

Gray Scale for Color Change

Adopted in 1954 by AATCC; under jurisdiction of AATCC Committee RA36; revised 1979, 1987, 2002; editorially revised 1991; editorially revised and reaffirmed 1992. Technically equivalent to ISO 105-A02.

1. Scope

1.1 This evaluation procedure describes the use of a Gray Scale for visually evaluating changes in color of textiles resulting from colorfastness tests. For instrumental assessment of change of color of a test specimen refer to AATCC Evaluation Procedure 7. A precise colorimetric specification of the differences between the reference and the 9-step Scale is given as a permanent record against which newly prepared Gray Scales, and old scales that might have changed, can be compared.

2. Principle

2.1 The result of a colorfastness test is rated by visually comparing the difference in color or the contrast between the untreated and treated specimens with the differences represented by the Scale (see 8.1). The colorfastness grade is equal to the gray scale step which is judged to have the same color or contrast difference.

3. Terminology

3.1 **color change**, *n.*—a change in color of any kind whether in lightness, hue or chroma, or any combination of these, discernible by comparing the test specimen with a corresponding untested specimen.

3.2 **colorfastness**, *n.*—the resistance of a material to change in any of its color characteristics, to transfer of its colorant(s) to adjacent materials or both, as a result of the exposure of the material to any environment that might be encountered during the processing, testing, storage or use of the material.

3.3 **Gray Scale**, *n.*—a scale consisting of pairs of standard gray chips, the pairs representing progressive differences in color or contrast corresponding to numerical colorfastness grades.

4. Description of the Scale

4.1 Colorfastness grade 5 is represented on the scale by two reference chips mounted side by side, neutral gray in color and having a Y tristimulus value of 12 ± 1 . The color difference of the pair is 0.0 ± 0.2 .

4.2 Colorfastness grades 4.5 to 1, inclusive, are represented by reference chips like those used in Step 5 paired with lighter neutral gray chips of similar dimensions and gloss. The visual differences in the whole step pairs — colorfastness grades 4, 3, 2 and 1 — are in geometric steps of color difference, or contrast. The differences in the half-step colorfastness grade pairs — 4-5, 3-4, 2-3 and 1-2 — are intermediate between the whole step pairs (see 8.2, 8.3 and Fig. 1).

5. Use of the Scale

5.1 Place a piece of the original textile and its corresponding exposed test specimen side by side in the same plane and oriented in the same direction. Take special care to create a sharp junction between the two pieces of material. Place the Gray Scale along the edges of the test specimen and original textile sample with the junctions of the textile and the Gray Scale pair aligned. Place the gray mask (Y tristimulus of 53 ± 1) provided with the scale over the samples and the scale to eliminate any influence of the surrounding areas. Back the specimens, both the original and tested, with a white material having a Y tristimulus value of at least 85. If the specimens are permanently mounted on a card, it must be with a Y tristimulus value of at least 85. Any means of attachment (staples, etc.) must not be in the area viewed (see Fig. 2).

Illuminate the surfaces with a daylight simulator with illumination level at the specimen plane in the range of 1080-1340 lx (100-125 fc) (see 8.4). The light should be incident upon the surfaces at $45 \pm 5^\circ$ and the direction of viewing $90 \pm 5^\circ$ to the plane of the surfaces (see Fig. 3).

Compare the perceived visual difference between original and tested textile with the perceived differences represented by the Gray Scale. The colorfastness grade is that number of the Gray Scale pair whose contrast corresponds to the contrast between the original and tested specimens. A grade of 5 is given only when there is no perceived difference in color or contrast between the original material and tested specimen. The cleanliness and physical condition of the Gray Scale is extremely important in obtaining consistent results (see 8.5).

