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INTERNATIONAL
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SURFACE VEHICLE RECOMMENDED PRACTICE

An American National Standard

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(R) Recommended Practice for Measuring Haze and Reflectance of Mirrors

1. ***Scope—***This SAE Recommended Practice describes methods for determining total and specular reflectance for mirrors with flat and curved surfaces and a method for determining diffuse reflectance and haze for mirrors with flat surfaces.

2. ***References***

2.1 **Applicable Publications—**The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J264—Vision Glossary

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

ASTME429—Standard Test Method for Measurement and Calculation of Reflecting Characteristics of Metallic Surfaces Using Integrating Sphere Instruments

3. ***Apparatus***

3.1 **General Description—**The apparatus shall consist of a light source, a sample holder, a receiver unit with a photodetector and indicating meter and a means for negating the effects of extraneous light. (See Figures 1, 2, and 3.)

When measuring non-flat (convex or aspheric) mirrors or measuring diffuse reflectance, the receiver shall incorporate a light-integrating sphere. (See Figure 1.)

3.1.1 When measuring diffuse reflectance, the receiver unit shall incorporate a light-integrating sphere with means for excluding the specular beam. (See Figure 2.)

3.1.2 When measuring prismatic mirrors, the apparatus shall measure only specularly reflected light and have a means for separately measuring the light reflected from the front and back surfaces of the prism. (See Figure 3.)

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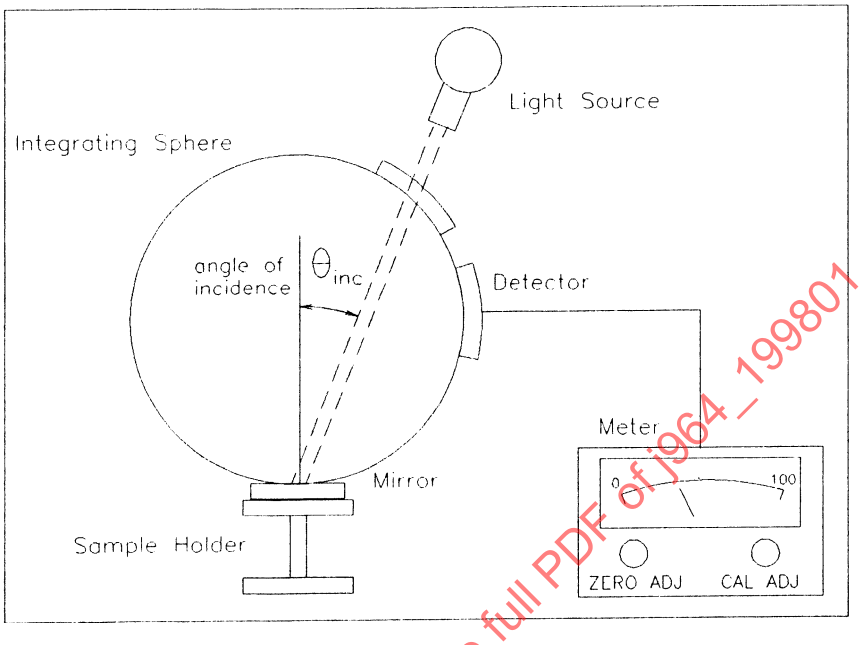

FIGURE 1—SCHEMATIC OF REFLECTOMETER WITH A FIXED RECEIVER AND A SAMPLE HOLDER WHICH LOCATES THE SAMPLE DIRECTLY ADJACENT TO THE SPHERE. THIS UNIT CAN BE USED TO MEASURE TOTAL REFLECTANCE OF FLAT AND NON-FLAT MIRRORS.

