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Accelerated Exposure of Automotive Exterior Materials Using a Fluorescent UV and Condensation Apparatus

SAE Standard
Issued June 1989

Submitted for Recognition as
an American National Standard

SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®

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MATERIALS STANDARD

SAE J2020

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ACCELERATED EXPOSURE OF AUTOMOTIVE EXTERIOR MATERIALS USING A FLUORESCENT UV AND CONDENSATION APPARATUS

1. SCOPE:

1.1 This test method specifies the operating conditions for a fluorescent ultraviolet (UV) and the condensation apparatus used for the accelerated exposure of various automotive exterior components.

1.2 The sample preparation, test, duration, and performance evaluation procedures are covered in the material specifications of the different automotive manufacturers.

2. SIGNIFICANCE AND USE:

2.1 This test method is designed to simulate extreme environmental conditions encountered on the outside of an automobile due to sunlight, heat, humidity, etc., and to provide an acceleration of exposure for the purpose of predicting the performance of exterior automotive materials.

3. DESCRIPTION OF TERMS:

3.1 Black Panel Thermometer (n): A temperature measuring device used to provide an estimation of the maximum temperature a specimen may attain during exposure to natural or artificial light. In practice, this device usually consists of a black coated or anodized metal panel with a platinum RTD, thermocouple, or other temperature sensor attached to the panel. Black panel thermometers from different manufacturers may not read identically when exposed under identical conditions due to differences in surface coatings, sensor attachment, isolation of the metal panel, etc.

3.2 Irradiance (n): The rate at which energy is incident on a surface, per unit area (W/m^2).

3.3 Irradiance, Spectral (n): The distribution of irradiance as a function of wavelength that is incident upon a unit area of exposed surface ($W/m^2/nm$).

3.4 Spectral Power Distribution (SPD) (n): The relative power emitted by a source as a function of wavelength.

3.5 Fluorescent UV Lamp (n): A lamp in which radiation at 254 nm from a low-pressure mercury arc is transformed to longer wavelength UV by a phosphor. The spectral power distribution of a fluorescent UV lamp is determined by the emission spectrum of the phosphor and the UV transmission of the glass tube.

4. APPARATUS[1]:

4.1 A more complete description of the apparatus may be found in ASTM G 53, Standard Practice for Operating Light and Water Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials.

4.1.1 Test Chamber: It shall be constructed of corrosion resistant materials enclosing eight fluorescent UV lamps, a heated water pan, test specimen racks, and provisions for controlling and indicating operating times and temperatures.

4.2 Lamps: They shall be rapid start, medium bipin fluorescent UV lamps with a length of 1220 mm, and a nominal rating of 40 W when operated from a ballast providing a controlled current of 430 mA at 102 V.

4.2.1 The lamps shall be F40 UVB[2] (previously called FS-40) lamps with a peak emission at 313 nm and a spectral power distribution as shown in Fig. 1.

4.2.2 Other fluorescent UV lamps meeting the size and electrical characteristics in 4.2.1 may be used by prior agreement, provided that the lamp and spectral power distribution are reported in conformance with section 7. The use of lamps other than those specified in 4.2.1 may result in significant differences in test results.

4.3 Lamp Spacing and Arrangement: The lamps shall be mounted in two banks of four lamps each. The lamps in each bank shall be mounted parallel in a flat plane on 70 mm centers.

4.4 Test Specimens: The test specimens shall be mounted in stationary racks with the plane of the test surface parallel to the plane of the lamps at a distance of 50 mm from the nearest surface of the lamps.

4.5 Condensation Mechanism: Water vapor shall be generated by heating a water pan extending under the entire sample area and containing a minimum water depth of 20 mm. The specimen racks and the test specimens themselves shall constitute the side walls of the chamber. The back side of the specimens shall be exposed to the cooling effects of ambient room air. The resulting heat transfer causes water to condense on the test surface.

[1] Available from Q-Panel Company, 26200 First St., Cleveland, OH 44145, Model Number: Q-U-V, or from Atlas Electric Devices Company, 4114 N. Ravenswood Ave., Chicago, IL 60613, Model Number: UVCON, or equivalent.

