Designation: D7251 – 10

An American National Standard

Standard Specification for Color and Appearance Retention of Variegated Color Plastic Siding Products[1]

This standard is issued under the fixed designation D7251; 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 specification establishes requirements and test methods for the color and appearance retention of variegated color plastic siding products.

1.2 Color retention testing provides a method for estimating the acceptability of color change in a siding product over a period of years of service.

1.3 Characterization of color and appearance for variegated colors is complicated by the presence of multiple colors in a random pattern. The procedure is based on using a template to reference six spots for color measurement.

1.4 Methods of indicating compliance with this specification are provided.

1.5 *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.*

NOTE 1—There is no known ISO equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D883 Terminology Relating to Plastics

D1435 Practice for Outdoor Weathering of Plastics

D1600 Terminology for Abbreviated Terms Relating to Plastics

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

E805 Practice for Identification of Instrumental Methods of Color or Color-Difference Measurement of Materials

G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests

3. Terminology

3.1 *Definitions*—Definitions are in accordance with terminologies in Terminologies D883 and D1600 unless otherwise noted.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *color region*—parameters that define the color space for a siding sample. Color is measured with Hunter Units, sphere geometry (di:8), Illuminant C, 2° Observer, specular component included.

3.2.1.1 *Discussion*—The color values used to classify colors by region were established by measuring the Hunter L, a, b color values from the sample population, calculating the average for Hunter L, a, b, and then choosing the integer from the corresponding L, a, b average values (that is, by truncating any fractional result) to be used to classify colors by region. Thus, average values greater than zero are truncated down to the next lowest integer, and average values less than zero are truncated up to the next highest integer. All values greater than -1 and less than +1 truncate to 0.

3.2.2 *color retention standards*—predictive color regions described by a three dimensional model which constitute acceptable color retention levels resulting from weathering of a specific product type and color.

3.2.2.1 *Discussion*—Color retention standards are defined by equations that describe the three dimensional ellipsoid value.

3.2.3 *ellipsoid value*—a mathematical calculation derived by inserting the measured ΔL, Δa, and Δb values of a weathered specimen into an ellipsoid equation.

3.2.4 *temperate northern climate—in weathering testing*, a North American metropolitan area testing site located within 73 to 100°W longitude and 37 to 45°N latitude.

3.2.5 *variegated plastic siding*—siding having discrete markings of different colors.

4. Classification

4.1 *Definitions*—Definitions are in accordance with terminology in Terminologies D883 and D1600 unless otherwise noted.

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.24 on Plastic Building Products.

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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.

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

4.2 *Color Regions*—The color region for a color is determined by measuring the Hunter L, a, b color values at six locations on each specimen in a sample population and calculating the average Hunter L, a, b color value. Use the integer value (by truncating any fractional result) of the average to determine the color region for the color using the following region boundaries.

