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INTERNATIONAL
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# SURFACE VEHICLE STANDARD

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An American National Standard

## ACCELERATED EXPOSURE OF AUTOMOTIVE INTERIOR TRIM MATERIALS USING OUTDOOR UNDER-GLASS CONTROLLED SUN-TRACKING TEMPERATURE AND HUMIDITY APPARATUS



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

### *1. Scope*

**1.1** This SAE Standard specifies operating procedure for the exposure of automotive interior trim materials in an outdoor behind-glass apparatus in which the temperature is controlled in a 24 h cycle. The humidity is controlled during the dark (night) portion of the cycle.

**1.2** Specimen preparation, test durations, and performance evaluation procedures 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 lastest 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

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

ASTM E824—Standard Method for Transfer of Calibration from Reference to Field Pyranometers

### *3. Definitions*

**3.1 Black Panel Thermometer, n.—**A temperature-measuring device, the sensing unit of which is a stainless steel panel coated with black material designed to absorb most of the radiant energy encountered in fade/ weathering testing.



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NOTE—This device provides an estimation of the maximum temperature a specimen may attain during exposure to natural or artificial light.

**3.2 Blue Wool Lightfastness Standard, n.—**One of a group of dyed fabrics which are sensitive to the amount of light, heat, and moisture to which the blue wool material is exposed. Because of their unstable nature, these materials are also sensitive to the heat and moisture conditions which exist before exposure testing, after exposure testing, and prior to sample measurement.

**3.3 Center Wavelength, n.—**The specified wavelength for bandpass filters; the wavelength midway between the half power points, e.g., 340 nm ± 2 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 Half Power Bandpass, n.—**The interval between wavelengths at which transmittance is 50% of peak. (It should not exceed 20 nm for a narrow bandpass filter.)

**3.6 Irradiance Total, n.—**The rate at which energy is incident on a surface, per unit area ($W/m^2$).

**3.7 Irradiance, Ultraviolet, n.—**Irradiance integrated over wavelengths 295 to 385 nm ($W/m^2/nm$).

**3.8 Irradiance, Center Wavelength, n.—**Irradiance integrated at wavelength 340 nm ± 2 nm ($W/m^2/nm$).

**3.9 Irradiation, n.—**See radiant exposure.

**3.10 Radiant Exposure, n.—**The accumulated amount of irradiance received during a specified time period per unit area ($J/m^2$). Since irradiance can be measured using a variety of different optical sensors, it is generally recommended that the type of radiant exposure be specified (e.g., radiant exposure from 295 to 385 nm or radiant exposure at 340 nm ± 2 nm).

**3.11 Reference Fabric, n.—**One or more blue wool lightfastness standards selected for exposure as a check on test apparatus and operating conditions.

**3.12 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 spectral distribution, temperature, relative humidity, and time of wetness during the uncontrolled portion of the test.

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

**3.14 Specimen, n.—**A specific portion of a material, laboratory sample, or production lot, upon which a test is performed or which is selected for that purpose.

## *4. Significance and Use*

**4.1** This 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.

**4.2** Variation in results may be expected when operating conditions are varied within the accepted limits of this method, or tests are conducted in different geographical locations. 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 location in compliance with Section 10, Exposure Report.

## *5. Apparatus*[1]

**5.1** The mounting stand shall be capable of tracking the sun in elevation and rotation with an accuracy of ± 1 degree in order to maintain the front surface of the cabinet normal to the direct beam of the sun (see Figure 1).