[2] Available from Q-Panel Company, 26200 First St., Cleveland, OH 44145, Part Number: QFS-40, or from Atlas Electric Devices Company, 4114 N. Ravenswood Ave., Chicago, IL 60613, Part Number FS-40, or equivalent.

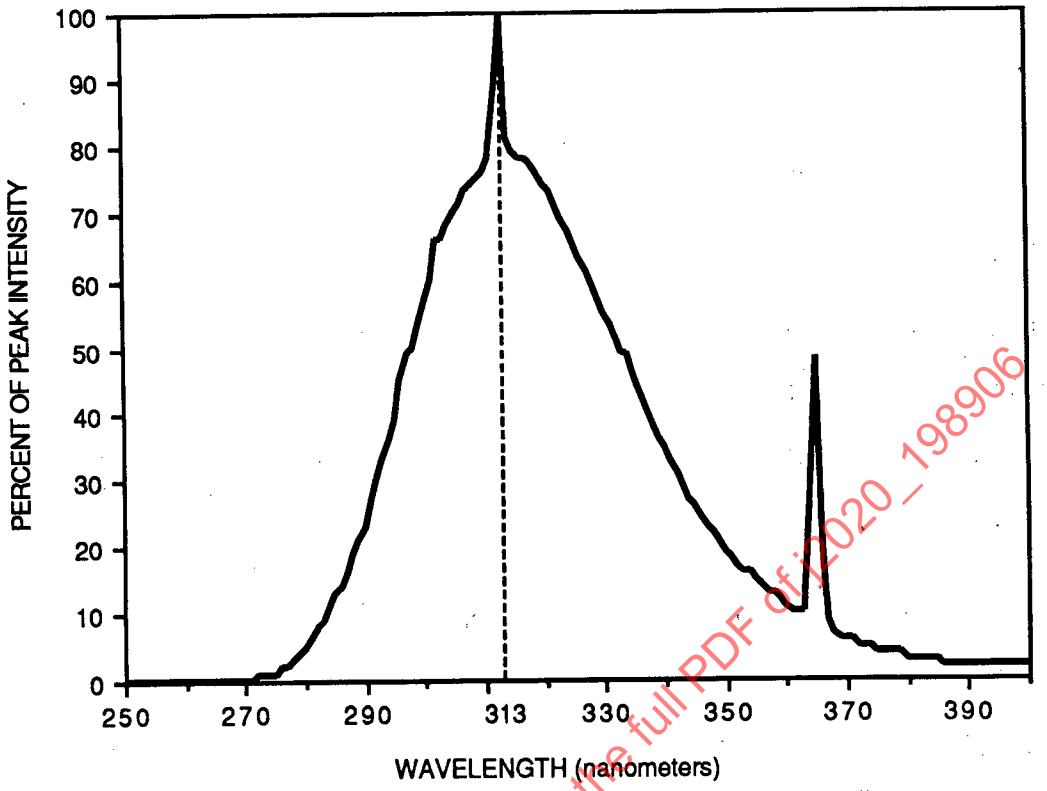

FIGURE 1 - Typical Relative SPD of FS-40 (F40 UVB) Lamp

4.5.1 Water Supply: The water supply with an automatic control to regulate the level in the water pan shall be provided. Distilled, deionized, or potable tap water are equally acceptable for purposes of the test, since the condensation process itself distills water onto the test surface.

4.6 Cycle Timer: A continuously operating cycle timer shall be provided to program the selected cycle of UV periods and condensation periods.

4.7 Temperature Measurement: The specimen temperature shall be measured by a remote sensor attached to a black aluminum panel 75 mm x 100 mm x 2.5 mm thick. The thermometer shall be precise to ±1°C through a range from 30 - 100°C. The temperature indicator shall be located outside the test chamber. The black aluminum panel with the thermometer sensor shall be positioned in the center of the exposure area so that the sensor is subject to the same conditions as the specimens.

4.8 Specimen Temperature Control: During UV exposure, the selected equilibrium temperature shall be maintained within ±3°C by supplying heated air to the test chamber. During condensation exposure, the selected equilibrium temperature shall be maintained within ±3°C by heating the water in the water pan. The UV and condensation temperature controls shall be independent of each other.

