

Issued 1989-06
Revised 1995-05

Superseding J2020 JUN89

Submitted for recognition as an American National Standard

**(R) ACCELERATED EXPOSURE OF AUTOMOTIVE EXTERIOR MATERIALS USING A FLUORESCENT UV AND
CONDENSATION APPARATUS**

Foreword—This Document has also changed to comply with the new SAE Technical Standards Board format.

1. Scope

- 1.1** This test method specifies the operating conditions for a fluorescent ultraviolet (UV) and condensation apparatus used for the accelerated exposure of various automotive exterior components.
- 1.2** Sample preparation, test duration, and performance evaluation procedures are addressed by each automotive manufacturer's material specifications.
- 1.3** This SAE Standard may involve hazardous materials, operations, and equipment. This document does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this document to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
- 1.4 Significance and Use**—This test method is designed to simulate extreme environmental conditions encountered on the outside of an automobile due to sunlight, heat, and humidity and to provide an acceleration of exposure for the purpose of predicting the performance of exterior automotive materials.

2. References

- 2.1 Applicable Publications**—The following publications form a part of this specification to the extent specified herein.

- 2.1.1 ASTM PUBLICATIONS—Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 220—Method for Calibration of Thermocouples by Comparison Techniques

ASTM G 53—Standard Practice for Operating Light and Water Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials

ASTM G 113—Standard Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-8512 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER; (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS <http://www.sae.org>

- 3. Definitions**—The terminology found in ASTM G 113 may be appropriate to this procedure.
- 3.1 Black Panel Thermometer, n**—A temperature measuring device consisting of a metal panel, having a black coating which absorbs all wavelengths uniformly, with a thermal sensitive element firmly attached to the center of the exposed surface. The black panel thermometer is used to control an artificial weathering device and to provide an estimate of the maximum temperature of samples exposed to a radiant energy source.
- 3.2 Irradiance, n**—The radiant power per unit area incident on a receiver, typically reported in watts per square meter W/m^2 .
- 3.3 Irradiance, Spectral, n**—The distribution of irradiance as a function of wavelength ($W/m^2/nm$).
- 3.4 Spectral Power Distribution (SPD), n**—The absolute or relative radiant power emitted by a source, or incident upon a receiver as a function of wavelength.
- 3.5 Fluorescent UV Lamp, n**—A lamp in which the irradiance from a low pressure mercury arc is transformed to a higher wavelength UV by a phosphor. The spectral power distribution of a fluorescent lamp is determined by the emission spectrum of the phosphor and the UV transmittance of the glass tube.
- 4. Apparatus¹**
- 4.1** A more complete description of the apparatus may be found in ASTM G 53.
- 4.1.1** Test Chamber, 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 shall be rapid start, medium bi-pin fluorescent UV type with a length of 1200 mm, and a nominal rating of 40 W when operated from a ballast providing a controlled current of 430 mA at 102V.
- 4.2.1** The lamps shall be FS-40² lamps with a peak emission at 313 nm. A representative spectral power distribution of this lamp is shown in Figure 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 the Report section. 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.

1. Available from Q-Panel Company, 26200 First St., Cleveland, OH 44145, Model Numbers: QUV and QUV/SE, 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.

