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Standard Guide for Preparation, Maintenance, and Distribution of Physical Product Standards for Color and Geometric Appearance of Coatings[1]

This standard is issued under the fixed designation D5531; 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 guide covers three levels of physical product standards for color or appearance, or both, commonly used in the coatings industry, provides terminology to describe each level, and describes techniques for generating and caring for standards.

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]

D16 Terminology for Paint, Related Coatings, Materials, and Applications
D523 Test Method for Specular Gloss
D823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels
D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials
D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
D3134 Practice for Establishing Color and Gloss Tolerances
D4086 Practice for Visual Evaluation of Metamerism
D4449 Test Method for Visual Evaluation of Gloss Differences Between Surfaces of Similar Appearance
E284 Terminology of Appearance
E308 Practice for Computing the Colors of Objects by Using the CIE System
E430 Test Methods for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry
E805 Practice for Identification of Instrumental Methods of Color or Color-Difference Measurement of Materials
E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation
E1331 Test Method for Reflectance Factor and Color by 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
E1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45°:0° or 0°:45°) Geometry

2.2 *Society of Automotive Engineers Standard:*

SAE J1545 Recommended Practice for Instrumental Color Difference Measurement for Exterior Finishes, Textiles, and Colored Trim[3]

3. Terminology

3.1 The definitions in Terminology E284 and D16 are applicable to this standard. The terms in E284 take precedence over those in D16 if differences exist.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *concept color, n*—the color of the material submitted by the customer as the target for generating the master standard.

3.2.2 *master standard, n*—the physical standard for color that the customer approves as the target for visual, spectrophotometric, and colorimetric evaluation of all products referenced to that standard.

3.2.2.1 *Discussion*—In SAE J1545 this is referred to as the "official" standard.

[1] This guide is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.26 on Optical Properties.

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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 Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

*A Summary of Changes section appears at the end of this standard

3.2.3 *duplicate master standard, n*—a replicate of the master standard that serves as the master standard at a secondary location.

3.2.3.1 *Discussion*—In SAE J1545 this is referred to as the "reference" standard.

3.2.4 *working standard, n*—the physical product standard for color or appearance, or both, used for routine measurements and visual assessments in the laboratory and at the production site.

4. Summary of Guide

4.1 Product standards are the only standards by which products should be accepted or rejected for color or appearance. A master standard is generated from the concept color submitted by the customer. Duplicate master standards, when needed, are generated from the master standard. Working standards are generated from a duplicate master standard. They are used in the laboratory or on the production line to accept or reject the color or appearance of coatings. After initial generation, product standards must be maintained to ensure they remain valid. This guide considers the characteristics of product standards, factors to be considered in their creation, and factors to be considered in their replacement.

5. Significance and Use

5.1 High quality physical product standards for color or appearance are the keystone of a successful color control program. Standards are often grouped into three major categories: product standards, intermediate production control standards, and instrument standards. This guide deals only with physical product standards. Some instrument-based color control programs use "numerical standards," derived from instrumental measurements of a physical product standard.

6. Characteristics of Physical Product Standards for Color and Appearance

6.1 Physical product standards for color should be made of the same material as the specimens to be evaluated. This is more difficult in the case of coatings because they are not sold in their final form, that is, they may be sold as a liquid or a powder but will end up as a finished film. The coating must be applied to a substrate, usually metal or paper, and dried or baked before evaluation. Agreement must be reached between the buyer and the seller on the method of application and cure for the coating before the master standard is produced.

6.2 The coatings supplier should produce the physical product standards for color. They must have the same spectral character at all viewing and illuminating geometries of concern as the coating.

6.3 The standard should have the same geometric appearance (nonspectral) characteristics as the final product. Changes in geometric characteristics may influence the noncolor aspects of appearance such as gloss and texture. They may also affect the assessed color of the coating with respect to both instrumental measurement and visual perception.

6.4 The desire for permanent physical product standards for color will sometimes lead people to consider other material such as ceramic for standards, but such substitution should be avoided. Fairman[4] states: "While a ceramic tile may be recognized as a material of greater permanence than the organic material being standardized, the probability of the introduction of metamerism between the two dissimilar materials far outweighs any possible permanence gains."

7. Three Levels of Physical Product Standards for Color and Appearance

7.1 The concept color submitted by the customer should not become the master standard because it may be made of different material or have gloss or texture (geometric appearance) different from the final product. The concept color simply represents the customer's best effort to illustrate the desired color for the coating. The concept color is to be "matched" by the master standard, usually per acceptance by the customer. The master standard represents the target, both spectrally and geometrically, for the manufactured coating. It becomes the reference by which the coating is accepted or rejected. Once the master standard is approved by the customer, the concept color should be properly stored for possible future use.

7.2 The master standard is the reference for judging the color of duplicate master standards. Although in the case of a dispute it is the ultimate reference for color and geometric appearance. It should not be used for routine evaluations in the laboratory or at the production site.

7.3 Multiple duplicate master standards should be prepared at the same time. Duplicate master standards are intended to be identical to the master standard. Because there will be variation in perceived or measured characteristics of duplicate master standards, buyer and seller must agree on tolerances for "duplicate master standards." Fairman[4] suggests that the measured color difference be less than 0.2 CIELAB unit, and Sherman[5] suggests that the measured color difference be less than 0.5 FMC-2 unit. SAE J1545 judges standards by stating that the tolerance should be the greater of 0.2 unit in each CIELAB color difference component, DL*, DC*, and DH*, or one-tenth the accepted tolerance for the product (see Practice D3134 and E1345). The number of duplicate master standards to be made will depend upon the life expectancy of the color or product, or both, the resistance of the coating to physical abuse in handling or cleaning, its resistance to color and geometric appearance change, and the number of times each standard will be used.

7.4 Each duplicate master standard should be given a unique identification with date of fabrication. A sufficient number of duplicate master standards should be generated initially to last for the lifetime of the color.

7.5 When a coating is manufactured at more than one location, each location should treat one duplicate standard as the master for that location. Another duplicate standard should

[4] Fairman, H. S., "A Standards Program for Color Control," *Color Research and Application*, Vol 6, 1981, pp. 5–6.

[5] Sherman, C. J., "A Color Standards Program for Color Control," *Technical Paper FC84-880*, Society of Manufacturing Engineers, presented at FINSTRAT '84 Conference, November 27–29, 1984, Anaheim, California.