4.9 Test Chamber Location:

4.9.1 The apparatus shall be located in an area maintained between 18 to 27°C (65 to 80°F). The ambient temperature shall be measured at a maximum distance of 6 in (150 mm) from the plane of the sample door of the apparatus. The control of ambient temperature is particularly critical for proper operation of the apparatus stacked one above the other, because the heat generated from one unit has the potential to interfere with the operation of adjacent units.

4.9.2 The apparatus shall be located at least 300 mm from the walls or other apparatus. Nearby heat sources, such as ovens or heated test apparatus, shall be avoided or shielded.

4.9.3 The room where the apparatus is located shall be ventilated to remove the heat and moisture produced and to maintain the temperatures specified in 4.8.1.

4.10 To insure repeatability of tests, maintain and calibrate the apparatus to the manufacturer's specifications as described in Appendix A.

5. TEST SPECIMENS:

5.1 The sample size shall be either 3 x 6 in (75 x 150 mm)or 4 x 6 in (100 x 150 mm).

5.1.1 For simultaneous exposures of original and repair coatings on one test sample, 4 x 6 in samples have been found useful. In this situation, each coating should cover one half of the sample and be an area of 2 x 6 in.

5.2 Replicate specimens are desirable to provide a record of degradation at different time intervals. The retention of an unexposed specimen is recommended as it is difficult to mask a specimen to prevent exposure to condensation.

5.3 For specimens of insulating materials, such as plastics or foams, maximum specimen thickness should be 20 mm to allow adequate heat transfer for condensation.

5.4 To provide rigidity, flexible specimens should be attached to a backing panel made of aluminum, 0.025 in thick, 3003 H14 alloy.

5.5 The holes in specimens larger than 2 mm and any openings larger than 1 mm around irregularly shaped specimens shall be sealed to prevent the loss of water vapor. Porous specimens, such as textiles, shall be backed with a vapor barrier such as metal.

6. PROCEDURE:

6.1 Mount the test specimens in the specimen racks with the test surfaces facing the lamp. When the test specimens do not completely fill the racks, the empty spaces must be filled with blank panels to maintain the test conditions within the chamber.

6.2 The test specimens shall be exposed within an area 210 mm in height by 900 mm wide on each side of the apparatus located as shown in Fig. 2 (do not use the extreme right and left hand specimen holders on the apparatus). It is possible to mount the specimens above, below and beside the 210 by 900 mm area, but specimens so mounted will be exposed to lower UV intensities.

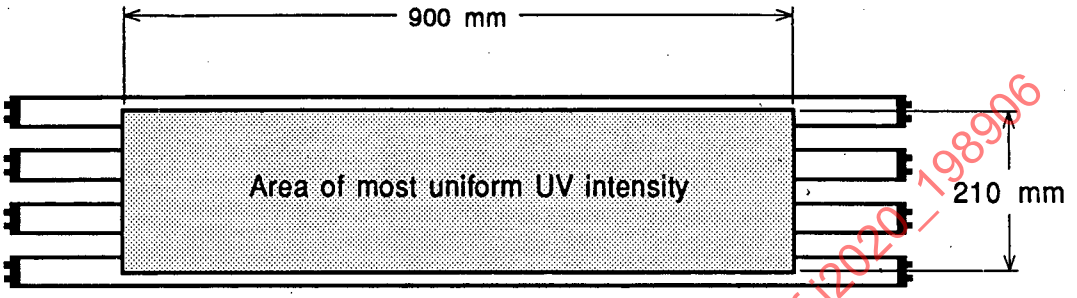

FIGURE 2 - Area of Most Uniform UV Intensity

6.3 Set the condensation cooling timer to 15 min if applicable.

6.4 Initiate all the exposures at the beginning of the condensation cycle.

6.5 Program the cycle timer to achieve the following test conditions: 8 h UV light exposure at 70°C, alternating with 4 h condensation exposure at 50°C.

6.5.1 Operate continuously, repeating the cycle, except for servicing the instrument and inspection of the specimens. Inspect the specimens daily during the condensation cycle.

