SAE International™ SURFACE VEHICLE STANDARD

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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 condensation apparatus used for the accelerated exposure of various automotive exterior components.

1.2 Specimen 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 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 to provide an acceleration of exposure for the purpose of predicting the performance of exterior automotive materials.

1.5 Unless otherwise specified, all dimensions reported in this method are nominal.

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, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 207—Standard Test Method for Thermal EMF Test of Single Thermoelement Materials By Comparison with a Reference Thermoelement of Similar EMF-Temperature Properties
ASTM E 220—Method for Calibration of Thermocouples by Comparison Techniques
ASTM G 113—Standard Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials
ASTM G 154—Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

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SAE WEB ADDRESS: http://www.sae.org

2.1.2 CIE PUBLICATION—Available from Commission Internationale de L'eclairage, 52 Bd Malesherbes, F-75008 Paris, France.

CIE Publication No. 85—Solar spectral irradiance (1989)

2.1.3 ISO PUBLICATION—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ISO 9370—Plastics—Instrumental determination of radiant exposure in weathering tests—General guidance and basic test method

2.2 Related Publication—The following publication is provided for information purposes only and is not a required part of this specification.

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

ASTM G 151—Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

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 wavelength 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 specimens 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. Apparatus

4.1 A more complete description of the apparatus may be found in ASTM G 154.

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 102 V.

4.2.1 The lamps shall be one of the following types:

a. UVB lamps with a peak emission of 313 nm as described in Table 3 of ASTM G 154. A representative spectral power distribution of this lamp is shown in Figure 1.

NOTE— In devices that do not automatically control irradiance, “FS-40” or “F40UVB” type lamps have historically been used. In devices that automatically control irradiance, UVB-313 lamps may be used.

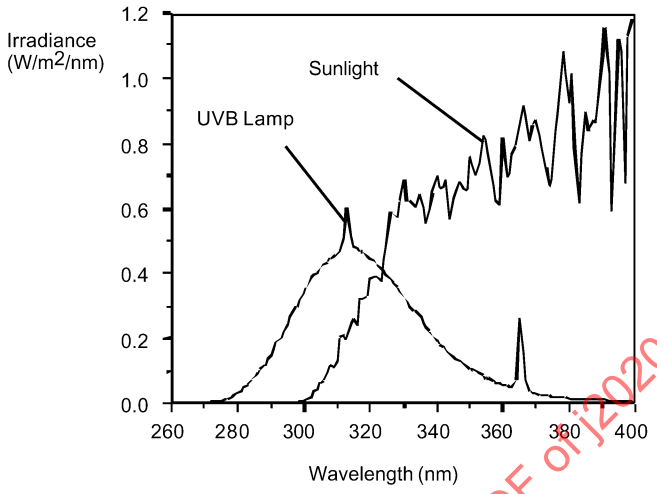

FIGURE 1—UVB LAMPS REPRESENTATIVE SPECTRAL POWER DISTRIBUTION

4.2.2 Other fluorescent UV lamps meeting the size and electrical characteristics in 4.2 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 may result in significant differences in test results.

a. UVA lamps with a peak emission of 340 nm as described in Table 1 of ASTM G 154. A representative spectral power distribution of this lamp is shown in Figure 2.

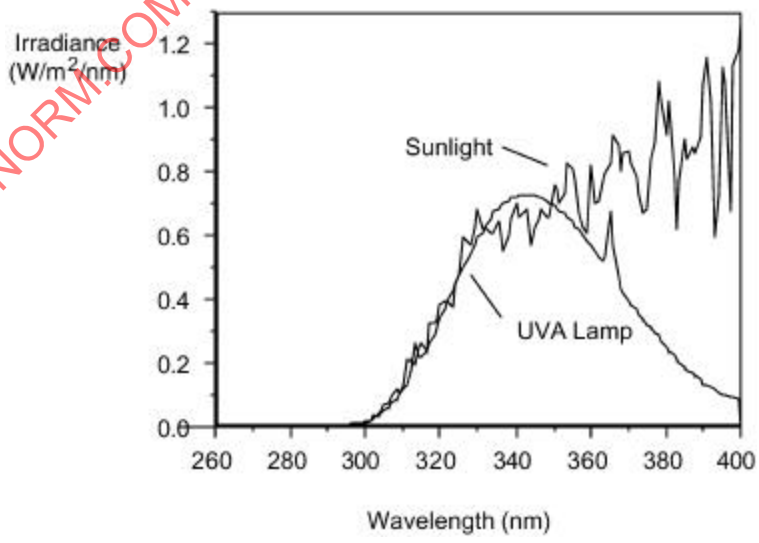

FIGURE 2—UVA LAMPS REPRESENTATIVE SPECTRAL POWER DISTRIBUTION

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 in a flat plane on 70 mm centers.