5.2 When a number of assessments have been made, it is very useful to compare all the pairs of original and tested specimens which have been given the same numerical grade. This gives a good indication of the consistency of the

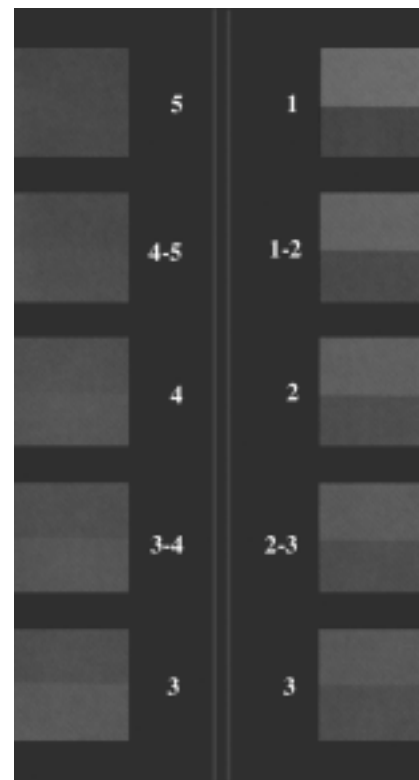


Fig. 1—Gray Scale for Color Change.

grades, since any errors become prominent. Pairs which do not appear to have the same degree of contrast as others with the same grades should be re-checked against the Gray Scale and, if necessary, the grades should be changed.

6. Describing Color Changes in Colorfastness Tests

6.1 In using the Gray Scale, the character of the change in color, whether in lightness, hue or chroma, or any combination of these, is not rated; the overall difference, or contrast, between original and tested specimens is the basis for the evaluation.

If a record of the character of the change in color of the textile in the test is needed, add appropriate qualitative terms to the numerical grade, as illustrated in Table I.

7. Colorimetric Specification of Color Differences of the Gray Scale

7.1 The color differences and tolerances between the reference gray and the nine steps of the scale are expressed as to-

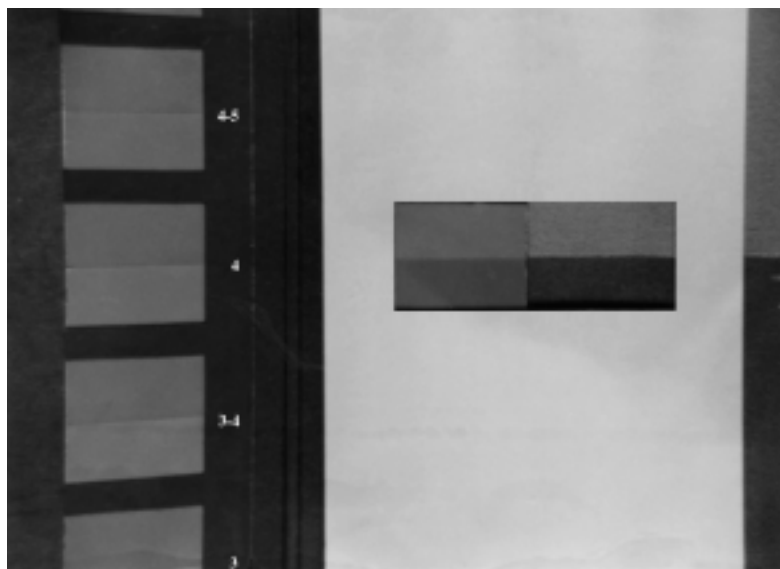


Fig. 2—Illustration of how to use scale.

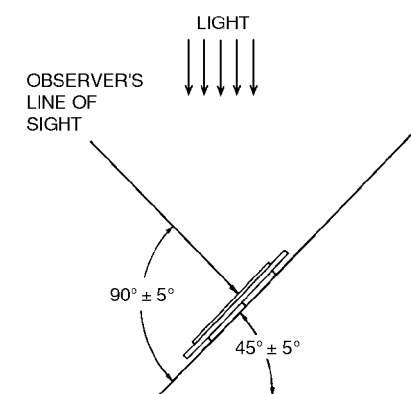


Fig. 3—Illumination and viewing angles for rating samples.

tal color difference ΔE_{CIELAB} using the CIE 1976 $L^*a^*b^*$ color difference formula:

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

where:

$$\begin{aligned} L^* &= 116 (Y/Y_n)^{1/3} - 16 \\ a^* &= 500 [(X/X_n)^{1/3} - (Y/Y_n)^{1/3}] \\ b^* &= 200 [(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}] \\ &\quad (X/X_n, Y/Y_n, Z/Z_n > 0.01) \end{aligned}$$

The tristimulus values X_n , Y_n , Z_n define the color of the nominally white object-color stimulus.

