



Standard Specification for Minimum Retroreflectance of Newly Applied Pavement Marking Using Portable Hand-Operated Instruments¹

This standard is issued under the fixed designation D 6359; 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 specification covers the minimum retroreflective properties of newly applied horizontal pavement markings containing retroreflecting spheres, such as traffic stripes and surface symbols. The geometry specified for these values corresponds to that of Test Method E 1710 and is the same as CEN geometry.

1.2 This specification is intended to provide standards of horizontal pavement markings to ensure that adequate conspicuity for the driver at night is provided by newly applied markings. This specification applies to the measurement of the markings using portable hand-operated instruments.

1.3 Newly applied pavement markings are those that have been applied within 14 days before testing and from which all excess glass spheres have been removed.

NOTE 1—Excess glass spheres contribute to erroneous readings directly after application and are generally not present a few days after application. They should be removed by strong brushing or by air pressure or other methods that do not remove the spheres that are correctly embedded and in water-borne paint after film coalescing.

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 4505 Specification for Preformed Plastic Pavement Marking Tape for Extended Service Life²

D 4592 Specification for Preformed Plastic Pavement Marking Tape for Limited Service Life²

E 284 Terminology of Appearance³

E 808 Practice for Describing Retroreflection³

E 1710 Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer³

¹ This guide is under the jurisdiction of ASTM Committee D-4 on Road Paving Materials and is the direct responsibility of Subcommittee D04.38 on Highway Traffic Control Materials.

Current edition approved July 10, 1999. Published September 1999. Originally published as D 6359-98. Last previous edition D 6359-98.

² *Annual Book of ASTM Standards*, Vol 04.03.

³ *Annual Book of ASTM Standards*, Vol 06.01.

2.2 Other Standards:

CEN/EN 1436:1997 Road Equipment. Horizontal Signalization. Road Marking Performance for Road Users⁴

US Mil-Std 105D Sampling Procedure and Tables for Inspection by Attributes⁵

3. Terminology

3.1 The terms and definitions in Terminology E 284 and Practice E 808 are applicable to this specification.

3.2 Definitions:

3.2.1 *coefficient of retroreflected luminance, R_L, n* —the 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 metre per lux ($\text{cd m}^{-2}\text{lx}^{-1}$).

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

3.3 Definitions of Terms Specific to This Standard:

3.3.1 *acceptable quality level, AQL, n* —the maximum percent defective that, for purposes of sampling inspection, can be considered satisfactory as a process average.

3.3.1.1 *Discussion*—This is the largest proportion of pavement marking readings with values below the acceptable level.

3.3.2 *CEN geometry*—the geometry of instrument measurement specified by CEN, based on a viewing distance of 30 m from an arbitrary passenger vehicle with an eye height of 1.2 m and a single headlight mounting height of 0.65 m in the same vertical plane and a pavement stripe directly ahead of the headlight.

3.3.3 *checkpoint area*—the marking area to be evaluated within each zone of measurement.

3.3.4 *global control area—*for pavement markings**, the road length containing the markings subjected to control, for example, lines, symbols, legends, pedestrian crossings, etc.

3.3.5 *inspection by attributes*—inspection whereby either the unit of product is classified simply as acceptable or non-acceptable, or the number of rejections in the unit of product is counted, with respect to a given requirement or set of requirements.

⁴ Available from European Committee for Standardization: Central Secretariat: rue de Stassart 36, B-1050 Brussels, Belgium.

⁵ Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC. 20402

3.3.5.1 *Discussion*—A discrete one-dimensional probability distribution used in industrial quality control. Mathematically known as hyper-geometric probability distribution functions.

3.3.6 *limit quality, LQ, n*—limit of the AQL that is acceptable, providing a specified limited quality for protection.

3.3.6.1 *Discussion*—This is the proportion of pavement marking readings with values below the acceptable level, which in the worst case, would be allowed.

3.3.7 *test point*—the point in the checkpoint area where the measurement is made.

3.3.8 *producer's risk*—the risk the producer of the marking takes that the marking will fail the requirement of 5.1.

3.3.8.1 *Discussion*—If the population of the entire pavement marking fulfills the specification, there is still the probability that the sampling of the marking will fall below the acceptable value. This is designated the *a* risk.

3.3.9 *user's risk*—the risk the end-user or controller takes that the marking will meet the requirement of 5.1.

3.3.9.1 *Discussion*—If the population of the entire pavement marking fails the specification, there is still the probability that the sampling of the marking will equal or exceed the acceptable value. This is designated the *b* risk.

3.3.10 *zone of measurement*—the road length containing the marking units to be measured that appear to below specification.

3.3.10.1 *Discussion*—Visual inspection of the marking is what is intended here. If the marking appears questionable in terms of its retroreflectivity, then measurements shall be undertaken. The zone of measurement for this visual inspection begins with the first stretch of suspect marking and extends to the last.