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 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 specimen 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 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 panel 75 mm X 100 mm X 2.5 mm thick. The temperature sensor shall be accurate to ±2 °C through a range from 30 °C to 100 °C. The temperature indicator shall be located outside the test chamber. The black panel with the temperature 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 of set-point temperature by supplying heated air to the test chamber. During condensation exposure, the selected equilibrium temperature shall be maintained within ±3 °C of set-point temperature 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. Ambient temperature shall be measured at a maximum distance of 150 mm from the plane of the specimen door of the apparatus and 150 mm 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 test results, maintain and calibrate the apparatus to the manufacturer's specifications as described in Appendix A.

5. Test Specimens

5.1 Specimen size shall be either 50 mm X 75 mm, 75 mm X 100 mm, 75 mm X 150 mm, 100 mm X 150 mm, or as agreed upon by concerned parties.

NOTE— Because of the geometry of some specimen 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 75 mm X 150 mm 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 specimen, 100 mm X150 mm specimens have been found useful. In this situation, each coating should cover one half of the specimen and be 50 mm X 150 mm 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 30mm to allow adequate heat transfer for condensation. Report any thickness greater than this in the test report.

5.4 To provide rigidity, flexible specimens should be attached to a backing panel made of aluminum, 0.635 mm 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 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 3.

NOTE— To avoid areas of variability in the specimen exposure area, do not use the extreme right- and left-hand specimen holders on the apparatus.

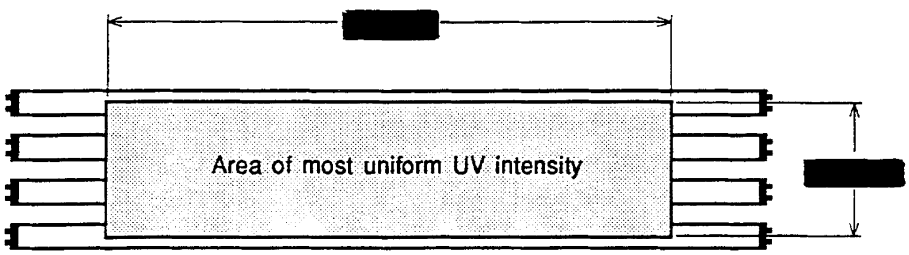

FIGURE 3—AREA OF MOST UNIFORM UV INTENSITY

6.3 Set Condensation Cooling Timer to 15 min, if applicable. Report any variations in the test report Figure 4.

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 4—EXPOSURE REPORT FORM

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 Operating continuously, repeating the cycle, except for servicing the instrument and inspection of specimens. Inspect specimens weekly during the condensation cycle for evidence of condensation.

6.6 In order to minimize any effect from temperature or UV light variation, specimens shall be repositioned periodically. As a minimum, specimens must be rotated horizontally once each week by (a) moving the two extreme right-hand specimen holders to the far left of the exposure area and (b) sliding the remaining specimen holders to the right (see Figure 5).

