Designation: E1696 – 15

Standard Test Method for Field Measurement of Raised Retroreflective Pavement Markers Using a Portable Retroreflectometer[1]

This standard is issued under the fixed designation E1696; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the measurement of the retroreflective properties of raised retroreflective pavement markers at a prescribed geometry, by means of a portable retroreflectometer that can be used in the field. The measurements can be compared to minimum requirements to determine the need for replacement.

1.2 The observation angle specified for retroreflectometers in this test method is that currently specified for raised pavement markers in the United States and may differ from the angles used elsewhere. For other jurisdictions, replace the observations angle specified herein with the observation angle specified by the pertinent agency.

1.3 This test method is intended to be used for field measurement of raised retroreflective pavement markers but may also be used to measure the performance of new markers before they are placed in the field.

1.4 This test method covers measurements of raised pavement markers mounted on a road surface or mounted in snow-plowable metal castings.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *The standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
E284 Terminology of Appearance
E808 Practice for Describing Retroreflection
E809 Practice for Measuring Photometric Characteristics of Retroreflectors

3. Terminology

3.1 The terms and definitions in Terminology E284 are applicable to this test method. Some terms particular to retroreflection are defined and illustrated in Practice E808.

3.2 *Definitions:*

3.2.1 The delimiting phrase "in retroreflection" applies to each of the following definitions when used outside the context of this or other retroreflection standards.

3.2.2 *coefficient of luminous intensity, R_I, n—of a retroreflector*, ratio of the luminous intensity (I) of the retroreflector in the direction of observation to the illuminance (E⊥) at the retroreflector on a plane perpendicular to the direction of incident light, expressed in candelas per lux ($cd \cdot lx^{-1}$).

3.2.2.1 *Discussion*—When values are low, the coefficient of (retroreflected) luminous intensity may be given in millicandelas per lux ($mcd \cdot lx^{-1}$). $R_I = (I/E_⊥)$.

3.2.3 *portable retroreflectometer*—a hand-held instrument that can be used in the field or in the laboratory for measurement of retroreflectance.

3.2.3.1 *Discussion*—In this test method, "portable retroreflectometer" refers to a hand-held instrument that can be placed over a raised retroreflective pavement marker to measure the coefficient of luminous intensity with a prescribed geometry.

3.2.4 *instrument standard, n*—a working standard used to standardize the portable retroreflectometer.

[1] This test method is under the jurisdiction of ASTM Committee E12 on Color and Appearance and is the direct responsibility of Subcommittee E12.10 on Retroreflection.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4. Summary of Test Method

4.1 This test method involves the use of commercial portable retroreflectometers for determining the coefficient of luminous intensity of pavement markers.

4.2 Entrance angle component β_1 shall be between −2° and 0°; entrance angle component β_2 shall be 0° ± 2°.

4.3 Unless otherwise specified by the user, the observation angle shall be 0.2° ± 0.01°.

4.4 The observation half plane shall be vertical. Rotation angle shall be 0° (see Fig. 1 and Fig. 2).

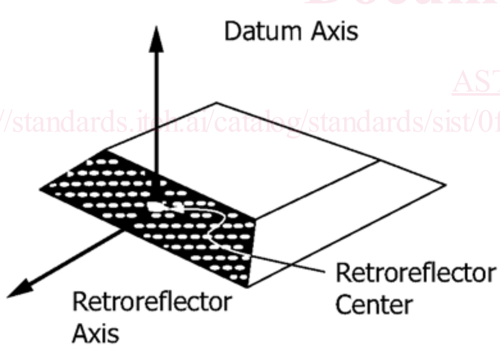
4.5 The aperture angles of the source and of the receiver shall each be 0.1° with a tolerance of ±0.04° on the sum of the two aperture angles.

4.6 The aperture angle of an individual retroreflective element shall be 0.02° max (see Practice E809). For a portable photometer this aperture angle can be achieved by interposing a collimating lens in the illumination and observation axes.

4.7 A portable standard shall be used for standardization.

4.8 After standardization place the retroreflectometer directly over the marker to be tested making sure that the road-axis marking on the retroreflectometer is parallel to the lane line of the road.

4.9 The reading displayed by the retroreflectometer is recorded. The retroreflectometer is removed from the marker, then replaced and the reading recorded again. If the difference in readings is greater than 10 %, the process is to be repeated a third time.



Location of retroreflector axis, datum axis and retroreflector center for use in testing raised pavement markers.

Retroreflector Center-located on the surface of the effective retroreflective area, centered both vertically and horizontally.

Retroreflector Axis-extends parallel to the road surface from retroreflector center.

Datum Axis-extends vertically from the road surface plane starting at retroreflector center.

FIG. 1 Position of Marker for Photometry

5. Significance and Use

5.1 Measurements of R_I made by this test method, with the 0.2° observation angle, are related to visual observation of raised retroreflective pavement markers at distances of approximately 220 m (720 ft) for cars or approximately 440 m (1440 ft) for trucks when illuminated by tungsten filament light sources such as car headlights.

5.2 There are some castings that block vehicle illumination of a portion of the marker mounted within it. In this case, measured R_I can be significantly lower than when the marker is photometered outside the casting, but will correspond to the visual observation.

5.3 The test method is not applicable to raised pavement markers mounted in depressions cut into the pavement.

5.4 The coefficient of luminous intensity of raised retroreflective pavement markers degrades with traffic wear and requires periodic measurement to ensure that sufficient visibility is provided to the driver.

5.5 The quality of the pavement markers as to materials used, age and wear pattern, will have an effect on the coefficient of (retroreflected) luminous intensity. These conditions need to be observed and noted by the user.

6. Apparatus

6.1 *Portable Retroreflectometer:*

6.1.1 The retroreflectometer shall be portable with the capability of being positioned over markers installed on the roadway surface.

6.1.2 The retroreflectometer shall be constructed so that placement on the road will preclude any stray light from entering the area being tested under daylight conditions.

6.1.3 The retroreflectometer shall be constructed so that it can be placed over the marker with the illumination axis approximately parallel to the road surface.

6.1.4 The combined spectral distribution of the light source and the spectral responsivity of the receiver shall match the *combined spectral distribution of* CIE Standard Illuminant *A* and the $V(\lambda)$ photopic spectral luminous efficacy function according to the following two criteria for all λ_0 between 470 nm and 640 nm:

$$0.9<\left(\frac{\sum_{\lambda=360}^{830} exp\left(\left(\frac{\lambda-\lambda_0}{25}\right)^2\right)S(\lambda)R(\lambda)\sum_{\lambda=360}^{830}A(\lambda)V(\lambda)}{\sum_{\lambda=360}^{830} exp\left(\left(\frac{\lambda-\lambda_0}{25}\right)^2\right)A(\lambda)V(\lambda)\sum_{\lambda=360}^{830}S(\lambda)R(\lambda)}\right)<1.1$$

and also

$$\left(\frac{\sum_{\lambda=670}^{1000}S(\lambda)R(\lambda)}{\sum_{\lambda=360}^{1000}S(\lambda)R(\lambda)}\right)<0.02$$

where:

S(λ) = instrument illumination spectral power distribution,
R(λ) = instrument spectral responsivity,
A(λ) = CIE Standard Illuminant A, and
V(λ) = CIE photopic luminous efficacy function.