4. Summary of Specification

4.1 This specification sets the minimum retroreflectance values for newly applied pavement markings and the sampling criteria used for determining compliance with this specification.

5. Performance Requirements

5.1 *Retroreflection*— The pavement marking material shall be retroreflecting white or yellow, and shall be readily visible as white or yellow when viewed with automobile headlights at night. The pavement marking shall be measured after removal of all excess glass spheres and within 14 days after application (see 1.3). The pavement marking shall have a minimum initial coefficient of retroreflective luminance of 250 mcd m⁻²lx⁻¹ for white and 175 mcd m⁻²lx⁻¹ for yellow.

5.2 *Measurement Geometry*— The measurement geometry used to determine the values in 5.1 shall be 88.76° for the entrance angle (β_1), ($\beta_2 = 0^\circ$) and 1.05° for the observation angle. The aperture angles for both the source and receiver shall not exceed 0.33°. Test Method E 1710 shall be used to determine the requirements of 5.1.

6. Sampling

6.1 All measurements obtained in the sampling areas listed as follows are to be made in the direction of traffic flow, except on the centerline of two-lane roads where the required number of measurements will be made in each direction. Both single

and double lines are to be measured, and the acceptance criteria of 6.3 shall be followed for each line in both directions.

NOTE 2—This sampling procedure shall be used when the pavement marking applied is typically uniform throughout the zone.

6.2 *Sampling*—This specification sets the *a* risk, *b* risk, and AQL at 6.5 % and the LQ at 20 %.

6.2.1 *Solid Longitudinal Lines:*

6.2.1.1 *300 m Zone of Measurement* (see Fig. 1)—Measurement containing one randomly located checkpoint area 100 m long.

6.2.1.2 *300 m Zone, Checkpoint Area*—Measurements shall be made approximately every 5 m along the line, with the sample size set at 20 and the acceptance criteria of 6.3 used.

6.2.1.3 *300 m - 10 km Zone of Measurement* (see Fig. 2)—Two checkpoint areas 100 m long are required up to 1 km. The checkpoint areas shall be randomly located with no overlap. Checkpoint areas shall be taken at the start, midpoint, and end zones of measurement greater than 1 km. Test point measurements within each checkpoint area shall be made with a sample size of 20 and the acceptance criteria of 6.3 used. Within the checkpoint areas test point measurements shall be made at approximately 5 m intervals along the line.

6.2.1.4 *Zone of Measurement Greater Than 10 km* (see Fig. 3)—Checkpoint areas 100 m in length shall be located at the start and end of the zone and every 5 km within the zone. Within the checkpoint areas, test point measurements shall be made at approximately 5-m intervals along the checkpoint area with a sample size of 20 and the acceptance criteria of 6.3 used.

6.2.2 *Broken Longitudinal Lines:*

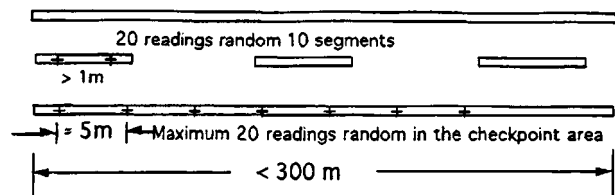
6.2.2.1 *300 m Zone of Measurement*, containing one randomly located checkpoint area.

6.2.2.2 *300 m Zone, Checkpoint Area*—Two test point measurements shall be taken randomly on each of 10 strokes, with the sample measurement size set at 20 and the acceptance criteria of 6.3 used. The random measurement shall be separated by at least 1 m.

6.2.2.3 *300 m - 10 km Zone of Measurement*—Two checkpoint areas are required. Two test point measurements shall be taken randomly on each of 10 strokes, with the sample size set at 20 and the acceptance criteria of 6.3 used. The random measurement shall be separated by at least 1 m.

6.2.2.4 *Zone of Measurement Greater Than 10 km*—Checkpoint areas shall be located at the start and end of the zone and every 5 km within the zone. Within the checkpoint

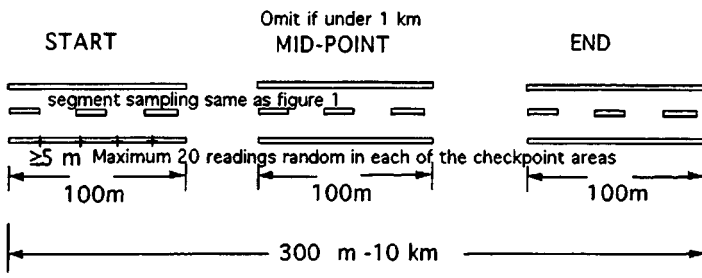
PORTABLE HAND-OPERATED INSTRUMENTS



NOTE 1—See 6.1 and 6.2 for further information.

