Test Method for Weather Resistance of Textiles: Sunshine-Arc Lamp Exposure With and Without Wetting

Developed in 2003 by AATCC Committee RR64; jurisdiction transferred in 2007 to Committee RA50; reaffirmed 2004, 2005, 2013; editorially revised 2007, 2008, 2016, 2019; revised 2009.

1. Purpose and Scope

1.1 This test method provides a means for determining the weather resistance of textile materials.

1.2 The test options described below are applicable to fibers, yarns and fabrics and products made therefrom, including coated fabrics, whether natural, colored, finished or unfinished. Test options included are:

A—Sunshine-Arc Lamp Exposure with Wetting

B—Sunshine-Arc Lamp Exposure without Wetting

1.3 The use of these options does not imply, expressly or otherwise, an accelerated test for a specific application. The degree of correlation between any weather resistance test and the actual exposure in use must be determined mathematically and agreed upon by the contractual parties.

1.4 Test duration and performance evaluation procedures are covered in material specifications agreed upon by the contractual parties.

1.5 This test method contains the following sections that assist in the use and implementation of the various options for determining the weather resistance of textiles.

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2. Principle

2.1 Test specimens and the agreed upon comparison standard(s) are exposed simultaneously to light source under specified conditions of either relative humidity or wetting. The amount of exposure is determined with respect to a specified degree of degradation such as color change, strength loss, etc. The weather resistance of the specimen is evaluated by comparison of a specified degradation of exposed portion of the test specimen to the unexposed original material: using one or more of the procedures recommended in this test method.

3. Terminology

3.1 **AATCC Blue Wool Lightfastness Standard,** n.—one of a group of dyed wool fabrics distributed by AATCC for use in determining the amount of light exposure of specimens during lightfastness testing.

NOTE: Because of the unstable nature of these materials they are also sensitive to the heat and moisture conditions which exist before exposure testing, after exposure testing, and prior to measurement.

3.2 **black panel thermometer,** n.—a temperature measuring device, the sensing unit of which is coated with black designed to absorb most of the radiant energy encountered in lightfastness testing.

NOTE: This device provides an estimation of the maximum temperature a specimen may attain during exposure to natural or artificial light (see 17.1).

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

3.4 **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.

3.5 **color change,** n.—as used in colorfastness testing, a change in color of any kind (whether a change in hue, chroma, or lightness).

3.6 **irradiation,** n.—the time integral of irradiance expressed in joules per square meter (J/m^2).

3.7 **laboratory sample,** n.—a portion of material taken to represent the lot sample, or the original material, and used in the laboratory as a source of test specimens.

3.8 **reference fabric,** n.—one or more blue wool lightfastness standards selected for exposure as a check on a test apparatus and operating conditions.

3.9 **reference plastic,** n.—a clear polystyrene plastic standard selected for exposure as a check on a test apparatus and operating conditions.

NOTE: It has not been verified that these reference materials can be used as a check on a test cabinet or operating conditions for outdoor exposure tests due to seasonal variations in ultraviolet, temperature, relative humidity, and time of wetness during the uncontrolled portion of the test.

3.10 **specimen,** n.—a specific portion of a material or a laboratory sample upon which a test is performed or which is selected for that purpose.

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

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

3.13 **tearing strength,** n.—the average force required to continue a tear previously started in a fabric.

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

3.15 **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 pre-

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cautions 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 on 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 Do not operate the test equipment until the manufacturer's instructions have been read and understood. It is the operator's responsibility to conform to the manufacturer's directions for safe operation.

4.2 The test equipment contains high intensity light source. The door of the test chamber must be kept closed when the equipment is in operation.

4.3 Before servicing light sources, allow 30 min for cool-down after lamp operation is terminated.

4.4 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 indicator light on the machine front panel goes out.

4.5 Daylight exposure of the skin and eyes for prolonged periods may be hazardous and therefore caution should be employed to protect these areas. Do not look directly at the sun under any circumstances.

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

5. Uses and Limitation

5.1 Not all materials are affected equally by the same light source and environment. Results obtained by the use of any one test option may not be representative of those of any other test option or any end-use application has been established between contractual parties.

5.2 Radiation emitted by the open flame carbon arc contains significant levels of very short wavelength UV (less than 260 nm) and must be filtered. None of the filter types used changes the spectral power distribution of the open flame carbon arc to make it match daylight in the long wavelength UV or the visible light regions of the spectrum. Although these filters are specified in many tests because of historical precedent, they transmit significant energy below 300 nm (the typical cut-on wavelength for terrestrial sunlight) and may result in aging processes not occurring outdoors.

