Downloaded from http://www.everyspec.com

FEDERAL TEST METHOD STANDARD

INSTRUMENTAL PHOTOMETRIC MEASUREMENTS OF RETROREFLECTIVE MATERIALS AND RETROREFLECTIVE DEVICES

This standard was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE

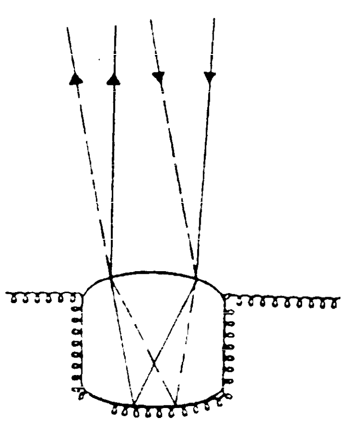
1.1 This standard covers procedures for instrumental determinations of photometric characteristics of retroreflective materials and retroreflective devices.

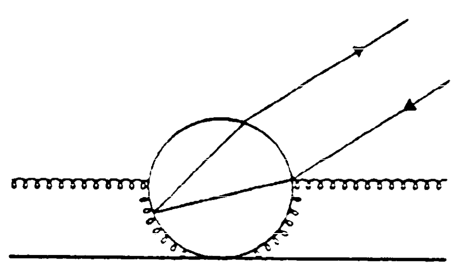
2. DEFINITIONS

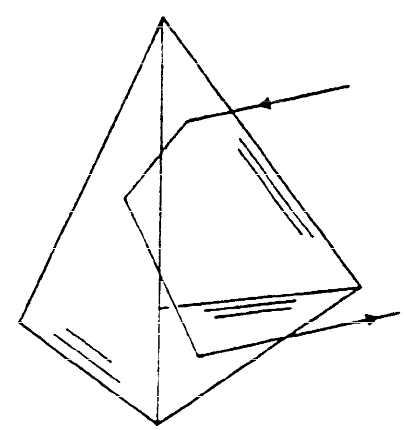
2.1 Retroreflective terms:

2.1.1 Retroreflector. A surface or device which reflects and returns a relatively high proportion of light in a direction close to the direction from which it came. This characteristic is maintained over a wide variation of the angle made by the incident light ray and the normal to the retroreflective surface.

2.1.2 Retroreflective element: One optical unit which by refraction and/or reflection produces the phenomenon of retroreflection.


Cat's Eye Element


Spherical Element


Cube Corner Element

2.1.3 Retroreflective device: A complete device, ready for use, consisting of one or more retroreflective elements (for example, a device containing cats eyes, a cube corner device, or a safety retroreflective device).

2.1.4 Retroreflective material: A retroreflective material which consists of a thin continuous layer of small retroreflective elements on or very near the exposed surface (for example, retroreflective sheeting, beaded paint, highway sign surfaces, or pavement striping).

