Designation: D7856 – 15a

Standard Specification for Color and Appearance Retention of Solid and Variegated Color Plastic Siding Products using CIELab Color Space[1]

This standard is issued under the fixed designation D7856; 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 solid and variegated colored plastic siding products.

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

NOTE 1—The exposure locations and durations specified in this standard have been shown to provide a good estimation of the color change in vinyl and polypropylene siding products over an extended period of service (see 2.2). It is expected that materials designed for the exposure conditions typical of exterior siding will respond similarly, but the applicability of this standard to other types of plastic siding has not been empirically established.

1.3 This specification is a successor to Specifications D6864 and D7251, which cover solid colors and variegated colors, respectively. This specification combines coverage for both, and has the same scope as those standards.

1.4 Specifications D6864 and D7251 use Hunter Lab color space for measurement of colors and evaluation of color change. These standards require classification of colors into regions based on the L, a, and b coordinates of the color, and evaluation of color changes is done using an ellipsoid value equation having unique coefficients for each color region. This specification uses CIE 1976 L* a* b* color space for measurement and evaluation of color change. Using this method, the need for separate color regions and evaluation equations has been eliminated.

1.5 Provisions for sample selection and preparation, and weathering are the same in this specification as in Specifications D6864 and D7251.

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

1.7 This standard specifies outdoor weathering in three specific climate zones for a single 24-month exposure, and the color retention performance requirements under these conditions are established to be indicative of acceptable performance over an extended period of service. However, nothing in this standard precludes the use of different or additional climate zones, or different exposure durations, so long as those conditions are clearly specified in any reports.

1.8 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.9 *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 2—There is no known ISO equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D660 Test Method for Evaluating Degree of Checking of Exterior Paints

D661 Test Method for Evaluating Degree of Cracking of Exterior Paints

D662 Test Method for Evaluating Degree of Erosion of Exterior Paints

D714 Test Method for Evaluating Degree of Blistering of Paints

D772 Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints

D883 Terminology Relating to Plastics

D1435 Practice for Outdoor Weathering of Plastics

D1600 Terminology for Abbreviated Terms Relating to Plastics

[1] This test method 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**

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
D4214 Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
D6864 Specification for Color and Appearance Retention of Solid Colored Plastic Siding Products
D7251 Specification for Color and Appearance Retention of Variegated Color Plastic Siding Products
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E1331 Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry
G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests

2.2 *Other Reference:*

VS2W Vinyl Siding Institute (VSI) Technical Research Report for Weatherability of Vinyl Siding Products[3]

NOTE 3—The report cited in 2.2 supports the conclusion that commercial vinyl siding products which demonstrate weathering behavior within conformance to these standards during a two year test program are likely to provide acceptable color retention properties over an extended period of service. Unpublished long term weathering study data support a similar conclusion for polypropylene siding (see Appendix X1).

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *polypropylene siding*—a shaped material, made principally from polypropylene homopolymer, or copolymer, which in some cases may contain fillers and/or reinforcements, that is used to clad exterior walls of buildings.

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

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

3.2.4 *vinyl siding*—a shaped material, made principally from rigid poly(vinyl chloride) (PVC), that is used to clad exterior walls of buildings.

4. Significance and Use

4.1 This specification uses two-year outdoor weathering to provide an indication of the long-term color retention properties of plastic siding samples.

4.2 The methodology and procedures prescribed are only applicable to this specification.

4.3 The exposure locations and durations specified in this standard have been shown to provide a good estimation of the color change in vinyl and polypropylene siding products over an extended period of service (see 2.2). It is expected that materials designed for the exposure conditions typical of exterior siding will respond similarly, but the applicability of this standard to other types of plastic siding has not been empirically established.

4.4 The response of siding color samples to outdoor exposure is sensitive to differences in weather, and is subject to variation from year to year. Differences in exposure and weather patterns, including temperature, moisture, total radiant energy, and type and concentration of pollutants, also affect response in different climates. For this reason, samples are weathered in three distinct North American locations. Samples must show acceptable weathering performance at all three locations.