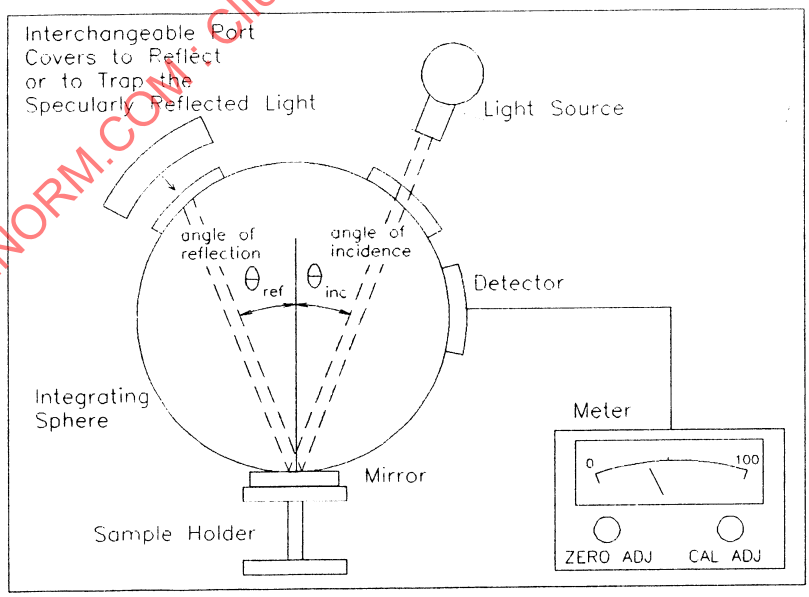

FIGURE 2—SCHEMATIC OF A REFLECTOMETER WITH THE MEANS FOR EXCLUDING THE SPECULARLY REFLECTED BEAM. THIS UNIT COULD BE USED FOR MEASURING TOTAL REFLECTANCE OF FLAT AND NON-FLAT MIRRORS, AND DIFFUSE REFLECTANCE OF FLAT MIRRORS.

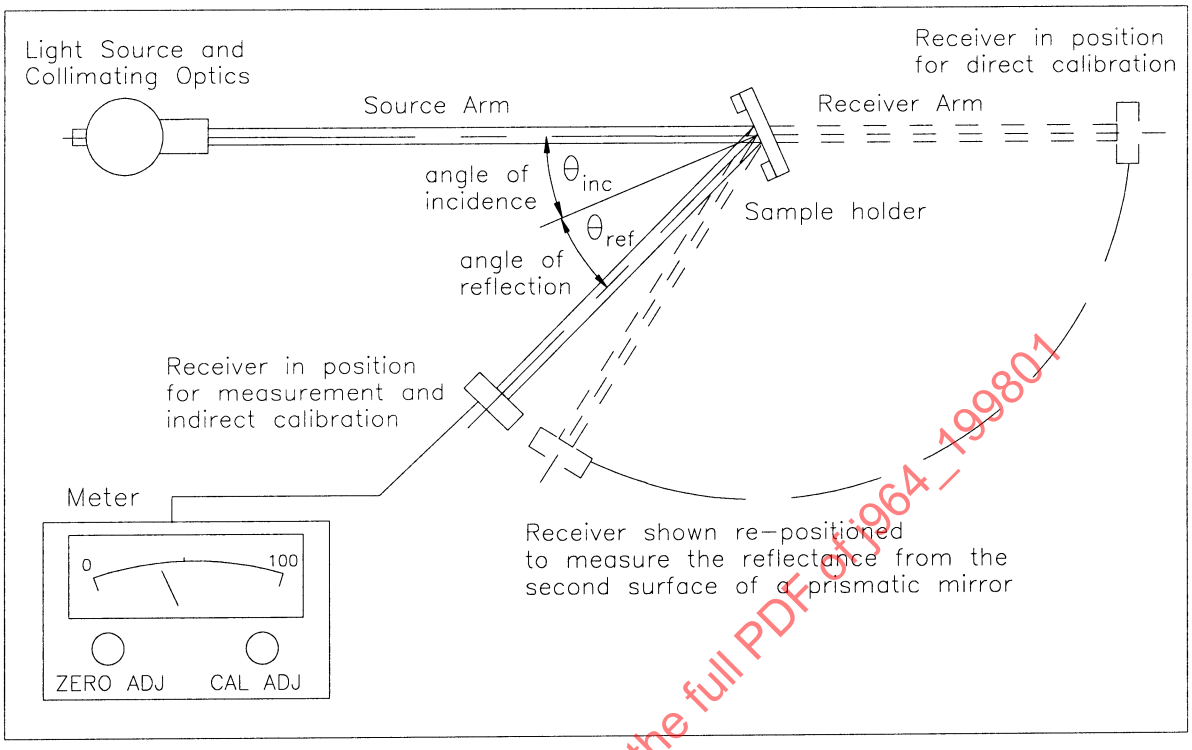

FIGURE 3—SCHEMATIC OF A GENERALIZED REFLECTOMETER WITH MOVEABLE DETECTOR. TO USE THE DIRECT CALIBRATON METHOD, THE DETECTOR IS LOCATED DIRECTLY IN LINE WITH THE LIGHT SOURCE. TO MEASURE REFLECTANCE, THE DETECTOR IS MOVED TO INTERCEPT THE BEAMS SPECULARLY REFLECTED FROM SURFACES OF THE MIRRORS.