2.1.4.1 Retroreflective sheeting: A retroreflective material preassembled as a thin film ready for use.

2.2 Geometric terms (See Figures 1 (page 2) and 2 (page 3)).

2.2.1 Reference center (O): The defined center of a retroreflector.

Downloaded from http://www.everyspec.com

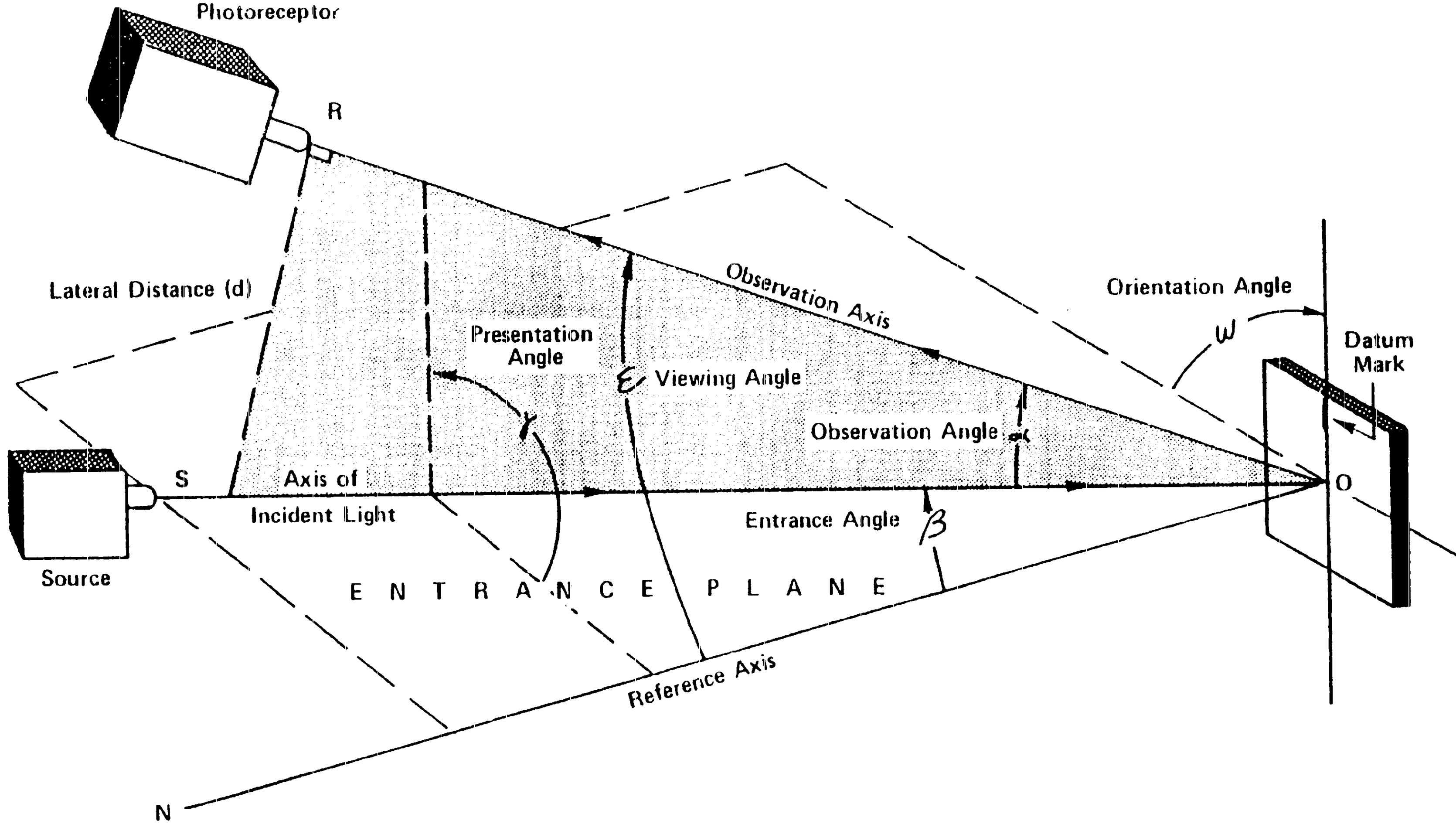


Figure 1.

Pictorial view with the presentation angle (γ) illustrated at 90°

(A presentation angle of 0° is normally used).