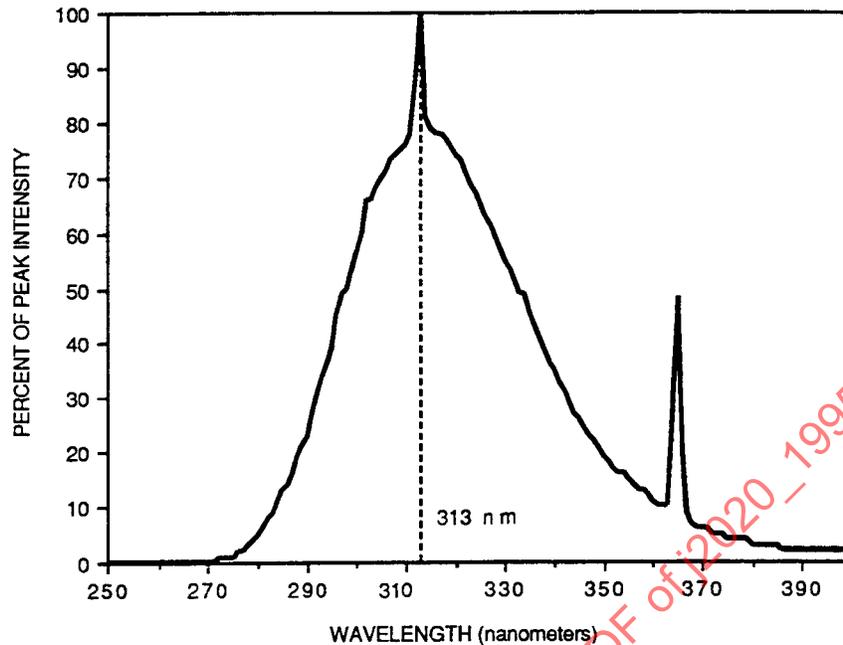


FIGURE 1—TYPICAL RELATIVE SPD OF FS-40 (F40 UVB) LAMP

- 4.3.1 Lamp manufacturing techniques typically result in a slight gradient in light output from one end of a lamp to the other end. To compensate for this, each lamp shall be positioned so that it is reversed 180 degrees from those mounted above it and below it.

NOTE—This can be accomplished by using the manufacturer's stamps which are generally located on the same end of every lamp.

- 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. 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 cooling effects of ambient room air. The resulting heat transfer causes water to condensate on the test surface.

- 4.5.1 **WATER SUPPLY**—Supply water 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.

NOTE—Use of distilled or deionized water is recommended. Using tap water may necessitate more frequent cleaning of the water pan.

- 4.6 **Cycle Time**—A continuously operating cycle timer shall be provided to program the selected cycle of UV periods and condensation periods.

4.7 Temperature Measurement—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 accurate to ± 1 °C through a range from 30 to 100 °C. The temperature indicator shall be located outside the test chamber. The black aluminum panel with the thermometer sensor shall be positioned 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 °C and 27 °C (65 °F and 80 °F). Ambient temperature shall be measured at a maximum distance of 150 mm (6 in) from the plane of the sample door of the apparatus and 150 mm (6 in) from the chamber air intake. Control of ambient temperature is particularly critical for proper operation of apparatus stacked one above the other, because the heat generated from one unit could interfere with the operation of adjacent units.

4.9.2 The apparatus shall be located at least 300 mm from 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 4.9.1.

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 Sample size shall be either 50 mm x 75 mm (2 in x 3 in), 75 mm x 100 mm (3 in x 4 in), 75 mm x 150 mm (3 in x 6 in), 100 mm x 150 mm (4 in x 6 in), or as agreed upon by concerned parties.

NOTE—Because of the geometry of some sample holders, the previous sizes may cause some problems if, after inspection, they are replaced in a different orientation than the original. For example, improper replacement of a 75 mm x 150 mm (3 in x 6 in) panel into a commonly used holder can cause the end 1/3's to be shielded (i.e., exposed less than the center 1/3).

5.1.1 For simultaneous exposures of original and repair coatings on one test sample, 100 mm x 150 mm (4 in x 6 in) samples have been found useful. In this situation, each coating should cover one half of the sample and be 50 mm x 150 mm (2 in x 6 in) area.

5.2 Replicate specimens are desirable to provide a record of degradation at different time intervals. Retention of unexposed specimens in a controlled environment 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 30 mm to allow adequate heat transfer for condensation. Report any thicknesses greater than this in the test report.

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 Holes in specimens larger than 2 mm and any openings larger than 1 mm around irregularly shaped specimens shall be sealed to prevent 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 Figure 2 (do not use the extreme right- and left-hand specimen holders on the apparatus). It is possible, but not recommended, to mount specimens above, below, and beside the 210 by 900 mm area, because specimens so mounted will be exposed to lower UV intensities. Report any and all mounting variations in the test report Figure 3.

