SURFACE VEHICLE STANDARD

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Accelerated Exposure of Automotive Interior Trim Components Using a Controlled Irradiance Xenon-Arc Apparatus

RATIONALE

This document is revised to correct a number of editorial errors, including an error in Section 2. Additionally, two technical updates are included. The first update is regarding the optional use of a window glass filter. The other update states 0.55 $W \cdot m^{-2} \cdot nm^{-1}$ as the recommended irradiance value and allows other values in the notes. This is inverse of the current table, which states no recommendation and includes the 0.55 value in the notes.

1. SCOPE

This test method specifies the operating procedures for a controlled-irradiance, xenon-arc apparatus used for the accelerated exposure of various automotive interior trim components.

Test duration, as well as any exceptions to the specimen preparation and performance evaluation procedures contained in this document, are covered in material specifications of the different automotive manufacturers.

Any deviation to this test method, such as the use of optical filter combinations, is to be agreed upon by contractual parties.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1767 Instrumental Color Difference Measurements for Colorfastness of Automotive Interior Trim Materials

SAE J2413 Protocol to Verify Performance of New Xenon ArcTest Apparatus

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/J2412_202311

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D859 Standard Test Method for Silica in Water

ASTM D4517 Standard Test Method for Low-Level Total Silica in High-Purity Water by Flameless Atomic Absorption Spectroscopy

ASTM G113 Standard Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

ASTM G130 Standard Test Method for Calibration of Narrow and Broad-Band Ultraviolet Radiometers Using Spectroradiometer

ASTM G147 Standard Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests

ASTM G151 Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

ASTM G155 Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Materials

ASTM G156 Standard Practice for Selecting and Characterizing Weathering Reference Materials Used to Monitor Consistency of Conditions in an Exposure Test.

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 AATCC Publications

Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709-2215, Tel: 919-549-8141, www.aatcc.org.

AATCC EP1 Gray Scale for Color Change

AATCC L2 Blue Wool Lightfastness Standard

AATCC L4 Blue Wool Lightfastness Standard

2.3 Polystyrene Plastic Weathering Reference Material

Available from Testfabrics, Inc., 415 Delaware Ave., P.O. Box 26, West Pittston, PA 18643, Tel: 570-603-0432, www.testfabrics.com.

3. DEFINITIONS

3.1 BLACK PANEL THERMOMETER, n

A temperature measuring device consisting of a flat metal plate coated with black coating, designed to absorb most of the radiant energy encountered in fade/weathering testing. A thermal-sensitive element shall be firmly attached to the center of the exposed surface.

NOTE: These devices provide an estimation of the maximum temperature a specimen might attain during exposures to natural light.

3.2 Definitions applicable to this standard can be found in ASTM G151.

4. SIGNIFICANCE AND USE

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

5. APPARATUS

5.1 The equipment manufacturer is responsible for the approval of the equipment and for providing the proof of compliance of the critical test parameters, including the different spectral irradiances (also known as spectral power distributions, or SPDs) that are required by contractual parties.

NOTE 1: In normal practice, different instruments (even equipment that is the same model number and from the same manufacturer) may give different results. The result depends on specimen characteristics and instrument design. Refer to ASTM G155 4.3 and 4.4 for more information.

5.2 The apparatus employed utilizes a xenon-arc lamp(s) as the source of radiation. The specimens shall be mounted in a manner to expose the specimens to the uniform conditions of the test chamber. The instrument shall have the means to automatically control irradiance, black panel temperature, chamber temperature and relative humidity.

5.2.1 A more complete description of the apparatus can be found in ASTM G151 and ASTM G155.

5.3 The apparatus shall have an uninsulated black panel thermometer, as described in ASTM G151, unless otherwise agreed upon by contractual parties.

5.4 Manufacturers of exposure devices shall assure that the irradiance at any location in the area used for specimen exposures is at least 70% of the maximum irradiance measured in this area.

5.4.1 If irradiance at any position in the area used for specimen exposure is at 90% of the maximum irradiance, it is not necessary to use periodic repositioning of the specimens during exposure to ensure uniform radiant exposure. While periodic repositioning of the specimens may not be necessary, it is nevertheless good practice in order to be sure that the variability in exposure period is kept to the minimum.