Downloaded from http://www.everyspec.com

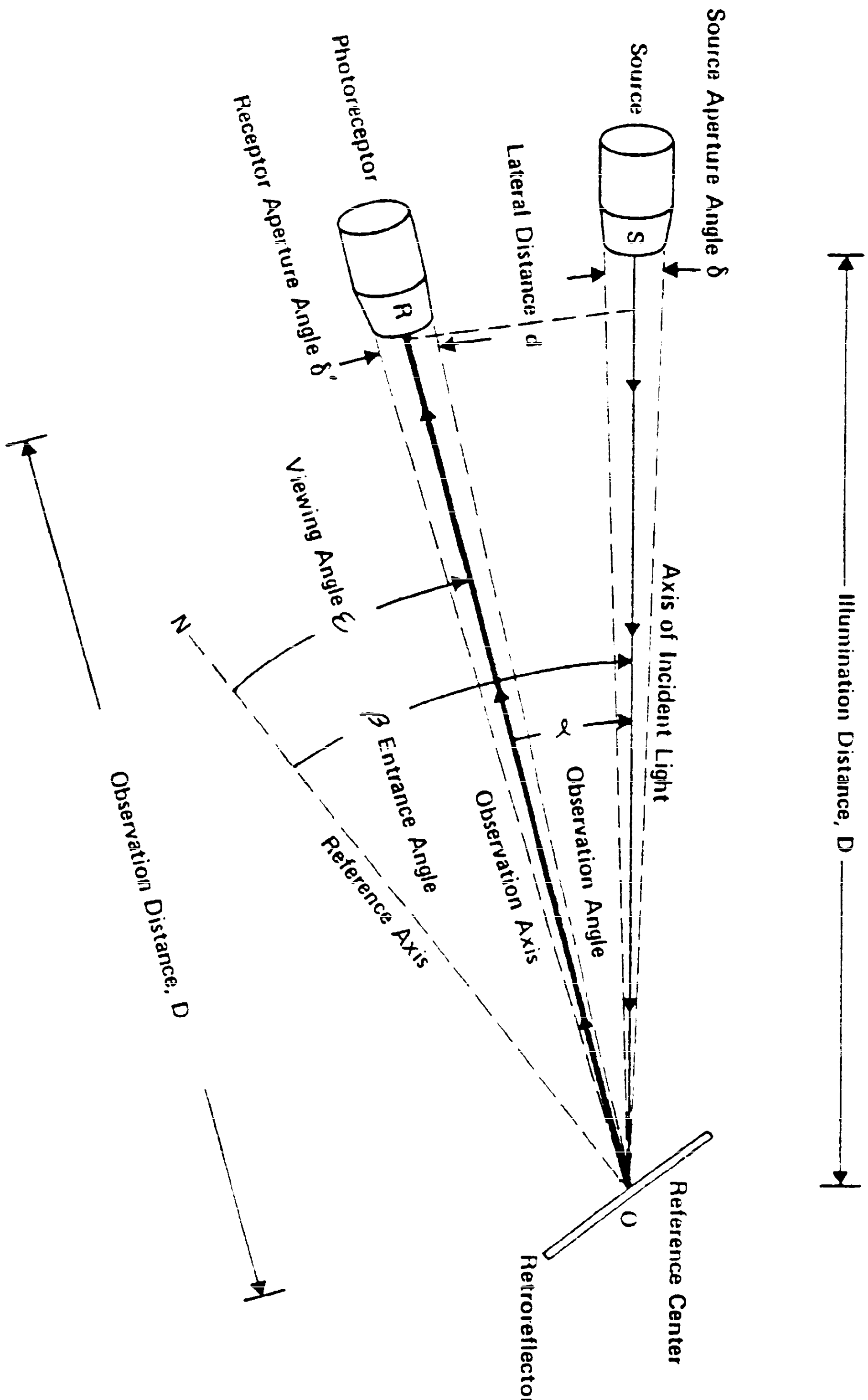


Figure 2.

Plane view from above with the presentation angle illustrated at 0°.

Downloaded from http://www.everyspec.com

2.2.2 Reference axis (ON): The defined axis used to determine the entrance angle in photometric measurements and in practical use. This axis passes through the reference center (O) (see Note 13).

2.2.3 Axis of incident light (OS): The line between the reference center and the center of the exit aperture of the light source.

2.2.4 Observation axis (OR): The line between the reference center and the center of the entrance aperture of the photoreceptor.

2.2.5 Entrance angle (β): The angle between the reference axis and the axis of incident light. Counter-clockwise rotation of the reference axis relative to the axis of incident light is considered positive as shown in Figure 2.

NOTE 1: Entrance angles are normally in the range of 0 to 90°. However, negative entrance angles can be used to indicate a change of 180° in the presentation angle, provided the 0° orientation of the datum mark is defined relative to the observation plane.

2.2.6 Viewing angle (ε): The angle between the observation axis and the reference axis.

NOTE 2: Since this angle is determined by other defined angles, the viewing angle is introduced simply for convenience in defining the specific luminance and the luminance factor.

2.2.7 Observation angle (α). The angle between the axis of incident light and the observation axis ("divergence angle" is an obsolete term for this angle).

2.2.8 Datum mark: The mark placed on the sample by the manufacturer which defines the initial (zero degree) orientation position, and from which the orientation angle is measured.

2.2.9 Orientation angle (ω). The angle, when viewed from Point N, through which the sample may be rotated about the reference axis, from the initial zero degree orientation of the datum mark. The initial zero degree orientation angle may be defined relative to either the observation plane or the entrance plane.

a. When defined relative to the observation plane, the zero degree orientation is when the datum mark is in the observation plane and on the same side of the axis of incident light as the photoreceptor.

b. When defined relative to the entrance plane, the zero degree orientation is when the datum mark is in the entrance plane and on the same side of the axis of incident light as the reference axis.

2.2.10 Presentation angle (γ): The dihedral angle between the entrance plane formed by the axis of incident light and the reference axis, and the observation plane formed by the axis of incident light and the observation axis. 0° is formed when the photoreceptor is placed in the plane formed by the axis of incident light and the reference axis, with the receptor on the same side of the source as the reference axis. A presentation angle of 0° as shown in figure 2 is used, unless otherwise specified. Figure 1 shows the presentation angle at plus 90°.

2.2.11 Illumination distance (D, equal to OS): The distance between the center of the exit aperture of the light source and the reference center.

2.2.12 Observation distance (D', equal to OR): The distance between the reference center and the center of the entrance aperture of the photoreceptor.

