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Test Method for Weather Resistance of Textiles: Xenon Lamp Exposure

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 an artificial weathering apparatus using controlled conditions of test. This test method includes procedures for both controlled wetting and no wetting of the specimen.

1.2 Resistance to degradation is measured either as percent strength loss or percent residual strength (breaking, tearing, or bursting) and/or colorfastness of the material when evaluated under standard textile testing conditions.

2. Principle

2.1 Samples of the textile material to be tested and the agreed upon comparison standard are exposed simultaneously to a xenon lamp source under specified conditions. Resistance of the test material to degradation is compared to that of a comparison standard.

3. Referenced Documents

3.1 AATCC EP1, Evaluation Procedure for Gray scale for Color Change.

3.2 AATCC EP7, Evaluation Procedure for Instrumental Assessment of the Change in Color of a Test Specimen.

3.3 AATCC TM16.3, Test Method for Colorfastness to Light: Xenon-Arc.

3.4 ASTM D123, Standard Terminology Relating to Textiles.

3.5 ASTM D1424, Tearing Strength of Fabrics by Falling Pendulum Type (Elmendorf) Apparatus.

3.6 ASTM D1776, Standard Practice for Conditioning and Testing Textiles.

3.7 ASTM D2256, Breaking Load (Strength) and Elongation of Yarn by the Single-Strand Method.

3.8 ASTM D2261, Tearing Strength of Fabrics by the Tongue (Single Rip) Procedure (Constant-Rate-Of-Extension Tensile Testing Machine).

3.9 ASTM D3512, Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Random Tumble Tester Method.

3.10 ASTM D3786, Hydraulic Bursting Strength of Knitted Goods and Non-woven Fabrics-Diaphragm Bursting Strength Tester Method.

3.11 ASTM D3787, Bursting Strength of Knitted Goods-Constant-Rate-of Traverse (CRT) Ball Burst Test.

3.12 ASTM D3884, Abrasion resistance of Textile Fabrics (Rotary Platform, Double-Head Method

3.13 ASTM D5035, Breaking Force and Elongation of Textile Fabrics (Strip Test).

3.14 ASTM D5587, Test Method for Tearing Strength of Fabrics by Trapezoid Procedure.

3.15 ASTM G151, Standard Practice for Exposing Non-Metallic Materials in Accelerated Test Devices that use Laboratory Light Sources.

3.16 ASTM G155, Standard Practice for Operating Xenon-Arc Light Apparatus for Exposure of Non-Metallic Materials.

4. Terminology

4.1 **breaking strength**, n.—the ability or capacity of a specific material to withstand the ultimate tensile load or force required for rupture. (ASTM D123).

4.2 **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. (ASTM D3786, D3787).

4.3 **colorfastness**, n.—the resistance of a material to change in any of its color characteristics, to transfer of its colorant(s) to adjacent materials, or both, as the result of exposure of the material to any environment that might be encountered during processing, storage, use or testing of the material.

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

4.5 **irradiation**, n.—the time integral of irradiance expressed in joules per square meter (J/m²).

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

4.7 **radiant flux density**, n.—rate of flow of the radiant energy past the specimen.

4.8 **radiant power**, n.—energy per unit time emitted, transferred, or received as radiation.

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

4.10 **spectral transmittance**, n.—the percent of incident radiant energy passing through a given material and not absorbed in the process, as a function of wavelength.

4.11 **standard atmosphere for testing**, n.—*in textiles*, an atmosphere for testing in which the air is maintained at a relative humidity of $65 \pm 2\%$ and at a

temperature of $21 \pm 1^\circ\text{C}$ ($70 \pm 2^\circ\text{F}$). (ASTM D123)

4.12 **tearing strength**, n.—*in fabrics*, the capacity of a material to withstand the ultimate tearing force required to propagate a tear after its initiation. (ASTM D1424, D2261, D5587, D5034)

4.13 **total irradiance**, n.—radiant power integrated over all wavelengths at a point in time expressed in watts per square meter (W/m²).

