Designation: D4280 – 18

Standard Specification for Extended Life Type, Nonplowable, Raised Retroreflective Pavement Markers[1]

This standard is issued under the fixed designation D4280; 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 nighttime lane marking and delineation.

1.2 The values stated in inch-pound units are to be regarded as the standard, except where noted in the document. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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

1.4 *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]

C778 Specification for Standard Sand

D5/D5M Test Method for Penetration of Bituminous Materials

D36/D36M Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)

D71 Test Method for Relative Density of Solid Pitch and Asphalt (Displacement Method)

D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester

D113 Test Method for Ductility of Asphalt Materials

D1785 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

D3111 Test Method for Flexibility Determination of Hot-Melt Adhesives by Mandrel Bend Test Method

D4402/D4402M Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer

D5329 Test Methods for Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphalt Pavements and Portland Cement Concrete Pavements

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

E811 Practice for Measuring Colorimetric Characteristics of Retroreflectors Under Nighttime Conditions

2.2 *Federal Specification:*[3]

TT-T-291 Thinner, Paint, Mineral Spirits, Regular and Odorless

2.3 *AASHTO Standard:*[4]

AASHTO M 237 Epoxy Resin Adhesive for Bonding Traffic Markers to Hardened Concrete

3. Terminology

3.1 *Definitions:*

3.1.1 *cleanability*—the ability of a raised retroreflective marker to keep its optical surfaces clean under traffic and environmental conditions.

[1] This specification is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.38 on Highway Traffic Control Materials.

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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 U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

[4] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

3.1.2 *coefficient of luminous intensity, R_I*—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 direction of the incident light, expressed in candelas per lux (cd/lx) (see Practice E808 and Terminology E284).

3.1.2.1 *Discussion*—The values presented for the coefficient of luminous intensity are presented in SI units, which are the accepted worldwide norm for expressing this value, rather than in inch-pounds. 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/fc). Historically, the term "specific intensity" and symbol ("SI") have been used to designate this term, but "R_I" is preferred.

3.1.3 *color*—chromaticity, according to the CIE (Commission Internationale de l'Eclairage) 1931 colorimetric system.

3.1.4 *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.

3.1.4.1 *Discussion*—This angle corresponds to the entrance angle β2 when the marker is positioned for photometry. The direction given in Practice E808 should be used when designating this angle.

3.1.5 *observation angle*—the angle between the illumination axis and the observation axis. (See also Practice E808.)

3.1.6 *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.

3.1.7 *retroreflective element*—a minimal optical unit that produces retroreflection, for example, a cube corner or a biconvex structure.

4. Classification

4.1 Markers should be classified as to type, color, and abrasion resistance.

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

4.1.2 *Retroreflected 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 *Abrasion Resistance:*

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

4.1.4 *Flexural Strength:*

4.1.4.1 *Designated F*—Marker with sufficient longitudinal strength for application to flexible, asphaltic concrete pavement.

4.2 Show classification in the order detailed in 4.1.1 – 4.1.3.1: type, color, abrasion resistance, and flexural strength. For example, ERWF is a two-way, red and white marker without abrasion-resistant surface and with sufficient flexural strength for application to flexible pavement.

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,

5.1.4 Abrasion resistance, if needed, and

5.1.5 Flexural strength, if needed.

NOTE 1—Flexural strength is not critical when application is to portland cement concrete pavement, but is critical when application is to some soft asphaltic concrete pavements.

6. Requirements for Retroreflective Markers

6.1 *Construction:*

6.1.1 The marker shall be comprised of materials with adequate chemical, water, and UV resistance for the intended use.

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

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

6.1.4 The angle between the face of the marker and the base shall be no greater than 45°, except as provided in 6.1.4.1.

6.1.4.1 If the angle between the face of the marker and the base is greater than 45°, or if the marker front has protuberances of more than 0.04 in. (1 mm), then as part of type acceptance, the marker shall be subjected to a six-month road test during the time of the year when weather and traffic conditions are most critical to cleanability. Cleanability is determined by measuring coefficient of luminous intensity before and after washing the marker lens.

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

6.1.6 The base of the marker shall be flat within 0.05 in. (1.3 mm). If the bottom of the marker is configurated, the protruding faces of the configurations shall not deviate more than 0.05 in. (1.3 mm) from a plane.

