



Designation: **D4960 – 08 (Reapproved 2013) D4960 – 20**

Standard Test Method for Evaluation of Color for Thermoplastic Traffic Pavement Marking Materials¹

This standard is issued under the fixed designation D4960; 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 test method describes the instrumental determination of color of thermoplastic traffic pavement marking materials using the CIE tristimulus Y_x, y color measurement system.

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 *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

D883 Terminology Relating to Plastics

D7307 Practice for Sampling of Thermoplastic Traffic Marking Materials

D7308 Practice for Sample Preparation of Thermoplastic Pavement Marking Materials

E179 Guide for Selection of Geometric Conditions for Measurement of Reflection and Transmission Properties of Materials

E284 Terminology of Appearance

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

E313 Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates

E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation

E1347 Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry

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

F412 Terminology Relating to Plastic Piping Systems

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology D883, E284, and F412, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *thermochromism, n*—a change in color that takes place in the thermoplastic material with temperature changes.

3.2.2 *thermoplastic traffic pavement marking material, n*—a highly filled 100 % total solids highway marking material that when heated to a molten state can be extruded or sprayed onto a road pavement surface and when cooled forms a solid, durable delineator.

4. Summary of Test Method

4.1 The test specimen, representative of the material to be tested, is taken from a molten sample obtained in accordance with Practice D7307. The thermoplastic specimen is prepared by pouring into a TFE-fluorocarbon coated pan, to form a patty of

¹ This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.44 on Traffic Coatings.

Current edition approved Nov. 1, 2013; July 1, 2020. Published November 2013; July 2020. Originally approved in 1989. Last previous edition approved in 2008; 2013 as D4960D4960 – 08 (2013). —08—DOI: 10.1520/D4960-08R13; 10.1520/D4960-20.

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.

approximately 7.6 cm (3 in.) in diameter. The patty is allowed to cool to room temperature before measuring the color. Color measurements are made on the flat side or the top side of the thermoplastic patty.

NOTE 1—No significant color differences are encountered in reading the top or bottom of the patty.

5. Significance and Use

5.1 This test method provides a standard procedure for the determination of color of thermoplastic trafficepavement marking materials. This test method can be used in conjunction with various thermoplastic pavement marking specifications to determine compliance of the material to said specification. This method can also be used by manufacturers of these materials to determine the uniformity of thermoplastic trafficepavement marking materials from batch to batch.

5.2 There is a slight variation in color standards and colorimeters. This test method is only applicable when results are reported with information listing the instrument model designation and calibration standard.

6. Apparatus

6.1 *60 mL (2 oz.) Metal Ladle.*

6.2 *Color Measuring Instrument*, conforming to all requirements of Guide **E179**, Practice **E1164**, Test Method **E1347**, Test Method **E1349**, and Practice **E308** (bidirectional $45^\circ/0^\circ$, $45^\circ/0^\circ$ and $0^\circ/45^\circ$ capable of reporting data for the CIE $D65/2^\circ$, $D65/10^\circ$ or $C/2^\circ$ illuminant/observer conditions).

6.3 *TFE-fluorocarbon Baking Pans or Uncoated Pint Can Lids*, for forming 7.6-cm (3-in.) diameter patties.

7. Procedure

7.1 Obtain a representative sample of the thermoplastic pavement marking material following the guidelines of Practice **D7307**. ~~Prepare the sample for testing by following Practice **D7308**.~~

7.2 Prepare the thermoplastic sample obtained from step 7.1 by following Practice **D7308**. Allow the material to remain at the specified temperature and specified time, under constant agitation, as required by the governing specification.

7.3 Remove the thermoplastic sample using a 60-mL (2-oz.) (2-oz.) ladle and pour the thermoplastic sample into a clean, TFE-fluorocarbon-lined pan, to form ~~a~~ an approximately 7.6-cm (3-in.) diameter patty. If a TFE-fluorocarbon pan is not available, pour the sample into an uncoated pint tin lid to form ~~a~~ an approximately 7.6-cm (3-in.) diameter patty. If the sample is to ~~be taken from a sample~~ not under constant agitation, ~~agitation, then the sample should be stirred vigorously for at least 10 sseconds~~ then the sample should be stirred vigorously for at least 10 sseconds prior to removing material for preparation of the test specimen to prevent settling of the components and to provide a smooth homogeneous surface for color measurement.