4.5 It has been shown (see 2.2) that most color change occurs during the first two years of outdoor exposure. After approximately two years, the rate of change levels off, and the degree of change observed after two years provides a significant indication of the overall degree of change that will be present through subsequent long term exposure.

4.6 Studies involving vinyl siding and polypropylene siding support the applicability of the methods and criteria in this standard to plastic siding. As essentially all plastic siding uses either vinyl or polypropylene, no comparable studies of siding using polymers other than these two have been identified.

4.7 No method that is subject to the vagaries of outdoor weather can be expected to absolutely predict the degree of color change at a specific point in the future. However, the above results show that acceptability of color change measured after two-years of outdoor exposure correlates sufficiently to the long term acceptability to provide an indication of the commercial viability of a color for long term use on customers' buildings, which is the purpose of this specification.

4.8 Criteria for acceptability were developed by correlating the results of visual evaluation of various colors and color differences to the measured degrees of color difference. Thus the performance requirements in Section 7 represent the human perception of the limits of acceptability of a measured color change.

5. Sampling and Specimen Preparation

5.1 Samples shall be representative of the product to be evaluated. Samples shall be taken either from commercial products or from laboratory samples. Laboratory samples shall be produced in the same manner as the commercial products to be evaluated.

NOTE 4—Production of laboratory samples in the same manner includes use of the same method of forming the product. For example, if the commercial product is extruded, the laboratory specimen shall be extruded; if the commercial product is injection molded, the laboratory specimen shall be injection molded, and so forth.

5.2 Mark each specimen permanently to ensure retention of identity during and after exposure testing. Ensure that the identification marking is small and does not interfere with the color measuring area.

NOTE 5—Use of a vibratool leaves a permanent mark that satisfies this criterion.

5.3 *Solid Color Specimens:*

[3] Available from Vinyl Siding Institute (VSI), National Housing Center, 1201 15th Street NW, Suite 220, Washington, DC 20005, http://www.vinylsiding.org.

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

5.3.2 The file specimen will be measured for color at each test location and will serve as the reference color for evaluation of color changes in the three replicates after weathering.

5.3.3 Specimens shall be a flat section and a minimum of 2 by 3¾ in. (51 by 95 mm). If the normally-exposed surface of the siding is heavily textured to the extent that correct or consistent color measurements cannot be obtained, weathering test exposure of the back surface or other surface is permitted, so long as the surface is representative of the exposed surface.

5.4 *Variegated Color Specimens:*

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

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

5.4.3 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.

5.4.4 Use the Variegated Color Measurement Template to identify the six 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. The actual diameter used shall be large enough to admit the aperture plate of the instrument used without extraneous light leakage.