2.2.13 Lateral distance (d): The distance from the center of the entrance aperture of the photoreceptor to the axis of incident light, measured perpendicularly to the observation axis. It may be computed by multiplying the observation distance D' by the tangent of the observation angle.

$$d = D' \tan \alpha$$

2.2.14 Source aperture angle (δ): The angle at the sample subtended by a given dimension of the source aperture.

2.2.15 Receptor aperture angle (δ'): The angle at the sample subtended by a given dimension of the receptor aperture.

2.3 Photometric terms

2.3.1 Commission Internationale de l'Eclairage (CIE) Photopic Standard Observer: A receptor of radiation with a spectral sensitivity curve (Table I) which conforms to the V(λ) distributions specified in Table 1

Downloaded from http://www.everyspec.com

Table I. Spectral Response of the CIE Standard Photopic Observer (Ref. 7.1)

Wavelength (nm)	Relative $V(\lambda)$ (%)	Wavelength (nm)	Relative $V(\lambda)$ (%)
380	0.00	570	95.20
390	0.01	580	87.00
400	0.04	590	75.70
410	0.12	600	63.10
420	0.40	610	50.30
430	1.16	620	38.10
440	2.30	630	26.50
450	3.80	640	17.50
460	6.00	650	10.70
470	9.10	660	6.10
480	13.90	670	3.20
490	20.80	680	1.70
500	32.30	690	0.82
510	50.30	700	0.41
520	71.00	710	0.21
530	86.20	720	0.10
540	95.40	730	0.05
550	99.50	740	0.02
555	100.00	750	0.01
560	99.50		

2.3.2 Illuminance (E): The ratio of the luminous flux to the area of the surface, when the latter is uniformly illuminated.

$$E = \frac{\Phi}{A}$$

where

Φ = Luminous flux

A = Area of the surface.

2.3.2.1 Normal illuminance (E_n): Normal illuminance is an expression used in the photometry of retroreflectors to designate the normal illuminance from the source on a retroreflective surface, and is measured in the plane which passes through the reference center and is perpendicular to the axis of incident light.

In metric units, normal illuminance is measured in lux.

2.3.3 Inverse-square law: The normal illuminance which a point-source produces at a point on a surface varies directly with the luminous intensity of the point source and inversely as the square of the distance between the source and that point, expressed as follows:

$$E_n = \frac{I}{D^2}$$

where

I = Luminous intensity.

2.3.4 Photoreceptor: An instrument for measuring luminous flux.

2.3.4.1 Photometer: A photoreceptor used for determining illuminance at a surface, and usually calibrated in units of footcandles or lux.

2.3.4.2 Telephotometer: A photoreceptor used for determining luminance at a distance or illuminance from a restricted field of view. The device is equipped with an objective lens that may be focused on a target.

2.3.5 Goniometer: An instrument for measuring or setting angles.

3. QUANTITIES AND UNITS FOR RETROREFLECTIVE PHOTOMETRIC MEASUREMENTS

3.1 Photometric quantities used to specify the performance of retroreflective materials and devices are specific intensity (SI), specific luminance (SL), specific intensity per unit area (SIA), specific

Downloaded from http://www.everyspec.com

intensity per unit length (SIL), and luminance factor (LF).

3.1.1 Specific intensity (SI): The ratio of the luminous intensity of the retroreflector to the normal illuminance.

$$SI = \frac{E'(D')^2}{E_n}$$

where

E' = Illuminance at the observation position

D' = Distance between the center of the photoreceptor entrance aperture and the reference center

Specific intensity is expressed in candelas per footcandle (cd fc^{-1}).

NOTE 3: The CIE vocabulary defines the above relationship as the coefficient of luminous intensity (CIL), which is expressed in metric units of candelas per lux.

NOTE 4: The quantity SI is recommended for determining the performance of such retroreflectors as button reflectors, delineators, or automotive reflectors, since it depends on a unit device and the area need not be measured.

3.1.2 Specific luminance (SL): The ratio of the luminous intensity of the projected surface to the normal illuminance at the surface on a plane normal to the incident light. The ratio is expressed as follows:

$$SL = \frac{E'\ (D')^2/(A\ \cos\epsilon)}{E_n} = \frac{I'\ /(A\ \cos\epsilon)}{E_n} = \frac{SI}{A\ \cos\epsilon}$$

where

I' = $E'(D')^2$ = Retroreflective luminous intensity of the sample

A = Surface area of the sample

ϵ = Viewing angle.

Specific luminance is expressed in candelas per square foot per footcandle [(cd ft^{-2}) fc^{-1}].

