Designation: F1515 – 15

Standard Test Method for Measuring Light Stability of Resilient Flooring by Color Change[1]

This standard is issued under the fixed designation F1515; 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 test method covers a procedure for determining the resistance of resilient floor covering to color change from exposure to light over a specified period of time.

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:*[2]

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

D4459 Practice for Xenon-Arc Exposure of Plastics Intended for Indoor Applications

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

G177 Tables for Reference Solar Ultraviolet Spectral Distributions: Hemispherical on 37° Tilted Surface

3. Summary of Practice

3.1 Specimens are exposed continuously at a controlled temperature and humidity to a properly filtered xenon-arc radiant-energy source. The filters selected are to simulate indoor exposure conditions behind window glass. See Practice D4459.

3.2 To ensure uniform exposure, periodic specimen repositioning is a good practice to reduce the variability in exposure stresses experienced during the test interval.

NOTE 1—See Practice G151 for guidance on repositioning of specimens.

3.3 The effect of radiation (actinic and thermal) on the specimen shall be the color difference between the specimen before and after exposure.

4. Significance and Use

4.1 Resilient floor covering is made by fusing polymer materials under heat or pressure, or both, in various manufacturing and decorating processes. The polymer material may be compounded with plasticizers, stabilizers, fillers, and other ingredients for processability and product performance characteristics. The formulation of the compound can be varied considerably depending on the desired performance characteristics and methods of processing.

4.2 Light stability, which is resistance to discoloration from light, is a basic requirement for functional use.

4.3 This test method provides a means of measuring the amount of color change in flooring products when subjected to accelerated light exposure over a period of time (functional use of the flooring product).

4.4 This test method specifies that a sample is measured by a spectrophotometer and expressed in ΔE* units before and after accelerated light exposure.

NOTE 2—It is the intent that this test method be used for testing light stability performance properties to be referenced in resilient flooring specifications.

5. Apparatus

5.1 The apparatus employed shall utilize either a water-cooled or air-cooled xenon-arc lamp as the source of radiation as described in Practices D4459 or G155.

5.2 *Xenon Light Source*—The xenon light source consists of a quartz-jacketed burner tube charged with xenon gas.

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[1] This test method is under the jurisdiction of ASTM Committee F06 on Resilient Floor Coverings and is the direct responsibility of Subcommittee F06.30 on Test Methods - Performance.

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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.

5.3 *Glass Filters*—Table 1 shows the relative spectral power distribution limits of xenon-arcs filtered for simulating a behind window-glass exposure.

5.4 *Light Monitor*—The light monitor shall be capable of measuring spectral irradiance at either 340 nm or at 300 to 400 nm incident to the specimen.

5.5 *Black Panel Temperature (BPT) Sensor*—A black-coated stainless steel panel, as specified in Practice G155, should be used as the standard reference to control test temperature. (Alternative devices such as the Black Standard Thermometer (BST) described in Practice G151 may be used. The BST equivalent to the BPT = 145°F (63°C) has been found to be approximately 153°F (67°C)).

5.6 A suitable spectrophotometer or colorimeter with a minimum 0.25-in. (6.35-mm) diameter opening having both cool white fluorescent (CWF) and daylight (D-65) light sources that measure color in CIE L*, a*, b* using CIE 10° Standard Observer and specular included. When an individual color cannot be totally covered within the 0.25 in. spectrophotometer opening, then the largest spectrophotometer opening shall be used. See Test Method D2244.

6. Hazards

6.1 Check to be sure the apparatus is operating properly at the start of each test. Check the lamp condition at weekly intervals to be sure that the burner tube and optical filters are clean and that they have not exceeded the maximum recommended period of use.

6.2 Be sure specimens are held flat when measuring color.

7. Procedure

7.1 The test specimens shall be flat and of uniform thickness. Dimensions are not critical. However, the specimens should be capable of fitting the exposure rack and covering the aperture (usually 2.0 in. by 2.0 in. (50.8 mm by 50.8 mm) of the color-measuring apparatus used.

7.2 For each exposure time cut three specimens or cut one specimen and mark three test areas from each sample. All specimens shall be of similar color, pattern and texture.

TABLE 1 Sunlight Behind Window Glass Simulation Relative Spectral Irradiance for Xenon-Arc Output as Percentage of Irradiance at 300–400 nm[A]

Bandpass (nm)	Minimum Percent[A]	Window Glass Filtered Solar Radiation Percent[B]	Maximum Percent[A]
Λ <300		0.0	0.29
$300 \leq \lambda \leq 320$	0.1	$\leq$ 0.5	2.8
$320 \leq \lambda \leq 360$	23.8	34.2	35.5
$360 \leq \lambda \leq 400$	62.5	65.3	76.1

[A] Table 1 is copied from Practice G155.

[B] The window glass filtered solar data is for a solar spectrum with atmospheric conditions and altitude chosen to maximize the fraction of short wavelength solar UV (defined in Practice G177) that has been filtered by window glass. The glass transmission is the average for a series of single strength window glasses tested as part of a research study for ASTM Subcommittee G3.02.9. While this data is provided for comparison purposes only, it is desirable for a xenon-arc with window glass filters to provide a spectrum that is a close match to this window glass filtered solar spectrum.

NOTE 3—White, monochromatic, flat material is preferred for testing.

7.3 Obtain and record initial L*, a*, and b* readings on each of the three specimens or areas with the color measuring equipment before placing in the xenon-arc test apparatus. Mark the exact area of the measurement for future location in the color measurement equipment.