5.4.5 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. The

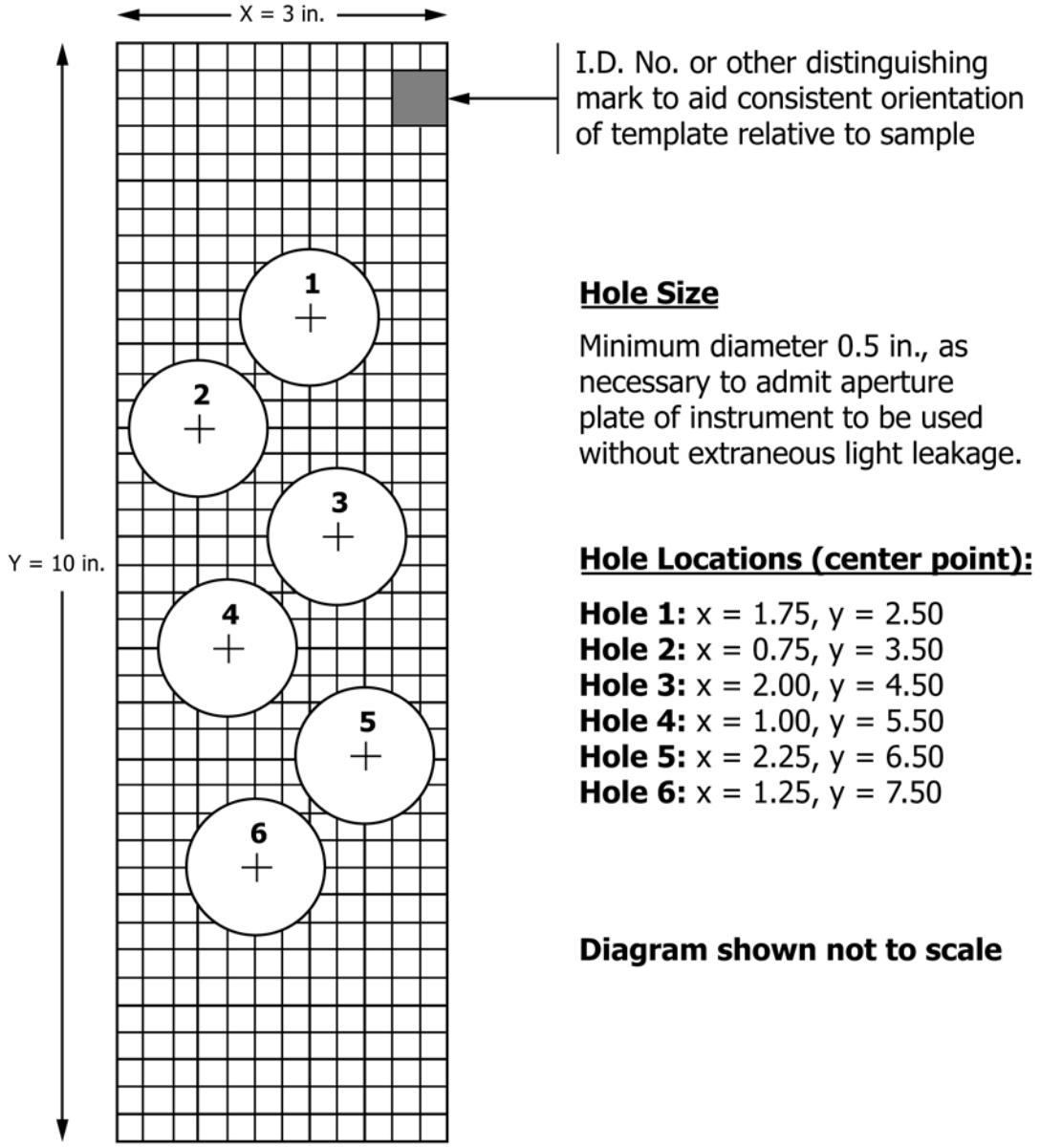

FIG. 1 Variegated Color Measurement Template

locations and spot sizes identified in 5.4.4 for each test specimen shall not change once the exposure test is started.

6. Procedure

6.1 *Outdoor Weathering:*

6.1.1 Samples shall be exposed at three test sites: Temperate Northern represented by a site located in near Louisville, KY or Cleveland, OH; hot, humid represented by a site located near Miami, FL; and hot, dry represented by a site located near Phoenix, AZ. Actual test locations are not limited to these representative cities so long as the location is representative of the indicated climate zone.

6.2 *Color Measurement (General):*

6.2.1 All color measurements are to be made in accordance with this section. Obtain test and file specimens in accordance with 5.3 or 5.4. The following procedure is used at each of the three weathering locations.

6.2.2 Color is measured using 8° sphere geometry, diffuse illumination, specular component included (di:8), Illuminant D65, and 10° observer, in accordance with Test Method E1331. For solid colors make at least three separate measurements on the specimen and average them. For variegated colors take one reading at each of the six spots identified in 5.4.4, and average them.

6.2.3 Calculate the CIE 1976 L*a*b* units in accordance with the "CIE 1976 L* a* b* Uniform Color Space and Color-Difference Equation" in Test Method D2244, using the average of the replicate measurements, and record them in a permanent record.

6.2.4 Measured specimen color values shall be reported to no more than two decimal places, in accordance with the rounding method in Practice E29.

6.3 *Initial Color Measurement:*

6.3.1 *Solid colors*—At each weathering location, measure the color of each file specimen in accordance with 6.2 and record the L*a*b* values in a permanent record. The initial L*a*b* values determined from the file specimens are used as the reference point for all measurements of color change of the weathered samples during the duration of the weathering study.