NOTE 5: The CIE vocabulary defines this relationship as the coefficient of luminance, which is expressed in metric units of candelas per square meter per lux.

NOTE 6: The quantity SL treats the retroreflector as a surface source whose projected area is visible as an area at the observation position. The quantity SL relates to the way the effective retroreflective surface is focused on the retina of the human eye and to the visual effect thereby produced. It is recommended for describing the performance of highway signs and striping, or large vehicular markings which are commonly viewed as discernable surface areas.

3.1.3 Specific intensity per unit area (SIA): The ratio of the luminous intensity of the surface to the normal illuminance and to the area of the retroreflective surface.

$$SIA = \frac{E'(D')^2/E_n}{A}$$

Specific intensity per unit area is expressed in candelas per footcandle per square foot [(cd fc^{-1}) ft^{-2}].

NOTE 7: The CIE vocabulary defines this relationship as the coefficient of luminous intensity (CIL) per unit area, which is expressed in metric units of candelas per lux per square meter.

NOTE 8: The quantity SIA treats the retroreflector as an apparent point source whose retroreflected luminous intensity is dependent on the area of the retroreflective surface involved It is a useful engineering quantity for determining the photometric performance of such retroreflective surfaces as highway delineators or warning devices. SIA may also be used to determine the minimum area of retroreflective sheeting necessary for a desired level of photometric performance.

3.1.4 Specific intensity per unit length (SIL): The ratio of the luminous intensity of the sample to the normal illuminance and to the length of the retroreflective sample.

Downloaded from http://www.everyspec.com

$$SIL = \frac{E'(D')^2/E_n}{L}$$

where

L = Length of the sample.

Specific intensity per unit length is expressed in candelas per footcandle per foot [(cd fc^{-1}) ft^{-1}].

NOTE 9: The CIE vocabulary defines the above relationship as the coefficient of luminous intensity (CIL) per unit length, which is expressed in metric units of candelas per lux per meter.

3.1.5 Luminance factor (LF): The ratio of the luminance of the surface to that of a perfect diffusing surface such that:

$$LF = \frac{\pi E'(D')^2}{A E_n \cos\beta \cos\epsilon} = \frac{\pi(SIA)}{\cos\beta \cos\epsilon}$$

The luminance factor has no dimensions.

NOTE 10: In this formula, the dimensions associated with the reflectance of the perfect diffusing surface are the same as those of SIA, and are thus canceled.

4. REQUIREMENTS TO BE STATED IN SPECIFICATIONS

4.1 When stating photometric retroreflective requirements, the following shall be specified in the specification for the material:

a. The retroreflective photometric quantities to be measured, limited to the following: specific intensity (SI), specific luminance (SL), specific intensity per unit area (SIA), specific intensity per unit length (SIL), or luminance factor (LF).

b. The units (metric or english) in which each quantity is to be measured.

c. The minimum acceptable quantitative value.

d. The observation angle.

e. The entrance angle.

NOTE 11: When specifying an entrance angle near 0°, care must be taken to prevent specular reflection from entering the photoreceptor. In this case, the entrance angle should be specified so that specular light will be reflected away from the photoreceptor.

f. The orientation angle and the 0° orientation of the datum mark shall be specified if random orientation of the sample is not suitable.

g. The presentation angle shall be specified if other than 0°.

h. The minimum test distance between the sample and the photoreceptor.

i. Sample dimensions and shape.

j. The maximum photoreceptor angular aperture [the angle at the sample (δ' in Figure 2) subtended by the maximum dimension of this aperture]. The solid angle subtended by the photoreceptor aperture at the reference center shall be specified. This can be accomplished by specifying the photoreceptor dimensions and test distance, or the maximum receptor aperture angle (generally 6 minutes of arc).

NOTE 12: The maximum value of the angle at the sample subtended by the maximum aperture diameter of the photoreceptor should be specified in the material specification; it should be in the order of 6 minutes of arc (see Figure 2). However, the maximum diameter of both apertures varies with the test distance. Reading R_1 and R_2 must be made with the same apertures (see 6.3).

k. The maximum angular aperture of the light projector [the angle at the sample (δ in Figure 2) subtended by the maximum dimension of this aperture]. The solid angle subtended by the light source aperture at the reference center shall be specified. This can be accomplished by specifying the source aperture dimensions and test distance or the maximum source aperture angle (generally 6 minutes of arc).

Downloaded from http://www.everyspec.com

l. The reference center.

m. The reference axis.

NOTE 13: The reference axis usually is perpendicular to the surface of sheeting. In such complex devices as automobile or bicycle reflectors, the reference axis and reference center may be defined with respect to the viewing direction.