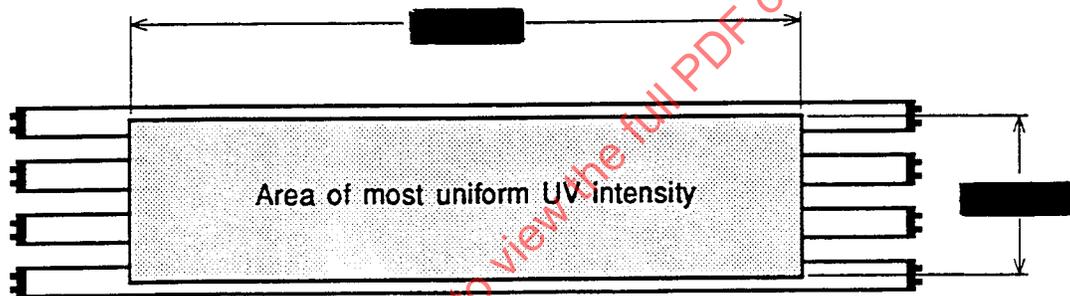


FIGURE 2—AREA OF MOST UNIFORM UV INTENSITY

6.3 Set Condensation Cooling Timer to 15 min, if applicable. Report any variations in the test report.

6.4 Initiate all 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 specimens. Inspect specimens daily during the condensation cycle for evidence of condensation.

6.6 In order to minimize any effects from temperature or UV light variation, samples shall be repositioned periodically. As a minimum, samples must be rotated horizontally once each week by (a) moving the two extreme right-hand sample holders to the far left of the exposure area and (b) sliding the remaining sample holders to the right Figure 4.

6.7 UV irradiance shall be measured and recorded every 425 h ± 25 h of light operation as specified in Appendix B.

6.7.1 The average of the readings taken throughout the test must be 0.43% ± 7.5% W/m²/nm at 310 nm (0.40 to 0.46 W/m²/nm at 310 nm).

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

Material Test Date: _____

Material Identification: _____

Total Hours Exposure: _____

Test Cycle

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

UV Light Source

Lamp Type: _____ Supplier: _____

Lot Number: _____ Peak Emission: _____

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: _____

Attach measurements of irradiance. Include all individual measurements and the average irradiance throughout the exposure test.