6.6 In order to minimize any effects from temperature or UV light variation, the samples should be repositioned periodically. The samples must be rotated horizontally once each week by (1) moving the two extreme right hand sample holders to the far left of the exposure area and, (2) sliding the remaining sample holders to the right. (See Fig. 3).

6.7 Expose the samples for the required time. See the material/manufacturer specification for specific requirements.

7. REPORT:

7.1 The report shall include the following:

7.1.1 Laboratory

7.1.2 Material

7.1.3 Test method

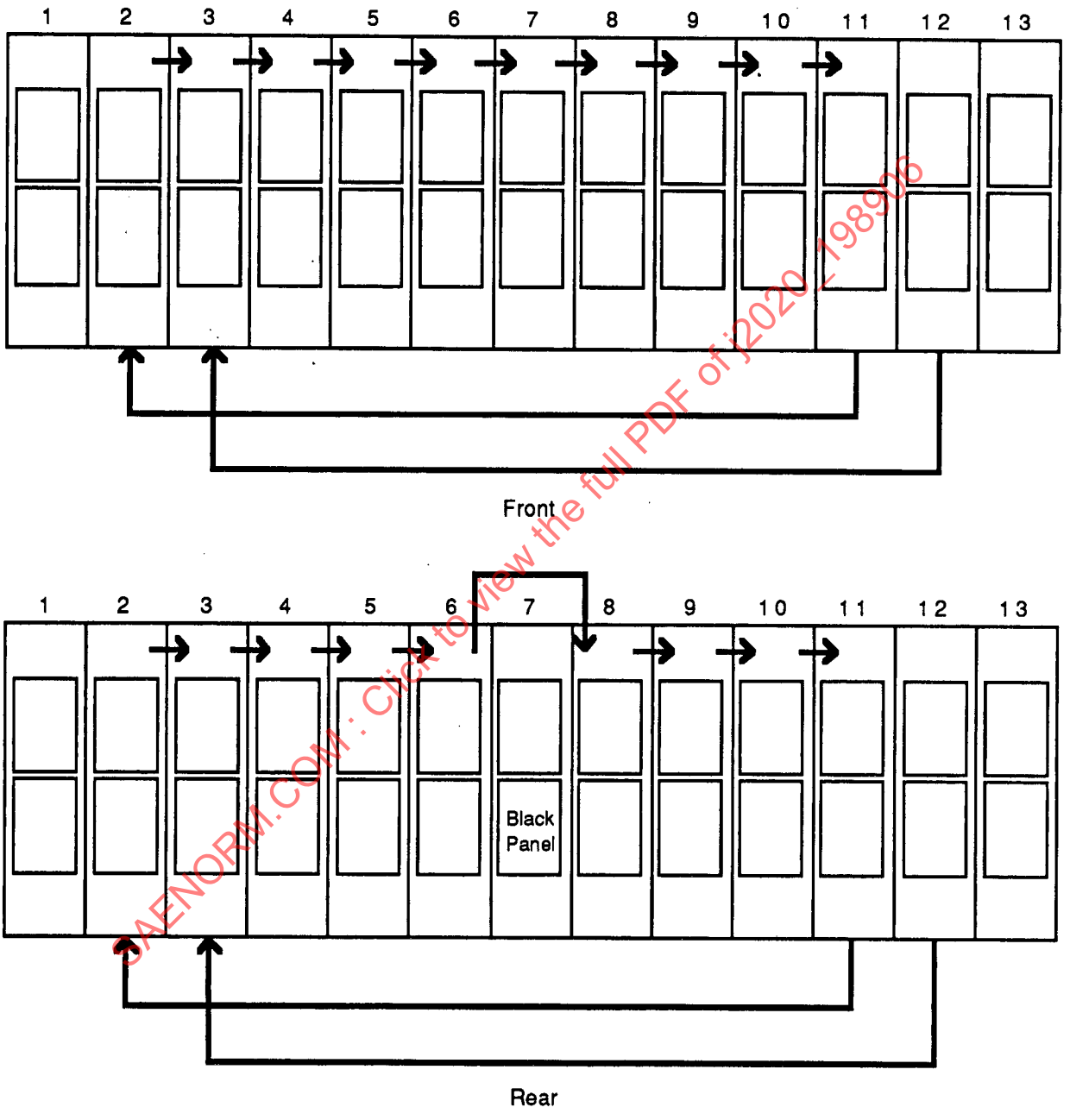

FIGURE 3 - Horizontal Sample Holder Rotation

7.1.4 The manufacturer and the model of the fluorescent UV/condensation apparatus.

7.1.5 The name of the manufacturer of the fluorescent UV lamp. The manufacturer's designation for the lamp, the lot number or date code, the wavelength (nm) at which peak emission occurs, and the short wavelength cutoff at which 1% of peak emission occurs, for example: North American Philips, F40 UVB, C6 lot, 313/280 nm.

7.1.6 Cycle of the UV exposure time and temperature, condensation time and temperature: (for example 8 h UV/70°C, 4 h condensation/50°C.)

7.1.7 Total hours exposure time.

7.1.8 Any special conditions of the test.

Exposure Report Form

Material Test Date: _____

Material Identification: _____

_____

Total Hours Exposure: _____

Test Cycle

_____ hours UV at _____ °C
_____ hours Condensation at _____ °C

UV Light Source

Lamp Type:....._____ Manufacturer: ....._____