NOTE 14: When evaluation requirements are different from those stated in this standard, it is recommended that the variations be defined relative to the test conditions used in this standard.

5. APPARATUS

5.1 The apparatus shall consist of a photoreceptor, a light projector source, a goniometer sample holder, and a photometric range.

5.1.1 Photoreceptor. The photoreceptor shall be equipped with:

a. CIE standard observer filter: A light filter to yield a response curve matching that of the CIE standard observer (see Note 22).

b. Photoreceptor stability and linearity: The stability and linearity of the photometric scale reading shall be within ±1 percent over the range to be measured.

c. Light filter holder attachment: If the filter correction factor is to be used, the photoreceptor shall be equipped with an attachment to mount filters in a way which prevents interreflection between the filter and the photoreceptor.

d. **Angular field aperture:** If the photoreceptor is equipped with field apertures, a range of 2 minutes to 3 degrees is desirable. In any case, baffling shall be used to reduce the effect of stray light to a negligible factor. This is particularly important when a photometer-type instrument is used.

NOTE 15: Because retroreflective material specifications require various test distances which affect the actual field aperture, a selection of angular field apertures may be necessary. The field of view should be limited to the smallest aperture that includes the entire sample (see 6.3.1).

e. Objective lens: If the photoreceptor is equipped with an objective lens, it shall focus at the test distance.

5.2 Light projector source: The light source shall be a lamp with appropriate reflector and lenses to provide normal illumination on the test sample with a spectral energy distribution conforming to the 1931 CIE standard source A (a tungsten filament lamp operated at a color temperature of 2856 K) (see Table II). The normal illuminance on the sample shall be uniform within 5 percent of the average normal illuminance over the area of the retroreflector at the test distance. The light projector shall be equipped with an adjustable iris diaphragm or a selection of fixed apertures. The intensity of light shall be regulated and shall not vary more than 1 percent for the duration of the test.

NOTE 16: Many projection lamps are designed to operate at color temperatures higher than 2856 K. In such cases, the terminal voltage at the lamp shall be adjusted to provide the specified temperature.

NOTE 17: The maximum diameter of the projector exit aperture and the angle at the test sample thus subtended should not exceed that specified in paragraph 4.

5.3 Goniometer sample holder: The goniometer shall support the test sample so that the complement of the specified entrance angle does not change more than ±0.5 percent. (A simple goniometer can be constructed using a rotary milling table and an adjustable angle milling vise attached to the table platform.) The vertical angle of the goniometer shall be set perpendicular to the axis of incident light. The horizontal angle movement (the goniometer table) shall permit photometric measurements which require plus or minus angle settings.

5.4 Photometric range: To minimize the effect of stray light, the background behind the sample shall be flat black. Light baffles shall be located, as necessary, between the projector and the sample. Goniometer parts, range wall, ceiling, and floor exposed to the light beam shall be painted flat black.

NOTE 18: The working distance should be sufficiently large so that the focusing or beam displacement properties of the retroreflective elements do not affect the readings. For most materials, 100 feet is sufficient. This facilitates measurements which require an observation angle of 0.2°. In Table III, the lateral distance (d) (see 2.2.13) is given for various distances and observation angles.

Downloaded from http://www.everyspec.com

Table II. Energy Distribution of CIE Source A (Ref. 7.2)

Wavelength (nm)	Relative energy	Wavelength (nm)	Relative energy
380	9.79	580	114.44
390	12.09	590	121.73
400	14.71	600	129.04
410	17.68	610	136.34
420	21.00	620	143.62
430	24.67	630	150.83
440	28.70	640	157.98
450	33.09	650	165.03
460	37.82	660	171.96
470	42.87	670	178.77
480	48.25	680	185.43
490	53.91	690	191.93
500	59.86	700	198.26
510	66.06	710	204.41
520	72.50	720	210.36
530	79.13	730	216.12
540	85.95	740	221.66
550	92.91	750	227.00
560	100.00	760	232.11
570	107.18		

Table III. Lateral Distance as a Function of Observation Angle and Observation Distance

Observation angle (α) (degrees)	Observation distance (D') (feet)	Lateral distance (d) (inches)
0.2	50	2.09
0.33	50	3.46
0.5	50	5.24
1.33	50	13.93
2.0	50	20.95
8.0	50	84.32
0.2	100	4.19
0.33	100	6.91
0.5	100	10.47
1.33	100	27.86
2.0	100	41.90
8.0	100	168.65

6. TEST PROCEDURES

6.1 General: The geometry used to determine the performance of retroreflective materials shall be in accordance with figures 1 and 2.

