



Designation: E 1743 – 96

Standard Practice for Selection and Use of Portable Retroreflectometers for the Measurement of Pavement Marking Materials¹

This standard is issued under the fixed designation E 1743; 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 practice covers the selection and use of portable retroreflectometers for the measurement at a prescribed geometry of the retroreflective properties of horizontal pavement marking materials containing glass spheres, such as traffic stripes and surface symbols.

1.2 The entrance and observation angles provided in the retroreflectometer greatly affect the test results and must be a major consideration in the selection of the instrument. Information on the relationship between instrument geometry and viewing geometry is provided in Section 5. Information on viewing geometry is provided in Table 1. Information on the relationship between viewing geometry and coefficient of retroreflected luminance, R_L is given in Fig. 1.

1.3 This practice is intended to be used for selection of portable retroreflectometers for field measurement of pavement markings but may also be used to select portable retroreflectometers to measure the performance of materials on sample panels before placing the marking material in the field.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- D 4061 Test Method for Retroreflectance of Horizontal Coatings²
- E 284 Terminology of Appearance²
- E 809 Practice for Measuring Photometric Characteristics of Retroreflectors²
- E 1710 Test Method for the Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer²

¹ This practice is under the jurisdiction of ASTM Committee E-12 on Appearance and is the direct responsibility of Subcommittee E12.10 on Retroreflection. Current edition approved May 10, 1996. Published July 1996.

² Annual Book of ASTM Standards, Vol 06.01.

TABLE 1 Examples of Viewing Geometry at Centerline for a Typical American Car and Driver

Distance, m	Left Headlight			Right Headlight		
	Entrance Angle, °	Co- entrance Angle, °	Obser- vation Angle, °	Entrance Angle, °	Co- entrance Angle, °	Obser- vation Angle, °
15	87.53	2.47	2.09	87.55	2.45	4.57
30	88.76	1.24	1.05	88.76	1.24	2.31
50	89.26	0.74	0.63	89.26	0.74	1.39
80	89.53	0.47	0.39	89.53	0.47	0.87
120	89.69	0.31	0.26	89.69	0.31	0.58

3. Terminology

3.1 The terminology used in this practice, agrees with that used in Terminology E 284.

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

3.2.1 *coefficient of retroreflected luminance*, R_L —ratio of the luminance, L , of a projected surface to the normal illuminance, $E_{\perp}$, at the surface on a plane normal to the incident light, expressed in candelas per square meter per lux ($\text{cd} \cdot \text{m}^{-2} \cdot \text{lx}^{-1}$).

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

3.2.2 *co-entrance angle*, β_c —the complement of the entrance angle ($90^\circ - \beta$).

3.2.3 *co-viewing angle*, ν_c —the complement of the viewing angle ($90^\circ - \nu$).

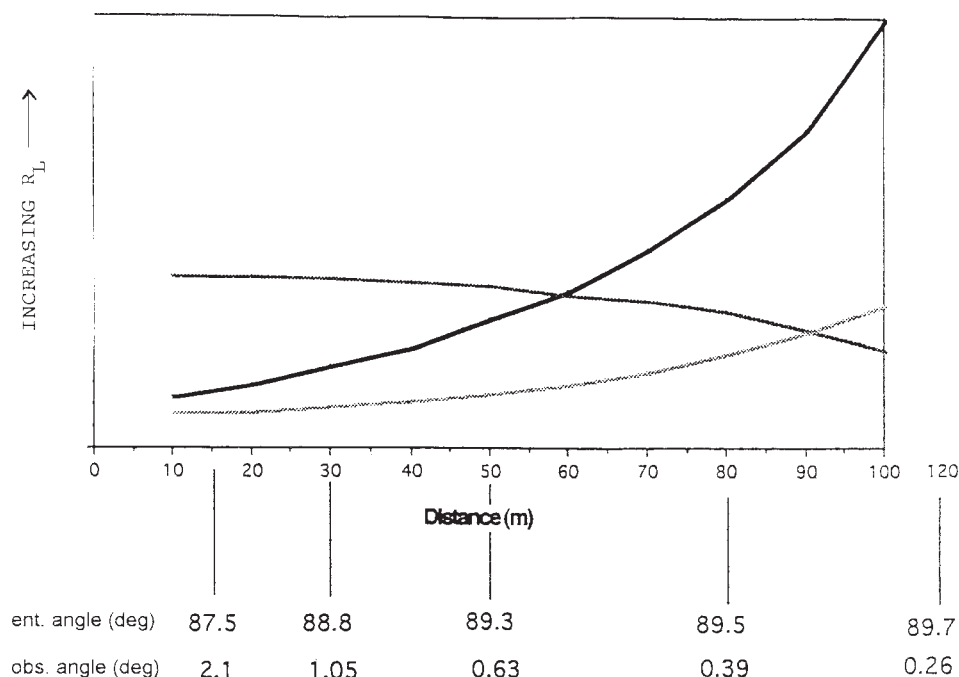
3.2.4 *entrance angle*, β —angle between the illumination axis and the retroreflector axis.

3.2.5 *instrument standard*—a working standard used to standardize the portable retroreflectometer.

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

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

3.2.7.1 *Discussion*—In this practice, “portable retroreflectometer” refers to a hand-held instrument that can be placed



NOTE 1—Observation and entrance angles at indicated viewing distances are examples based upon a typical car and driver and may change if either the car or driver is changed.

FIG. 1 Curve of R_L versus Viewing Distance for Three Different Types of Markings

over roadway delineation to measure the coefficient of retroreflected luminance with a prescribed geometry.

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

3.2.9 *retroreflection*—reflection in which the reflected rays are preferentially returned 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.

3.2.10 *viewing angle*, v —the angle between the retroreflector axis and the receiver axis.

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

4. Summary of Practice

4.1 This practice involves the selection and use of commercial portable retroreflectometers for measurement at a prescribed geometry of the coefficient of retroreflected luminance of horizontal coating materials used in pavement markings.

4.2 The entrance angle used in such instruments is generally between 85.0° and 89.5° .

4.3 The observation angle used in such instruments is generally between 0.5° and 2.0° .

4.4 The instrument shall be selected so that the observation and entrance angles provided in the instrument conform to the angles specified by the pertinent agency or, if there is no specification for angles, the instrument shall be selected with attention to the general information provided in Section 5, Table 1, and Fig. 1.

4.5 The portable retroreflectometers may use either a built-in reference white for standardization or an external panel of known coefficient of retroreflected luminance.

4.6 General practice is to place the retroreflectometer directly over the pavement marking to be measured making sure that the measurement area of the retroreflectometer fits within the width of the stripe. The reading displayed by the retroreflectometer shall be recorded.

4.7 General practice is to then move the retroreflectometer to a number of other positions on the pavement marking and record and average the readings.

4.8 For a centerline, readings are generally taken and averaged in each direction.

4.9 Because of the extreme range of entrance and observation angles available in commercial instruments it should not be anticipated that there will be any correlation between instruments except for those using identical entrance and observation angles. This caution is true even when the instruments are standardized using as a standard, materials having the same glass bead indices, penetration, binder index, etc.

5. Significance and Use

5.1 The quality of the stripe is determined by the coefficient of retroreflected luminance and depends on the materials used, the age, and the wear pattern. These conditions should be observed and noted by the user.

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

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 The relative visibility rankings of two different pavement markings may vary with the distance at which the markings are viewed. The material with the higher visibility