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

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

5. Safety Precautions

5.1 The safety precautions specified in the method/procedure are ancillary to the testing procedures and are not intended to be all inclusive.

5.2 It is the user's responsibility to reference applicable safety data sheets, use safe and proper techniques, and wear appropriate personal protective equipment in handling materials in this standard.

5.3 Users MUST consult manufacturers for specific details such as safety data sheets, equipment operating instructions, and other recommendations. Consult and follow all applicable health and safety regulations (e.g., OSHA standards and rules). 5.4 The test equipment contains high intensity lamps. The door of the test machine must be kept closed whenever it is running.

5.5 Before servicing xenon lamps, allow time for cool down after test machine is shut down.

5.6 When servicing the test machine, shut off both the off switch and, if applicable, unplug the machine from the wall electrical socket. Insure that the main power indicator light on the machine front panel goes out.

6. Uses and Limitations

6.1 Results obtained by this test method should not be considered equivalent to those results obtained by weathering in an outdoor environment unless a mathematical correlation for a given material has been established and agreed upon by the contractual parties. Outdoor environments vary with respect to season, geography and topography and, as a consequence, the effects of outdoor ex-

posure will vary accordingly. Not all materials are affected equally by the same environment. The instruments for determining weather resistance described in this test method are considered satisfactory, since they have been used extensively in the trade for acceptance testing of textile materials. The decision as to which machine type to use should be agreed upon by the purchaser and supplier based on their historical data and experience. There may be distinct differences in spectral distribution, water spray application, air and humidity sensor location, and test chamber size between weathering test machines supplied by different manufacturers that can result in differences in reported test results. Consequently, data obtained from machines supplied by different manufacturers and different size test chambers and xenon lamps cannot be used interchangeably unless a mathematical correlation has been established and agreed upon. No comparison between differently manufactured test apparatus is known to AATCC Committee RA50 using this test method.

6.2 When using this test method, the contracting parties must agree upon a reasonable test program cycle incorporating light, temperature, humidity, and wetting effects. The cycle selected must reflect expected environmental conditions relative to season, geography, and topography associated with the use of the material (see Option 1, 8.2.1).

6.3 When using this test method, use a standard of comparison (such as a weathering reference material or other control specimen), which has a known change in property value after a specific exposure.

6.4 Other procedures for measuring resistance to degradation can be used as agreed upon between the contracting parties.

7. Apparatus (see 16.1)

7.1 Different types of xenon-arc test apparatus may be utilized provided that the test apparatus is constructed of corrosion resistant material and shall provide for means of automatically controlling irradiance level, humidity level, chamber air temperature, and Black Panel or Black Standard Thermometer temperature. Xenon-arc test apparatus may be water or air cooled (see 17.2).

7.2 Xenon-Arc Light Source. The xenon-arc test apparatus utilizes a long-arc quartz-jacketed xenon-arc lamp as the source of irradiance, which emits radiation from below 270 nm in the ultraviolet through the visible spectrum and into the infrared. While all of the xenon-arc lamps are of the same general type, different size lamps operated in different wattage ranges are employed in several sizes and types of apparatus. In each of

the various models, the specimen exposure area varies according to the lamp size and the wattage at which it is operated to provide an irradiance at the face of the specimen of 0.35 W/m^2 measured at 340 nm or equivalent. Operate the xenon-arc test apparatus in accordance to one of the selected test cycle Options 1-4 (see 8.2.1-8.2.4).

7.2.1 Optical Filter—In order for xenon-arcs to simulate terrestrial daylight, optical filters must be used to remove short wavelength UV radiation. In addition, optical filters to remove infrared radiation may be used to prevent unrealistic heating of test specimens that can cause thermal degradation not experienced during outdoor exposures.

Xenon-Arc test apparatus shall be equipped with a Daylight Filter to provide the appropriate spectrum. The Daylight Filter shall comply with the relative spectral power distribution requirements specified in Appendix A.