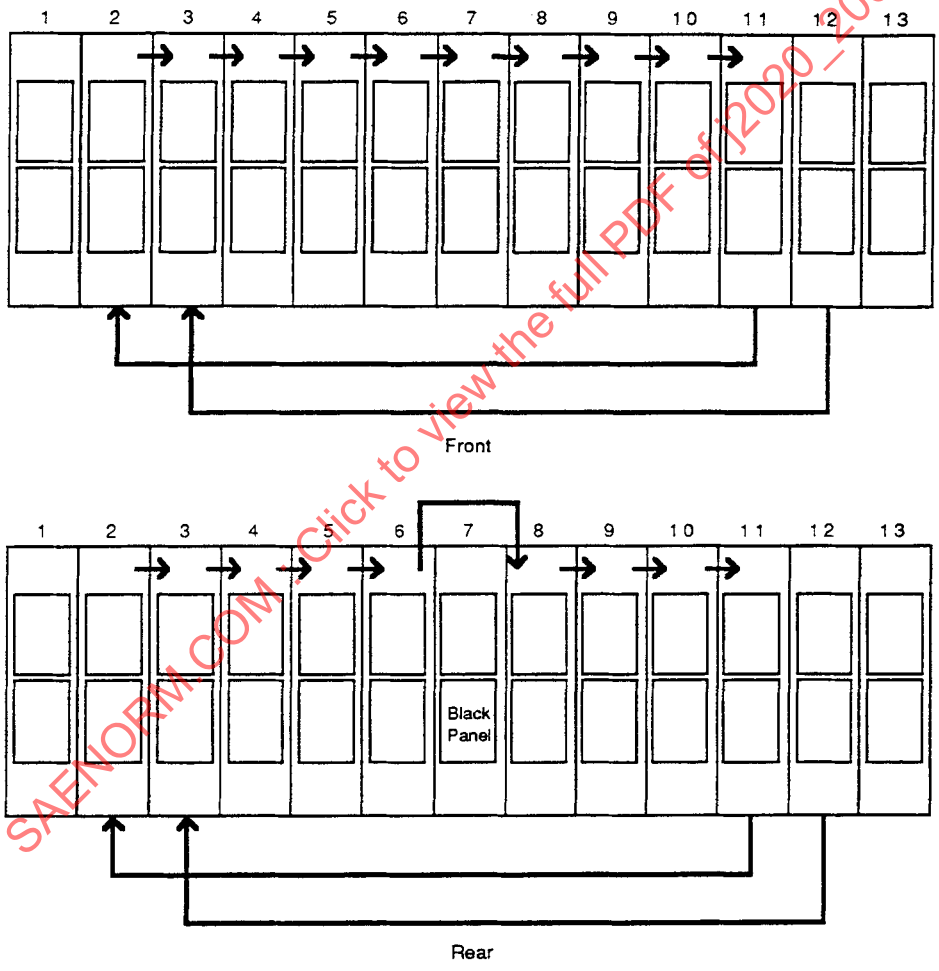

FIGURE 5—HORIZONTAL SPECIMEN HOLDER ROTATION

6.7 UV Irradiance

6.7.1 UV irradiance shall be maintained within a specified range by one of the methods shown in Appendix A.

6.7.2 For UVB lamps, the irradiance level shall be 0.48 ± 15% W/m^2/nm at 310 nm (0.41 to 0.55 W/m^2/nm at 310nm). If the irradiance deviates beyond this tolerance, terminate the test until the cause of the deviation has been determined and corrected.

NOTE— The previous edition of SAE J2020 specified an irradiance level of 0.43 W/m^2/nm at 310 nm (0.37 to 0.49 W/m^2/nm at 310 nm). The new 0.48 irradiance level is not an increase from the previously specified 0.43 irradiance level. The 0.48 target irradiance level is based on more precise radiometer calibration in accordance with B.1.3.1 of SAE J2020.

6.7.2.1 Other irradiance levels can be used by mutual agreement between contracting parties.

6.7.3 For UVA lamps, the irradiance level shall be mutually agreed upon by contracting parties.

NOTE— For devices that automatically control irradiance, target irradiance levels between the range of 0.67 to 0.77 W/m^2/nm at 340 nm are commonly used. CIE Publication No. 85, Table 4, states that noon summer sunlight, air mass 1.0, is 0.68 W/m^2/nm at 340 nm.

6.8 Expose specimens 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, and the wavelength (nm) at which peak emission occurs. For example: FS-40, 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 and the intervals at which it was measured during the exposure test as specified in Appendix A.

7.1.9 Any special conditions of test

8. Notes

8.1 Marginal Indicia—The change bar (l) located in the left margin is for the convenience of the user in locating areas where 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

APPENDIX A

REQUIRED PERIODIC MAINTENANCE

A.1 Maintenance and Calibration of Test Apparatus

A.1.1 The test apparatus requires periodic maintenance to maintain uniform exposure conditions. Perform required maintenance and calibration in accordance with manufacturer's instructions.

A.2 Maintenance of Irradiance

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

A.2.2 Method 1, 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 h ± 25 h of lamp operation, measure light output and calibrate the system as recommended by the manufacturer.

A.2.2.2 Replace all of the lamps in the unit when they can no longer maintain the center point of the desired range.

A.2.2.3 Using the procedure in B.1.3, re-calibrate the calibration radiometer every 6 months.

A.2.3 Method 2, Manual Irradiance Measurement Method—This system uses constant output ballasts which do not compensate for variability in light output caused by lamp aging, temperature, or lot-to-lot variability.

NOTE— Many fluorescent lamps age significantly with extended use. Follow the apparatus manufacturer's instructions on the procedure necessary to maintain desired irradiance.

A.2.3.1 At a minimum, operators should measure lamp irradiance every two weeks (336 total hours) to assure that the irradiance is within the specified range. If the light intensity is below 0.48 ± 15% W/m^2/nm at 310 nm (0.41 to 0.55 W/m^2/nm at 310 nm) replace one lamp in each bank and rotate the others as shown in Figure A1.

