Designation: ~~D2616 – 12~~ D2616 – 19

Standard Test Method for Evaluation of Visual Color Difference With a Gray Scale[1]

This standard is issued under the fixed designation D2616; 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.

INTRODUCTION

This test method was developed to provide a precise procedure for visually evaluating color difference of non-self luminous specimens. It was patterned after a method standardized by the American Association of Textile Chemists and Colorists (AATCC)[2] designed to evaluate "change in color" and this antecedent was reflected in the original title.

This test method provides for evaluation of small to moderate color differences (less than 15 CIELAB (International Commission on Illumination) color difference units) by comparing test specimens to a series of paired gray color chips having progressively larger lightness differences. Color difference is ~~rated~~evaluated according to which of nine gray pairs of differences is visually closest to the test pair, or by interpolation between gray-pair differences.

1. Scope

1.1 This test method describes a painted gray scale and the procedure to be used in the visual evaluation of color differences of non-self luminous materials by comparison to this scale.

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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.3 *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:*[3]

D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials

E284 Terminology of Appearance

~~E1729 Practice for Field Collection of Dried Paint Samples for Subsequent Lead Determination~~

E1499 Guide for Selection, Evaluation, and Training of Observers

E3040 Practice for Evaluation of Instrumental Color Difference with a Gray Scale

2.2 *AATCC Procedures:*

AATCC Evaluation Procedure 1 Gray Scale for Color Change[2]

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions of appearance terms in Terminology E284 are applicable to this test method.

4. Summary of Test Method

4.1 The gray scale consists of nine pairs of neutral gray color standards of which Reference Pair 5 is two examples of the same gray. One element common to each pair is the gray of Reference Pair 5; the other element, being progressively lighter, provides

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[2] *Technical Manual of the American Association of Textile Chemists and Colorists*, P.O. Box 12215, Research Triangle Park, NC ~~27709, Vol~~ 27709.~~86, 2011, pp. 365–366.~~

[3] 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.

a succession of lightness differences. Total color differences between ~~non-self luminous~~ non-self-luminous specimens are expressed as either fractional, linear scale value between 1 and 5 by comparison with the paired differences of the gray scale, which are predominantly lightness differences.

~~NOTE 1—The gray specimen common to each pair is specified to have CIE 1976 metric lightness, L^* = 41.2 (+ 0.6, − 0.60).~~

5. Significance and Use

5.1 The total perceived color difference between two ~~non-self luminous~~ non-self-luminous specimens is compared as an equivalent lightness difference between two neutral gray specimens on a gray scale. A fundamental assumption is made that the total color difference can be so evaluated in terms of an equivalent lightness difference. Only the total color differences, that is, a summation of the differences in hue, lightness, and chroma between two specimens is evaluated; this test method is not applicable to the separate precise evaluation of the hue, lightness, and chroma components of color difference.

5.2 The total color difference determined by this test method depends on the degree of uniformity of the specimens and on the sharpness of the dividing line between them. The color difference between specimens having rough or mottled surfaces appears smaller than it would if the specimens had smooth and uniform surfaces. Thus the equivalent CIELAB lightness difference determined for non-uniform specimens will be smaller than for uniform specimens. Likewise, specimens whose dividing line is not sharp will appear to have smaller color differences than those with sharp dividing lines, and for this reason, the equivalent visually observed CIELAB lightness differences will be smaller than the color differences obtained from instrumental measurements.

5.2.1 A physically sharp border between colors differing slightly in the yellow-blue direction in color space appears diffuse. The perceived color difference is noticeably increased by a hairline black separation. This technique imposes a more rigorous test of such small differences.

5.3 In the CIELAB system, a unit of color difference is intended to represent the same visual difference in each of the three attributes; lightness, hue and chroma or alternatively lightness, ~~redness-greeness,~~redness-greenness, yellowness-blueness. It is valid to express color differences that are not simply lightness differences by comparison to a lightness-difference scale.

5.4 Personnel to be employed in the evaluation of color differences with the paired gray scale should be tested for color vision using the procedures in Guide E1499.

6. Apparatus

6.1 *Gray Scale Chart,*[4] ~~having~~ having the characteristics as shown in Table ~~1~~X1.1 in Appendix X1. The DE* values in this table are only for the purpose of determining if the Gray Scale Chart itself meets performance specifications. It is not to be used to convert either visual ratings to DE* values or DE* values to Gray Scale ratings.

NOTE 1—It should be recognized that the practical requirements of gray scale production mitigate against members of a reference pair either being absolutely neutral, or being of identical near-neutral chromaticity. However, chromaticity differences, if present, are of negligible magnitude.

6.2 *Gray Masks*—Light gray masks with rectangular openings shall be used to ensure comparison of equal areas of specimen and reference pairs. Masks are included with each AATCC gray-scale chart.

6.3 *Color Matching Light Booth*—See Practice ~~E1729~~D1729 for a description of an appropriate color-matching light booth for use in visual evaluation of color differences.

7. Preparation of Specimens

7.1 Specimens shall be uniform in color and gloss and shall be free of scratches and other imperfections of surface texture. The specimen being compared to the standard should have the same gloss and surface texture as the standard for maximum precision of color differences determination.

8. Procedure

8.1 *Illumination and Viewing:*

8.1.1 Place the specimens and the paired gray-scale charts in the same plane on a horizontal surface with a neutral background (middle gray to white) under the prescribed light source. The light source shall be daylight or a daylight simulator, for example a color-matching light booth. Make sure that the specimen pairs whose color differences are to be evaluated are juxtaposed as are the reference pairs, so that there is no space between the elements of a pair. It is also desirable to locate the specimen pairs immediately adjacent to the reference pairs when making a judgment. These procedures are designed to provide ease of handling and optimum accuracy in judging color differences.

8.1.2 Avoid specular reflection of the source by illuminating the specimens at an angle of about 45° and viewing them perpendicularly, or the reverse geometry. Shield specimens from extraneous light sources and resulting reflected images by placing a black cloth at the mirror reflection position.

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[4] Available from American Association of Textile Chemists and Colorists (as Gray Scale for Color Change).