Designation: D4960 – 08 (Reapproved 2013)

Standard Test Method for Evaluation of Color for Thermoplastic Traffic Marking Materials[1]

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 marking materials using the CIE tristimulus 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 and health practices and determine the applicability of regulatory limitations prior to use.*

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 Traffic 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 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 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 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 traffic 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 traffic 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.

[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. Published November 2013. Originally approved in 1989. Last previous edition approved in 2008 as D4960 – 08. DOI: 10.1520/D4960-08R13.

[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.

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°:0°, capable of reporting data for the CIE D65/2°, D6510° or C/2° 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. 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.) ladle and pour the thermoplastic sample into a clean, TFE-fluorocarbon-lined pan, to form a 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 3-in. diameter patty. If the sample is to be taken from a sample not under constant agitation the sample should be stirred vigorously for at least 10 s 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.

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

NOTE 2—A 30 ± 5-min conditioning of the patty negates the initial effects of thermochromism.

7.5 Select the largest port available and calibrate the color-measuring instrument with a white 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 *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.

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 2 CIE *x*

	Average $\bar{x}$	Repeatability Standard Deviation Sr	Reproducibility Standard Deviation SR	Repeatability Limit r	Reproducibility Limit R
Material A	0.311304	0.000547	0.001242	0.001532	0.003477
Material B	0.318659	0.000549	0.000954	0.001536	0.002670
Material C	0.491804	0.000463	0.001885	0.001296	0.005278
Material D	0.497219	0.000385	0.001385	0.001078	0.003878

TABLE 3 CIE *y*

	Average $\bar{x}$	Repeatability Standard Deviation Sr	Reproducibility Standard Deviation SR	Repeatability Limit r	Reproducibility Limit R
Material A	0.330322	0.002556	0.005478	0.007156	0.015338
Material B	0.337504	0.002493	0.004929	0.006979	0.013800
Material C	0.463115	0.001074	0.003177	0.003007	0.008895
Material D	0.460333	0.001096	0.002286	0.003068	0.006400

8. Report[3]

8.1 Report the following information:

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

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

8.1.3 The exact cooling period and CIE *Y*, *x* and *y* color values (D65/2°, D6510° or C/2° illuminant/observer conditions) for each sample.

8.1.4 For white thermoplastic materials, users may find it beneficial to report Whiteness Index 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 report *Y*, *x*, *y* values for the thermoplastic color.

9. Precision and Bias[4]

9.1 The precision of this test method is based on an Interlaboratory study of Test Method 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.

9.1.1 *Repeatability*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the "*r*" value for that materials; "*r*" is the interval representing the critical difference between two test results for

[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.

[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.

the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

9.1.2 *Reproducibility*—Two test results should be judged not equivalent if they differ by more than the "*R*" value for that material; "*R*" is the interval representing the difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

9.1.3 Any judgment in accordance with these two statements would have an approximate 95 % probability of being correct.

9.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias is being made.

9.3 The precision and bias statements were determined through statistical examination of 48 test results, from a total of nine laboratories, analyzing four materials.

10. Keywords

10.1 accepted reference value; accuracy; bias; color measurement; interlaboratory study; precision; precision conditions; repeatability; reproducibility; standard deviation; thermoplastic traffic marking