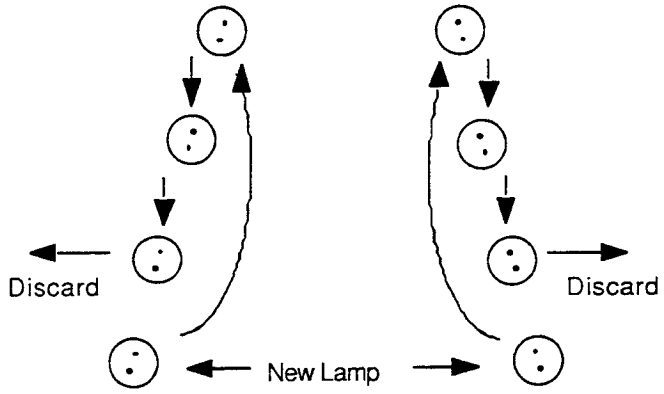

FIGURE A1—LAMP ROTATION/REPLACEMENT PROCEDURE

A.2.3.2 Using the procedure in B.1.3, re-calibrate the calibration radiometer every 6 months.

A.3 ***Thermometer Calibration—***The Black Panel thermometer shall 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 ASTM E 220 or by using the calibration method specified in ASTM E 207.

A.4 The rate of deterioration caused by exposure in this apparatus may be monitored by exposing weathering reference materials.

A.5 ***Water Pan Maintenance—***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.

APPENDIX B

MEASUREMENT OF IRRADIANCE

B.1 Equipment Needed

B.1.1 The instrumentation required to measure irradiance is a radiometer and, in addition, for the manual method, special specimen holders with measurement ports.

B.1.2 Special Specimen Holders with Measurement Port—Follow the manufacturer's instructions to measure in the prescribed locations shown in Figure B1. Maintain temperature integrity within the chamber so that the measurements are not affected.

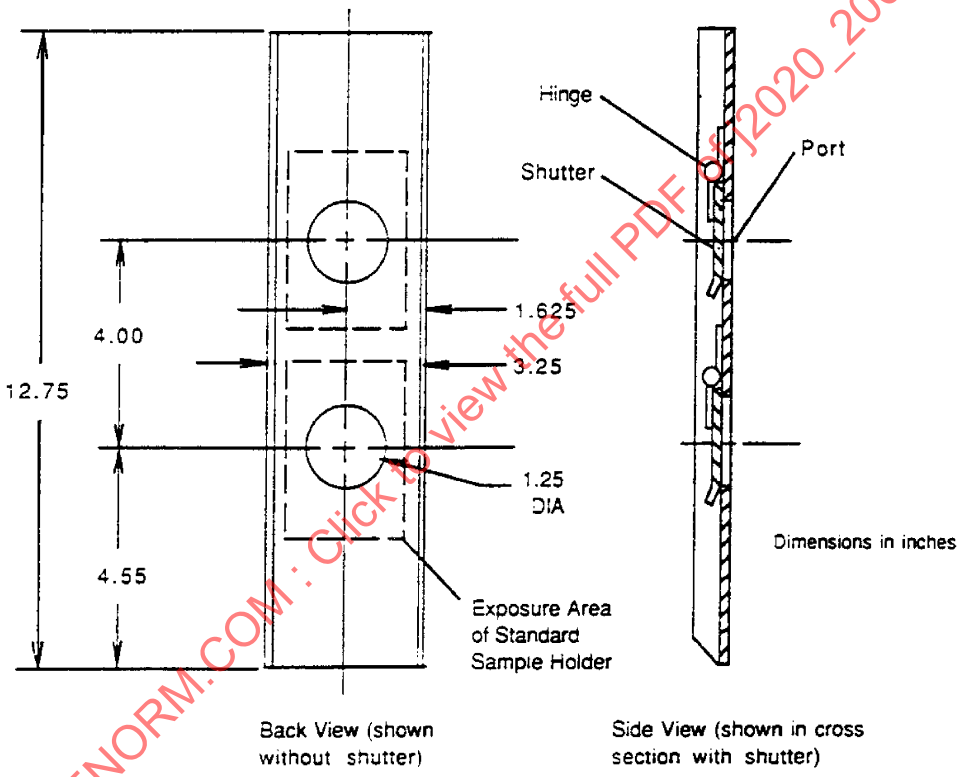

FIGURE B1—SPECIAL SAMPLE HOLDER WITH MEASUREMENT PORT

B.1.3 The Radiometer—The radiometer used to measure irradiance must have a detector which can be placed in the specimen plane of the apparatus. The detector must have some spectral response at 310 nm but no response between 400 and 600 nm.

B.1.3.1 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, the type of lamps used in the test and a spectroradiometer. The spectroradiometer used for this calibration procedure must itself be calibrated traceable to the National Institute of Standards and Technology (NIST), have a double grating monochromator, with a half bandwidth of 2 nm or less, and a cosine receptor that is within ±4% of the cosine between ±60 degrees of normal incidence as specified in ISO 9370.