Designation: E3320 – 21

Standard Test Method for Measurement of Retroreflective Pavement Marking Materials Using a Mobile Retroreflectometer Unit (MRU) [1]

This standard is issued under the fixed designation E3320; 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 horizontal pavement marking materials containing retroreflecting optics, such as traffic stripes and surface symbols, using a mobile retroreflectometer unit that can be operated at traffic speed, mounted on a vehicle to measure the retroreflection at a prescribed geometry.

1.2 The entrance and observation angles of the MRU affect the readings. As specified by the European Committee for Standardization (CEN) and in Test Method E1710, the entrance and observation angles shall be 88.76° and 1.05°, respectively.

1.3 This test method is intended to be used for field measurement of pavement markings at traffic speed.

1.4 This test method is intended to be used for retroreflectivity measurement of dry pavement markings.

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.6 This standard does not purport to address regulatory and safety regulations of the MRU and its use. It is the responsibility of the manufacturer to fulfill regulatory standards. 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.

1.7 *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]

D7585 Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments

E284 Terminology of Appearance

E808 Practice for Describing Retroreflection

E1710 Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer

2.2 *Other Standards:*

CEN EN 1436 Road Marking Materials—Road Marking Performance for Road Users and Test Methods[3]

CIE publication No. 54.2 Retroreflection – Definition and Measurement[4]

ISO 10526 CIE standard illuminants for colorimetry[5]

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 test methods:

3.2.1 *actual measuring distance, D, n*—the actual horizontal distance from the MRU to the center of the measuring areas of the pavement marking.

3.2.2 *coefficient of retroreflected luminance, R_L, n*—the ratio of the luminance, *L*, of a projected surface to the normal

[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] Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, http://www.cen.eu.

[4] Available from U.S. National Committee of the CIE (International Commission on Illumination), C/o Alan Laird Lewis, 282 E. Riding, Carlisle, MA 01741, http://www.cie-usnc.org.

[5] Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.

illuminance, E', at the surface on a plane normal to the incident light expressed in candelas per square meter per lux ($cd \cdot m^{-2} \cdot lx^{-1}$).

3.2.2.1 *Discussion*—Because of the low luminance of pavement markings, the units used commonly are millicandelas per square meter per lux ($mcd \cdot m^{-2} \cdot lx^{-1}$).

3.2.3 *co-entrance angle, β_C, n*—the complement of the entrance angle ($90° - \beta$).

3.2.4 *co-viewing angle, v_C, n*—the complement of the viewing angle ($90° - v$).

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

3.2.5.1 *Discussion*—The retroreflector axis for pavement markings is normal to the marking.

3.2.6 *entrance angle components, n—β_1* and β_2 are the entrance angle components as defined in CIE publ. 54.2 and Practice E808.

3.2.7 *instrument standard, n*—working standard used to calibrate the MRU.

3.2.8 *intended measuring distance, D_0, n*—the intended horizontal distance from the MRU to the center of the measuring areas of the pavement marking.

3.2.9 *longitudinal measurement field, L, n*—longitudinal dimension of the measuring field.

3.2.10 *mobile retroreflectometer unit (MRU), n*—refers to a measurement system that can be mounted on a vehicle to measure the coefficient of retroreflected luminance with a prescribed geometry at traffic speed.

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

3.2.12 *presentation angle, γ, n*—the angle between the observation half-plane and the half-plane that originates on the illumination axis and that contains the retroreflector axis.

3.2.13 *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.

3.2.14 *rotation angle, ε, n*—the angle in a plane perpendicular to the retroreflector axis from the observation half-plane to the datum axis, measured counterclockwise from a viewpoint on the retroreflector axis; according to Practice E808.

3.2.15 *transverse measurement field, T, n*—dimension of the width of the measurement field in the traverse direction in order to fully measure the width of the road marking(s).

3.2.16 *viewing angle, v, n*—the angle between the retroreflector axis and the observation axis.

4. Summary of Test Method

4.1 This test method involves the use of MRU for determining the coefficient of retroreflected luminance of horizontal coating materials used in pavement markings, at traffic speed.

4.2 The entrance angle is fixed at 88.76° (co-entrance angle 1.24°). See Fig. 1.

4.3 The observation angle is fixed at 1.05°. See Fig. 1.

4.4 The entrance angle component β_2 (the side angle) measured between the longitudinal direction of the road marking and the vertical plane containing the direction of view shall be within ±10°. Measurement uncertainty increases as β_2 increases. See Fig. 1.

4.5 The MRU uses for calibration an external white standard, an external beaded horizontal panel, or a diffuse reflection tilted panel of known coefficient of retroreflected luminance.

4.6 The retroreflectometer is mounted to the vehicle, ensuring the pavement marking(s) to be measured is(are) within its field-of-view.

4.7 The vehicle is driven down the road with the flow of traffic collecting data on the pavement marking(s) as it goes. Data collection is averaged over a given distance driven (typically 0.1 miles or 100 m) and saved with GPS coordinates.

4.8 Other peripheral data such as vehicle speed, calendar date, time of day, road conditions, pavement marking contrast, width, color, etc. may also be collected by the MRU.

4.9 Measurements shall be taken and averaged in each direction of traffic for a centerline.

5. Significance and Use

5.1 The quality of the pavement marking is determined by the coefficient of retroreflected luminance, R_L, and depends on the materials used, age, wear pattern, application method, pavements surface, and other conditions.

5.2 Under the same conditions of illumination and viewing, larger values of R_L correspond to higher levels of visual performance in dark conditions.

5.3 Retroreflectivity of pavement (road) markings degrades with traffic wear and requires periodic measurement to ensure that sufficient line visibility is provided to drivers.

5.4 MRUs are used to measure R_L values of road markings while moving at traffic speed, and can be used for longer stretches of road than portable instruments and in cases where the use of portable instruments require extensive precautions, in particular on motorways.

5.5 The measurement geometry of the MRU is based on a viewing distance of 30 m, a headlight mounting height of 0.65 m directly over the stripe, and an eye height of 1.2 m directly over the marking according to CEN 1436 and Test Method E1710.

5.6 MRUs are to be calibrated, maintained, and operated according to instructions by the instrument supplier or manufacturer.

5.7 It shall be the responsibility of the user to employ an MRU fulfilling the required specifications in this standard.

6. MRU System

6.1 *Vehicle Mounted Retroreflectometer System:*

6.1.1 The MRU shall be mountable on a vehicle and operated at traffic speed. Alignment to establish the specified