

**ACCELERATED EXPOSURE OF AUTOMOTIVE INTERIOR TRIM COMPONENTS  
USING A CONTROLLED IRRADIANCE AIR-COOLED XENON-ARC APPARATUS**

**Foreword**—This Document has not changed other than to put it into the new SAE Technical Standards Board Format. The Definition Section has been changed to Section 3.

**1. Scope**

- 1.1** This SAE Recommended Practice specifies the operating procedures for a controlled irradiance, air-cooled xenon-arc apparatus used for the accelerated exposure of various automotive interior trim components.
- 1.2** Test durations, as well as any exceptions to the sample preparation and performance evaluation procedures contained in this document, are covered in material specifications of the different automotive manufacturers.

**2. References**

**2.1 Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

**2.1.1 SAE PUBLICATIONS**—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1545—Instrumental Color Difference Measurement for Exterior Finishes, Textiles, and Colored Trim

**2.1.2 AATCC PUBLICATIONS**—Available from AATCC, P.O. Box 12215, Research Triangle Park, NC 27709.

AATCC Evaluation Procedure 1 (1987)—Gray Scale for Color Change (AATCC Technical Manual)

**2.1.3 ASTM PUBLICATIONS**—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM G 26—Standard Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials (ASTM Standards Vol. 14.02)

**2.1.4 CIE PUBLICATIONS**—Available from Commission Internationale de Leclairage, 52 Bd Malesherbes, F-75008 Paris, France

CIE DO.85 (1989)

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### 3. Definitions

- 3.1 **Black Standard Thermometer, n.**—A temperature-measuring device which uses a resistance thermometer with good heat-conducting properties, fitted to the reverse side of a metal plate. The metal plate is fixed to a plastic plate so that it is thermally insulated. It is coated with a black layer.
- 3.2 **Blue Wool Lightfastness Standard, n.**—One of a group of dyed fabrics used to determine the amount of light, or combined light and heat, to which a specimen is exposed during fade/weathering testing.
- 3.3 **Wavelength Range, n.**—The specified wavelength range for bandpass filters; for example, 300 to 400 nm.
- 3.4 **Color Change, n.**—As used in fade/weathering testing, a change in color of any kind (whether a change in hue, saturation, or lightness).
- 3.5 **Irradiance, Controlled, n.**—The maintenance by closed loop feedback of a preselected irradiance throughout a designated exposure interval.
- 3.6 **Irradiance, Spectral, n.**—The radiant energy within a specified wavelength interval that falls upon a unit area of exposed surface ( $W/m^2/nm$ ).
- 3.7 **Irradiance, Total, n.**—Radiant energy integrated over all wavelengths falling upon a unit area of exposure at a point in time expressed in watts per square meter ( $W/m^2$ ).
- 3.8 **Irradiation, n.**—See Radiant Exposure.
- 3.9 **Long-Arc Xenon, n.**—A xenon-arc in which the length of the arc between electrodes is greater than the diameter of the envelope enclosing the arc.
- 3.10 **Radiant Exposure, n.**—The time integral of irradiance expressed in joules per square meter ( $J/m^2$ ).
- 3.11 **Radiant Exposure, Spectral, n.**—The integration of spectral irradiance with respect to time.
- 3.12 **Reference Fabric, n.**—One or more blue wool lightfastness standards selected for exposure as a check on a test apparatus and operating conditions.
- 3.13 **Reference Plastic, n.**—A clear polystyrene standard selected for exposure as a check on a test apparatus and operating conditions. This reference material is normally used for long-term exposures.
- 3.14 **Sample, Laboratory, 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 specimen(s).
- 3.15 **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.
- 3.16 **Spectral Power Distribution, n.**—The variation of energy due to the source over the wavelength span of the emitted radiation.

### 4. Significance and Use

- 4.1 This test method is designed to simulate extreme environmental conditions encountered inside a vehicle due to sunlight, heat, and humidity for the purpose of predicting the performance of automotive interior trim materials.

