



Standard Specification for Extended Life Type, Nonplowable, Prismatic, Raised, Retroreflective Pavement Markers¹

This standard is issued under the fixed designation D 4280; 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 nonplowable, retroreflective, raised pavement markers for lane marking and delineation for nighttime visibility.

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

1.3 The following precautionary caveat pertains only to the test methods portion, Section 9, of this specification: *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:

- C 184 Test Method for Fineness of Hydraulic Cement by the 150- μm (No. 100) and 75- μm (No. 200) Sieves²
- C 430 Test Method for Fineness of Hydraulic Cement by the 45- μm (No. 325) Sieve²
- D 5 Test Method for Penetration of Bituminous Materials³
- D 36 Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)⁴
- D 70 Test Method for Density of Semi-Solid Bituminous Materials (Pycnometer Method)³
- D 92 Test Method for Flash and Fire Points by Cleveland Open Cup⁵
- D 788 Classification System for Poly(Methyl Methacrylate) (PMMA) Molding and Extrusion Compounds⁶
- D 1754 Test Method for Effects of Heat and Air on Asphaltic Materials (Thin-Film Oven Test)³
- D 1856 Test Method for Recovery of Asphalt from Solution by Abson Method³
- D 2171 Test Method for Viscosity of Asphalts by Vacuum

- Capillary Viscometer³
- D 2172 Test Methods for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures³
- D 2176 Test Method for Folding Endurance of Paper by the M.I.T. Tester⁷
- D 2669 Test Method for Apparent Viscosity of Petroleum Waxes Compounded with Additives (Hot Melts)⁸
- D 3935 Specification for Polycarbonate (PC) Unfilled and Reinforced Material⁹
- D 4402 Test Method for Viscosity Determinations of Unfilled Asphalts Using the Brookfield Thermoset Apparatus⁴
- D 5329 Test Methods for Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements³
- E 284 Terminology of Appearance¹⁰
- E 308 Practice for Computing the Colors of Objects by Using the CIE System¹⁰
- E 808 Practice for Describing Retroreflection¹⁰
- E 809 Practice for Measuring Photometric Characteristics of Retroreflectors¹⁰
- E 811 Practice for Measuring Colorimetric Characteristics of Retroreflectors Under Nighttime Conditions¹⁰
- 2.2 *Federal Specifications:*¹¹
 - FF-W-1825A Wool and Gauze, Metallic
 - TT-T-291 Thinner, Paint, Mineral Spirits, Regular and Odorless
- 2.3 *AASHTO Standards:*¹²
 - AASHTO No. M237 Epoxy Resin Adhesive for Bonding Traffic Markers to Hardened Concrete
 - AASHTO No. T237 Testing Epoxy Resin Adhesive

3. Terminology

3.1 Definitions:

3.1.1 *coefficient of luminous intensity*, R_1 (specific intensity)—the 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

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² *Annual Book of ASTM Standards*, Vol 04.01.

³ *Annual Book of ASTM Standards*, Vol 04.03.

⁴ *Annual Book of ASTM Standards*, Vol 04.04.

⁵ *Annual Book of ASTM Standards*, Vol 05.01.

⁶ *Annual Book of ASTM Standards*, Vol 08.01.

⁷ *Annual Book of ASTM Standards*, Vol 15.09.

⁸ *Annual Book of ASTM Standards*, Vol 05.02.

⁹ *Annual Book of ASTM Standards*, Vol 08.02.

¹⁰ *Annual Book of ASTM Standards*, Vol 06.01.

¹¹ Available from U.S. Government Printing Office, Washington, DC 20402.

¹² Available from American Association of State Highway and Transportation Officials, 444 N. Capitol, Washington, DC 20001.

direction of the incident light, expressed in candelas per lux (cd/lx) (see Practice E 808 and Terminology E 284).

3.1.1.1 *Discussion*—When values are low the coefficient of (retroreflected) luminous intensity may be given in millicandelas per lux. In inch-pound units, R_I is given in candelas per footcandle (cd/ftc). Historically, the term specific intensity and symbol (SI) have been used to designate this term but R_I is preferred.

3.1.2 *color*—expressed by chromaticity coordinates according to the CIE (Commission Internationale de l’Eclairage 1931) standard colorimetric system.

3.1.3 *horizontal entrance angle*—the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker.

3.1.3.1 *Discussion*—This angle corresponds to the second component of the entrance angle β_2 . The direction given in Practice E 808 should be used when designating this angle.

3.1.4 *observation angle*—the angle at the reflector between the illumination axis and the observation axis. (See also Practice E 808.)

3.1.5 *retroreflection*—reflection in which radiation is returned in directions close to the direction from which it came, this property being maintained over wide variations of the direction of incident radiation.