5.4.2 If irradiance at any position in the area used for specimen exposure is between 70% and 90% of the maximum irradiance, specimens shall be periodically repositioned to reduce variability in radiant exposure.

6. APPARATUS SETUP

6.1 To minimize variability, maintain and calibrate the apparatus to manufacturer's specifications.

NOTE: Appendices C and D describe the optional use of weathering reference materials (blue wool and polystyrene) that may help the user evaluate if the xenon-arc apparatus is operating properly in terms of repeatability and reproducibility.

6.1.1 The water for humidification or other purposes shall leave no objectionable deposits or stains on the exposed specimens. The water shall have less than 1 ppm solids and less than 0.2 ppm silica.

NOTE: Silica levels may be determined using ASTM procedures D859 or D4517 or other suitable methods. A combination of deionization and reverse osmosis treatment can effectively produce water with the desired purity.

6.1.2 If applicable, to prevent accidental spraying of the test samples, turn off all water spray assemblies.

6.1.3 Fit the xenon-arc lamp with an extended UV filter to provide the spectral irradiance indicated in Appendix A, Table A1 and Figure A1.

NOTE: Extended UV filters have historically been used for testing interior materials according to SAE J2412. However, the extended UV spectral irradiance will likely not match what these specimens experience in their service environment. A window-type filter may be appropriate. Alternative optical filters may be used with the agreement of all parties.

6.1.4 Operate the equipment to alternating cycles as described in Table 1.

Table 1 - Target values at control panel sensor

Controls	Dark Step		Light Step	
	Target	*Tolerance*	*Target*	*Tolerance*
Automatic Irradiance	None	n/a	0.55 $W \cdot m^{-2} \cdot nm^{-1}$ (see Note 1)	±0.02 $W \cdot m^{-2} \cdot nm^{-1}$
Black Panel Temperature	38 °C	±2.5 °C		±2.5 °C
Dry Bulb Temperature	38 °C	±3 °C		±2 °C
Relative Humidity	95%	±10%		±10%
Radiant Exposure	n/a	n/a	Contractual Agreement	n/a
Step Duration	1 hour (see Note 2)	±6 minutes	3.8 hours (see Note 2)	±6 minutes

Note 1: 0.55 Wm^{-2} nm^{-1} at 340 nm is the historic preferred irradiance for this test. Equipment monitoring a broad band rather than the narrow band will have different target values than those listed in Table 1. Other values, higher or lower, agreed upon by contractual parties can be used, but they invalidate the values listed for the blue wools in Appendix B and polystyrene reference material shown in Appendix C.

Note 2: Other cycle times may be used upon contractual agreement, if, for example, an irradiance different than the specified default value is specified.

Note 3: Operate the apparatus to maintain the indicated range at the control panel. If the actual operating conditions measured and reported by the test instrument's onboard sensors do not agree with the machine settings after the equipment has stabilized, discontinue the test and correct the cause of the disagreement before resuming the test.

7. TEST PROCEDURE

7.1 Prepare the specimens to be exposed to fit the specimen holder being used. Refer to ASTM G147 for conditioning and handling of specimens.

7.2 Subject to 7.3, specimen sizes shall conform to the size of the approved specimen holder(s) unless agreed upon otherwise by contractual parties (e.g., to accommodate mounting of odd-sized specimens). Specimens that exceed these sizes may not give proper exposure results. It is important to follow the manufacturer guidelines to obtain uniform light exposure on the specimens, as the distance from the light source is a major factor on the amount of irradiance received and the surface temperature of the specimen, hence the exposure results obtained from the test.

7.3 Specimens that do not completely fill the exposure area of the specimen holder shall be backed with white cardboard. Interiors textiles (body cloth, carpet, vinyl-coated fabrics, etc.) shall always be backed with white cardboard[1] In all cases the white cardboard shall be the size of the specimen holder to eliminate any gaps.

7.4 Fill all unused slots with an inert non-reflective material (e.g., white cardboard panels[1]) to maintain desired air flow. Cardboard blanks should be changed when noticeable physical distortion occurs.

7.5 Program the weathering device for the specified radiant exposure *($kJ \cdot m^{-2} \cdot nm^{-1}$ @ 340 nm, for example)* and ensure that the test begins with the light cycle. Refer to applicable material specification. This is to accommodate scheduling of optional weathering reference materials.