NOTE 2—Be extremely careful stirring a low viscosity sample because molten thermoplastic may splash.

7.4 Allow the patty to cool to room temperature for a minimum of 30 min.

NOTE 3—A 30 ± 5 -min conditioning of the patty ~~negates the initial~~ allows the sample temperature to equilibrate at ambient room temperature, which minimizes the effects of thermochromism.

7.5 Select the largest port available and calibrate the color-measuring instrument with ~~a white~~ the appropriate calibration color standard according to the instructions supplied by the manufacturer.

7.6 Remove the patty from the TFE-fluorocarbon pan and read the color measurement values from the flat smooth side. If a pint tin lid is used, then read the top of the patty. Without removing the patty from the sample port immediately take three readings. ~~For a normal color measurement, record the average of two (2) each readings and record the average Y_x , and y readings with a 90 degree rotation between each reading.~~

7.6.1 ~~If there is any evidence of thermochromism (measurements changing with sample orientation), record the average of 4 readings with a 90 degree rotation between each reading.~~ temperature), wait until the samples have equilibrated to room temperature and reread.

8. Report³

8.1 Report the following information:

8.1.1 The formula code, batch number, formula type, and color for each patty ~~read,~~ read.

8.1.2 The type of color measuring instrument used and the identification of the ~~white~~ color calibration standard, and standard.

8.1.3 The exact cooling period in minutes.

8.1.4 ~~The exact cooling period and~~ In accordance with Practice **E308** calculate the CIE Y_x , and y color values ($D65/2^\circ$, $D65/10^\circ$ coordinates for either $D65/2^\circ$, $D65/10^\circ$, or $C/2^\circ$ illuminant/observer conditions) using the mean of the measured reflectance data for each sample. Report the color coordinates and the illuminant/observer used. See **Note 4**.

³ This method allows for reporting of color values for several CIE illuminant/observer combinations in order to facilitate color communication. For direct comparison of color values – color scale, illuminant, standard observer, instrument geometry and standardization, sample preparation and presentation must be the same.

8.1.5 For white thermoplastic materials, users may find it beneficial to report Whiteness Index or Yellowness Index, or both, in accordance with Practice E313 in comparing lots for internal QA purposes. Similarly, for yellow thermoplastic materials, Yellowness Index in accordance with Practice E313 can be used to quantify small yellowness differences in lots. These metrics can be calculated from the same color measurement as used to mean measured reflectance data from 7.6 report. Y, x, y values for the thermoplastic color.

NOTE 4—CIE, xy coordinates are typically expressed to the following precision: Y to two decimal places, xy to four decimal places (for example, Y = n.nn, x = n.nnnn, y = n.nnnn).

9. Precision and Bias⁴

9.1 The precision of this test method is based on an Interlaboratory study of Test Method ~~D4960–89~~D4960 – 89 conducted in 2005. Each of nine laboratories tested four different materials. Each “test result” was an individual observation of a color property. Participating laboratories obtained three replicate test results for each material and property combination. See Tables 1-3.

NOTE 5—Testing was done using Illuminant D65 with a 2 degree observation angle (D65/2°).

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TABLE 1 CIE Y

	Average \bar{x}	Repeatability Standard Deviation Sr	Reproducibility Standard Deviation SR	Repeatability Limit r	Reproducibility Limit R
Material A	81.5211	0.0985	1.1272	0.2757	3.1563
Material B	78.6059	0.1365	1.4383	0.3821	4.3073
Material C	54.0563	0.1334	0.8587	0.3735	2.4044
Material D	47.3507	0.0743	0.4720	0.2081	1.3217

TABLE 1 CIE Y

	Average \bar{z}	Repeatability Standard Deviation Sr	Reproducibility Standard Deviation SR	Repeatability Limit r	Reproducibility Limit R
Material A	81.52	0.10	1.13	0.28	3.16
Material B	78.61	0.14	1.44	0.38	4.31
Material C	54.06	0.13	0.86	0.37	2.40
Material D	47.35	0.07	0.47	0.21	1.32

⁴ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D01-1136. Contact ASTM Customer Service at service@astm.org.