6.3.2 *Variegated Colors*—At each weathering location, measure the color of each of the six spots on each of the test specimens in accordance with 6.2. Determine the average of the six spots for each test specimen and record the average L*a*b* values in a permanent record. 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.

6.4 *Exposure:*

6.4.1 Expose the test specimens at the test sites in specified in 6.1.1. Record the test start date in a permanent record.

6.4.2 Expose the specimens at an angle of 45° facing South and backed using unpainted plywood in accordance to Practices D1435 and G147. The surface of the specimens must be fully exposed.

6.4.3 Remove test specimens for color measurement after 24 months of exposure.

6.4.4 If the specimens are to be subjected to further weathering exposure, return them to the test rack no later than seven days after removal.

6.5 *Color Measurement and Appearance Evaluation:*

6.5.1 After they are removed from exposure, wash the exposed test specimens in accordance with the procedure in Annex A1.

6.5.2 Measure the exposed test specimens for color and evaluate them for appearance and surface condition. Color measurement shall take place within seven days of specimen removal from the exposure test rack. Record the date and time of removal and the date and time of color measurement.

NOTE 6—It is recommended that color measurement and appearance evaluation be conducted at the test site. Additional color development is known to occur for PVC products after removal from exposure to solar radiation. This artificial color change is referred to as Dark Time Yellowing. It is recommended that color measurement take place within 48 h of the specimen's removal from the exposure test rack, especially for PVC products.

6.5.3 *Solid Colors*—Measure the color of each test specimen in accordance with 6.2 and record the L*a*b* values in a permanent record.

6.5.4 *Variegated Colors*—Referencing the file specimen, evaluate each test specimen for loss of variegation in accordance with 7.6. Measure the color of each of the six spots on each of the test specimens in accordance with 6.2. Determine the average of the six spots for each test specimen and record average L*a*b* values in a permanent record.

6.5.5 *Visual Evaluation*—For both solid and variegated colors, evaluate each test specimen for appearance and surface condition in accordance with Annex A2.

7. Performance Requirements

7.1 For each specimen determine the change in L*, a*, and b* between the initial color measurement and the color measurement after 24 months exposure. For solid colors the initial color reference is to the file specimen, determined in 6.3.1. For variegated colors the initial color reference is to the initial color of that test specimen, determined in 6.3.2.

7.2 The ΔE_{00} for an individual specimen is calculated using the measured color change and the "CIEDE2000 Color Difference Equation" in Test Method D2244. For K_L, K_C, K_H, use a value of 1. Average the ΔE_{00} for the three test specimens of each color at each test location.

7.3 Acceptable color retention is determined by the average ΔE_{00} of the three test specimens at each test location being less than or equal to 4.0. In addition, no individual specimen shall have a ΔE_{00} greater than 6.0. For purposes of determining compliance with these requirements, the calculated value of ΔE_{00} shall be rounded to the nearest one decimal place in accordance with the rounding method of Practice E29.

7.4 For both solid and variegated colors, the specimen shall be free of any visual surface or structural changes such as peeling, chipping, cracking, flaking, and pitting when evaluated in accordance to Annex A2.

7.5 For solid colors, each specimen shall be of uniform appearance and void of blemishes, streaks, and splotches.

7.6 For variegated colors, acceptable variegation change is any remaining presence of variegation. Failure is defined as complete loss of variegation and the presence of a uniform color.

8. Keywords

8.1 color retention; plastic siding; polypropylene siding; vinyl siding; weatherability

ANNEXES

(Mandatory Information)

A1. WASHING WEATHERING SPECIMENS

A1.1 Scope

A1.1.1 This procedure describes a practice for washing weathering specimens prior to instrumental color measurement. The procedure is intended to minimize any effects of altering the specimen's surface in other than a predictable manner.

A1.2 Equipment

A1.2.1 Mild Detergent, such as Joy, Palmolive, Liquid Dawn, or equivalent. Avoid using detergents that have any additives, such as citrus, fragrances or bleach.

A1.2.2 Sponge or soft cloth.

A1.2.3 Purified water, such as deionized or distilled water.

