WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD OF TEST FOR DETERMINING SPECIFIC INTENSITY AND SPECIFIC BRIGHTNESS OF REFLEX REFLECTORS AND DELINEATORS

1.0 PURPOSE

1.1 The purpose of this procedure is to establish a standard method of test for photometrically evaluating certain types of reflectors.

2.0 SCOPE

2.1 This method of test is applicable to those types of reflectors which are constructed in such a manner as that set forth in the governing specifications.

3.0 APPARATUS AND EQUIPMENT

3.1 All photometric evaluations are to be conducted in a bench-size reflex photometer whose optional components and geometry have been scaled to be consistent with actual highway dimensions and viewing conditions. The complete photometer consists of the following individual components and/or pieces of equipment.

3.2 Housing - The housing is a rigid plastic tube, 152 mm sq and 3.4 m. The inside of the housing is painted with optical flat black enamel to eliminate errors from specularly reflected stray light. Seven openings along its length provide access to seven test stations. These stations permit measurements at different photometric distances, corresponding to actual highway observation angles. Data on seven stations are listed on the following page.

Observation Angle Station	Photometric Distance (m)	Equivalent Highway Distance, (m)
$1/2^o$	0.6 m	61.0 m
$1/3^o$	0.9 m	91.4 m
$1/4^o$	1.2 m	121 m
$1/5^o$	1.5 m	152 m
$1/6^o$	1.8 m	183 m
$1/8^o$	2.4 m	244 m
$1/10^o$	3.0 m	305 m

3.3 Goniometer - This device is used to hold the reflector in position for testing. The vertical angle of the goniometer face is adjustable, making it possible to measure reflectors at any entrance angle from 0 to 50 degrees. Samples are attached to the goniometer by means of various size holding plates which may be rotated at 300 rpm to eliminate effects of orientation. The goniometer can be relocated to any of the seven test stations.

3.4 Specific Intensity Meter - This is a solid state picoameter having an accuracy of at least two percent of full scale reading. A decade switch changes the scale ratio to permit readings over a total range from 10^{-2} to 10^{-12} amperes.

3.5 Optical System - This system consists of a high intensity projection lamp, two iris diaphragms, one of which limits the amount of light entering the system and the other which varies the divergence of the beam, and a photocell in the form of a ring of 4.7 mm inside radius and 1.3 mm width. The output of the projection lamp is concentrated through a lens system coaxial with the photometer axis.

3.6 Power Unit - This contains a 150 watt voltage regulator for maintaining a constant voltage input to the photometer, a transformer for supplying current to the projection lamp, a hi-lo switch in the lamp supply circuit for controlling the degree of illumination from the lamp on-off and motor switches, and receptacles for the various leads.

3.7 Lamp - The lamp is standard 150 watt, 20 volt projection lamp, GE Type DEF.

3.8 Fan - A 115 volt blower type fan mounted on the end of the photometer circulates air past the lamp and other optical elements.

4.0 PHOTOMETRIC PRINCIPLE

4.1 The light output from the projection lamp is directed through a collimating and focusing lens system then through a small aperture to the reflector being tested. The light is then reflected to a photocell built in the form of a very narrow ring surrounding the aperture. The current output of the photocell is fed into a sensitive picoameter, the deflection of which is proportional to the light incident on the photocell, and therefore, to the specific intensity of the reflector. By properly adjusting the intensity of the light the meter reading can be made numerically equal to the specific intensity. Observation angle is changed by changing the location of the reflector within the photometer. Orientation angle is changed by rotating the reflector on the goniometer.

5.0 TEST PROCEDURE

5.1 Calibration

5.1.2 A random reflector (known as the reference reflector) from the LOT to be tested is fastened to a holding plate of the proper size and placed on the goniometer.

5.1.3 The goniometer is set to 0 degrees entrance angle.

5.1.4 Adjust the second iris diaphragm so that the beam spread is only slightly larger than the reflector.

5.1.5 Turn on the goniometer motor to spin the reflector, thus eliminating any possible effects of orientation.

5.1.6 Read the picoameter, using any scale setting which gives a convenient large scale deflection and record the result.

5.1.7 Remove the photocell from its normal position near the lamp end of the tube and mount it on the goniometer in place of the reflector. With the goniometer not spinning and still at 0 degrees entrance angle, the picoameter is read on the same scale as the referenced reflector.

5.1.8 Compute the specific intensity of the reference reflector using the following formula:

$$Sr = \frac{R\,(Dr^4)}{C\,(Dc^2)}$$

Where: Sr = Specific intensity of reference reflector in Candelas/Lux

R = Meter reading of reference reflector outlined in 5.1.6.

C = Meter reading of photocell as outlined in 5.1.7.

D = Photometric distance of observation angle station.

5.1.9 Should the meter reading from the photocell (as outlined in 5.1.7) not be on the same scale as that used in reading the referenced reflector, then the photocell should be shifted to any other station at which a usable reading is obtained on the same scale. Under this condition, the formula in 5.1.8 would be modified as follows:

$$Sr = \frac{R\,(Dr^4)}{C\,(Dc^2)}$$

Where: D_r = Photometric distance at which reference reflector is read

D_c = Photometric distance at which photocell is read.

5.2 Testing Crystal Reflectors and Delineators

5.2.1 A random reflector from the LOT to be tested is calibrated in accordance with the procedures outlined in 5.1.1 through 5.1.9 and its meter reading, scale and specific intensity recorded and computed.

5.2.2 Having computed the specific intensity of the reference reflector above, the optical system is now adjusted by means of the iris diaphragms (reference reflector sti11 in place), unti1 the meter reading is numerically equal to the computed specific intensity and on exactly the same meter scale.

5.2.3 Remove the reference reflector and place the unknown reflectors on the goniometer at the appropriate entrance and observation angles, spin and read the specific intensity (SI) directly from the meter. Record reading on worksheet.

5.3 Testing Colored Reflectors And Delineators

5.3.1 A reflector from the LOT being tested is calibrated in accordance with the procedure outlined in 5.1.1 through 5.1.9 with the exception that in 5.17 a color filter of known transmission factor is placed in front of the photocell. The formulas in 5.1.8 and 5.1.9 then become respectively:

(1) $Sr = \frac{R\,(D^2K)}{C}$

(2) $Sr = \frac{R}{C}\,\frac{D_r^{\,4}}{D_c^{\,2}}\,K$

Where: = Transmission factor for the filter

5.3.2 Testing is completed as outlined in steps 5.2.1 through 5.2.3.

5.4 Specific Brightness

5.4.1 Compute the specific brightness of a reflector using the following formula:

$Sb = \frac{SI}{A}$ Where: Sb = Specific Brightness

SI = Specific Intensity

A = Area of reflectance surface in square millimeter.

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