6.2 Goniometer calibration: The goniometer shall be calibrated at the 0° entrance angle position in the vertical and horizontal planes of the test sample. All measurements shall be made relative to this point and shall be checked each time the goniometer or light projector is moved.

> NOTE 19: This can be accomplished by locating an approximately 305 mm (12 in) square, high-quality, plane mirror in place of the sample. A 305 mm (12 in) cross, centered on the surface of the mirror can be made with photographic black tape. A 610 mm (24 in) square piece of white construction paper, with a hole in the center, can be placed over the light projector exit aperture. By observing the white paper, the goniometer can be adjusted so that the shadow of the cross is reflected directly on the exit aperture of the projector. This horizontal position of the goniometer is the 0° entrance angle of the test sample.

6.3 Photometric measurements: In this method, the same instrument with the same apertures and field of view shall be used to measure E' and E_n. Therefore, the photoreceptor need not be calibrated, and the *uncalibrated readings of E' and E_n are referred to as R_1 and R_2, respectively.* Different instruments shall not be used to measure E' and E_n.

Downloaded from http://www.everyspec.com

NOTE 20: It should be noted that luminance measurements could be made with a photoreceptor calibrated in footlamberts (fl) or in footcandles (fc). This procedure is not allowed in this test method because the potential for error due to inaccuracies in calibration is higher than in Procedure I below, which uses the same photoreceptor to measure both incident and reflected light.

6.3.1 Procedure I: The smallest available field aperture large enough to include both the entire retroreflector as seen from the photoreceptor, and the source as viewed from the retroreflector shall be chosen for measurement of R_1 and R_2. The normal illuminance at the face of the sample shall be measured by substituting the photoreceptor for the sample. The photoreceptor entrance aperture shall be placed where the sample is mounted and R_2 shall be recorded. Then, the photoreceptor and the sample shall be returned to their original positions, and R_1 shall be recorded in the same units as R_2.

A measure of the amount of stray light shall be made by replacing the sample with a black surface of the same shape and area. *The stray light readings, R_s, shall be subtracted from the reading R_1.* The value R_1 in the following equations is the value of R_1 less the stray light reading R_s.

NOTE 21: To stabilize the instrument and improve the accuracy of the measurements, the photoreceptor must remain energized between measurement of R_2 and R_1.

NOTE 22: Color correction of the photoreceptor may be necessary because of deficiencies in the photoreceptor's CIE photopic standard observer filter. A correction factor K can be applied by means of a filter having a spectral transmittance proportional to the spectral retroreflectance of the sample. If close spectral matches in permanent filters are not available, it is recommended that the correction factor not be used. When the calibration factor is used, it is determined by the following relation:

$$K = R_2 T / R_f$$

where

K = The correction factor

R_2 = The reading of the photoreceptor while measuring the normal illuminance at the face of the retroreflective sample (i.e., an uncalibrated E_n)

R_f = The reading of the photoreceptor placed at the same position as for the R_2 reading, but with the addition of the color filter placed immediately in front of the acceptance aperture

T = The known (total) luminance transmittance of the filter for a 2856 K source (CIE source A)

6.3.1.1 Specific intensity (SI)

$$SI = \frac{R_1 (D')^2}{R_2}$$

where

R_1 = Uncalibrated E' (see 6.3)

The color corrected specific intensity is:

$$SI = \frac{K\, R_1 (D')^2}{R_2} = \frac{R_1 (D')^2 T}{R_f}$$

6.3.1.2 Specific luminance (SL)

$$SL = \frac{R_1 (D')^2}{R_2 A \cos\epsilon}$$

The color corrected specific luminance is:

$$SL = \frac{K\, R_1 (D')^2}{R_2\, A \cos\epsilon} = \frac{R_1 (D')\ T}{R_f\, A \cos\epsilon}$$

Downloaded from http://www.everyspec.com

6.3.1.3 Specific intensity per unit area (SIA)

$$SIA = \frac{R_1 (D')^2}{R_2\ A}$$

The color corrected specific intensity per unit area is:

$$SIA = \frac{K\ R_1 (D')^2}{R_2\ A} = \frac{R_1 (D')^2\ T}{R_f\ A}$$

6.3.1.4 Specific intensity per unit length (SIL)

$$SIL = \frac{R_1 (D')^2}{R_2\ L}$$

The color corrected specific intensity per unit length is:

$$SIL = \frac{K\ R_1 (D')^2}{R_2\ L} = \frac{R_1 (D')^2\ T}{R_f\ L}$$

6.3.1.5 Luminance factor (LF)

$$LF = \frac{\pi\ R_1 (D')^2}{R_2\ A\ \cos\beta\ \cos\epsilon}$$

The color corrected luminance factor is:

$$LF = \frac{\pi K\ R_1 (D')^2}{R_2\ A\ \cos\beta\ \cos\epsilon} = \frac{\pi R_1 (D')^2\ T}{R_f\ A\ \cos\beta\ \cos\epsilon}$$