NOTE: Testers are often programmed in terms of irradiance (power density), while exposure is reported in radiant exposure (energy density). The units can be converted recognizing that 1 W = 1 $J \cdot s^{-1}$.

7.6 For some instruments and/or materials, periodic repositioning of specimens during the exposure period may be needed to ensure that each receives an equal amount of radiant exposure. Reposition specimens as specified in 5.4.1.

NOTE: Care should be taken to avoid mixing potentially incompatible specimens in the same machine load (e.g., textiles should not be exposed together with foam-backed textiles, foams, or plastics). This is due to out gassing cross-contamination and other issues that may affect other specimens.

NOTE: 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

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 color measurement of the specimens shall conform to that specified in Appendix C for non-rigid materials or Appendix D for rigid materials

8.1.2 Visual Assessment

8.1.3 Assign colorfastness ratings using the AATCC Gray Scale for Color Change in accordance with AATCC Evaluation Procedure 1.

8.1.4 Using the viewing conditions specified in AATCC Evaluation Procedure 1, quantify the color change using the following terminology:

a. NONE - No change in hue, lightness, or saturation

b. SLIGHT - A change in lightness and/or saturation which can be determined only upon close examination but no change

[1] Franklin, Grain long-felt side up 110/500 white index, Stock Number 06506 or 9016 White Bristol Card Stock have been found suitable for this purpose. Franklin white index is usually available from local office supply or art supply stores. Weight of card stock should be sufficient to prevent warping.

in hue

c. NOTICEABLE - A change in lightness and/or saturation which can be easily seen and/or a change in hue

d. SEVERE - An extreme change in lightness, saturation and/or hue

9. EXPOSURE REPORT

9.1 The exposure report is as agreed to by contractual parties.

9.2 The following items shall be reported at the completion of the test:

a. Laboratory name

b. Type and serial number of exposure equipment

c. Start and stop dates for the exposure

d. Setup conditions including cycle times, filters used, irradiance, temperature, and humidity

e. A list of the identification numbers for the specimens

f. Total radiant exposure in $kJ \cdot m^{-2} \cdot nm^{-1}$ or $MJ \cdot m^{-2}$ and the wavelength range used

g. A statement that the exposure was performed in accordance with this test method

h. A list of any deviations from this test method

i. A record of any occasions when the equipment did not meet the required operating conditions

j. A note of any interruptions to the exposure greater than 24 hours

10. NOTES

10.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY SAE TEXTILE AND FLEXIBLE PLASTICS COMMITTEE

APPENDIX A - REPRESENTATIVE SPECTRAL IRRADIANCE (SPECTRAL POWER DISTRIBUTION, OR SPD) FOR EXTENDED UV FILTER (MANDATORY)

A.1 SCOPE

A.1.1 This appendix consists of reference tables and a figure.

Table A1 (Part 1) - Irradiance in W/m² based on 81 SPDs for xenon-arc lamps with extended UV filters normalized to exactly 0.55 W.m^{-2} at 340 nm

Bandpass	Average	Standard Deviation	Min	Max
250-260	0.00	0.00	0.00	0.02
261-270	0.00	0.00	0.00	0.03
271-280	0.04	0.02	0.01	0.10
281-290	0.22	0.08	0.09	0.42
291-300	0.73	0.16	0.36	1.16
301-310	1.60	0.20	1.04	2.19
311-320	2.72	0.19	2.13	3.26
321-330	3.91	0.14	3.48	4.29
331-340	5.06	0.04	4.95	5.18
341-350	6.10	0.10	5.91	6.33
351-360	7.06	0.22	6.48	7.67
361-370	7.97	0.33	7.19	8.83
371-380	8.65	0.48	7.55	9.77
381-390	9.17	0.59	7.99	10.57
391-400	10.67	0.70	9.17	13.29
300-400	63.10	1.97	58.30	68.17

Notes:

1. For Extended UV spectrum, lamp is operated at 0.55 W.m^{-2} @ 340 nm. Wide band, 300 - 400 nm, equivalence is approximately 60.0 W.m^{-2}.
2. The spectral irradiance data contained in Table A1 was developed using the "rectangular" integration technique. The data is based on 81 spectra for the 250 - 400 nm bandpass and the same 37 spectra used for the 400 - 800 nm region. The formula used for calculating irradiance using rectangular integration in indicated bandpass when spectra at 2 nm increments are used is:

$$I_{x,y} = 2 \times \sum_{n=x}^{n=y} i_n \quad \text{(Eq. 1)}$$

where:

$I_{x,y}$ = total irradiance in bandpass with lower wavelength x and upper wavelength y

x = lower wavelength limit

y = upper wavelength limit

i_n = irradiance at wavelength n within the indicated bandpass between x and y

Other integration techniques can be used to evaluate spectral irradiance data but may give different results.

