



Designation: D6628 – 23

Standard Specification for Color of Retroreflective Pavement Marking Materials¹

This standard is issued under the fixed designation D6628; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This specification covers the daytime and nighttime color of retroreflective pavement marking materials used for traffic control lane markings and symbols on road surfaces.

1.2 This specification applies to all retroreflective pavement markings (markings that include retroreflective optics residing on the surface) except structured pavement markings as defined in 3.2.5.

1.3 This specification is not applicable to pavement markings that do not include retroreflective optics on the surface.

1.4 This specification does not address any requirements other than the color of retroreflective pavement markings.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5.1 *Exception*—This specification is noted to be an SI document, where angles are generally expressed in radians. However, as angles used in retroreflection have historically been identified in degrees, the International Committee for Weights and Measures (CIPM, Comité International des Poids et Mesures) accepts the use of degrees with SI units, and European Normatives and documents from the International Commission on Illumination (CIE) use degrees for retroreflection geometry.

1.6 *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.*

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. Referenced Documents

2.1 ASTM Standards:²

D4061 Test Method for Retroreflectance of Horizontal Coatings

D4505 Specification for Preformed Retroreflective Pavement Marking Tape for Extended Service Life

D4592 Specification for Preformed Retroreflective Pavement Marking Tape for Limited Service Life

D7585/D7585M Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments

E284 Terminology of Appearance

E308 Practice for Computing the Colors of Objects by Using the CIE System

E811 Practice for Measuring Colorimetric Characteristics of Retroreflectors Under Nighttime Conditions

E1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45°:0° or 0°:45°) Geometry

E2367 Test Method for Measurement of Nighttime Chromaticity of Pavement Marking Materials Using a Portable Retroreflection Colorimeter

2.2 CIE Publications:³

No. 15.2 Colorimetry

No. 39.2 Recommendations for Surface Colours for Visual Signalling

2.3 Federal Register:⁴

23 CFR Chapter 1, Subchapter G, Part 655, Subpart F Traffic Control Devices on Federal-Aid and Other Streets and Highways

3. Terminology

3.1 Definitions:

3.1.1 Definitions in Practice E308 and of appearance terms in Terminology E284 are applicable to this specification.

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 USNC-CIE Publications Office, TLA Lighting Consultants, Inc., 7 Pond Street, Salem, MA 01970.

⁴ Available from U.S. Government Publishing Office (GPO), 732 N. Capitol St., NW, Washington, DC 20401, http://www.gpo.gov.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *in-service pavement markings*—pavement markings that have been applied in the field longer than 30 days.

3.2.1.1 *Discussion*—This specification does not promote or condone the requirements of holding these requirements to in-service pavement markings. If this specification is planned to be required for longer than 30 days, some precautions are to be considered. Those are discussed in [Appendix X2](#).

3.2.2 *luminance factor (daytime luminance, Y)*, *n*—ratio of the luminance of a specimen to that of a perfect diffuser when illuminated and viewed under specified geometric conditions.

3.2.2.1 *Discussion*—In the CIE 1931 system this quantity is tristimulus value Y (1991a). For fluorescent media, the luminance factor is the sum of two quantities, the reflection luminance factor Y_s and the fluorescence luminance factor Y_f . ($Y = Y_s + Y_f$). Such usage may be assumed unless the above definition is specifically required by the context. [CIE]

3.2.3 *newly applied pavement markings*—newly applied pavement markings are those that have been applied and tested after 24 h and before 30 days and from which all excess retroreflective optics or aggregates have been removed.

3.2.3.1 *Discussion*—Excess retroreflective optics and aggregates 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 drop-on materials that are correctly embedded.

3.2.4 *retroreflective optics*—

(1) *glass beads*—spherical glass with a typical refractive index between 1.5 and 1.95, manufactured for use with pavement marking materials to provide retroreflective properties to the marking, allowing them to be visible when viewed at night under automobile headlights.

(2) *composite optics*—a multi-component retroreflective particle comprised of a pigmented core (typically white or yellow) covered with very small glass or ceramic beads typically having a refractive index of between 1.90 and 2.4.

3.2.5 *structured pavement markings*—a structured pavement marking has raised faces or edges in a regular or random pattern to enhance retroreflection in wet or rainy conditions or to produce acoustic or vibrational effects by the passage of wheels, or both. The pattern can be produced by nonuniform application of the material in the liquid state, by reworking the surface of applied material while still liquid, or by other suitable means. Pavement markings that are installed in a rumble strip pattern are considered to be structured markings and therefore not applicable to this specification. For visual examples of structured pavement markings, see [Appendix X1](#). Road marking tapes with a surface pattern, as defined in Specifications [D4505](#) and [D4592](#), are not considered to be structured pavement markings for the intent of this specification.