A1.3 Procedure

A1.3.1 Flush exposed specimen with water to remove loose particles.

A1.3.2 Gently wash the specimen with a dilute solution (0.05 % by weight in purified water, maximum concentration) of a mild detergent using a sponge or soft cloth.

A1.3.3 The washing action shall not be excessive and shall be limited to a back-and-forth motion along the grain or pattern, if one exists.

A1.3.4 Avoid circular motions.

A1.3.5 Rinse thoroughly with clean water to remove any mild detergent residue.

A1.3.6 The washed specimen shall air dry and be free of any water or moisture before conducting color measurements.

A2. VISUAL EVALUATION FOR APPEARANCE AND SURFACE CONDITION

A2.1 Scope

A2.1.1 This procedure describes a practice for evaluating and rating specimens for appearance and surface conditions after a period out outdoor weathering exposure.

A2.2 Practice

A2.2.1 Upon completion of the two-year outdoor exposure, visually evaluate the specimens for structural and surface changes. Rate and report any defects in accordance with the following Test Methods:

A2.2.1.1 *Checking:* Test Method D660

A2.2.1.2 *Cracking:* Test Method D661

A2.2.1.3 *Erosion:* Test Method D662

A2.2.1.4 *Blistering:* Test Method D714

A2.2.1.5 *Flaking (scaling):* Test Method D772

A2.2.1.6 *Chalking:* Test Methods D4214, Procedure A

A2.2.1.7 *Defects not included in the above*—Describe the defect and rate as Mild, Moderate, or Severe.

APPENDIXES

X1. LONG-TERM CORRELATION WITH TWO-YEAR WEATHERING

(Nonmandatory Information)

X1.1 Background

X1.1.1 This standard specifies outdoor weathering in three specific climate zones for a single 24 month exposure, and the color retention performance requirements under these conditions are established to be indicative of acceptable performance over an extended period of service.

X1.1.2 The utility of using 24-month weathering results as a basis for expected longer-term performance is supported for vinyl siding by the study referenced in 2.2, and for polypropylene siding by a similar study conducted by a manufacturer. The results of those studies are summarized in the following sections.

X1.2 Vinyl Siding

X1.2.1 Samples of vinyl siding with large variety of colors were subjected to outdoor weathering in three locations, representing a hot/dry, hot/humid and northern temperate climate zones. The color of each of the siding samples was read in Hunter Lab color space at initiation of the study, after two years of exposure, and at periodic intervals up to ten years after inception.

X1.2.2 At each reading interval each sample was evaluated for acceptability of color change at each measurement period, using methodology and criteria similar to that in Specification D6864. The acceptability (expressed as "pass" or "fail") of the degree of color change after that period of exposure was compared with that at two years.

X1.2.3 The success of the method is indicated by the percentage of individual samples that had the same result (either pass or fail) at both two years and ten years. The results are summarized in Table X1.1. Note that the absolute number of passes or fails at any given time is irrelevant; it is the percentage of samples having the same result at two years and ten years that matters.

X1.2.4 Agreement of the pass/fail evaluation at two years and at ten years ranged from 72 % to 86 %, with similar percentages at all three weathering locations. The overall correlation between two-year and ten-year results for all samples was 81 %.

X1.3 Polypropylene Siding

X1.3.1 A manufacturer of polypropylene siding conducted proprietary testing similar to that described for vinyl siding in X1.2.1. Fewer samples were available, and individual samples were read at different time intervals. The readings for each sample were evaluated as described in X1.2.2.

X1.3.2 Table X1.2 shows the results of comparison of readings taken after two years of exposure with those taken at later intervals. Not all samples that were read at two years were read in later years; some years were skipped, and in some cases testing was discontinued. For instance, in Arizona, 61 samples were read at both two years and at five years, but only 22 of those samples were read at seven years and at ten years.

X1.3.3 As very few samples were evaluated as "fail" at two years, no conclusion can be drawn about the effectiveness of the study for indicating long-term failure after two years. For samples that were evaluated as "pass" at two years, the correlation to that rating in later years is similar to that for vinyl siding, generally in the range of 75 % to 90 %.

