

Test Method for Weather Resistance: UV Light and Moisture Exposure

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1. Purpose and Scope

1.1 This test method provides a procedure for the exposure of textile materials of all kinds, including coated fabrics and products made thereof, in a laboratory artificial weathering exposure apparatus employing fluorescent UV lamps as a light source and using condensing humidity and/or water spray for wetting.

2. Principle

2.1 Specimens are exposed to a fluorescent UV light source and to periodic wetting under controlled conditions. Resistance to degradation is rated in terms of a comparison standard and the exposure criteria, percent loss in strength or percent residual strength (breaking or bursting as appropriate) and/or color change of the material when evaluated under standard textile conditions.

3. Terminology

3.1 **breaking strength**, n.—the maximum force applied to a specimen in a tensile test carried to rupture.

3.2 **bursting strength**, n.—the force or pressure required to rupture a textile by distending it with a force, applied at right angles to the plane of the fabric, under specified conditions.

3.3 **fluorescent UV lamp**, n.—a lamp in which radiation at 254 nm from a low-pressure mercury arc is transformed to longer wavelength UV by a phosphor.

3.4 **irradiance**, n.—radiant power per unit area as a function of wavelength expressed as watts per square meter, W/m².

3.5 **radiant energy**, n.—energy traveling through space in the form of photons or electromagnetic waves of various lengths.

3.6 **spectral energy distribution**, n.—the variation of energy due to the source over the wavelength span of the emitted radiation.

3.7 **standard atmosphere for testing textiles**, n.—air maintained at 21 ± 2°C (70 ± 4°F) and 65 ± 5% relative humidity.

3.8 **standard atmosphere for storing textiles**, n.—laboratory conditions maintained as required in ASTM D1776.

3.9 **ultraviolet radiation**, n.—radiant energy for which the wavelengths of the monochromatic components are smaller than those for visible radiation and more than about 100 nm.

NOTE: The limits of the spectral range of ultraviolet radiation are not well defined and may vary according to the user. Committee E-2.1.2 of the CIE distinguishes in the spectral range between 400 and 100 nm:

UV-A	315-400 nm
UV-B	280-315 nm
UV-R	280-400 nm

3.10 **UV-A Type Fluorescent UV lamp**, n.—a fluorescent UV lamp where radiant emission below 300 nm is less than 2% of its total light output.

3.11 **UV-B Type Fluorescent UV lamp**, n.—a fluorescent UV lamp where radiant emission below 300 nm is more than 10% of its total light output.

3.12 **weather**, n.—climatic conditions at a given geographic location, including such factors as sunlight, rain, humidity and temperature.

3.13 **weather resistance**, n.—ability of a material to resist degradation of its properties when exposed to climatic conditions.

4. Safety Precautions

NOTE: These safety precautions are for information purposes only. The precautions are ancillary to the testing procedures and are not intended to be all inclusive. It is the user's responsibility to use safe and proper techniques in handling materials in this test method. Manufacturers MUST be consulted for specific details such as material safety data sheets and other manufacturer's recommendations. All OSHA standards and rules must also be consulted and followed.

4.1 Good laboratory practices should be followed. Wear safety glasses in all laboratory areas.

4.2 Do not operate the test equipment until the manufacturer's operating instructions have been read and understood. It is the responsibility of whoever operates the test equipment to conform to the manufacturer's directions for safe operation.

4.3 The test equipment emits ultraviolet radiation. Do not look directly at the light source. During normal operation, care must be taken to shield operators from ultraviolet radiation, either by closing the chamber door, using specimen holders that prevent light from escaping, or some other effective method.

4.4 Before servicing the light sources, allow 30 min for cool-down after the lamp operation has been terminated.

4.5 When servicing the test equipment, shut off both the "off" switch on the front panel and the main power disconnect switch. When equipped, ensure that the main power light on the machine front panel goes out.

5. Uses and Limitations

5.1 The use of this procedure is intended to simulate the deterioration caused by the UV energy in sunlight and water. Exposures are not intended to simulate the deterioration caused by localized weather phenomena, such as atmospheric pollution, biological attack and salt water exposure.

5.2 Cautions. Variation in results may be expected when operating conditions are varied within the accepted limits of this procedure. Therefore, no reference shall be made to results from the use of this procedure unless accompanied by a report detailing the specific operating conditions in conformance with the section on Report.

5.3 Results obtained from this procedure can be used to compare the relative durability of materials subjected to the specific test cycle used. Comparison of results from specimens exposed in different types of apparatus should not be made unless correlation has been established among devices for the material to be tested. Variations in results may be expected when operating conditions vary within the limits of this procedure. Because of the variability in results obtained using this practice and the variability in results from exterior exposures, use of a single "acceleration factor" that relates hours of an accelerated exposure to a specific period of outdoor exposure is not recommended. Because of possible variations in results, no reference should be made to results obtained from tests conducted in the apparatus using this procedure unless accompanied by the information required in the section on Report.

5.4 There are a number of factors that may decrease the degree of correlation between accelerated tests using laboratory light sources and actual use exposures.

5.4.1 Differences in the spectral distribution between the laboratory light source and sunlight.

5.4.2 Shorter than normal wavelength exposures are often used to obtain faster failure rates in laboratory accelerated exposure tests. For outdoor exposures, the

cut-on for short wavelength UV radiation is generally considered to be 300 nm. Exposures to UV radiation of wavelengths less than 300 nm, may produce degradation reactions, which do not occur when the material is used outdoors. If a laboratory light source used in an accelerated test contains UV radiation of wavelengths shorter than that found in the actual use condition, the mechanism of degradation and stability ranking of materials can be dramatically different in the accelerated test.