Lot Number:....._____ Peak Emission/Cutoff:.._____

Total Time Meter
at Start of Test:..... _____

Total Time Meter
at End of Test:....._____

Frequency of Sample
Rotation:..... _____

Apparatus Model:..... _____

Special Test Conditions: _____

_____

Remarks:..... _____

_____

Name/Signature:..... _____

Date:....._____

APPENDIX A - Required Periodic Maintenance

A.1 Periodic maintenance is required to maintain uniform UV and condensation exposure conditions.

A.1.1 After 400 h of lamp operation time, replace one lamp in each bank and rotate the others as shown in Fig. A1. This procedure provides a useful lamp life of 1600 h.

A.1.2 Drain the water and clean the pan every six months or more frequently if local water conditions warrant it. Heavy scum on the top of the water can inhibit water vaporization.

A.1.3 The thermometer must be calibrated every six months. The thermometer or thermocouple, which indicates test temperature, shall be calibrated by immersing the sensing element and a liquid-in-glass thermometer in water heated to approximately 70°C and comparing the two temperatures as in ASTM E 220, Calibration of Thermocouples by Comparison Techniques.

A.1.4 The deterioration caused by exposure in this apparatus may be observed by exposing reference materials in the apparatus.

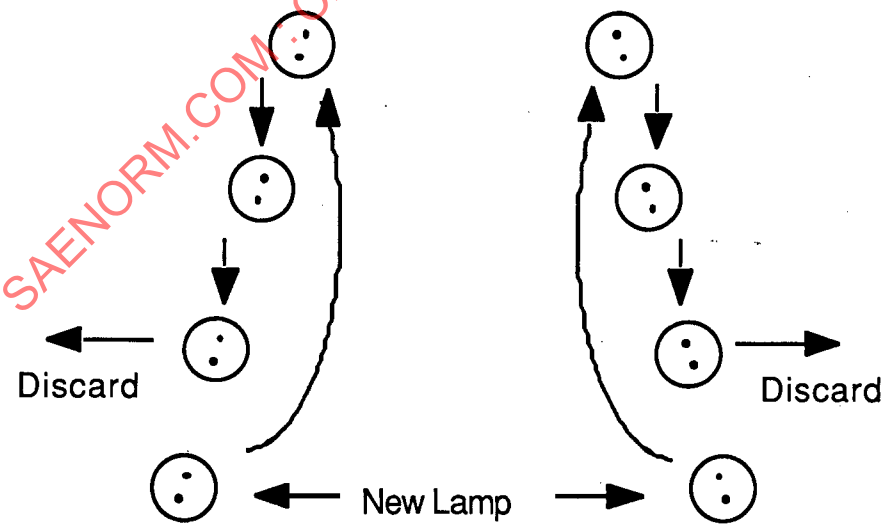

FIGURE A1 - Lamp Rotation/Replacement Procedure

APPENDIX B - Measurement of Irradiance

B.1 SCOPE:

B.1.1 The measurement of irradiance as specified in this appendix is optional.