7.2 Permissible tolerances for the Gray Scales used as working standards are given in the last column of Table II, Appendix A.

8. Notes

8.1 Available from AATCC, P.O. Box 12215, Research Triangle Park NC 27709; tel: 919/549-8141; fax: 919/549-8933; e-mail: orders@aatcc.org.

8.2 The colorfastness grades of the scale steps and the corresponding total color differences and tolerances, determined by the CIE 1976 $L^*a^*b^*$ (CIELAB) formula, are given in Table II, Appendix A. Sphere geometry spectrophotometric measurements of the chips shall be taken with the specular component included. A $0^\circ/45^\circ$ ($45^\circ/0^\circ$) geometry is an acceptable alternate. The colorimetric data shall be calculated using the CIE 1964 10° observer data for Illuminant D_{65} .

8.3 Provision for a colorfastness grade lower than 1 is provided for in Nomenclature for Subjective Rating Processes elsewhere in this MANUAL. Any test specimen which has a change in color or contrast decidedly greater than a grade of 1 may be rated a 0.

8.4 See AATCC Evaluation Procedure 9, Visual Assessment of Color Difference of Textiles, for notes on choice of daylight simulator and illumination level.

8.5 The Scale should be inspected frequently for fingerprints and any other marks. If the marks are considered to interfere with the rating process, then the Scale should be replaced. The Scale can also be physically damaged through handling. Again, if the physical damage to the Scale interferes with the rating process, it should be replaced. Periodically, the Scale can be measured on a spectrophotometer or colorimeter to ensure that the total color differences are within specification as shown in Table II, Appendix A. Keep the Scale in its case when it is not in use.

Table I

Grade		Meaning
3 lighter	Contrast equal to Step 3 of Gray Scale	Specimen is lighter only
3 redder	Contrast equal to Step 3 of Gray Scale	No significant change in lightness but change in hue in red direction has occurred
3 lighter yellower	Contrast equal to Step 3 of Gray Scale	Specimen is lighter and change in hue in yellow direction has occurred
3 lighter bluer, less chroma	Contrast equal to Step 3 of Gray Scale	Specimen is lighter and change in hue in blue direction and change in chroma has occurred
4-5 redder	Contrast equal to Step 4-5 of Gray Scale	No significant change in lightness, but change in hue in red direction has occurred

When space available for recording qualitative terms is restricted as on pattern cards, the following abbreviations may be used:

Bl = bluer	L = lighter
G = greener	Da = darker
R = redder	MC = more chroma
Y = yellower	LC = less chroma

Appendix A

A.1 Table II provides the color difference values in CIE 1976 $L^*a^*b^*$ (CIELAB) units for the grade pairs in each step of the Gray Scale for Color Change. This table is for instrumental measurement and confirmation that a Gray Scale is within tolerance, only. Table II is NOT to be used for assigning a Gray Scale grade based on instrumental measurement of two specimens (see AATCC Evaluation Procedure 7, Instrumental Assessment of the Change in Color of a Test Specimen).

Table II

Colorfastness Grade	Total Color Difference CIELAB Units	Tolerance for Working Standards CIELAB Units
5	0.0	+ 0.2
4-5	0.8	± 0.2
4	1.7	± 0.3
3-4	2.5	± 0.3
3	3.4	± 0.4
2-3	4.8	± 0.5
2	6.8	± 0.6
1-2	9.6	± 0.7
1	13.6	± 1.0