7.4 Program the instrument to operate in the continuous light-on mode without water spray at an irradiance equivalent to 0.30 W/m^2 at 340 nm (that is, 37 W/m^2 at 300 nm to 400 nm). Place the black panel sensor and specimens on the specimen rack in accordance with manufacturer's recommendations and fill the remaining vacancies with non-UV reflecting blanks, for example, gray card stock.

7.4.1 Control black-panel temperature at 145°F ± 4°F (63°C ± 2°C) or BST at 153°F ± 4°F (67°C ± 2°C).

7.4.2 Control the relative humidity at 50 ± 10 %.

7.5 Expose the specimens to be tested for a total of 400 h, with specimens removed for color measurements at 100 h, 200 h, 300 h, and 400 h.

7.6 Remove the specimens from the test apparatus and recondition at 73.4°F (23°C) for a minimum of 1 h.

7.7 Within 24 h after reconditioning, obtain final L*, a*, b* and calculate ΔE* readings on each specimen at the marked position using the color measuring equipment. Use either the cool white fluorescent (CWF) or daylight (D-65) light source. If during testing localized spotting is noted, additional sample testing is advised. However, judgment of color change will still be based upon ΔE* value.

8. Reporting

8.1 Record the light source used for measurement.

8.2 Record initial and final L*, a*, b* and ΔE* values for each specimen and report the individual and average ΔE* values.

9. Precision and Bias

9.1 *Interlaboratory Test Program*—An interlaboratory study evaluating the color stability of resilient vinyl flooring to the effects of exposure to light was run in 1991–1993. Six laboratories tested three categories of an experimental unprinted resilient sheet flooring structure having a 0.010 in. (0.254 mm) transparent top layer containing varying levels of stabilizers. Exposure to xenon lighting for 100, 200, 300 and 400 h was used to provide an accelerated light aging environment. Color measurements were made under daylight (D-65) and cool white fluorescent (CWF) illumination. Each category level contained four test specimens randomly drawn from the master batch of material prepared by a single manufacturing site. Practice E691 was followed for the design and analysis of the data, the details of the test program are contained in an ASTM research report.[3] This data was conducted utilizing only water-cooled xenon.

[3] Supporting data have been filed at ASTM Headquarters and may be obtained by requesting Research Report RR F06-1003.

TABLE 2 Daylight (D-65)

Material	Stabilization Level	ΔE* Average	Repeatability Standard Deviation	Repeatability Limit	Reproducibility Standard Deviation	Reproducibility Limit
100 hours xenon						
B	High	2.310	0.221	0.619	0.769	2.153
A	Medium	3.143	0.125	0.350	0.959	2.685
C	Low	3.793	0.111	0.311	1.092	3.058
200 hours xenon						
B	High	3.468	0.120	0.336	1.002	2.806
A	Medium	3.932	0.158	0.442	1.087	3.044
C	Low	4.089	0.178	0.498	1.046	2.929
300 hours xenon						
B	High	3.169	0.171	0.479	1.249	3.497
A	Medium	3.699	0.163	0.456	1.120	3.136
C	Low	3.146	0.630	1.764	0.806	2.257
400 hours xenon						
B	High	3.154	0.331	0.927	0.867	2.428
A	Medium	3.500	0.242	0.678	0.916	2.565
C	Low	4.617	0.886	2.481	3.056	8.557

TABLE 3 Cool White Fluorescent (CWF)

Material	Stabilization Level	ΔE* Average	Repeatability Standard Deviation	Repeatability Limit	Reproducibility Standard Deviation	Reproducibility Limit
100 hours xenon						
B	High	2.514	0.175	0.490	0.883	2.472
A	Medium	3.514	0.135	0.378	1.093	3.060
C	Low	4.244	0.127	0.356	1.214	3.399
200 hours xenon						
B	High	3.857	0.123	0.344	1.178	3.298
A	Medium	4.369	0.143	0.400	1.269	3.553
C	Low	4.535	0.278	0.778	1.172	3.281
300 hours xenon						
B	High	3.557	0.175	0.490	1.441	4.035
A	Medium	4.132	0.143	0.400	1.291	3.615
C	Low	3.395	0.484	1.355	0.837	2.344
400 hours xenon						
B	High	3.405	0.253	0.708	1.133	3.172
A	Medium	3.945	0.294	0.823	0.991	2.775
C	Low	4.641	0.900	2.520	2.871	8.039

9.2 *Test Results*—The terms repeatability limit and reproducibility limit are used as specified in Practice E177. The precision information has been summarized in Table 2 and Table 3. There is a mixture of constancy and proportionality when the 2.8s indices are compared throughout the test range. It should be noted that in this study measurement of color change correlated with the various levels of stabilization. All categories exhibit constancy in performance at 100, 200 and 300 h exposure. At 400 h exposure, categories B & A continue this trend of constancy; however, category C shows divergence behavior.

9.3 *Precision*—A comparison of standard deviations shows the reproducibility value to be approximately 3 to 9 times greater than the corresponding repeatability value. Repeatability within a laboratory is better than reproducibility between laboratories.

9.4 *Bias*—Since there is no accepted reference material, method, or laboratory suitable for determining the bias for the procedure in this test method for measuring the light induced discoloration in vinyl resilient flooring, no statement on bias is being made.

10. Keywords

10.1 accelerated test; light resistance; light stability; resilient flooring; spectrophotometer