FIG. 1 Typical Measurement Locations for Zones Less than 300 M

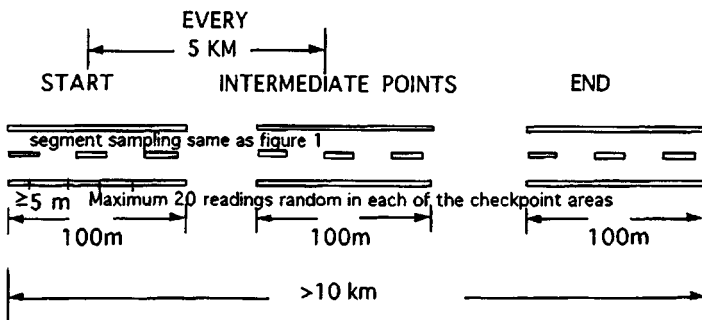
PORTABLE HAND-OPERATED INSTRUMENTS



NOTE 1—See 6.1 and 6.2 for further information.

FIG. 2 Typical Measurements for Zones 300 m to 10 km

PORTABLE HAND-OPERATED INSTRUMENTS



NOTE 1—See 6.1 and 6.2 for further information.

FIG. 3 Typical Measurements for Zones Greater than 10 km

areas two test point measurements shall be taken randomly on each of 10 strokes, with the sample size set at 20 and the acceptance criteria of 6.3 used. The random measurement shall be separated by at least 1 m.

6.2.3 *Legends, Symbols, Pedestrian Crossing, etc.:*

6.2.3.1 *Legends*—Every letter is considered as a checkpoint, and three (3) measurements shall be made in each letter in the direction of travel. The average (mean) value shall be used to determine acceptance.

6.2.3.2 *Symbols or Transverse Lines*—Considered as a checkpoint, and six (6) test point measurements shall be made on symbols or transverse lines that are 2.4 m tall or wide. Three (3) measurements on symbols or transverse lines smaller than 2.4 m shall be made. The average (mean) value shall be used to determine acceptance.

6.2.3.3 *Continental Style Pedestrian Crossings*—Three (3) random stripes shall be selected as checkpoints. Six (6) measurements shall be made in each of the selected stripes. The average (mean) value shall be used to determine acceptance.

6.3 *Project Acceptance*—The number of readings below the

minimum values listed in 5.1 are used to determine project (or zone) acceptance or rejection.

6.3.1 For cases in which six (6) or three (3) sample size measurements are specified, all readings shall be taken. The average and coefficient of variation shall be calculated. If the grand average falls below the requirements of 5.1, the marking is not acceptable.

6.3.1.1 *Discussion*—The coefficient of variation allows the controller to determine whether the marking shall be restriped even if the average exceeds the requirements of 5.1. Large coefficient of variations (>30 %, as an example) indicate that the appearance of the marking will be nonuniform and may cause problems for the observer’s visibility.

6.3.2 For cases in which 20 sample size measurements are specified: If three or fewer readings are below the minimum, the project (or zone) is accepted. If four or more values are below the minimum, the project (or zone) is rejected.

NOTE 3—Acceptance/rejection decisions are made for the entire project based on the cumulative sampling completed within the project regardless of the number of sample measurements taken at any given checkpoint.

6.3.3 Use of the sampling procedure and tables for inspection by attributes forms the basis of the acceptance criteria given in this section. Measurements shall proceed until the decision point for rejection is reached, in which case, the probability is 95 % that more than 20 % of the pavement marking will fall below the requirement in 5.1, and the pavement marking does not meet this specification. If less than the acceptance number of readings fall below the requirements in 5.1, after taking the required number of sample measurements, the probability is 95 % that less than 5 % of the pavement marking will fall below the values specified in 5.1 and the pavement marking is accepted.

7. Reporting

7.1 Include the following in the test report:

7.1.1 Test date and time,

7.1.2 Date and time of application of the pavement marking,

7.1.3 The location (highway, route #, cardinal points, direction of traffic, line identification, and other designated information),

7.1.4 The description of the instrumentation and the test method used,

7.1.5 The respective section or subsection from this specification used in determining the measurements and acceptance/nonacceptance criteria, and

7.1.6 The readings shall be recorded in millicandelas per square metre per lux ($mcd\ m^{-2}lx^{-1}$). Measurements shall be reported for each traffic direction for each lane marking.

8. Keywords

8.1 pavement markings; retroreflection

ANNEX**(Mandatory Information)****A1. OTHER MEASUREMENT GEOMETRIES**

A1.1 This specification does not replace Specification D 4505 or D 4592. The current geometry specified in Specifications D 4505 and D 4592 shall be used when determining the performance of the type of material covered by Specifications D 4505 and D 4592.

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

This standard is copyrighted by ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (<http://www.astm.org>).