5.3 Option A is intended for use in evaluating the resistance to degradation of a textile and related material, including coated fabrics, when subjected to simulated weathering including wetting, and radiant energy factors, and are further intended to check the level of durability represented in a material specification. Option B is intended for use in evaluating the resistance to degradation due to weathering and sunlight exposure under conditions where wetting is not a factor.

5.4 In interpreting the results of these test options, it should be remembered that resistance to degradation under simulated sunlight exposure is dependant upon such factors as:

5.4.1 The inherent properties of the material, its physical state, mass and compactness.

5.4.2 Spectral energy distribution and density of the radiant flux (from artificial source).

5.4.3 The temperature and relative humidity of the air about the textile specimen during exposure.

5.4.4 The effect of leaching or degradation of additive products, including fiber stabilizers, by rain or water sprays.

5.4.5 Atmospheric contaminants.

5.4.6 The action of additive finishes and colorants including spectral absorption characteristics.

5.4.7 Where applicable, the action of residual laundry or dry cleaning chemicals.

5.5 The relative rates of degradation of different textile materials do not necessarily change to the same degree as those factors themselves change. Consequently, the relative durability of textile and related materials under the varying conditions of use cannot be predicted with certainty with any one test. Therefore, it is common practice to investigate the durability of materials by exposure to the variety of conditions under which they can be used to arrive at a full understanding of the performance that can be expected from them.

5.6 Having once established the acceptability of a given material, subsequent lots of it can be rated by direct comparison between the test specimen and the initially accepted material using the agreed upon option(s) provided in this test method. Although these options lead to results that are in general agreement for the majority of textiles, they do not lead to the same result for all textiles. When significantly different levels of resistance to degradation are found between the natural sunlight and weather methods and their artificial (laboratory) counterparts, the results obtained from direct sunlight and the elements of the weather will be regarded as the level of durability of the particular material for the purposes of intended end use.

5.7 When using this test method, the test option selected should incorporate light, humidity, wetting and temperature effects based upon historical data and experience. The test option selected should also reflect expected end-use conditions associated with the material to be tested.

5.8 When using this test method, use a standard of comparison. This comparison material should have a known history in terms of a change in property value after a specific exposure.

5.9 Variations in results may be expected when operating conditions are varied within the accepted limits of this method. Therefore, no reference shall be made to results from the use of this method unless accompanied by a report detailing the specific operating conditions and locations in conformance with Section 14.

5.10 In case of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Statistical analysis is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens that are as homogeneous as possible and that are from a lot of material of the type in question. Test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using the appropriate Student's t-test and an acceptable probability level chosen by the two parties before testing is begun. If a bias is found and corrected or the purchaser and the supplier must agree to interpret future test results with consideration for the known bias.

6. Apparatus and Materials (see 17.2)

6.1 If possible, install the test apparatus in a room where temperature and relative humidity are controlled to minimize the effects of air supply variations.

6.2 Sunshine-arc type exposure apparatus with means of providing water sprayed to the specimen (see Appendix A and 17.3).

6.3 Sunshine-arc type exposure apparatus without providing water sprayed to the specimen (see Appendix A and 17.3).

7. Comparison Standards

7.1 Standards for comparison must be determined and agreed upon by the contractual parties. They 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 exposures or outdoor test locations. When test data of the exposed standards differ by more than 10% from the known data, the test apparatus machine malfunction, then the test standard should be questioned and re-

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evaluated. Test data obtained with questionable standards must be treated with caution and resolution provided with quantitative analysis.

7.2 When colorfastness is the sole evaluation criterion, Blue Wool Standards, as defined in AATCC TM16.2, Test Method for Colorfastness to Light: Carbon-Arc (see 16.2.1 of AATCC TM192), have been found acceptable for exposures without water spray (see 17.4). However, caution should be employed since the rate of fade of the Blue Wool Standards by any one method may not agree with other methods.

8. Calibration and Verification

8.1 Maintain and calibrate the apparatus described in the manufacturers instructions.

9. Test Specimen Preparation and Mounting

9.1 Specimen Preparation.

9.1.1 Prepare specimens for the specified test procedures of at least the size given in Table I. When applicable, cut specimens with the longer direction parallel to the warp or filling direction as required in a material specification or contract order.

9.1.2 Prepare specimens as required to meet the needs of the applicable test method given in Table I (see 17.5, 17.6, 17.7 and 17.8).