FIGURE 3—EXPOSURE REPORT FORM

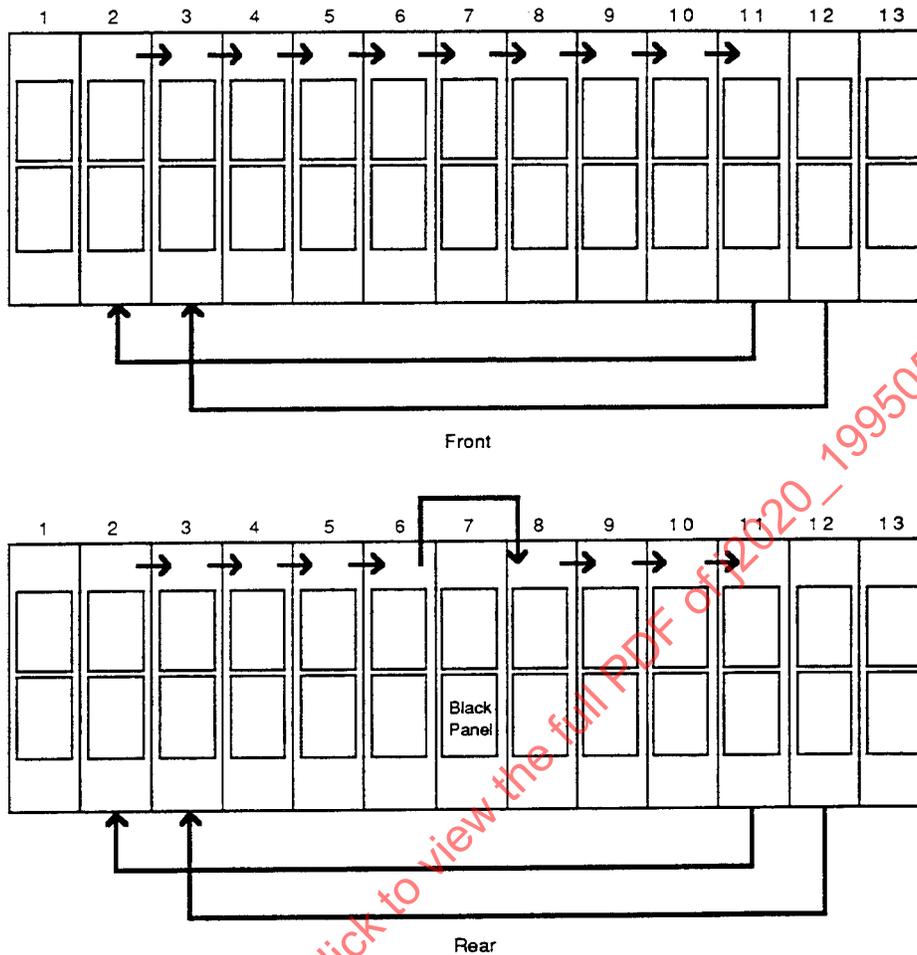


FIGURE 4—HORIZONTAL SAMPLE HOLDER ROTATION

6.7.2 If any irradiance measurement deviates more than $\pm 15\%$ from $0.43 \text{ W/m}^2/\text{nm}$ at 310 nm (0.37 to $0.49 \text{ W/m}^2/\text{nm}$ at 310 nm), terminate the test until the cause of the deviation has been determined and corrected.

NOTE—This acceptability range applies only to FS-40 (F-40 UVB) lamps measured in accordance with the procedure in Appendix B. Different types of lamps will produce significantly different irradiance values. Furthermore, the specified range only applies to the specific measurement temperature indicated. Light output from fluorescent lamps is extremely temperature sensitive. Lamps operated or measured at different temperatures will have significantly different irradiance values.

6.7.3 Irradiance may be measured continuously, as in a feedback-loop irradiance control system, or it may be measured intermittently. All irradiance measurements shall be recorded in Section 7.

6.8 Expose samples for the required time. See 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
- 7.1.4 The supplier and model of fluorescent UV/Condensation apparatus
- 7.1.5 The name of the supplier 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. For example: (Lamp Supplier Name), F40 UVB, C6 lot, 313 nm.
- 7.1.6 Cycle of 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 Results of UV irradiance measured every 425 light hours during the exposure test
- 7.1.9 Any special conditions of test

8. Notes

- 8.1 **Marginal Indicia**—The change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE TEXTILES AND FLEXIBLE PLASTICS COMMITTEE

SAENORM.COM : Click to view the full PDF of j2020_199505

APPENDIX A

REQUIRED PERIODIC MAINTENANCE

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

A.2 Maintenance of Irradiance

A.2.1 Maintenance of proper UV irradiance can be achieved by any of the three methods specified as follows. Regardless of the method used for regular monitoring and control, the system should be measured every 6 months using the procedure specified in Appendix B.

A.2.2 Method A, Automatic Feedback-Loop Method—The system consists of a programmable controller that continuously monitors the UV intensity. A feedback loop system maintains the programmed irradiance level by adjusting power to the UV lamps.

A.2.2.1 Every $425 \text{ h} \pm 25 \text{ h}$ of lamp operation, measure light output and calibrate the system as recommended by the manufacturer.

A.2.2.2 Replace a pair of lamps only when they can no longer maintain the set point.

A.2.2.3 Using the procedure in B.2.3.1, calibrate the calibration radiometer once every 6 months.

A.2.3 Method B, Lamp Rotation/Replacement Method—The output of any light source declines with use. Using this method, the operator compensates for this by regularly replacing and rotating the lamps. Each tester uses eight lamps, four on each side. After $425 \text{ h} \pm 25 \text{ h}$ of lamp operation time, replace one lamp in each bank and rotate the others as shown in Figure A1. This insures that, at any point in time, the irradiance is an average of lamps at four different points on the age/output curve. Lamp life is 1600 h.