6.3.2 Procedure II: This procedure shall be used to determine the performance of a material or a device, using a working standard similar to the material or device being tested. The performance value of the working standard shall be determined in accordance with Procedure I. For each test condition, the values to be used for each of the geometric terms in paragraph 2.2 shall be defined. The photometric performance values [specific intensity (SI), specific luminance (SL), specific intensity per unit area (SIA), specific intensity per unit length (SIL), or the luminance factor (LF)] shall be assigned to the working standard. Photometric performance of the sample shall be determined by comparison of the sample to the working standard. These comparative measurements shall be accomplished by following Procedure I, except that the working standard shall be placed on the goniometer and reading R_{1std} shall be taken. The standard shall then be replaced with the sample, and reading R_{1test} shall be taken.

NOTE 23: Procedure II offers many advantages where a large number of performance measurements on similar samples are to be determined. However, the working standard and the sample must be similar in size, color, and performance value. Also, periodic recalibration of the working standard is required to compensate for aging. The photoreceptor must be corrected to the photopic standard observer, but does not require the color correction factor K, since the standard and the sample are similar in color (see Note 22). Optical means to shorten the photometric range, such as high quality mirrors, are allowable under Procedure II.

6.3.2.1 Specific intensity (SI)

$$SI = \frac{R_{1test}}{R_{1std}} (SI_{std})$$

Downloaded from http://www.everyspec.com

6.3.2.2 Specific luminance (SL)

$$SL = \frac{A_{std}\ R_{1test}}{A_{test}\ R_{1std}}\ (SL_{std})$$

6.3.2.3 Specific intensity per unit area (SIA)

$$SIA = \frac{A_{std}\ R_{1test}}{A_{test}\ R_{1std}}\ (SIA_{std})$$

6.3.2.4 Specific intensity per unit length (SIL)

$$SIL = \frac{L_{std}\ R_{1test}}{L_{test}\ R_{1std}}\ (SIL_{std})$$

6.3.2.5 Luminance factor (LF)

$$LF = \frac{A_{std}\ R_{1test}}{A_{test}\ R_{1std}}\ (LF_{std})$$

where

R_{1std} = The (uncalibrated) illuminance of the working standard at the photoreceptor aperture, measured in accordance with Procedure I

R_{1test} = The (uncalibrated) illuminance of the sample at the photoreceptor aperture, measured in accordance with Procedure I

SI_{std} = Specific intensity determined by Procedure I (relative to a fixed set of test conditions) and assigned to the working standard

SIA_{std} = Specific intensity per unit area determined by Procedure I (relative to a fixed set of test conditions) and assigned to the working standard

SIL_{std} = Specific intensity per unit length determined by Procedure I (relative to a fixed set of test conditions) and assigned to the working standard

SL_{std} = Specific luminance per projected area determined by Procedure I (relative to a fixed set of test conditions) and assigned to the working standard

LF_{std} = Luminance factor determined by Procedure I (relative to a fixed set of test conditions) and assigned to the working standard

A_{std} = Retroreflective area of the working standard

A_{test} = Retroreflective area of the sample

L_{std} = Length of the working standard

L_{test} = Length of the sample

Downloaded from http://www.everyspec.com

7. REFERENCES

7.1 International Lighting Vocabulary (CIE Publication 17 (E-1.1)). Available from the National Bureau of Standards (Code 232.14), Washington, D. C., 20234, 1970, page 51.

7.2 Kaufman, J.E., Ed., IES Lighting Handbook, Fifth Edition. Illuminating Engineering Society, 345 East 47th Street, New York, NY 10017, 1972, page 1-19.

7.3 Nimeroff, I., and Hall, W.A., Instrumental Colorimetry of Retroreflective Sign Materials (Report No. FHWA-RD-75-4), National Technical Information Service, Springfield, Va., 22151, 1975.

PREPARING ACTIVITY
GSA-FSS

CIVIL AGENCY COORDINATING ACTIVITY
COM-NBS

This document is available from the General Services Administration (GSA), acting as an agent for the Superintendent of Documents. A copy for bidding and contracting purposes is available from GSA Business Service Centers. Copies are for sale at the GSA, Specification and Consumer Information Distribution Branch, Building 197, Washington Navy Yard, Washington, DC 20407, **for 35 cents each.**