



Designation: E805 – 22

# Standard Practice for Identification of Instrumental Methods of Color or Color-Difference Measurement of Materials<sup>1</sup>

This standard is issued under the fixed designation E805; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers the documentation of instrumental measurement of color or color difference for current communication or for future reference. The practice is applicable to instrumental measurements of materials where color is seen by reflected, transmitted or emitted light and any combinations of one or more of these processes. The practice is recommended for documentation of methodology in interlaboratory color-measurement programs.

1.2 Providing an adequate identification of an instrumental measure of color or color-difference involves documenting the metadata necessary for archiving and future use of the measurement data collected. The metadata can be divided in five parts:

1.2.1 Nature and source of available samples and the form of specimens actually measured,

1.2.2 Instrumental conditions of measurement, including instrument geometrical and spectral conditions of measurement,

1.2.3 Standards used,

1.2.4 Data acquisition procedure, and

1.2.5 Color scales employed.

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.*

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee E12 on Color and Appearance and is the direct responsibility of Subcommittee E12.04 on Color and Appearance Analysis.

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## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

D156 Test Method for Saybolt Color of Petroleum Products (Saybolt Chromometer Method)

D1209 Test Method for Color of Clear Liquids (Platinum-Cobalt Scale)

D1500 Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)

D1535 Practice for Specifying Color by the Munsell System

D1544 Test Method for Color of Transparent Liquids (Gardner Color Scale)

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

D5386 Test Method for Color of Liquids Using Tristimulus Colorimetry

D6166 Test Method for Color of Pine Chemicals and Related Products (Instrumental Determination of Gardner Color)

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

E259 Practice for Preparation of Pressed Powder White Reflectance Factor Transfer Standards for Hemispherical and Bi-Directional Geometries

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

E991 Practice for Color Measurement of Fluorescent Specimens Using the One-Monochromator Method

E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation

E1247 Practice for Detecting Fluorescence in Object-Color Specimens by Spectrophotometry

E1331 Test Method for Reflectance Factor and Color by

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- Spectrophotometry Using Hemispherical Geometry
- E1345** Practice for Reducing the Effect of Variability of Color Measurement by Use of Multiple Measurements
- E1347** Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry
- E1348** Test Method for Transmittance and Color by Spectrophotometry Using Hemispherical Geometry
- E1349** Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45°:0° or 0°:45°) Geometry
- E1708** Practice for Electronic Interchange of Color and Appearance Data
- E1767** Practice for Specifying the Geometries of Observation and Measurement to Characterize the Appearance of Materials
- E2152** Practice for Computing the Colors of Fluorescent Objects from Bispectral Photometric Data
- E2153** Practice for Obtaining Bispectral Photometric Data for Evaluation of Fluorescent Color
- E2175** Practice for Specifying the Geometry of Multiangle Spectrophotometers
- E2194** Test Method for Multiangle Color Measurement of Metal Flake Pigmented Materials
- E2729** Practice for Rectification of Spectrophotometric Bandpass Differences
- 2.2 *Other Standard Documents:*
- CIE Publication 51 A** Method for Assessing the Quality of Daylight Simulators for Colorimetry<sup>3</sup>
- DIN 6176** Farbmetrische, Bestimmung von Farbabstände bie Körperfarben nach der DIN99o-Formel (Colorimetric Determination of Color-Differences of Object Colors According to the DIN99o Formula)<sup>4</sup>

### 3. Terminology

3.1 Definitions of terms in Terminology **E284** are applicable to this practice.

3.2 *Definitions of Terms Specific to This Standard:*

3.3 *metadata, n*—structured information that describes, explains, locates, and otherwise makes it easier to retrieve and use an information resource **(1)**.<sup>5</sup>

NOTE 1—In the case of color and color difference measurements, the data about the instrument, the measurement procedure, the treatment of the specimen, identification of color scale and the calculations are to be included in the metadata.

### 4. Significance and Use

4.1 The options available in methods for the measurement of color or color-difference are many. These involve choices in: (1) specimens, (2) geometric and spectral properties of instruments, (3) calibration bases for standards used, (4) procedure for sample handling including conditioning, (5) procedure for taking data, and (6) equations for converting

<sup>3</sup> Available from CIE (International Commission on Illumination), <http://www.cie.co.at> or <http://www.techstreet.com>.

<sup>4</sup> Available from Beuth Verlag GmbH (DIN-Deutsches Institut für Normung e.V.), Burggrafenstrasse 6, 10787, Berlin, Germany, <http://www.en.din.de>.

<sup>5</sup> The boldface numbers in parentheses refer to the list of references at the end of this practice.

instrumental data to final results. Once the measurements have been made, it is essential to document what has been done for the purpose of interlaboratory comparisons, or for future use. A sample form is provided in Fig. 1 to record identifying information applicable to any instrumental method of color or color-difference measurement.

4.2 Refer to Guide **E179**, Practices **E991**, **E1164**, **E1345**, **E1708**, **E1767**, **E2152**, and **E2194** and Test Methods **D5386**, **D6166**, **E1247**, **E1331**, **E1347**, **E1348**, and **E1349**, for specific details of measurements.