## 5. Equipment

5.1 A more complete description of the apparatuses listed as follows may be found in ASTM G 26.

5.2 **Air-Cooled Type<sup>1</sup>**—The apparatus employed shall use an air-cooled xenon-arc lamp as the source of radiation and should be as follows:

5.2.1 GENERAL—An apparatus using three lamps based on xenon-arc technology that meets the conditions specified in Section 6 is acceptable as long as the filter/optical systems reproduce the spectral distribution of the lamp output and filter system specified in this document. Also, all temperature and humidity must be identical to the conditions specified in Section 6.

5.2.1.1 *Spectral Power Distribution*—The spectral distribution shown in Table 1 (based on CIE Publication No. 85 (1989) Table No. 4) specifies acceptable ranges within wavebands to describe the lamp output defined in this document.

**TABLE 1—RELATIVE SPECTRAL IRRADIANCE**

Wavelength	Relative Spectral Irradiance &
290 to 400	100
below 290	0 <sup>(1)</sup>
> 290 to 320	5.4 ± 1.8
> 320 to 360	38.2 ± 4.6
> 360 to 400	56.4 ± 9.0

1. Xenon arcs operating according to the method emit a small amount of radiation below 290 nm. In some cases, this may cause degradation reactions which do not occur in natural sunlight exposures.

5.2.1.2 Specimen holders should revolve around the arc, with the sample plane describing a spherical or cylindrical surface. A slight tilting of the upper and lower sample holders can provide uniformity satisfactory to eliminate the need to reposition specimens in the sample rack and allows use of the complete sample holder.

5.2.1.3 Testing temperatures should be calibrated using a Black Standard Thermometer unit that is mounted so that the face of the unit is subjected to the same influences as the test specimens.

5.2.1.4 A blower unit in the base of the apparatus shall provide a flow of air through the test chamber and over the test specimens. Control of the specimen, test chamber, and the black standard temperature should be accomplished by thermostatic control of the chamber temperature and adjustment of the air flow rate to obtain the specified black standard temperature.

5.2.1.5 Relative humidity in the test chamber should be measured and controlled by a hygrometer. Water should be vaporized and diffused to enrich the air with moisture and produce the required humidity.

1. Model XENOTEST® 1200 CPS or equivalent with chamber air heater and variable fan speed controller meets the requirements of this test method. This apparatus is available from Heraeus DSET Laboratories, Inc., 45601 N. 47th Avenue, Phoenix, AZ 85027-7042.

**6. Apparatus Set-Up**

**6.1** To insure repeatability of tests, maintain and calibrate the apparatus to manufacturer's specifications, and as described in Appendices A, B, and C. Appendix A contains additional maintenance instructions and replacement schedules and Appendices B and C describe the use of reference materials to determine if the xenon-arc apparatus is operating within the desired range. Appendix C provides an alternative to the method described in Appendix B using a polystyrene reference plastic suitable for use during long-term exposure and requires less frequent interruption of machine operation. Contractual agreement will determine which method(s) will be used.

6.1.1 The input voltage must be between 200 to 240, 380, or 400 to 440 V based on manufacturer's specifications.

6.1.2 Water for humidification and lamp cooling must be purified so that it is free of silica and has no more than 20 ppm total dissolved solids.

6.1.3 Install 3 sections of Suprax filter system, or equivalent to match 5.2.1.1.

6.1.4 Program the microprocessor for the test conditions in Table 2. Program other functions to be OFF.

**TABLE 2—MICROPROCESSOR PROGRAM**

Parameter	Program Light	Program Dark
Irradiance Level	80 W/m <sup>2</sup>	0 W/m <sup>2</sup>
Irradiance	ON	OFF
Rel. Humidity	50%	95%
Chamber Temperature	62 °C	38 °C
Phase Time	228 min	60 min
Phase No.	1	2
Number of filters	Window Glass0	
Number of filters	Suprax 1/33	
Number of filters	Suprax 1/60	

6.1.5 Operate the equipment to maintain the conditions in Table 3. If the actual operating conditions do not agree with the machine settings after the equipment has stabilized, discontinue the test and identify the cause of the disagreement.