B.1.2 This procedure specifies the instrumentation and measurement protocol necessary for the measurement of irradiance in a fluorescent UV and condensation apparatus. The values and acceptability range specified in section B5 relate only to FS-40 lamps measured in a fluorescent UV and condensation apparatus and operated at the specified temperature.

B.1.3 The range shown in Fig. B3 is intended to take in to account the inherent variability between different measurement instruments from the same manufacturer (approximately ±5%).

B.1.4 This procedure is intended as an aid to interlaboratory and intralaboratory correlation.

B.1.5 This practice may involve hazardous operations and equipment. This practice does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this practice to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. The operator should use safety glasses during the following procedure.

B.2 RADIOMETER[1]:

B.2.1 Only the radiometer specified below can be used for irradiance measurements that are directly comparable to the acceptability range shown in Fig. B3. Other types of radiometers will give significantly different readings. This is true even if the radiometers are calibrated in the same units and even if they are calibrated against the same standard lamp. Some of the variables that lead to different readings are (1) the spectral response of the sensor, (2) the spectral transmission of the filter, (3) the cosine response of the input optics, (4) the calibration procedure and (5) the standard calibration lamp. In order for alternative radiometers to yield comparative results, the characteristics of each of these four components would have to be identical.

Readout Unit:	Radiometer Model IL1350
UV Detector:	Vacuum Photodiode Detector SED400/CB42
Filter:	Narrow Band Interference Filter NS313, with peak response at 313 nm
Cosine Receptor:	W Quartz Wide-Eye Diffuser

[1] Available from International Light, Dexter Industrial Green, Newburyport, MA 01950. Part Number: IL 1350/SED400/CB42/NS313/W, or equivalent.

B.3 SPECIAL SAMPLE HOLDERS WITH MEASUREMENT PORT:

B.3.1 Measurement of irradiance requires the use of six special panel holders[2] each fitted with two measurement ports. Each measurement port consists of a 1 1/4 in hole. The ports are located to line up with the centers of the top and bottom sample positions as shown in Fig. B1. Each port is equipped with a hinged cover that seals that hole when not in use and that flips out of the way during measurement.

B.4 IRRADIANCE MEASUREMENT PROCEDURE:

B.4.1 Calibrate the thermometer per section A.1.3.

B.4.2 Stabilize the test chamber for a minimum of 2 h on the UV cycle at 70°C.

B.4.3 Place three measurement panel holders on each side of the test chamber at sample holder positions 2, 6, and 12 as shown in Fig. B2.

B.4.4 Stabilize the test chamber for a minimum of another 5 min after the measurement panels are in place.

B.4.5 Take measurements by opening the viewing shutter and placing the sensor against the viewing panel and over the port. Take the irradiance reading. Immediately after each reading, close the shutter to prevent heat loss from the chamber.

B.4.6 The average irradiance (i.e., average of six readings) of each side of a tester shall be compared to the acceptability range shown in Fig. B3. If the readings do not correspond to the acceptability range, terminate the test until the reason for the discrepancy has been determined.

B.5 ACCEPTABILITY RANGE:

B.5.1 For purposes of this method, each side of the test chamber is considered as a single unit. The irradiance of each side of a test chamber shall be characterized by the average of the six readings described under procedure. The acceptability range for cycles utilizing a 70°C black panel temperature is shown in Fig. B3. The irradiance units are 0.1 mW/cm^2.

B.5.2 This acceptability range applies only to FS-40 (F-40 UVB) lamps. The different types of lamps will produce significantly different irradiance values. In addition, lamps other than the FS-40 have less drop in irradiance during the course of the rotation sequence. Furthermore, the ranges shown below only apply to the specific measurement temperature indicated. The light output from fluorescent lamps is extremely temperature sensitive. The lamps operated or measured at different temperatures will have significantly different irradiance values.

[2] Available from Q-Panel Company, 26200 First St., Cleveland, OH 44145, Part Number: V-131-3K, Kalmbach Measurement Panel or equivalent.