4. Classification

4.1 Markers should be classified as to type, color, and surface characteristics.

4.1.1 *Types of Markers:*

4.1.1.1 *Type A*—Two-way reflective markers, one color.

4.1.1.2 *Type B*—One-way reflective markers, one color.

4.1.1.3 *Type D*—One-way reflective markers, two colors (one-way reflective red with non-reflecting white surface on opposite side).

4.1.1.4 *Type E*—Two-way reflective markers, two colors.

4.1.2 *Color of Markers:*

4.1.2.1 *W*—White.

4.1.2.2 *Y*—Yellow.

4.1.2.3 *R*—Red.

4.1.2.4 *B*—Blue.

4.1.2.5 *G*—Green.

4.1.3 *Surface Characteristics:*

4.1.3.1 *No designation*—Marker with plastic lens surface.

4.1.3.2 *Designated H*—Marker with hard, abrasion-resistant lens surface.

4.2 Show classification in the order detailed in 4.1.1 through 4.1.3.2: type, color, and surface condition. For example, ERWH is a two-way red and white marker with abrasion resistant surface.

5. Ordering Information

5.1 Orders for material under this specification should include the following information:

5.1.1 Quantity,

5.1.2 Type of marker: retroreflective one way, or retroreflective two way,

5.1.3 Color of marker, and

5.1.4 Surface condition, as-molded or abrasion resistant

6. Requirements for Retroreflective Markers

6.1 *Construction:*

6.1.1 Markers shall be of the prismatic reflector type.

6.1.2 The retroreflecting area shall be molded of methyl methacrylate material (see Classification D 788, Grade 8), impact modified methyl methacrylate (Classification D 788, see Note 1) or polycarbonate (Specification D 3935, Grade PC110B34750).

NOTE 1—A grade has not been stipulated because the committee responsible has not yet assigned a number.

6.1.3 Marker height shall not exceed 20.3 mm (0.80 in.).

6.1.4 Marker width shall not exceed 130 mm (5.1 in.).

6.1.5 The angle between the face of the marker and the base shall be no greater than 45°.

6.1.6 The base of the marker shall be substantially free from gloss or substances that may reduce its bond to adhesive.

6.1.7 The base of the marker shall be flat within 1.3 mm (0.05 in.). If the bottom of the marker is configured, the outermost faces of the configurations shall not deviate more than 1.3 mm (0.05 in.) from a flat surface.

6.1.8 Other construction meeting the performance requirements will be acceptable following a six-month road test during the time of the year when weather and traffic conditions are most critical to determine cleanability and durability.

6.2 *Performance Requirements:*

6.2.1 For flat bottom markers, adhesive bond strength measured in accordance with 9.1 shall be not less than 3.4 MPa (500 psi). Flat bottom markers passing the 3.4 MPa (500 psi) requirement when tested with epoxy will be considered acceptable also for installation using bitumen as the adhesive. No suitable laboratory method for evaluating the adherence of configured-bottom (“waffle”-bottom) markers to either portland cement or asphalt roads has been developed.

6.2.2 Coefficient of luminous intensity measured in accordance with 9.2 shall be not less than the values in Table 1.

6.2.3 *Physical Properties:*

6.2.3.1 *Flexural Strength* (for markers with length and width both equal to or greater than 4 in.)—Tested in accordance with 9.3.1, a marker shall withstand 909 kg (2000 lb)

TABLE 1 Coefficient of Luminous Intensity R_I

NOTE 1—Entrance angle component β_1 and rotation angle ϵ are 0°.

Entrance Angle β_2	Observation Angle α	Minimum Value R_I , mcd/lx				
		White	Yellow	Red	Green	Blue
0°	0.2°	279	167	70	93	26
+ 20°/-20°	0.2°	112	67	28	37	10
Entrance Angle β_2	Observation Angle α	Minimum Value R_I , cd/ftc				
		White	Yellow	Red	Green	Blue
0°	0.2°	3.0	1.8	0.75	1.0	0.28
+ 20°/-20°	0.2°	1.2	0.72	0.30	0.4	0.11

without breakage or significant deformation. Significant deformation shall be understood to be 3.3 mm (0.13 in.).

6.2.3.2 *Compressive Strength* (for markers with length or width less than 4 in.)—Tested in accordance with 9.3.2, a marker shall support a load of 2727 kg (6000 lb) without breakage or significant deformation of the marker. Significant deformation shall be understood to be 3.3 mm (0.13 in.).

6.2.4 *Color*—When the retroreflector is illuminated by CIE Standard Source A and when measured in accordance with 9.4, the color of the retroreflected light shall fall within the color gamuts given by the following corner points and shown in Fig. 1.