When comparing spectral power distribution data to Table A1, the same integration technique, rectangular, should be applied.

Table A1 (Part 2) - SPD table for xenon-arc lamps from 400 - 800 nm at 50 nm bandpasses based on 37 SPDs

Bandpass	Average	Standard Deviation	Min	Max
400-450	57.47	5.13	47.20	67.74
451-500	73.71	6.22	61.28	86.15
501-550	66.26	7.40	51.46	81.06
551-600	67.61	7.43	52.75	82.48
601-650	64.85	7.69	49.46	80.24
651-700	60.52	6.14	48.25	72.80
701-750	57.06	6.17	44.72	69.40
751-800	48.44	7.39	33.66	63.22

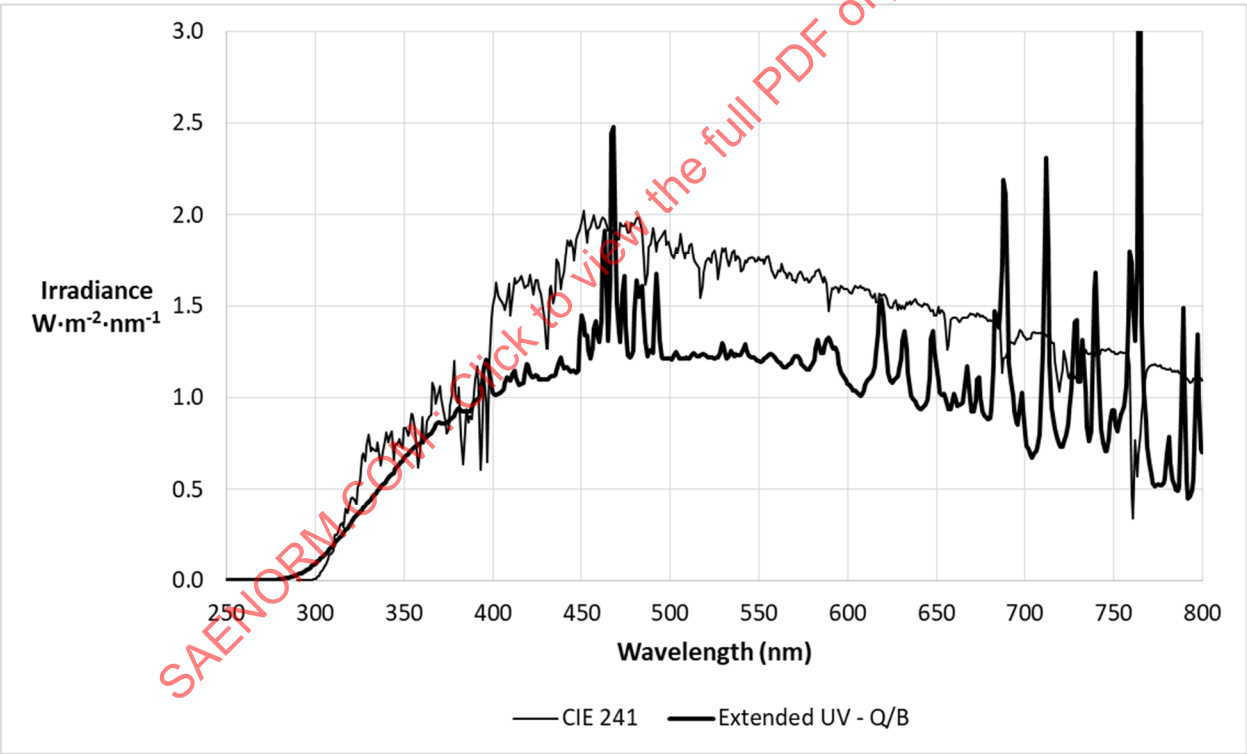

Figure A1 - Extended UV filter vs. sunlight spectral power distribution (SPD)

APPENDIX B - MAINTENANCE AND CALIBRATION (NONMANDATORY)

B.1 MAINTENANCE

B.1.1 For best test results, a weathering device must be cleaned regularly. Adhere strictly to the manufacturer's recommendations for cleaning and maintaining the testing device. In general, the frequency of cleaning necessary will depend on the quality of water used in the device, as well as the quality of air used in the device and is present in the laboratory.