5.5 It may not be necessary to simulate daylight over the entire spectrum, if radiation in a specific region is known to produce the type of degradation of interest in the materials being tested and does not alter stability ranking of materials. Laboratory light sources, which have a very strong emission in a narrow band relative to the rest of the ultraviolet or visible spectrum, however, may cause a particular reaction to be favored relative to others which may be very important. This type of light source also may not produce changes caused in exposures to daylight. Exposures to light sources, which only produce ultraviolet radiation may not produce color fade caused by visible radiation, and may cause polymer yellowing that is more pronounced than that produced in exposures to daylight.

6. Apparatus (See 17.1, 17.2 and 17.4)

6.1 Test chamber (see 17.4).

6.2 UV-A type fluorescent UV lamp (see 17.8).

6.3 Moisture system.

6.3.1 Condensation. The moisture system may be used to generate either condensation or water spray or both (see 17.9).

6.3.2 Water spray. The test chamber may be equipped with a means to introduce intermittent water spray onto the test specimens under specified conditions. The spray shall be uniformly distributed over the samples. The spray system shall be made from corrosion resistant materials that do not contaminate the water employed.

6.4 Black panel thermometer (see 17.10 and 17.11).

6.5 Specimen holders (see 17.12).

6.6 Test chamber location (see 17.13).

7. Test Samples

7.1 Number of Specimens (see 17.3). Replicate specimens of the material to be tested and a comparable number of the standard for comparison should be used as required to ensure accuracy. It is recommended that at least three replicates of each material evaluated be exposed in each test to allow for statistical evaluation of results.

Expose a sufficient number of speci-

mens so that the expected test result is not more than 5% of the average above or below the true average of the lot at the 95% probability level. Determine the number of specimens using standard deviation with one-sided limits as directed in ASTM D2905, Standard Practice for Statements on Number of Specimens for Textiles.

7.2 Specimen Dimensions. Certain materials may exhibit a dimensional change as a result of exposure. The test equipment manufacturer, physical test apparatus and number of replicate specimens required will affect the needed specimen dimension. The test procedures which will be used to assess the change in properties should be reviewed to ensure that specimen size is appropriate for performing the subsequent procedures.

Cut strips of fabric at least 102×152 mm with the longer dimension parallel to the warp of machine direction, unless otherwise specified, for the following tests:

7.2.1 Bursting Strength (Ball Burst).

7.2.2 Breaking Strength (Grab Tensile).

7.2.3 Color Change.

7.2.4 When required to prevent raveling, the specimens may be edged using a flexible epoxy resin or similar material.

7.2.5 Label each specimen for identification using material resistant to the environment encountered during the test.

8. Test Cycle Determination

8.1 The test cycle is best determined by the influencing factors of the end use, in particular, the climatic conditions. Not all materials are affected equally by the same environment. Results obtained by the use of any one test cycle may not be representative of those of any other test cycles or any outdoor weathering test. Any acceleration factor derived for one geographic location does not necessarily apply to any other geographic location. However, certain test cycles are suggested to group similar climates with respect to the test cycle.

8.2 The nature of the test material contributes to the selection of the appropriate test cycle with respect to UV exposure, wetting, wet time and temperature. The following test cycles options have been used for textile materials.

8.2.1 Option 1, General Applications: 8 h UV at an irradiance of 0.77 W/m^2 @ 340 nm at 60°C (140°F) followed by 4 h condensation at 50°C (122°F). This option is used for general applications such as outdoor furniture fabrics, tent material, etc.

8.2.2 Option 2, Thermal Shock Applications: 8 h UV at an irradiance of 0.77 W/m^2 @ 340 nm at 60°C (140°F); followed by 0.25 h water spray; followed by

3.75 h condensation at 50°C (122°F). This option has been used for architectural and other applications where thermal shock may be an issue.

8.2.3 Option 3, Automotive Exterior: 8 h UV at an irradiance of 0.72 W/m^2 @ 340 nm at 70°C (158°F) followed by 4 h condensation at 50°C (122°F). UV irradiance may be monitored and maintained by the manual method or by the feedback-loop method as described in SAE J2020.

8.3 The use of these cycles does not imply, expressly or otherwise, an accelerated weathering test, nor is this method restricted to the use of these cycles. The degree of correlation to any actual outdoor weathering exposure must be determined by quantitative analysis.

8.4 The test conditions in this method are subject to acceptable test apparatus operational fluctuation of $\pm 0.02 \text{ W/m}^2$ @ 340 nm for irradiance and $\pm 2^\circ\text{C}$ for temperature. In addition, a transition time of approximately one hour between test conditions is acceptable.

9. Standards of Comparison

9.1 Standards for comparisons can be made of any suitable textile material where a history of strength degradation or color change rates are known depending upon individual test needs. They must be exposed simultaneously with the test specimen to be investigated. The intent of these standards is to demonstrate uniformity between separate machine and test runs. When test data of the exposed standards differ by more than 10% from the known data, the test machine operating conditions must be thoroughly reviewed and any malfunctions or defective parts corrected. The test is then repeated. If the data still differ by more than 10% from the known data and there is no evidence of machine malfunction, then the test standard should be questioned and re-evaluated. Test data obtained with questionable standards must be treated with caution and resolution provided with quantitative analysis.

10. Procedure

10.1 Maintain and calibrate the apparatus in accordance with the manufacturer's recommendations.

10.2 Before beginning the exposure test, bring all specimens, control and test, to moisture equilibrium in the atmosphere for testing textiles in accordance with ASTM D1776, Standard Practice for Conditioning and Testing Textiles. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weightings made at intervals of not less than 2 h does not exceed 0.2% of the mass of the specimen. Perform any necessary tests or evalua-