3.2.5.1 *Discussion*—When measuring color, daytime, or nighttime on non-flat pavement markings, care should be taken to minimize the introduction of any stray light into the viewing area. The introduction of stray light may provide measured values and results that are different from those under visual

viewing conditions. The geometry of the instrument illumination, with respect to the profiles, can also cause misleading results. The small illumination field in this type of instrumentation makes the reading sensitive to the positioning of the instrument.

4. Significance and Use

4.1 This specification identifies the color performance requirements for retroreflective pavement markings under daytime and nighttime lighting conditions. Requirements for characteristics other than retroreflective color are found in other ASTM standards.

4.2 Newly applied pavement markings, as defined in [3.2.3](#), shall meet the requirements of this specification for both daytime and nighttime color.

5. Performance Requirements

5.1 *Chromaticity Limits*—The material must plot within the boundaries described by the four corner points listed in Tables 1 and 2 when measured in accordance with the test methods in Section 7.

5.1.1 *Table 1*—Daytime (x,y) chromaticity coordinates of the corners of the regions for the colors of white, yellow, blue, purple, and red pavement markings. See [Fig. 1](#).

TABLE 1 Daytime Color^A

NOTE 1—Daytime, Geometry—45/0 (0/45), CIE illuminant D65 and the CIE 1931 (2°) standard observer.

Color	Daytime Chromaticity Coordinates (Corner Points)							
	1		2		3		4	
	x	y	x	y	x	y	x	y
White	0.355	0.355	0.305	0.305	0.285	0.325	0.335	0.375
Yellow	0.560	0.440	0.490	0.510	0.420	0.440	0.460	0.400
Red	0.480	0.300	0.690	0.315	0.620	0.380	0.480	0.360
Blue	0.105	0.100	0.220	0.180	0.200	0.260	0.060	0.220
Purple	0.300	0.064	0.309	0.260	0.362	0.295	0.475	0.144

^A These chromaticity coordinates are also referenced in 23 CFR Chapter 1, Subchapter G, Table 5 to Appendix to Part 655, Subpart F—Daytime Color Specification Limits for Retroreflective Pavement Marking Material.

5.1.2 *Table 2*—Nighttime (x,y) chromaticity coordinates of the corners of the regions for the colors of white, yellow, and purple pavement markings. See [Fig. 2](#).

TABLE 2 Nighttime Color^A

NOTE 1—Nighttime, Geometry—Observation angle of 1.05° and entrance angle of 88.76°. CIE illuminant A and the CIE 1931 (2°) standard observer.

Color	Nighttime Chromaticity Coordinates (Corner Points)							
	1		2		3		4	
	x	y	x	y	x	y	x	y
White	0.480	0.410	0.430	0.380	0.405	0.405	0.455	0.435
Yellow	0.575	0.425	0.508	0.415	0.473	0.453	0.510	0.490
Purple	0.338	0.080	0.425	0.365	0.470	0.385	0.635	0.221

^A These chromaticity coordinates are also referenced in 23 CFR Chapter 1, Subchapter G, Table 6 to Appendix to Part 655, Subpart F—Nighttime Color Specification Limits for Retroreflective Pavement Marking Material.