B.1.2 For recommended cleaning practice, please consult the appropriate instruction manual. Special attention must be given to the care of the following:

Test chamber
Conditioning chamber (if applicable)
Xenon filters
Optical components
Black sensor (BPT)
Xenon lamp(s)

B.2 REPLACEMENT SCHEDULE

B.2.1 Lamp Assembly and Related Parts

In general, the xenon lamp and/or its filters should be replaced when the specified irradiance can no longer be achieved or when there is visual evidence of deterioration, such as discoloration of filter assembly or increasing opacity of the lamp. Otherwise, adhere strictly to the manufacturer's recommendations for the replacement of all consumable items, especially the following:

Xenon lamp
Xenon lamp filters
Optical components

B.2.2 Replace the black panel sensor when local surface luster can no longer be maintained or when any bare metal can be seen.

B.2.3 Where applicable, inspect wet bulb wick weekly and replace when discoloration or mineral deposits are observed. In all cases, observe manufacturer's instructions for the maintenance and proper operation of the device's humidification system.

B.3 CALIBRATION CHECKS

B.3.1 Check controls or program daily (except weekend and holidays) to ensure compliance to required test parameters specified in Table 1 and other critical test parameters. Also, on a daily (except weekend and holidays) basis, ensure the parameters specified in Table 1 and other critical test parameters are accurately recorded.

B.3.2 Calibrate the apparatus per the manufacturer's recommendation following the procedures detailed in the operating manual provided by the manufacturer.

B.3.3 To facilitate reporting the performance of optional weathering reference materials, the Xenon-Arc Weathering Reference Material control chart may be used to document change in properties during exposure (Figure 1).