**TABLE 3—EQUIPMENT OPERATING CONDITIONS**

Parameter	Cycle Light	Cycle Dark
Automatic Irradiance	80W/m <sup>2</sup> ± 1 W/m <sup>2</sup> @ 300 to 400 nm	—
Black Standard Temperature	97 °C ± 3 °C	—
Chamber Temperature	62 °C ± 2 °C	38 °C ± 2 °C
Relative Humidity	50 % ± 5%	95 % ± 5%
Radiant Exposure	See applicable specifications	

NOTE— It may be necessary to adjust the blower speed to maintain the temperature difference between the black standard and the chamber temperatures.

**7. Test Procedure**

- 7.1 Prepare the specimens to be exposed to fit the specimen holder being used.
- 7.2 Specimen sizes must conform to the size of the specimen holder(s) supplied by the manufacturer for use with the equipment. Specimens that exceed these sizes may not give proper exposure results. Instructions for mounting parts or portions of a part can be obtained from the responsible engineering group.
- 7.3 Back interior textiles (body cloth, carpet, vinyl coated fabrics, etc.) with white cardboard<sup>2</sup>. Specimens other than interior textiles do not completely fill the exposure area of the specimen holder and are also backed with white cardboard.
- 7.4 Insert specimen in holder and secure. Under no circumstances should the face side of the sample be closer to the arc than the front side of the specimen holder.
- 7.5 Fill all unused slots in specimen holders with stainless steel blanks to maintain desired air flow.
- 7.6 Expose specimens, beginning with the light cycle, for the required radiant exposure (Megajoules per square meter [MJ/m<sup>2</sup>]) measured in the wavelength range of 300 to 400 nm. See applicable material specification.

NOTE—Care should be taken to avoid mixing potentially incompatible specimens in the same machine load, i.e., textiles should not be exposed together with foam backed textile, foams, or plastics.

Once exposure has been initiated, equipment operation should not be interrupted more than once daily. Additional interruptions, e.g., opening the chamber door during the course of daily operation, may cause variation in test results.

**8. Evaluating and Reporting the Degree of Fade**

- 8.1 The degree of fade should be evaluated and reported as specified between the contractual parties. One or more of the following methods may be specified:
- 8.1.1 INSTRUMENTAL MEASUREMENT
- 8.1.1.1 Color difference values in CIELAB units are obtained by instrumentally measuring the specimen before and after a specified amount of radiant exposure. The procedure used for specimen measurement will conform to that specified in Appendix B.
- 8.1.2 VISUAL ASSESSMENT
- 8.1.2.1 Assign colorfastness ratings using the AATCC Gray Scale for Color Change in accordance with AATCC Evaluation Procedure 1 (1987).
- 8.1.2.2 Using the viewing conditions specified in AATCC Evaluation Procedure 1 (1987), quantify the color change using the following terminology:
- NONE—No change in hue, lightness, or saturation.
  - SLIGHT—A change in lightness and/or saturation which can be determined only upon close examination but no change in hue.

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2. Six-ply white card stock, lined on both sides, manufactured by the Beverage Paper Company or equivalent has been found suitable for this purpose. This part is available as stock No. GJ003 from the Dilliard Paper Company, P.O. Box 7550, Norfolk, VA 23509. Weight of card stock should be sufficient to prevent warping.

- c. NOTICEABLE—A change in lightness and/or saturation which can easily be seen and/or change in hue.
- d. SEVERE—An extreme change in lightness, saturation, and/or hue.

**9. Report**

**9.1** A copy of the Exposure Control/Report Form (Figure 1)<sup>3</sup> indicating the color change of the exposed reference material in CIELAB color difference units must accompany each exposed specimen being submitted for approval. If any one of the color difference data points is outside the specified tolerance (control limits), the cause and corrective action must be indicated in the space provided.