TABLE X1.1 Agreement of Ten-Year Results with Two-Year Results for Vinyl Siding

	Arizona		Florida		Ohio	
Two Year Status	Pass	Fail	Pass	Fail	Pass	Fail
Number at Two Years	265	18	230	56	193	93
Same Status at Ten Years	229	13	178	47	151	71
Percentage in Agreement	86 %	72 %	77 %	84 %	78 %	76 %
Total Agreement by Location	86 %		79 %		78 %	
Total Agreement, All Locations	81 %					

TABLE X1.2 Agreement of Long-Term Results with Two-Year Results for Polypropylene Siding

Arizona

	Two to Three Year Agreement		Two to Five Year Agreement		Two to Seven Year Agreement		Two to Eight Year Agreement		Two to Ten Year Agreement	
Two Year Status	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Number at Two Years	61	0	61	0	22	0	0	0	22	0
Same Status at X Years	60	0	55	0	18	0	0	0	18	0
Percentage in Agreement	98 %	...	90 %	...	82 %	...	...	...	82 %	...

Florida

	Two to Three Year Agreement		Two to Five Year Agreement		Two to Seven Year Agreement		Two to Eight Year Agreement		Two to Ten Year Agreement	
Two Year Status	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Number at Two Years	60	1	60	1	22	0	0	0	22	0
Same Status at X Years	60	1	55	1	18	0	0	0	17	0
Percentage in Agreement	100 %	100 %	92 %	100 %	82 %	...	...	...	77 %	...

Ohio

	Two to Three Year Agreement		Two to Five Year Agreement		Two to Seven Year Agreement		Two to Eight Year Agreement		Two to Ten Year Agreement	
Two Year Status	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Number at Two Years	49	2	58	3	11	1	9	1	20	2
Same Status at X Years	43	0	54	0	9	0	7	0	20	0
Percentage in Agreement	88 %	0 %	93 %	0 %	82 %	0 %	78 %	0 %	100 %	0 %

X2. GUIDELINES FOR USING THE VARIEGATED COLOR MEASUREMENT TEMPLATE

X2.1 The template is intended to provide the user a tool to reliably measure the color of areas on multiple occasions.

X2.2 The size of the holes in the template will vary depending on the aperture size and spectrophotometer configuration, that is, portable or benchtop.

X2.3 The template is to be used with both portable and bench top color spectrophotometers.

X2.4 Means for using the template for each of the above configurations are described.

X2.4.1 *Portable Color Spectrophotometer:*

X2.4.1.1 The template is placed on the test surface of the test specimen.

X2.4.1.2 Align and secure the template and test specimen together in a manner that allows the same area to be measured on multiple occasions.

X2.4.1.3 Align the measurement port of the spectrophotometer with template's circular opening to measure the test specimen's color.

X2.4.1.4 Repeat for the remaining five circular openings in the template.

X2.4.2 *Bench Top Color Spectrophotometer:*

X2.4.2.1 Many bench top spectrophotometers are configured with a spring-loaded clamp to hold the test specimen against the instrument's measurement port.

X2.4.2.2 This clamp is usually circular in shape and consequently provides a convenient way to index the test specimen.

X2.4.2.3 Design the template so the circular opening is the same diameter as the instrument's clamp.

X2.4.2.4 Place the template on the backside of the test specimen and trace the outline of each circular opening onto the test specimen.

X2.4.2.5 Place the test specimen on spectrophotometer so the outer edge of the clamp is aligned with the circle indexed on the backside of the specimen.

X2.4.2.6 Measure the test specimen's color.

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D7856 – 15) that may impact the use of this standard. (December 1, 2015)

(1) Revised 1.2 and 1.7; and added a new Note 1.
(2) Revised Note 2.
(3) Added definitions for "vinyl siding" and "polypropylene siding."
(4) Added a new Appendix X1.
(5) Added Significance and Use section (Section 4).

Committee D20 has identified the location of selected changes to this standard since the last issue (D7856 – 14) that may impact the use of this standard. (April 1, 2015)

(1) Removed Practice E805 from 2.1 and 6.2.2 and replaced it with Test Method E1331.