### 5. Identification of Samples and Specimens

5.1 *Identification of Samples and Specimens:*

5.1.1 Identify samples by material and form, together with markings or document identification.

5.1.2 Mark each specimen with a serial number or letter, and other identifying markings.

5.2 *Description of Specimens*—For specific forms of specimens, additional identification shall be included:

5.2.1 Solid sheet or web, specify thickness and backing material.

5.2.2 Powder or granular substance (packed or poured); if placed behind window, state material and thickness.

5.2.3 Fiber or yarn, describe form, type of transparent specimen window (if used), pressure on backing plate.

5.2.4 Paste (if placed behind window), state material and thickness.

5.2.5 Liquid (if observed through window), state window material and path length.

5.2.6 Film drawdown, specify film thickness and background.

5.2.7 For gonioapparent materials, identify the direction of illumination and viewing relative to the specimen.

5.2.8 Conditioning, if any.

NOTE 2—When specimens are measured behind glass or other material, specify thickness and material type. In addition, specify the method used for data correction.

### 6. Identification of Instrument

6.1 Sufficient description of the instrumentation shall be provided to enable one of ordinary skill in the art to reproduce the measurement. The make and model number of the instrument used shall be reported.

6.2 For interlaboratory comparisons, long-term studies, and measurements used to document conformance to a color specification, the physical properties of the instrument shall be identified by it, as follows:

6.2.1 *Mode of Measurement*, such as transmittance factor, reflectance factor, total radiance factor, etc.

6.2.2 *Geometric Properties of Instrument*, for multi-angle spectrophotometers following Practice **E2175** or for all others following Practice **E1767** the influx geometry and efflux geometry including aperture angles and sizes.

6.2.3 *Specular Component*, where hemispherical illumination or view is employed, or both, but the specular light is excluded by means of a light trap, designate by the words “specular excluded.” If a light trap is used, details of its size,

(1) Instrumental Method for Measurements of:  Color  Color difference of: \_\_\_\_\_

(2) Color Scales Used (Section 9): \_\_\_\_\_

(3) Specimen Description (Section 5)

(a) Form: \_\_\_\_\_

(b) Additional information (see 5.3) \_\_\_\_\_  
 thickness (number of layers)  single layer backed by  powder (note packing pressure)  paste  liquid  film drawdown (specify thickness and backing material).

(c) Special Considerations:  
 Sensitivity to Environmental Conditions: temperature: \_\_\_\_\_, humidity \_\_\_\_\_

(d) Specimen Directionality: Specify orientation and rotation \_\_\_\_\_

(e) Specimen Conditioning: \_\_\_\_\_

(4) Instrument Description (Section 6)

Spectrophotometer  Tristimulus Colorimeter

Make and model \_\_\_\_\_

(a) Measurement Mode \_\_\_\_\_

(b) Geometry: Influx and Efflux Geometry \_\_\_\_\_  
 Specular Component included or excluded? \_\_\_\_\_  
 Light Trap (if applicable) size, shape, and position \_\_\_\_\_  
 Size and Shape of aperture \_\_\_\_\_  
 Cover glass at specimen window \_\_\_ Yes \_\_\_ No  
 Method of Correction \_\_\_\_\_

(c) Spectral: Lamp \_\_\_\_\_ Filters and elements used \_\_\_\_\_  
 Detector \_\_\_\_\_ Modified by filters and elements \_\_\_\_\_

(5) Material Standard Used: \_\_\_\_\_  
 Date of preparation or calibration: \_\_\_\_\_

(6) Reduction of Data: \_\_\_\_\_

(a) Tristimulus Integration:  Filter  Computed from spectral data taken every \_\_\_\_\_ nm over range \_\_\_\_\_ nm to \_\_\_\_\_ nm, with spectral bandwidth \_\_\_\_\_ nm bandpass correction according to E2729 \_\_\_\_\_ E308 Table 5 \_\_\_\_\_ E308 Table 6

(b) Color Difference Equation and Parameters used \_\_\_\_\_

**FIG. 1 Sample Report Form**

shape, and position should be given. Conversely, when the specular component of light is included, specify “specular included.”

6.2.4 Give aperture size and shape through which specimens are exposed for measurement and any glass or plastic intervening window(s). Also, note the area of specimen actually illuminated or viewed.

NOTE 3—Measurements of some type of specimens (for example, pearlescent, metal flake or retroreflective materials) may require different and multiple geometries. In these cases, specify the details of all the geometries used. See Practices E2175 and E2194.

### 6.3 Spectral Properties of Instrument:

6.3.1 Identify spectral power distribution illuminating the specimen and spectral response of receiver system. The spectral characteristics of the instrument will be affected by the spectral transmittance of filters or other wavelength selective

devices in either the illuminating or viewing beams. For photoluminescent specimens, the spectral distribution should be reported in terms of its conformance to a standard illuminant as outlined in CIE Publication 51 and Practice E991. For non-photoluminescent specimens, the spectral distribution illuminating the specimen can be reported in terms of its conformance to a standard illuminant or its correlated color temperature.

6.3.2 In the absence of a detailed spectral power distribution as in 6.3.1, identify illumination with other terms that indicate the general spectral content, for example: (1) a gas-filled tungsten lamp at 2855.5 K correlated color temperature approximating CIE Standard Illuminant A, (2) CIE Source C, (3) simulated daylight D65 (2), (4) simulated daylight D65 (2) with pulsed xenon lamp with uv control, (5) light emitting diodes (LEDs), etc.