7.2.2 Follow the xenon-arc test apparatus manufacturer's instructions for recommended maintenance. Unless otherwise specified, control the level of irradiance to $0.35 \pm 0.02 \text{ W/m}^2/\text{nm}$ bandpass at 340 nm, or $40 \pm 2.0 \text{ W/m}^2$ bandpass at 300-400 nm. Operate the xenon-arc test apparatus in accordance to one of the selected test cycle Options 1-4 (see 8.2.1-8.2.4).

8. Test Cycle Determination

8.1 The test cycle is 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 cycle or any outdoor weathering test. Acceleration factors derived for one geographic location do not necessarily apply to any other geographic location. However, certain test cycles have been used 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 apparatus may be equipped to monitor specific portions of a continuous spectrum, control the level of irradiance to $0.35 \pm 0.02 \text{ W/m}^2/\text{nm}$ bandpass at 340 nm, or $40 \pm 2.0 \text{ W/m}^2$ bandpass at 300-400 nm unless otherwise specified. The following test cycle options have been used for textile materials.

8.2.1 Option 1—This cycle has been used to approximate a subtropical climate such as found in South Florida: 120 min cycle, 90 min light only, $70 \pm 5\%$ RH, black panel temperature $77 \pm 3^\circ\text{C}$ ($170 \pm 5^\circ\text{F}$) alternating with 30 min light and water spray. Black panel temperature and

relative humidity control is not necessary during periods of water spray.

8.2.2 Option 2—This cycle has been used to approximate a subtropical climate such as found in South Florida when appropriate machine water supply is restricted: 120 min cycle, 60 min light only, $70 \pm 5\%$ RH, alternating with 60 min dark, black panel temperature $77 \pm 3^\circ\text{C}$ ($170 \pm 5^\circ\text{F}$), no water spray.

8.2.3 Option 3—This cycle has been used to approximate a desert climate such as found in Phoenix, Arizona: Light on cycle, continuous light only, no water spray, black panel temperature $77 \pm 3^\circ\text{C}$ ($170 \pm 5^\circ\text{F}$), $27 \pm 3\%$ RH.

8.2.4 Option 4—This cycle has been used to approximate a temperate climate such as found in Columbus, Ohio: 120 min cycle, 102 min light only, $50 \pm 5\%$ RH, black panel temperature $63 \pm 3^\circ\text{C}$ ($145 \pm 5^\circ\text{F}$) alternating with 18 min of light and water spray. Black panel temperature and relative humidity control is not necessary during periods of water spray.

8.3 The use of these cycles does not imply, expressly or otherwise, an accelerated weathering test. This test method is not restricted to the use of these cycles.

9. Standards for Comparison

9.1 Standards for comparison must be determined and agreed upon by the contractual parties. The standards can be any suitable textile material where a history of the rates of strength degradation or color change is known. Standards must be exposed simultaneously with the test specimen. The use of the standard is to determine time-to-time equipment and test procedure variations. If test results of the exposed standards differ by more than 10% from the known standard data, thoroughly review the test machine operating conditions, and correct any malfunctions or defective parts. Then, repeat the test. If the data still differ by more than 10% from the known data and there is no evidence of machine malfunction, then the standard should be questioned and re-evaluated.

9.2 When colorfastness is the sole evaluation criterion, Blue Wool Standards, as defined in AATCC TM16.3, are acceptable for options using no water spray. However, use caution since the rate of any fade of the Blue Wool Standards by any one test method may not agree with that of other test methods.

9.3 Visual Comparison—For AATCC Blue Wool Lightfastness Standards L4, equals the Step 4 color change of the Gray Scale for Color Change, or equals the L4 Standard of Fade for 20 AATCC Fading Units (AFU) applicable to the Lot designation used as determined by AATCC EP 1. For AATCC Blue Wool Lightfastness Standards L2, equals the Step 2-3 color change of the Gray Scale