Designation: D4798/D4798M – 11

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

This standard is issued under the fixed designation D4798/D4798M; 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 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 Practice for Preparation of Test Panels for Accelerated and Outdoor Weathering of Bituminous Coatings

D1670 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.

6. Test Specimens

6.1 Unless otherwise agreed upon, test specimens shall be approximately 70 by 150 mm [2¾ by 5⅞ in.]. Bituminous

[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.

Current edition approved Jan. 1, 2011. Published January 2011. Originally approved in 1988. Last previous edition approved in 2010 as D4798/D4798M – 10. DOI: 10.1520/D4798_D4798M-11.

[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.

materials with adequate flow resistance shall be applied as uniform coatings on aluminum panels in accordance with Practice D1669. 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 ± 3°C [45 ± 5°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 W/(m^2·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 ±0.02 W/(m^2·nm) and the maximum allowable deviation from the desired uninsulated black panel temperature is ±2.5°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 ±5°C [±9°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 and/or relative humidity. 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 and/or relative humidity 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 ±2°C. When the relative humidity is controlled, the maximum allowable deviation from the desired relative humidity during equilibrium conditions is ±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.

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.

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