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

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1. Scope

1.1 This guide covers three levels of physical product standards for color commonly used in the coatings industry, provides terminology to describe each level, and describes techniques for generating standards.

1.2 *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:*

D 16 Terminology for Paint, Related Coatings, Materials and Applications[2]

D 523 Test Method for Specular Gloss[2]

D 823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels[2]

D 1729 Practice for Visual Evaluation of Color and Color Differences of Opaque Diffusely Illuminated Materials[2]

D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates[2]

D 3134 Practice for Establishing Color and Gloss Tolerances[2]

D 4086 Practice for Visual Evaluation of Metamerism[2]

D 4449 Method for Visual Evaluation of Gloss Difference Between Surfaces of Similar Appearance[2]

E 284 Terminology of Appearance[2]

E 308 Practice for Computing the Colors of Objects by Using the CIE System[2]

E 430 Test Methods for Measurement of Gloss of High Gloss Surfaces by Goniophotometry[2]

E 805 Practice for Identification of Instrumental Methods of Color or Color-Difference Measurement of Materials[2]

E 1164 Practice for Obtaining Spectrophotometric Data for Object-Color Evaluation[2]

E 1331 Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry[2]

E 1345 Practice for Reducing the Effect of Variability of Color Measurement by Use of Multiple Measurements[2]

E 1347 Test Method for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry[2]

E 1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional Geometry[2]

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 E 284 and D 16 are applicable to this test method. The terms in E284 take precedence over those in D 16 if there are differences.

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.

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 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. A master

[1] This guide is under the jurisdiction of ASTM Committee D-1 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] *Annual Book of ASTM Standards*, Vol 06.01.

[3] Available from the Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

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 of coatings. After initial generation, product standards must be maintained to ensure that 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 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 instrumentally based color control programs use "numerical standards," derived from instrumental measurements of a physical product standard.

6. Characteristics of Physical Product Standards for Color

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 usually 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 cured 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 fabricated.

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 perceived 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 use other material such as ceramic for standards. 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

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. 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 filed 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 major 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 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 D 3134 and E 1345). The number of duplicate master standards to be made will depend upon the life expectancy of the color or product, or both, the standard's resistance to physical abuse, its cleanability, 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 be designated for the location. The remaining duplicate standards should be designated working standards to be used for routine evaluation of the coating.

7.6 Working standards may become unsuitable for use because of physical damage, dirt, contamination, or changes in geometric appearance and color due to exposure or use. Therefore, it is essential to compare working standards frequently to duplicate master standards.

7.7 The duplicate master should be compared to the master only rarely. The master should be kept in a secure, environmentally stable and clean area.

NOTE 1—The master standard should be treated as you would an original software disk; make sure you have a copy, then store it in a safe place. It should be used only when necessary to confirm or replace the duplicate master.

[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.