**9.2** The Exposure Control/Report Form shall include the following additional information:

9.2.1 Laboratory name

9.2.2 Type and serial number of exposure equipment

9.2.3 Month and Year of equipment operation represented by the control chart

9.2.4 Test method

9.2.5 Reference material(s) used

9.2.6 Frequency of operation verification, e.g., daily, three, or seven day intervals

9.2.7 Color change, target value, and tolerance, in CIELAB color difference units for the reference material(s) used

9.2.8 The monthly average color difference for the reference material(s)

9.2.9 Measured color change, in CIELAB color difference units, for reference material 1

9.2.10 Measured color change, in CIELAB color difference units, for reference material 2 (if more than one material is used)

9.2.11 Daily record of black standard temperature

9.2.12 Daily record of chamber temperature

9.2.13 Sample identification

9.2.14 Total radiant exposure applied to the specimen

9.2.15 Date specimen exposure was initiated

9.2.16 Date specimen exposure was completed

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3. Copies of the Exposure Control/Report Form can be obtained from any automotive company using this procedure.

APPENDIX A

**A.1 Maintenance**

**A.1.1 Test Chamber**—The frequency of cleaning will vary with water quality. However, the chamber must be cleaned at least once a month and flushed with deionized water. Do NOT use cleaning agents containing chlorine.

**A.1.2 Conditioning Chamber**—The frequency of cleaning will vary with water and air quality in the laboratory. However, the water reservoir must be drained once a month and flushed with deionized water to remove any deposits.

**A.1.3 Optical Assembly**—Frequency of cleaning will vary with water quality. However, at least once each week wipe the outer surface of the filter with reagent grade alcohol and a soft cloth. If deposits cannot be removed, the filter should be disassembled and cleaned as necessary.

**A.1.4 Black Standard Sensor**—Polish monthly using a good quality automotive polish.

**A.2 Replacement Schedule**

**A.2.1 Lamp Assembly and Related Parts**—Replace lamps as required by the manufacturer specifications. To adequately control both low wavelength UV and the infrared component of the lamps spectral irradiance, lamps should be rotationally replaced so that individual lamps do not exceed 1500 h. For systems with more than 1 lamp, a rotational replacement schedule is recommended.

**A.3 Calibration Checks**

**A.3.1** Check the calibration of the exposure chamber as instructed by the manufacturer, or when the control materials deviate from the specified ranges. (Record these values on the form shown in Figure A1).

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**EQUIPMENT CALIBRATION REPORT**

Equipment Type: \_\_\_\_\_ Company/Area: \_\_\_\_\_ Model #: \_\_\_\_\_ Serial #: \_\_\_\_\_  
 Filter Combination: \_\_\_\_\_ Test Specification: \_\_\_\_\_

CALIBRATION	Date	BEFORE ADJUSTM.		AFTER ADJUSTM.		BEFORE ADJUSTM.		AFTER ADJUSTM.							
		SET POINT	W/m <sup>2</sup>	UV sensor serial #	as indicated	°C	BST serial #	Ambient	65°C	35%	80%	Total	Lamp 1	Lamp 2	Lamp 3
Irradiance															
PLC Readout indicates power to lamp															
Black Standard Temperature (BST)															
Chamber Temperature															
Humidity (% RH)															
Operating Hours															

FIGURE A1—EQUIPMENT CALIBRATION REPORT

APPENDIX B

**B.1 Scope**

- B.1.1** This appendix describes the procedure for using AATCC blue wool lightfastness standards as reference fabrics for the purpose of determining whether the xenon-arc apparatus is operating properly.
- B.1.2** Color difference values in CIELAB units are obtained by instrumentally measuring the reference fabrics before and after a specified amount of radiant exposure.
- B.1.3** AATCC L-2<sup>4</sup> Blue Wool Lightfastness Standard shall be exposed daily. An AATCC L-4<sup>4</sup> Blue Wool Lightfastness Standard shall be used to monitor continuous three day operating cycle as agreed upon between contractual parties.