4.2.1 *Region 1*—Brown

L = 20 to 49
a = –1 to 5
b = 2 to 11

L = 25 to 49
a = –8 to 5
b = 12 to 25

4.2.2 *Region 2*—Medium Blue

L = 45 to 64
a = –26 to 1
b = –25 to –2

4.2.3 *Region 3*—Light Blue

L = 65 to 93
a = –12 to 1
b = –25 to –2

4.2.4 *Region 4*—Green

L = 50 to 84
a = –12 to –1
b = –1 to 10

L = 50 to 64
a = –25 to –3
b = 11 to 30

L = 50 to 64
a = –25 to –13
b = –1 to 10

L = 65 to 93
a = –25 to –13
b = 25 to 30

L = 85 to 93
a = –12 to –3
b = –1 to 3

4.2.5 *Region 5*—Medium Beige

L = 50 to 74
a = 0 to 1
b = 4 to 12

L = 50 to 64
a = –2 to 1
b = 11 to 15

L = 65 to 74
a = –12 to –1
b = 11 to 12

4.2.6 *Region 6*—Light Beige

L = 75 to 84
a = 0 to 1
b = 4 to 12

L = 85 to 93
a = –12 to 1
b = 4 to 12

L = 75 to 84
a = –12 to –1
b = 11 to 12

4.2.7 *Region 7*—Gold

L = 65 to 93
a = 0 to 4
b = 13 to 30

L = 65 to 93
a = 5 to 25
b = 16 to 30

4.2.8 *Region 8*—Yellow

L = 65 to 93
a = –12 to –1
b = 13 to 30

4.2.9 *Region 9*—White

L = 85 to 100
a = –2 to 1
b = –1 to 3

All L = 94 to 100

4.2.10 *Region 10*—Light Gray

L = 65 to 84
a = 0 to 1
b = –1 to 3

4.2.11 *Region 11*—Mauve

L = 65 to 93
a = 2 to 25
b = 2 to 12

L = 65 to 93
a = 5 to 25
b = 13 to 15

L = 50 to 64
a = 2 to 25
b = 2 to 30

L = 50 to 64
a = –2 to 1
b = 16 to 30

4.2.12 *Region 12*—Medium Gray

L = 50 to 64
a = 0 to 1
b = –1 to 3

4.2.13 *Region 13*—Dark Gray

L = 25 to 49
a = –1 to 5
b = –1 to 1

4.2.14 *Region 14*—Dark Blue

L = 25 to 44
a = –25 to 3
b = –25 to –2

4.2.15 *Region 15*—Dark Green

L = 25 to 49
a = –20 to –2
b = –1 to 11

4.2.16 *Region 16*—Dark Red

L = 25 to 49
a = 6 to 30
b = –1 to 25

4.2.17 *Region 17*—Purple

L = 25 to 44
a = 4 to 30
b = –25 to –2

L = 45 to 49
a = 2 to 30
b = –25 to –2

L = 50 to 93
a = 2 to 25
b = –25 to 1

4.3 *Ellipsoid Value Equations*—Use the following equations to determine the ellipsoid value representing the change in color due to weathering. Use the equation that corresponds to the color region determined for the specimen's initial color (prior to weathering) in 4.2.

4.3.1 *Region 1*—Brown

$$\frac{(\Delta L - 1.6)^2}{(5.2)^2} + \frac{(\Delta a + 1.0)^2}{(3.0)^2} + \frac{(\Delta b - 0.5)^2}{(2.5)^2} = \text{Ellipsoid Value}$$

4.3.2 *Region 2*—Medium Blue

$$\frac{(\Delta L + 1.0)^2}{(6.0)^2} + \frac{(\Delta a + 0.6)^2}{(2.9)^2} + \frac{(\Delta b - 0.8)^2}{(5.4)^2} = \text{Ellipsoid Value}$$

4.3.3 *Region 3*—Light Blue

$$\frac{(\Delta L + 0.3)^2}{(6.4)^2} + \frac{(\Delta a + 0.1)^2}{(2.7)^2} + \frac{(\Delta b - 0.8)^2}{(4.3)^2} = \text{Ellipsoid Value}$$

4.3.4 *Region 4*—Green

$$\frac{(\Delta L - 0.2)^2}{(5.9)^2} + \frac{(\Delta a - 0.8)^2}{(4.8)^2} + \frac{(\Delta b - 0.2)^2}{(5.6)^2} = \text{Ellipsoid Value}$$

4.3.5 *Region 5*—Medium Beige

$$\frac{(\Delta L + 0.1)^2}{(6.1)^2} + \frac{(\Delta a - 0.0)^2}{(2.8)^2} + \frac{(\Delta b - 0.4)^2}{(3.9)^2} = \text{Ellipsoid Value}$$

4.3.6 *Region 6*—Light Beige

$$\frac{(\Delta L - 0.0)^2}{(5.0)^2} + \frac{(\Delta a - 0.2)^2}{(2.6)^2} + \frac{(\Delta b - 0.3)^2}{(5.4)^2} = \text{Ellipsoid Value}$$

4.3.7 *Region 7*—Gold

$$\frac{(\Delta L + 0.6)^2}{(6.6)^2} + \frac{(\Delta a + 0.3)^2}{(3.4)^2} + \frac{(\Delta b + 0.4)^2}{(4.7)^2} = \text{Ellipsoid Value}$$

4.3.8 *Region 8*—Yellow

$$\frac{(\Delta L + 0.3)^2}{(5.5)^2} + \frac{(\Delta a - 1.0)^2}{(3.3)^2} + \frac{(\Delta b + 0.1)^2}{(5.5)^2} = \text{Ellipsoid Value}$$

4.3.9 *Region 9*—White

$$\frac{(\Delta L - 0.6)^2}{(8.2)^2} + \frac{(\Delta a + 0.0)^2}{(3.3)^2} + \frac{(\Delta b - 1.9)^2}{(5.3)^2} = \text{Ellipsoid Value}$$

4.3.10 *Region 10*—Light Gray

$$\frac{(\Delta L + 1.8)^2}{(7.0)^2} + \frac{(\Delta a - 0.2)^2}{(2.1)^2} + \frac{(\Delta b - 1.3)^2}{(4.0)^2} = \text{Ellipsoid Value}$$

4.3.11 *Region 11*—Mauve

$$\frac{(\Delta L - 0.4)^2}{(6.5)^2} + \frac{(\Delta a - 0.8)^2}{(4.0)^2} + \frac{(\Delta b - 1.1)^2}{(4.5)^2} = \text{Ellipsoid Value}$$

4.3.12 *Region 12*—Medium Gray

$$\frac{(\Delta L + 1.0)^2}{(6.6)^2} + \frac{(\Delta a + 0.3)^2}{(2.5)^2} + \frac{(\Delta b - 1.2)^2}{(3.7)^2} = \text{Ellipsoid Value}$$

4.3.13 *Region 13*—Dark Gray

$$\frac{(\Delta L - 0.1)^2}{(5.1)^2} + \frac{(\Delta a + 0.8)^2}{(3.4)^2} + \frac{(\Delta b + 0.1)^2}{(3.0)^2} = \text{Ellipsoid Value}$$