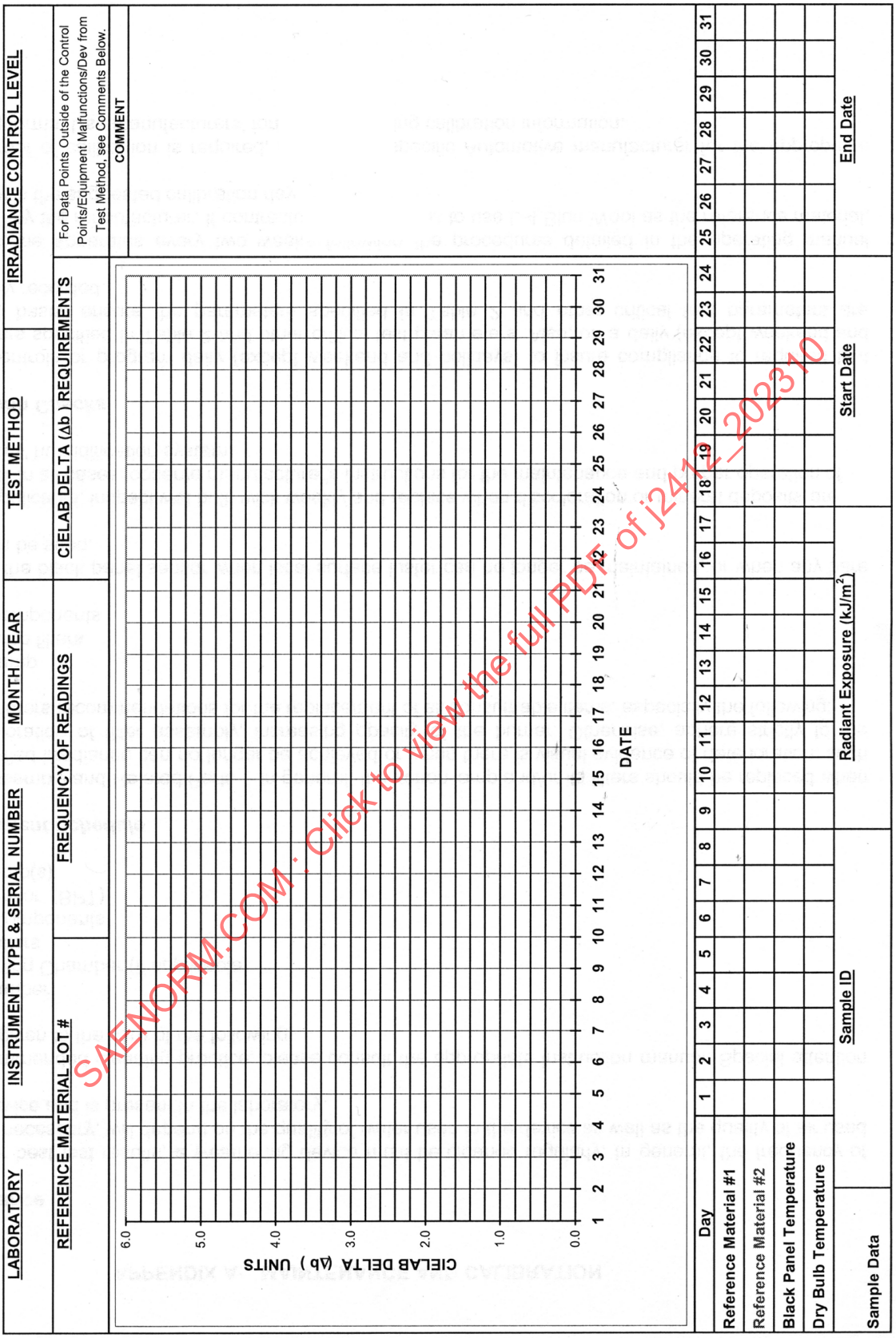

Figure 1 - Xenon-arc reference material control chart

APPENDIX C - PROCEDURE FOR DETERMINING COLORFASTNESS TO LIGHT (AATCC BLUE WOOL LIGHTFASTNESS STANDARDS) (NONMANDATORY)

C.1 SCOPE

C.1.1 This appendix describes a procedure for using AATCC Blue Wool Lightfastness Weathering Reference Materials as reference fabrics for the purpose of determining whether the xenon-arc apparatus is operating properly. This section is optional.

C.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.

C.1.3 AATCC L-2 Blue Wool Lightfastness Weathering Reference Materials shall be exposed daily and/or an AATCC L-4 Blue Wool Lightfastness Weathering Reference Material shall be used to monitor a continuous three-day operating cycle. AATCC L-4 Blue Wool may be used exclusively if agreed upon between contractual parties.

C.2 PROCEDURE

C.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 J1767 for details).

C.2.2 Calibrate the instrument to be used for the color measurements to the manufacturer's recommendations.

C.2.3 Back the reference fabric to be measured with white cardboard. Condition the backed reference fabric in a standard atmosphere (relative humidity 50 RH ±10% and temperature 22 °C ± 3 °C) for a minimum of 2 hours. 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).

C.2.4 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.

C.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 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 C.2.5 cannot be used for different pieces of reference fabric. Each individual piece must be conditioned and measured prior to exposure.

C.2.6 Place the cardboard backed reference fabric (single layer) in a specimen holder and secure on the specimen rack adjacent to the black panel thermometer.

C.2.7 Always start the exposure apparatus at the end of the dark cycle. Expose the L-2 reference fabric and/or the L-4 reference fabric as agreed upon by contractual parties.

C.2.8 After the specified radiant exposure, remove the reference fabric and the white cardboard backing and allow them to condition at (relative humidity 50 RH ±10% and temperature 22 °C ± 3 °C) for a minimum of 1 hour.

C.2.9 Repeat the color measurements steps specified in C.2.2 through C.2.5 on the exposed reference fabric(s) and, using the previously stored pre-exposed measurement, determine the Delta L*, a*, b*, and E* values.

C.2.10 Compare the Delta E* value determined to that specified in the AATCC chart supplied.

C.2.10.1 The supplier (AATCC) is to provide the determined values with each purchase of reference fabric as furnished to them by IFAI Transportation Division.