Daytime Chromaticity Coordinates of Pavement Marking Retroreflective Materials

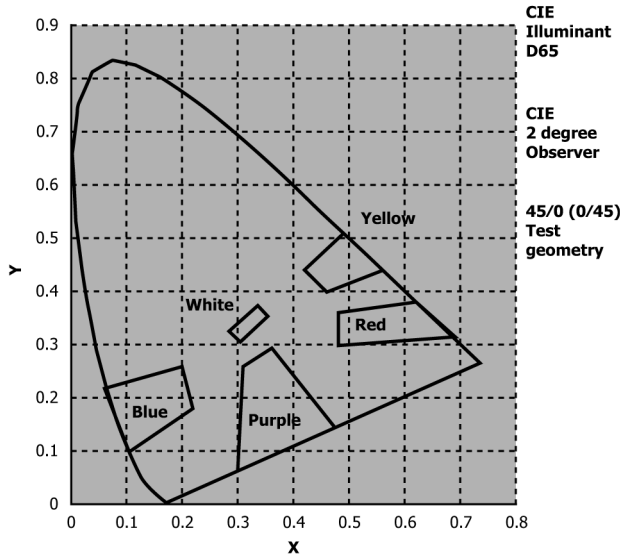


FIG. 1 Daytime Chromaticity of Pavement Markings

Nighttime Chromaticity Coordinates of Pavement Marking Retroreflective Materials

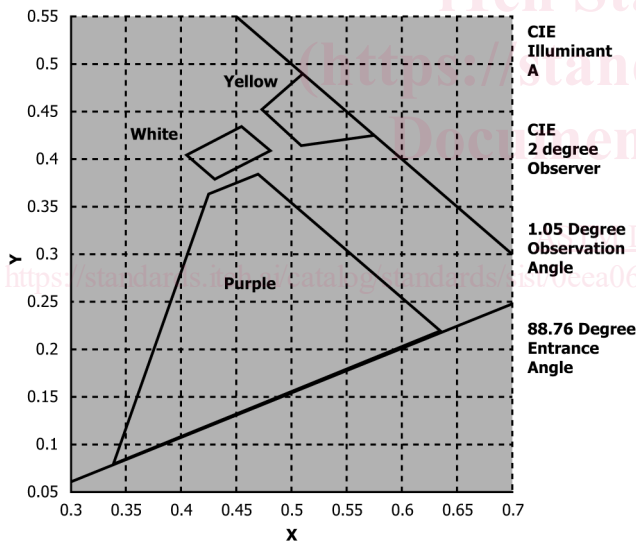


FIG. 2 Nighttime Chromaticity of Pavement Markings

5.1.3 *Retroreflectance*—The third dimension of the perceived appearance of the retroreflective pavement marking at night is the retroreflectance. This quantity is specified in other ASTM standards on pavement markings and is not part of this pavement marking nighttime color / chromaticity specification.

5.2 *Daytime Luminance (Y Tristimulus Value)*—The daytime luminance limits shall conform to Table 3. Measurements shall be taken using 45/0 (0/45) geometry, CIE illuminant D65, and the 1931 CIE 2° standard observer. Also known as “luminance factor.”

NOTE 1—Daytime luminance testing of pavement markings excludes structured pavement materials because of the difficulty of reading color on

non-flat surfaces that may potentially allow stray light into the viewing area. Structured pavement markings should be tested at the viewing angle encountered in usage using diffuse illumination and 87.71° viewing angle, which is not covered in this standard.

NOTE 2—Historically, the term “daytime reflectance” has been used to describe the luminance factor measured under mid-day daylight conditions (D65) using the pre-1964 observer function (1931, 2°). For the purpose of this standard, we consider daytime reflectance to be an equivalent reference to the Y specified in 23 CFR Part 655. Note that Tristimulus Y is also referred to as Y Brightness, Luminosity Function, or Y Index, depending on application and use.

TABLE 3 Daytime Luminance (Luminance Factor %), Y^A

Color	With Retroreflective Optics	
	Y	
	Minimum	Maximum
White	35	...
Yellow	25	...
Red	6	15
Blue	5	14
Purple	5	15

^A These values are also referenced in 23 CFR Chapter 1, Subchapter G, Table 5a to Appendix to Part 655, Subpart F—Daytime Luminance Factors (%) for Retroreflective Pavement Marking Material with CIE 2° standard observer and 45/0 (0/45) geometry and CIE standard illuminant D65.

6. Specimen Preparation

6.1 For laboratory testing using a photometric range, specimens to be measured should be mounted on a flat test panel with a minimum test area of 0.1 m² in size. Typical test specimen dimensions are 100 mm (~4 in.) by 1000 mm (~36 in.). This allows for the adequate area to be measured from a distance following the methodology referenced in 7.3.1.

6.2 For laboratory testing using a handheld device, test specimens to be measured should be mounted on a flat test panel with a minimum test area of 0.1 m² in size. Typical test specimen dimensions are 100 mm (~4 in.) by 1000 mm (~36 in.). This allows for multiple measurements to be taken when following the methodology referenced in 7.3.2.

6.3 Field measurements should be taken on markings that are clean and dry, following the methodology referenced in 7.3.3. Areas where there are visible contaminants on the markings or where there is visible tracking should be avoided. If areas to be tested have questionable surface contamination, readings could be taken before and after adequate cleaning of the markings to determine the degree of surface contamination.

7. Test Methods

7.1 *Sample Conditioning*—For new material conditioning, see Practice D7585/D7585M. For in-service testing, samples should be free of dirt or other obvious contamination.

7.2 *Daytime Color*—Daytime color shall be measured in accordance with Test Method E1349, using 45/0 (0/45) geometry, CIE illuminant D65, and the 1931 CIE 2° standard observer.