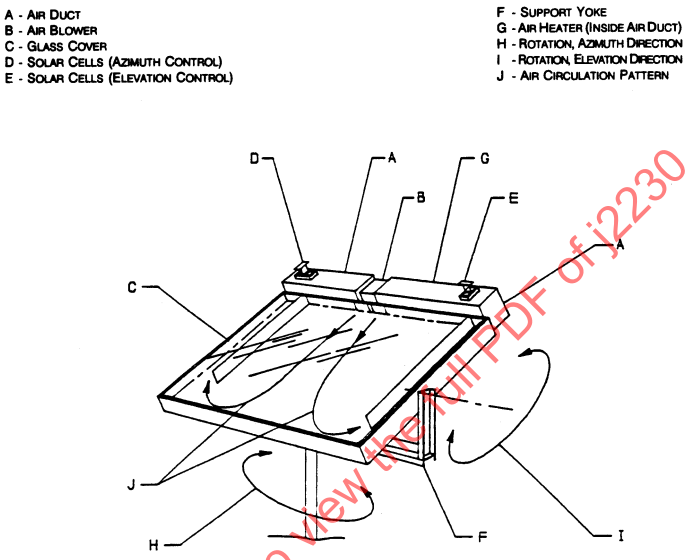


FIGURE 1—EXPOSURE APPARATUS

**5.2** The test cabinet (Figure 1) shall be constructed of corrosion-resistant metal and contain a specimen rack, air circulation fan(s), and a hinged glass cover.

**5.3** The glass cover (Figure 1) shall be a single piece of 3 mm (1/8 in) thick clear tempered safety glass, such as Herculite®[2], or equivalent.

**5.4** The specimen rack shall be designed and positioned so that the test specimens may be mounted with the plane of the test surface parallel to, and not less than 75 mm (3 in) below the glass.

**5.5** The cabinet shall be equipped with a sensor, heater(s), fan(s), and a control system capable of maintaining a specified air temperature to within ±5 °C at any location with the specimen exposure area. An example of such a system is given in Figure 1.

**5.6** The cabinet shall be equipped with a sensor, controller, and solenoids, evaporators, or ultrasonic humidifiers capable of controlling the relative humidity to within ± 10% of the set humidity during the night portion of the cycle. Optionally, the wet-bulb temperature or dew point may be controlled in order to maintain the desired humidity level.

**5.7** An ultraviolet radiometer shall be used to measure irradiance, and connected to an integrator for computing

1. Apparatus from Heraeus DSET Laboratories, Inc., 45601 N. 47th Avenue, Phoenix, AZ 85027-7042, or equivalent.
2. Available from PPG Industries.

ultraviolet radiant exposure. The ultraviolet radiometer shall be mounted behind glass, such as Herculite®, or equivalent, in a ventilated enclosure to avoid overheating the instrument. The enclosure containing the radiometer shall maintain the same orientation as the test cabinet. Two different types of radiometers may be used:

5.7.1 A wide-band ultraviolet radiometer[3], an instrument which measures irradiance at wavelengths 295 to 385 nm.

5.7.2 A narrow-band ultraviolet radiometer [4], an instrument which measures irradiance at 340 nm ± 2 nm.

## *6. Apparatus Set-Up*

**6.1** To enhance the possibility of repeatability of tests, maintain and calibrate the apparatus as described in Appendices A and B. Appendix A contains maintenance and calibration instructions. Appendix B describes the use of reference materials which may assist in determining the performance of the apparatus, and interpreting exposure results when compared to previous tests.

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

## *7. Test Specimens*

**7.1** Unless otherwise specified, test specimens shall be 75 x 150 mm (3 x 6 in), with 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 obtained from the responsible material engineer of the different automotive manufacturers or automotive suppliers.

**7.2** Replicate specimens are desirable to provide a record of the changes when they are exposed for different radiant exposure levels. An unexposed specimen should be saved for visual comparison with the exposed specimen.

## *8. Test Procedure*

**8.1** Mount test specimens to the specimen rack. To minimize variations in results caused by nonuniform exposure conditions, the sample area is restricted in accordance with the procedure in Appendix A.

**8.2** Ensure the timer and temperature and humidity set points are correct for the method specified in Table 1:



**TABLE 1—TEST CONDITIONS**

| Parameters | Day Conditions | Night Conditions |
|---|---|---|
| Temperature | 70 °C ± 5 °C air | 38 °C ± 5 °C air |
| Humidity | Not Controlled | 75% ± 10% R.H. |
| Hours | 8 a.m. to 6 p.m. | 6 p.m. to 8 a.m. |

Operate continuously, except for performing maintenance and calibration as specified in Appendix A, inspecting specimens, removing specimens, or starting new tests.