9.1.3 These dimensions are given as a general guide and in most cases will be adequate to perform the required evaluation. Certain materials may exhibit a dimensional change with respect to the exposure. The test equipment manufacturer, physical test apparatus and number of specimens required will affect the needed specimen size. In any event, the test procedures given in Table I should be reviewed to ensure sufficient specimens are exposed for individual needs.

9.1.4 Unless otherwise specified, test specimens shall be a maximum thickness of 25 mm (1 in.). For specimens over 25 mm (1 in.) thick, formed or configured specimens, and large components, specific instructions must be agreed upon between the purchaser and the supplier.

9.1.5 When required to prevent raveling, the specimens may be edged using a flexible epoxy resin or similar material, or they may be edged by sewing, pinking or fusing.

9.1.6 Label each specimen. Replicant specimens are preferred to provide a record of the changes encountered at different radiant exposure levels. Retain an unexposed specimen for comparison to the exposed specimen.

9.2 Specimen Mounting.

9.2.1 Mount the specimens on frames which are installed in the test chamber without backing, unless otherwise specified (see 17.9).

9.2.2 Fabrics. Secure the specimens to the frames to hold them smoothly without curling of the edges. Fabrics may be stitched to a gauze backing. For colorfastness determinations, mount the specimens in frames as directed in AATCC TM16.2.

9.2.3 Yarns. Wind yams on frames. Only that portion of the yarns directly facing the radiant energy is tested for breaking strength. Single strand or multiple strand testing may be performed. When multiple strand testing may be performed, the yarns are wound on the frame closely packed to 2.5 cm (1.0 in.) width. The control specimens must contain the same number of strands as the specimen subjected to exposure. After the exposure has been completed and before the yarns are removed from the frame for testing, those yarns facing the light source are bound together using 2.0 cm (0.75 in.) wide masking or other suitable tape to maintain the closely packed arrangements on the exposure frame.

10. Conditioning

10.1 When the exposure cycle is completed, remove the test and control specimens from the exposure rack and transfer them to a standard atmosphere for testing textiles for conditioning.

10.2 If the specimens are wet upon removal from the racks, dry them at ambient laboratory conditions or at a temperature not exceeding 71°C (160°F) before placing them in the conditioning atmosphere. The unexposed reference standard (comparison standard) and the retained unexposed original should be treated under exactly those same conditions of drying and conditioning as the test specimens.

10.3 Bring all specimens, control and test, to moisture equilibrium in the atmosphere for 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. In general practice, the industry approaches equilibrium from the 'as received' side.

10.3.1 It is recognized that, in practice, textile materials are frequently not weighed to determine when moisture equilibrium has been reached. While such a procedure cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing for a reasonable period of time before the specimens are tested. Twenty-four hours has been found acceptable in most cases: however, certain fibers may exhibit slow moisture equalization rates from the "as received" wet side. When this is known, a preconditioning cycle, as described in ASTM D1776, Standard Practice for Conditioning and Testing Textiles, may be agreed upon between contractual parties.

10.4 For each test to be made on the test material and control, exposed and unexposed, prepare test specimens by marking and raveling or cutting the central portion of each exposed specimen to the dimensions specified in the respective test methods given in Table I. The marking and raveling or cutting of the test specimens is preferred after the exposure but may be done before exposure. Control specimens not exposed are similarly prepared. For samples exposed are similarly prepared. For samples exposed with wetting, control specimens are wet-out and allowed to dry without tension before testing. All specimens, control and test, are conditioned simultaneously to the standard atmosphere for testing textiles for a minimum of 24 h and preferably longer, depending upon the material, and tested at the same time.

11. Preparation of Test Apparatus Machine Exposure

11.1 Prior to running a new set of conditions, operate the machine for 24 h to ensure conformance to the specified op-

Table I—Specimen Size and Preparation

Property	Test Method	Specimen Size
Breaking Strength:		
Strip Test	ASTM D5034	5 × 20 cm (2 × 8 in.)
Grab Test	ASTM D5035	13 × 28 cm (5 × 7 in.)
Single Strand	ASTM D2256	15 cm (6 in.)
Bursting Strength:		
Woven Fabric	ASTM D3786	15 × 15 cm (6 × 6 in.)
Nonwoven Fabric	ASTM D3786	15 × 15 cm (6 × 6 in.)
Knit Fabric	ASTM D3787	15 × 15 cm (6 × 6 in.)
Test Strength:		
Elmendorf	ASTM D1424	10 × 13 cm (4 × 5 in.)
Trapezoid	ASTM D1117	10 × 18 cm (4 × 7 in.)
Colorfastness to Light: Carbon-Arc	AATCC TM16.2	3 × 6 cm (1.25 × 2.4 in.)

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