8.1.3 The number of 24-h cycles required to produce mutually agreed upon minimum acceptable changes in either the test specimen or a mutually agreed upon control sample.

8.2 Changes in the exposed specimens are either evaluated visually at the end of each 24-h cycle by comparing them with unexposed specimens, or evaluated in terms of the number of cycles required to produce property changes as determined by Test Method **D1670/D1670M**.

NOTE 6—When changes in properties of the test and control specimens are determined, a statistical analysis on the results is recommended to determine if there is a difference between the test and control materials. Guide **G169** provides information about the use of statistical analysis for results from weathering exposures.

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9. Report

9.1 In addition to the items specified in Practice **G151**, the report shall include the following information:

9.1.1 Cycle used (refer to this practice),

9.1.2 Level of irradiance at 340 nm, uninsulated black panel temperature, and, when controlled, relative humidity and chamber air temperature,

9.1.3 Coating thickness used, and

9.1.4 Method of sample repositioning, if used, or other means of assuring equal radiant exposure on all specimens or compensation for differences in irradiance within the exposure chamber.

10. Precision and Bias

10.1 *Precision*—The repeatability 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. It is essential to determine reproducibility of the exposure/property measurement process when using the results from exposures conducted according to this practice in product specifications.

10.2 *Bias*—Bias cannot be determined because no acceptable standard weathering reference materials are available.

11. Keywords

11.1 accelerated weathering; bituminous materials; degradation; exposure; light exposure; roofing; ultraviolet; waterproofing; xenon-arc