3. Available as model TUVR from Eppley Laboratories, 12 Sheffield Avenue, Newport, RI 02840, or equivalent.
4. Available as model LM3A from Atlas Electric Devices Company, 4114 North Ravenswood Avenue, Chicago, IL 60613, or model NBUVR-340 from Heraeus DSET Laboratories, Inc., 45601 N. 47th Avenue, Phoenix, AZ 85027-7042, or equivalent.

**8.3** Use one of the following methods for timing the exposure:

8.3.1 Expose specimens for the specified radiant exposure measured in $MJ/m^2$ total ultraviolet, 295 to 385 nm.

8.3.2 Expose specimens for the specified radiant exposure measured in $kJ/m^2/nm$ at 340 nm ± 2 nm.

## *9. Evaluating and Reporting the Degree of Fade*

**9.1** The degree of fade shall be evaluated and reported as specified between the contractual parties. Instrumental values are recommended:

9.1.1 INSTRUMENTAL MEASUREMENT

*9.1.1.1* Color difference values in CIELAB units are obtained by instrumentally measuring the specimen before and after a specified amount of radiant exposure. The instrument used for specimen measurement shall conform to that specified in Appendix B.

9.1.2 VISUAL ASSESSMENT

*9.1.2.1* *Rating Method A*—Assign colorfastness ratings using the AATCC Gray Scale for Color Change in accordance with AATCC Evaluation Procedure 1 (1987).

*9.1.2.2* *Rating Method B*—Using the viewing conditions specified in AATCC Evaluation Procedure 1 (1987), quantify the color change using the following terminology:

a. NONE—No change in hue, lightness, or saturation (chroma).
b. SLIGHT—A change in lightness and/or saturation (chroma) which can be determined only upon close examination but no change in hue.
c. NOTICEABLE—A change in lightness and/or saturation (chroma) which can easily be seen and/or a change in hue.
d. SEVERE—An extreme change in lightness, saturation (chroma), and/or hue.

## *10. Exposure Report*

**10.1** The final report shall contain the following:

10.1.1 Laboratory and location

10.1.2 Type and serial number of exposure apparatus

10.1.3 Test method

10.1.4 Specimen identification

10.1.5 Total radiant exposure ($MJ/m^2$/295 to 385 nm) or ($kJ/m^2$/nm @ 340 nm)

10.1.6 Date specimen exposure was initiated

10.1.7 Date specimen exposure was completed

10.1.8 Special conditions which may have existed during a specific test period, such as control failure, unusual atmospheric conditions, etc.

***11. Precision and Bias—***Neither repeatability (precision of multiple determinations at one site) nor reproducibility (precision of multiple determinations at different sites) have been established. Therefore, it is inappropriate to compare results from different sites or results obtained at different times at the same site. It is strongly recommended that a control material having a known history be exposed simultaneously with test specimens if it is desirable to compare results obtained at different times and/or sites.

PREPARED BY THE SAE TEXTILES AND FLEXIBLE PLASTICS COMMITTEE

## APPENDIX A

### *A.1 Maintenance*

**A.1.1 Specimen Mounting—**Check specimens daily to ensure they are properly mounted.

**A.1.2 Glass Cover—**The glass cover shall be inspected weekly, and both surfaces shall be cleaned whenever there is visual evidence of dirt accumulation, outgassing, or other undesirable deposits.

**A.1.3 Ultraviolet Radiometer—**The glass cover and the diffusing lens shall be cleaned daily with deionized water. The desiccant visible through the sight glass shall be replaced whenever the color changes from dark blue to light pink.

**A.1.4 Temperature/Humidity Control System—**Check temperature/humidity readouts once during the day cycle and once during the night cycle daily to ensure proper operation of thermocouples, humidity sensors, heaters, air circulation fans, etc.

### *A.2 Calibration Checks*

**A.2.1 Temperature—**The temperature sensor used to control chamber temperature shall be checked using a NIST traceable temperature sensor at the chamber set points no less often than every 6 months. The sensor shall be adjusted or replaced whenever the measured temperature fails to agree with the reference by an average of more than ± 1.5 °C.