6.1.7 Construction not meeting the requirements of 6.1.2, 6.1.3, 6.1.4, 6.1.6, or 6.1.7, but meeting the performance requirements of 6.2, will be acceptable following a twelve-month road test to determine cleanability, durability, and adhesion to the road.

6.2 *Performance Requirements:*

6.2.1 *Retroreflectivity:*

6.2.1.1 For new markers, coefficient of luminous intensity (R_I) measured in accordance with 9.1 shall be not less than the values in Table 1.

6.2.1.2 For abrasion-resistant markers, after abrading the marker in accordance with 9.5, coefficient of luminous intensity at 0° entrance angle measured in accordance with 9.1 shall be not less than the values in Table 1 multiplied by 0.5.

NOTE 2—No abrasion resistance test has been established for markers having biconvex optical elements.

NOTE 3—Some two-color markers may intentionally have only one of the retroreflective faces abrasion resistant, in which case, the second face should not be abraded.

TABLE 1 Coefficient of Luminous Intensity R_I

NOTE 1—The retroreflector axis and datum axis of the marker are as shown in Fig. 2 and Fig. 3.

NOTE 2—Entrance angle component β1 and rotation angle ε are 0°.

NOTE 3—The values presented for the coefficient of luminous intensity in the table are given in SI units, which are the accepted worldwide norm for expressing this value, rather than in inch-pounds. The values in *cd/fc* are provided for information.

Entrance Angle Component β2	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 Component β2	Observation Angle α	Minimum Value R_I, cd/fc				
		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

NOTE 4—No laboratory abrasion test can be expected to model the full range of surface wear of pavement markers in use.

6.2.2 Because no practical laboratory procedures have been determined to provide complete, reliable, and predictive information on adhesive bond strength, the user is encouraged to seek information from alternative sources such as field tests. A field test duration of twelve months is recommended. A control marker is chosen with known satisfactory adhesion. The test markers may be required to experience no more than 1.5 times as great an adhesion failure rate as the controls. The test severity should be such that between 3 % and 20 % of the controls fail during the field test. There must be adequate numbers of test markers and controls for statistical validity.

6.2.3 *Physical Properties:*

6.2.3.1 *Flexural Strength* (designation F markers only)—When tested in accordance with 9.2.1, a marker shall withstand 2000 lbf (8914 N) without breakage.

NOTE 5—Method 9.2.1 tests longitudinal flexural strength, distinct from the flexural strength tested in previous editions of this specification.

6.2.3.2 *Compressive Strength*—When tested in accordance with 9.2.2, a marker shall support a load of 6000 lb (2727 kg) without breakage or significant deformation of the marker. Significant deformation shall be understood to be 0.13 in. (3.3 mm).

6.2.4 *Color*—When the retroreflector is illuminated by CIE Standard Source A and when measured in accordance with 9.3, 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:*

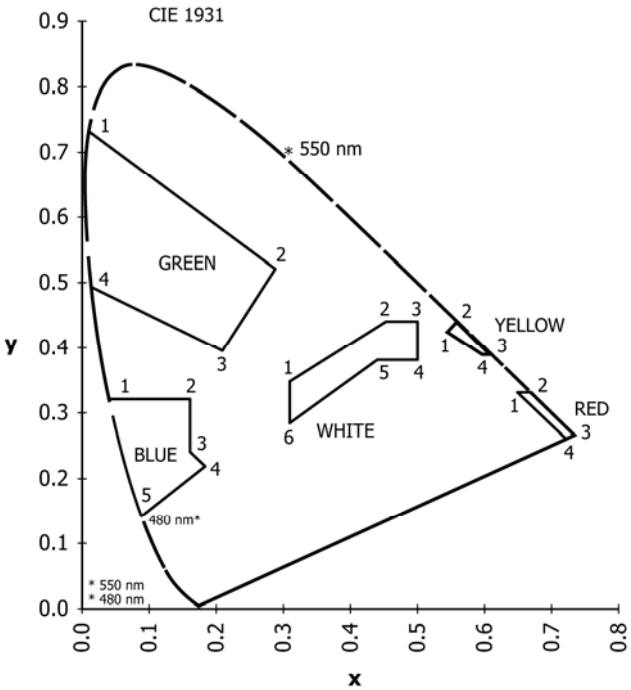

FIG. 1 Color Gamut in Accordance with 6.2.4

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:*

6.2.5.1 *Lens Impact Strength*—When impacted in accordance with 9.4.1, the face of the lens shall show no more than two radial cracks longer than 0.25 in. (6.4 mm). There shall be