3.2 Characteristics of the Light Source—The light source shall consist of an incandescent tungsten filament lamp operating at a nominal color temperature of 2856 °K (CIE Illuminant A), or any combination of light source and filters which provide the equivalent of Illuminant A. Optics associated with the source shall provide a near collimated beam. A voltage stabilizer is recommended for maintaining a fixed lamp voltage during instrument operation.

When the receiver does not include an integrating sphere, the reflected beam shall cover at least 50%, but not more than 100% of the sensitive area of the photodetector. The beam should cover the same section of the photodetector during measurements as was covered during calibration.

3.3 Characteristics of the Receiver—The spectral response of the receiver shall match the 1924 CIE standard luminous efficiency function V(λ) for photopic vision. Any combination of photodetector and filters which gives the equivalent of V(λ) may be used.

3.4 Characteristics of the Integrating Sphere—When an integrating sphere is used in the receiver section, it shall have a minimum diameter of 127 mm (5 in). The interior surface of the sphere shall be coated with a matte (diffusive) spectrally non-selective white coating. The ports for the sample, the incident beam, and specularly reflected beam (if present) shall be large enough to admit the entire beam, but shall not, in total, exceed 5% of the area of the sphere.

The photodetector shall be located so that it cannot receive direct light from either the incident or reflected beams.

If diffuse reflectance is to be measured, the sphere shall have an additional port for the exclusion of the specularly reflected beam. (See Figure 2.) This port shall be located such that the reflected beam is centered in it and shall be large enough that the beam is surrounded by an annulus of 0.6 degrees ± 0.2 degrees as measured from the sample port. Two covers should be provided for this port: a black cover or light trap and a white cover with a coating similar to the interior of the sphere. The first is used when measuring diffuse reflectance and the second, when measuring total reflectance.

3.5 Electrical Characteristics of the Photodetector Indicator Unit—The photodetector output, as read on the indicating meter, shall be a linear function of the light intensity on the photosensitive area. Means (electrical and/or optical) shall be provided to facilitate zeroing and calibration adjustments. Such means shall not affect the linearity or the spectral characteristics of the instrument. The accuracy of the receptor-indicator unit shall be within ±2% of full scale, or ±10% of the magnitude of the reading, whichever is smaller.

3.6 Geometric Conditions—The angle between the perpendicular to the surface of the sample and the incident beam (Θ_i) shall not exceed 30 degrees. Preferably, the angle shall be 25degrees ±5 degrees. The incident beam, upon arrival to the test surface, shall have a diameter of not less than 13 mm (0.50 in).

3.7 Sample Holder

3.7.1 SPECULAR REFLECTANCE—Except when the sample is located directly adjacent to an integrating sphere, the sample holder shall be capable of locating the test sample such that the axes of the source arm and the receptor arm intersect at the reflecting surface (see Figure 3). The reflecting surface may lie within, or at either face of the mirror sample, depending upon whether it is a first-surface, second surface, or prismatic "flip" mirror.

3.7.2 TOTAL OR DIFFUSE REFLECTANCE—The sample holder shall be capable of locating the test sample directly adjacent to the integrating sphere and such that a line perpendicular to the sample at the center of the incident beam lies along a line through the center of the sphere.

4. Procedure

4.1 Calibration

4.1.1 DIRECT CALIBRATION METHOD—In the direct calibration method, air is used as the reference standard. This method is for those instruments which permit the receiver to swing from a measurement position to a position directly on the axis of the light source (See Figure 3). The meter is set to 100% with the receiver in direct line with the light source. The meter is set to zero with the receiver blocked from viewing the light source either by swinging it away from the light source axis or by blocking the beam.

It may be desired in some cases (such as when measuring low reflective surfaces) to use an intermediate calibration point (between 0 and 100% on the scale) with this method. In such a case, a neutral density filter of known transmittance may be inserted in the optical path, and the calibration control adjusted so the meter reads the percent transmission of the neutral density filter. This filter must be removed before making any reflectance measurements.

For measurement, the receiver is moved to a position where the angle between its axis and the perpendicular to the reflective surface of the sample equals the angle between the axis of the light source and the perpendicular to the reflective surface.