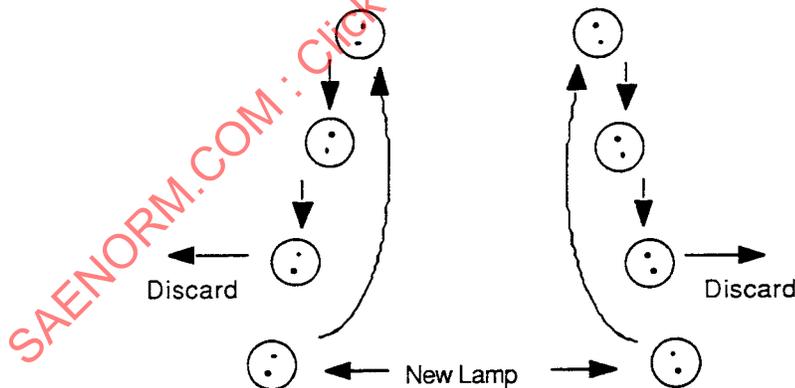


FIGURE A1—LAMP ROTATION/REPLACEMENT PROCEDURE

A.2.4 Method C, Irradiance Measurement Method—Operators may develop longer rotation periods than those required in Method B as long as the specifications and limitations in 6.6.1 and 6.6.2 are met.

A.3 Drain the water and clean the pan every 6 months or more frequently if local water conditions warrant it. Heavy scum or residue on the top of the water can inhibit water vaporization.

- A.4 Thermometer Calibration**—The thermometer must be calibrated every 6 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 Calibration of Thermocouples by Comparison Techniques (ASTM E 220).
- A.5** The rate of deterioration caused by exposure in this apparatus may be monitored by exposing reference materials in the apparatus.

SAENORM.COM : Click to view the full PDF of j2020 _ 199505

APPENDIX B

MEASUREMENT OF IRRADIANCE

B.1 Scope

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

B.1.2 This appendix specifies the instrumentation, the instrumentation calibration protocol, and the irradiance measurement protocols necessary for the measurement of irradiance in a Fluorescent UV and Condensation Apparatus.

B.1.3 The measurement of irradiance is intended as an aid to repeatability and reproducibility correlation.

B.1.4 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 must use UV resistant safety glasses during the following procedure.

B.2 Equipment Needed

B.2.1 The instrumentation required to measure irradiance is a radiometer and, for the manual method, special sample holders with measurement ports.

B.2.2 Special Sample Holders With Measurement Port—Manual measurement of irradiance requires the use of six special panel holders ¹ each fitted with two measurement ports. The ports are located to line up with the centers of the top and bottom sample positions as shown in Figure B1. Each port is equipped with a hinged cover that seals the hole when not in use, and that flips out of the way during measurement.

B.2.3 The Radiometer—The radiometer ² used to measure irradiance must have a detector which can be placed in the sample plane of the apparatus. The detector must have some spectral response at 310 nm but no response between 400 and 600 nm.

B.2.3.1 RADIOMETER CALIBRATION—In order to obtain good inter-instrument agreement, the radiometer must be calibrated via a special procedure using a Fluorescent UV and Condensation Apparatus, a set of FS-40 lamps and a spectroradiometer. The spectroradiometer used for this calibration procedure must itself have a calibration traceable to the National Institute of Science and Technology (NIST) in $W/m^2/nm$, have a double grating monochromator, a cosine receptor, and a half bandwidth of 2 nm or less.

1. Available from Q-Panel Company, 26200 First St., Cleveland, OH 44145; Part Number V-131-3K for use with IL1350 Radiometer, or Part Number V-131-3KRX for use with CR10 Radiometer.
2. Radiometer model CR10 available from Q-Panel Company, 26200 First St., Cleveland, OH 44145, and radiometer model IL1350 available from International Light, Dexter Industrial Green, Newburyport, MA, have been found to be satisfactory.