6.2.4.1 *White*

Point No.	x	y
1	0.310	0.348
2	0.453	0.440
3	0.500	0.440
4	0.500	0.380
5	0.440	0.380
6	0.310	0.283

6.2.4.2 *Yellow*

Point No.	x	y
1	0.545	0.424
2	0.559	0.439
3	0.609	0.390
4	0.597	0.390

6.2.4.3 *Red*

Point No.	x	y
1	0.650	0.330
2	0.668	0.330
3	0.734	0.265
4	0.721	0.259

6.2.4.4 *Blue*

Point No.	x	y
1	0.039	0.320
2	0.160	0.320
3	0.160	0.240
4	0.183	0.218
5	0.088	0.142

6.2.4.5 *Green*

Point No.	x	y
1	0.009	0.733
2	0.288	0.520
3	0.209	0.395
4	0.012	0.494

6.2.5 *Resistance to Lens Cracking*—(abrasion resistant markers only).

6.2.5.1 *Lens Impact Strength*—When impacted in accordance with 9.5.1, the face of the lens shall show no more than two radial cracks longer than 6.4 mm (0.25 in.). There shall be no radial cracks extending to the edge of the abrasion resistant area. There shall be no delamination.

6.2.5.2 *Temperature Cycling*—When subjected to temperature cycling in accordance with 9.5.2 there shall be no cracking or delamination.

7. Sampling

7.1 For markers not resistant to abrasion, sample size shall be twenty markers for each lot of 10 000 markers or less and forty markers for each lot of more than 10 000 markers. For markers with an abrasion resistant surface, ten additional samples shall be required. Lot size shall not exceed 25 000 markers.

8. Number of Tests and Retests

8.1 For coefficient of luminous intensity (9.2.1), the entire sample of retroreflective pavement markers shall be tested. Failure of more than 10 % of the reflective faces shall be cause for rejection of the entire lot represented by the sample. For abrasion resistant markers, in addition to the test of 9.2.1, four reflective faces passing the photometric requirements of 9.2.1 shall be subjected to abrasion (9.2.2) and remeasured; failure of more than one sample shall be cause for rejection of the entire lot.

8.2 For adhesive bond strength (9.1), flexural strength (9.3.1), compressive strength (9.3.2), and color (9.4) three specimens shall be tested. Specimens previously subjected to photometry (9.2.1), color (9.4) and the abrasion specified for 9.2.2 may be used for tests of adhesive bond strength (9.1), flexural strength (9.3.1) and compressive strength (9.3.2). Failure of more than one specimen shall be cause for rejection of the entire lot.

8.3 For abrasion resistant markers only, for lens impact strength (9.5.1) and resistance to temperature cycling (9.5.2), ten specimens shall be tested for each requirement. Failure of more than one of the specimens in either test shall be cause for rejection of the entire lot.

8.4 At the discretion of the engineer, a resample may be taken consisting of double the number of samples originally tested. Tolerances for resamples shall be in the same ratio as specified above.

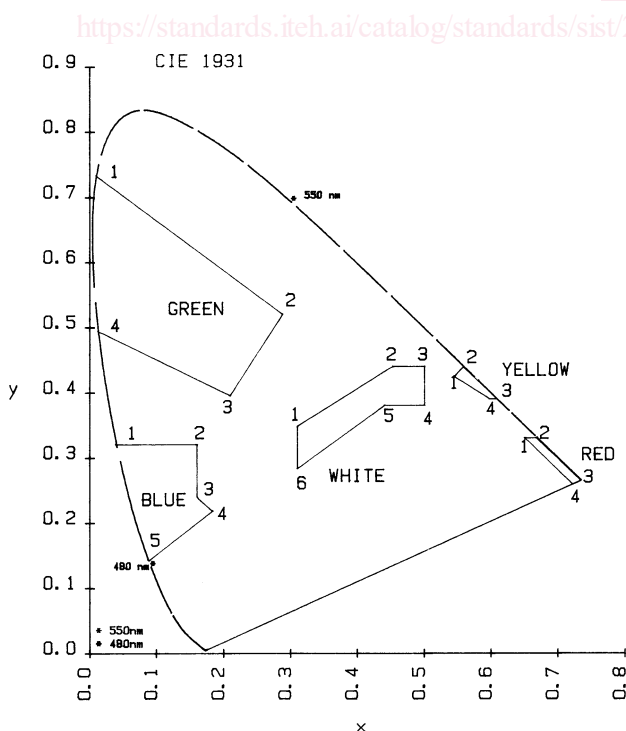


FIG. 1 Color Gamut per 6.2.4