**A.2.2 Temperature Uniformity—**Within the planned exposure area, temperature uniformity shall be measured no less often than every 6 months using Type T thermocouples (attached to the specimen rack) placed as follows in Figure A1:

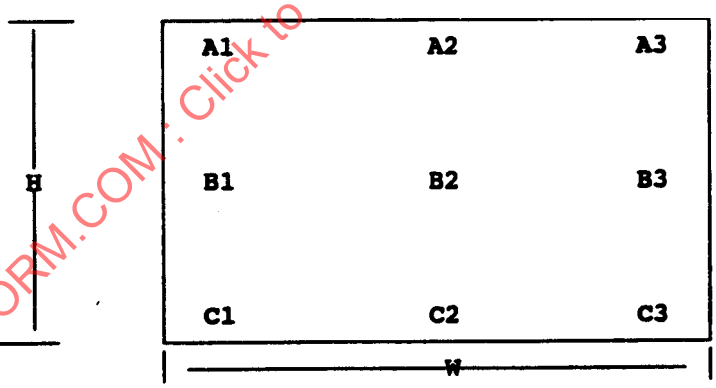


FIGURE A1—THERMOCOUPLE PLACEMENT

Thermocouples shall be monitored no less often than every 15 min for a 24-h period. The exposure area shall be limited to the area over which temperature can be maintained to within ± 5 °C of the setpoint temperature.

**A.2.3 Irradiance—**Perform an absolute calibration no less often than every 6 months either by using a spectroradiometer, by returning the unit to the manufacturer, or by comparing the instrument to a reference instrument in accordance with ASTM E 824.

## APPENDIX B

CAUTION—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 seasonable variations in ultraviolet, temperature, relative humidity, and time of wetness during the uncontrolled portion of the test.

### *B.1 Scope*

**B.1.1** This appendix describes the procedure for using an AATCC Blue Wool Lightfastness Standard (L-4)[5] and a Polystyrene Plastic Lightfastness Standard (PPLS)[6] as reference materials for the purpose of determining whether the exposure cabinet is operating within the desired range.

**B.1.2** Color difference values in CIELAB ΔE units for the L-4 and CIELAB Δb units for the PPLS are obtained by measuring the reference materials before and after a specified radiant exposure.

**B.1.3** The L-4 and PPLS shall be exposed for 20.0 MJ/m$^2$/295 to 385 nm.

### *B.2 Instrumentation*

**B.2.1** Instruments used to determine color difference for this procedure require capability for providing CIELAB color values using illuminant D65, 10 degree standard 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 manufacturers' recommendations.

### *B.3 Blue Wool Lightfastness Standards*

**B.3.1** Back the reference fabric to be measured with white cardboard [7] Condition the backed reference fabric in a standard atmosphere (50% RH ± 5% RH and 21 °C ± 1 °C) for a minimum of 2 h. Insert one layer of unexposed material of the same lightfastness standard between the reference fabric and the 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.3.2** Place the reference fabric against the sample port of the instrument in such a way that a smooth surface of the face of the fabric is presented for measurement.

**B.3.3** After taking an initial reading in CIELAB units, rotate the reference fabric 90 degrees and take a second reading. Average the readings and store 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.

NOTE—The measurement obtained in B.3.3 cannot be used for different pieces of reference fabric. Each individual piece must be conditioned and measured prior to exposure.

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5. AATCC L-4 Blue Wool Lightfastness Standards may be obtained from AATCC, P.O. Box 12215, Research Triangle Park, NC 27709.
6. PPLS's may be obtained from Testfabrics, Inc., 200 Blackford Avenue, Middlesex, NJ 08846.
7. Franklin, Grain long-felt side up, 110/500 white index made by Union Camp or 9016 White Bristol Card Stock are suitable for this purpose. Franklin white index is usually available from local office supply or art stores, and is also available from Dilliard Paper Company. Any equivalent may be used.