**B.2 Procedure**

- B.2.1** Instruments used to determine color difference for this procedure require capability for providing CIELAB color values using illuminant D-65, 10 degree observer data. If an instrument with diffuse geometry is used, the specular component of reflectance shall be included in the measurement. (Refer to SAE J1545, 3.6 for details.)

NOTE—An aperture diameter smaller than 20 mm cannot be used for these measurements.

- B.2.2** Calibrate the instrument to be used for the color measurements to the manufacturer's recommendations.
- B.2.3** Back the reference fabric to be measured with white cardboard<sup>5</sup>. Condition the backed reference fabric in a standard atmosphere (50% RH  $\pm$  5% RH and 21  $^{\circ}$ C  $\pm$  1  $^{\circ}$ C) for a minimum of 2 h. Insert one layer of unexposed material of the same lightfastness standard between the reference fabric and cardboard-backing prior to measurement.

NOTE—The reference fabrics are light-sensitive. Therefore, the piece used as the backing layer during measurement will need to be replaced when noticeable color change has occurred (after approximately 50 uses).

- B.2.4** Place the reference fabric against the sample port of the instrument in such a way that a smooth surface is presented for measurement.
- B.2.5** After taking an initial reading in CIELAB units, rotate the reference fabric 90 degrees and take a second reading. Average the readings and store them as the standard measurement for the identified piece of reference fabric. REMOVE THE BACKING FABRIC AND PLACE IN A LIGHT TIGHT CONTAINER FOR LATER USE.
- B.2.6** Place the cardboard backed reference fabric (single layer) in specimen holder(s) and secure on specimen rack adjacent to the black standard thermometer (if used).
- B.2.7** Always start the exposure apparatus at the beginning of the light cycle. Expose the L-2 reference fabric for 5.47 MJ/m<sup>2</sup>/@ 300 to 400 nm or the L-4 reference fabric for 16.42 MJ/m<sup>2</sup>/300 to 400 nm as agreed upon by contractual parties.

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4. AATCC L-2 and L-4 Blue Wool Lightfastness Standards may be obtained from AATCC, P.O. Box 12215, Research Triangle Park, NC 27709.

5. Six-ply white card stock, lined on both sides, manufactured by the Beverage Paper Company or equivalent has been found suitable for this purpose. This part is available as stock No. GJ003 from the Dilliard Paper Company, P.O. Box 7550, Norfolk, VA 23509. Weight of card stock should be sufficient to prevent warping

**B.2.8** After the specified radiant exposure, remove the reference fabric and the white cardboard backing and allow them to condition at  $21\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$  and  $50\% \pm 5\%$  relative humidity for a minimum of 1 h.

**B.2.9** Repeat the color measurement steps specified in B.2.2 through B.2.5 on the exposed area of the reference fabric(s) and using the previously stored pre-exposure measurement, determine the delta L\*, a\*, b\*, and E\*.

**B.2.10** Compare the delta E\* value determined to that specified in Table B1:

**TABLE B1—COLORIMETRIC SPECIFICATIONS FOR TOTAL COLOR CHANGE OF BLUE WOOL LIGHTFASTNESS STANDARDS**

Lightfastness Standards	delta E
AATCC LJ-2 (Lot 5)	$11.0 \pm 0.60$
AATCC L-4 (Lot 4)	$6.90 \pm 0.50$

NOTE—The stated color difference values may change when new lots of the reference materials are produced. The target values desired should be confirmed by the contractual automotive company.

**B.2.11** If the delta value does not fall within the following tolerances, do not resume the test until the reason has been determined and resolved.

**B.2.12** As each group of test specimens completes its specified radiant exposure, record and report the color change information in terms of delta E\* values of the reference fabric piece(s) used during the test period on the Exposure Control Report Form (Figure B1).

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