4.3.14 *Region 14*—Dark Blue

$$\frac{(\Delta L - 0.3)^2}{(5.2)^2} + \frac{(\Delta a - 1.0)^2}{(3.6)^2} + \frac{(\Delta b + 1.3)^2}{(4.5)^2} = \text{Ellipsoid Value}$$

4.3.15 *Region 15*—Dark Green

$$\frac{(\Delta L - 0.0)^2}{(5.0)^2} + \frac{(\Delta a + 0.4)^2}{(3.0)^2} + \frac{(\Delta b + 0.2)^2}{(3.8)^2} = \text{Ellipsoid Value}$$

4.3.16 *Region 16*—Dark Red

$$\frac{(\Delta L - 0.4)^2}{(5.4)^2} + \frac{(\Delta a - 0.8)^2}{(4.0)^2} + \frac{(\Delta b - 0.2)^2}{(3.0)^2} = \text{Ellipsoid Value}$$

4.3.17 *Region 16*—Purple

$$\frac{(\Delta L - 0.0)^2}{(6.0)^2} + \frac{(\Delta a - 0.0)^2}{(5.0)^2} + \frac{(\Delta b - 0.0)^2}{(5.2)^2} = \text{Ellipsoid Value}$$

5. Procedure for Measuring Color Retention

5.1 *Test Site Setup and Exposure Duration Test Times*:

5.1.1 Samples shall be exposed at three test sites: Temperate Northern represented by a site located in Louisville, KY or Cleveland, OH; hot, humid represented by a site located in Miami, FL, and hot, dry represented by a site located in Phoenix, Arizona. Additional test sites are permitted as agreed upon by the buyer and the seller.

5.1.2 All exposures shall be conducted at an angle of 45° facing South and backed using unpainted plywood in accordance with Practices D1435 and G147.

5.1.3 Remove test specimens for color measurement at 24-month exposure. In some cases, 24 months are not sufficient to distinguish material durability differences and longer exposure periods are necessary. Additional exposure times are permitted as agreed upon by the buyer and the seller.

5.2 *Sampling and Specimen Preparation*:

5.2.1 Samples shall be representative of the product to be evaluated.

NOTE 2—Samples prepared in the laboratory in the same manner as commercial samples are an acceptable alternate to a commercial part. If the commercial product is extruded, the laboratory specimen must be extruded; if the commercial product is injection molded, the laboratory specimen must be injection molded, and so forth.

5.2.2 Select a minimum of four specimens per sample per test site to allow for three test specimens and one file specimen for each sample evaluated.

5.2.3 The file specimen will be used for a visual assessment of variegation/contrast change. The test specimens will be measured for color and weathered.

5.2.4 Specimens shall be a flat section and a minimum of 3 by 10 in. (76 by 254 mm). The variegated pattern shall be parallel to the long edge of the specimen.

5.2.5 Use the Variegated Color Measurement Template to identify the 6 spots on each test specimen for color retention testing. The center points of these six spots are specified in Fig. 1. The diameter of the six spots is specified as 0.50 in. (12.2 mm) minimum. Those shown in the diagram are for illustration only.

5.2.6 The exact locations of these test spots must be determined and recorded for each test specimen to allow measurement of color change following exposure testing.

5.2.7 The locations and spot sizes identified in 5.2.5 for each test specimen shall not change once the exposure test is started.

5.2.8 Mark each specimen permanently to ensure retention of identity during and after exposure testing.

NOTE 3—Use of a vibratool leaves a permanent mark that satisfies this criteria.

5.3 *Data Record*:

5.3.1 Measured specimen color values shall be reported to one decimal place.

5.3.2 Calculation of color units shall be reported to one decimal place.

5.4 *Practice*:

5.4.1 Obtain test and file specimens in accordance with 5.2.

5.4.2 Measure the original tristimulus X, Y, and Z values for the six spots identified in 5.2.5 for each test specimen. Color is measured using sphere geometry (di:8), illuminant C, 2° observer, specular component included in accordance with Practice E805. The minimum aperture size for color measurement 0.50 in. (12.2 mm).

5.4.3 Calculate the Hunter L, a, and b units in accordance with the equations in the section on "Hunter L, a, and b Color Space and Color-Difference Equation" in Test Method D2244 using the average of the six measurements and record in a permanent record.

5.4.4 The measured average color of each test specimen is the specimen's initial color and is used to determine color change after specified periods of exposure testing.

5.4.5 Repeat steps 5.4.2 through 5.4.4 for each test specimen.

5.4.6 Calculate the average color in Hunter L, a, b for the three test specimens to determine their color region as defined in 4.2.

5.4.6.1 Calculate the overall average color of the three test specimens for each test site from step 5.4.5.

5.4.6.2 A single color region must be determined and used at all test sites. If the color regions determined for each test site are not the same, re-measure the test specimens for the non-conforming test site. If the three test sites still do not agree,