Designation: E2540 – 16 (Reapproved 2022)

Standard Test Method for Measurement of Retroreflective Signs Using a Portable Retroreflectometer at a 0.5 Degree Observation Angle[1]

This standard is issued under the fixed designation E2540; 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 measurement of the retroreflective properties of sign materials such as traffic signs and symbols (vertical surfaces) using a portable retroreflectometer that can be used in the field. The portable retroreflectometer is a hand-held instrument with a defined standard geometry that can be placed in contact with sign material to measure the retroreflection in a standard geometry. The measurements can be compared to minimum requirements to determine the need for replacement. Entrance and observation angles specified in this test method are those used currently in the United States and may differ from the angles used elsewhere in the world.

1.2 This test method is intended to be used for the field measurement of traffic signs but may be used to measure the performance of materials before placing the sign in the field or before placing the sign material on the sign face.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E284 Terminology of Appearance

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

E808 Practice for Describing Retroreflection

E809 Practice for Measuring Photometric Characteristics of Retroreflectors

E810 Test Method for Coefficient of Retroreflection of Retroreflective Sheeting Utilizing the Coplanar Geometry

3. Terminology

3.1 The terminology used in this test method generally agrees with that used in Terminology E284.

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

3.2.1 *annular geometry, n*—the portable instrument retroreflection collection method where the retroreflected lux is collected in an annulus 0.1 degrees wide centered on the illumination axis.

3.2.1.1 *Discussion*—The angle measured from the illumination axis to the circle which divides the annulus into equal areas corresponds to a specific observation angle.

3.2.2 *coefficient of retroreflection, R_A, n—of a plane retroreflecting surface*, the ratio of the coefficient of luminous intensity (R_I) of a plane retroreflecting surface to its area (A), expressed in candelas per lux per square metre ($cd \cdot lx^{-1} \cdot m^{-2}$).

3.2.3 *datum axis, n*—a designated half-line from the retroreflector center perpendicular to the retroreflector axis.

[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.

3.2.4 *entrance angle, β, n*—the angle between the illumination axis and the retroreflector axis.

3.2.5 *entrance half-plane, n*—the half plane that originates on the line of the illumination axis and contains the retroreflector axis.

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

3.2.7 *observation angle, α, n*—the angle between the illumination axis and the observation axis.

3.2.8 *observation half-plane, n*—the half plane that originates on the line of the illumination axis and contains the observation axis.

3.2.9 *orientation angle, ω_s, n*—the angle in a plane perpendicular to the retroreflector axis from the entrance half-plane to the datum axis, measured counter-clockwise from the viewpoint of the source.

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

3.2.10.1 *Discussion*—In this test method, "portable retroreflectometer" refers to a hand-held instrument that can be placed in contact with sign material to measure the retroreflection in a standard geometry.

3.2.11 *presentation angle, γ, n*—the dihedral angle from the entrance half-plane to the observation half-plane, measured counter-clockwise from the viewpoint of the source.

3.2.12 *retroreflection, n*—a reflection in which the reflected rays are returned preferentially in directions close to the opposite of the direction of the incident rays, this property being maintained over wide variations of the direction of the incident rays.

3.2.13 *rotation angle, ε, n*—the angle in a plane perpendicular to the retroreflector axis from the observation half-plane to the datum axis, measured counter-clockwise from the viewpoint of the source.

3.3 Definitions of entrance angle components β_1 and β_2, as well as other geometrical terms undefined in this test method, may be found in Practice E808.

4. Summary of Test Method

4.1 This test method involves the use of commercial portable retroreflectometers for determining the retroreflectivity of highway signing materials.

4.2 The entrance angle shall be –4°.

4.3 The observation angle shall be 0.5°.

4.4 The portable retroreflectometer uses an instrument standard for standardization.

4.5 After standardization, the retroreflectometer is placed in contact with the sign to be tested, ensuring that only the desired portion of the sign is within the measurement area of the instrument.

4.6 The reading displayed by the retroreflectometer is recorded. The retroreflectometer is then moved to another position on the sign, and this value is recorded. A minimum of four readings shall be taken and averaged for each retroreflective color on the sign to be tested.

5. Significance and Use

5.1 Measurements made by this test method are related to the night time brightness of retroreflective traffic signs approximately facing the driver of a mid-sized automobile equipped with tungsten filament headlights at about 100 m distance.

5.2 Retroreflective material used on traffic signs degrades with time and requires periodic measurement to ensure that the performance of the retroflection provides adequate safety to the driver.

5.3 The quality of the sign as to material used, age, and wear pattern will have an effect on the coefficient of retroreflection. These conditions need to be observed and noted by the user.

5.4 This test method is not intended for use for the measurement of signs when the instrument entrance and observation angles differ from those specified herein.

6. Apparatus

6.1 *Portable Retroreflectometer*—The retroreflectometer shall be portable, with the capability of being placed at various locations on the signs. The retroreflectometer shall be constructed so that placement on the sign will preclude stray light (daylight) from entering the measurement area of the instrument and affecting the reading.

6.2 *Instrument Standard,* or standards of desired color(s) and material(s).

6.3 *Light Source Requirements:*

6.3.1 The projection optics shall be such that the illuminance at any point over the measurement area shall be within 10 % of the average illuminance.

6.3.2 The aperture angle of the source as determined from the center of the measurement area shall be not greater than 0.1°.

6.4 *Receiver Requirements:*

6.4.1 The receiver shall have sufficient sensitivity and range to accommodate coefficient of retroreflection values from 0.1 to 1999.9 $cd \cdot lx^{-1} \cdot m^{-2}$.

6.4.2 The combined spectral distribution of the light source and the spectral responsivity of the receiver shall match the combined spectral distribution of CIE Illuminant A and the V(λ) spectral luminous efficiency function according to the following criterion: For any choice of plano-parallel colored absorptive filter mounted in front of a white retroreflective sample, the ratio of the R_A measured with the filter to the R_A measured without the filter shall be within 10 % of the Illuminant A luminous transmittance of an air spaced pair of two such filters.

6.4.3 The instrument may be either an instrument with point geometry, a "point instrument," or an instrument with annular geometry, an "annular instrument," depending on the shape of the receiver aperture (see Fig. 1). Point and annular instruments make geometrically different measurements of R_A, which may produce values differing on the order of 10 %. Both measurements are valid for most purposes, but the user should learn the