Evaluation Procedure for Visual Assessment of Color Difference of Textiles

1. Purpose and Scope

1.1 This evaluation procedure provides general principles and a procedure for determining and describing the color difference of test specimens by visual comparison with a standard. The scope is to standardize the procedure for visual color difference evaluations of textile materials.

2. Principle

2.1 The color of a specimen or specimens and a reference standard are compared and evaluated under specific lighting and viewing conditions. The observed color difference can also be compared with tolerance range specimens.

3. Terminology

3.1 **chroma,** n.—the proportion of spectrally pure color that expresses the degree of departure from the gray of the same lightness.

3.2 **hue,** n.—the attribute of visual perception according to which a color field is judged similar to one conventionally named yellow, red, blue, or green or a combination of an adjacent pair of these colors, considered to be arranged in a closed ring.

3.3 **lightness,** n.—the attribute of visual perception by which a non-self-luminous body is judged to reflect more or less light.

3.4 **metamerism,** n.—visual phenomenon according to which spectrally different materials have, for a given observer in a given illumination, matching color appearance. The fields may no longer match when viewed in a different light or by a different observer.

3.5 **reference standard,** n.—a material that defines the specific color to be matched, and may also be used to define other appearance properties, such as finish, texture and construction.

3.6 **tolerance range specimens,** n.—selected specimens which deviate from the reference standard in hue, lightness, chroma, or in combinations of the three, and impose a range of observable color differences around the reference standard for evaluation purposes.

4. Uses and Limitations

4.1 This evaluation procedure is used for the determination and description of the magnitude of color difference of textile materials against a standard color specimen.

4.2 When evaluating multicolored patterns, each color is evaluated separately.

4.3 To determine if illuminant metamerism is present, evaluate specimens under more than one illuminant.

4.4 This procedure shall be performed only by observers with normal color vision according to color discrimination test methods such as the Farnsworth Munsell 100 Hue Test (see 10.1) and pseudoisochromatic plate tests such as the Ishihara Color Vision Test (see 10.2).

5. Apparatus

5.1 Illumination conditions. The source under which the comparison is made shall be determined prior to evaluation. Sources simulating any of the following illuminants may be utilized (see 10.3 and 10.4):

Illuminant	Description	Color Temperature
D_{65}	Daylight	6500K ± 200
D_{75}	Daylight	7500K ± 200
A	Incandescent	2856K ± 200
CWF	Cool White Fluorescent	4150K ± 350

Note: Additional illuminants or changes in color temperature can be negotiated between the contractual parties.

5.1.1 Specimens may be viewed with UV illumination to test for the presence of Fluorescent Whitening Agents (FWAs).

5.1.2 The recommended illumination level at the specimen plane is in range of 1080-1340 lx (100-125 fc).

5.2 Viewing environment. The viewing environment consists of an illumination source (such as a lighting cabinet or luminaire) and a viewing surface located within the lighting cabinet or on a table in a designated visual evaluation area of a room and is limited in area to that which corresponds to the normal field of view of an observer performing normal visual evaluations. Within the viewing environment the specimens will be placed on a flat, uniform surface having no distortions or depressions, and having a color matching the range of grays from Munsell N5/ to N7/ (see 10.5). The color of the area surrounding the viewing surface, that is, the interior surfaces of the lighting cabinet or the walls surrounding the designated visual evaluation area of a room, shall be a matte gray matching to within +/1 N value the Munsell gray selected for the viewing surface (see Table I). The gray selected for the viewing surface and surrounding area may be negotiated between the contractual parties. The viewing environment shall contain no other items, and *shall be shielded from extraneous light*. Observers shall wear clothing of neutral color, and there shall be no reflection on the specimens from surrounding surfaces.

5.3 Viewing geometry.

5.3.1 Option A. The illumination source is horizontal. The specimen plane shall be at a 45 ± 5° angle to horizontal, resulting in illumination incident at a 45° angle relative to the specimen plane. The observer shall view at a 90° angle relative to the specimen. This option shall be used for either glossy or matte specimens.

5.3.2 Option B. The illumination source is horizontal. The specimen plane shall be horizontal, resulting in illumination incident at a 90° angle, relative to the specimen plane. The observer shall view at a 45 ± 5° angle relative to the specimen. This option shall be used for either glossy or matte specimens.

5.3.3 Option C. The specimen plane and illumination source shall be parallel to each other and aligned so that the light flux is incident at the center of the specimen plane, which is set at a 35 ± 5° angle relative to the horizontal. The observer shall view the specimens at a 90° angle, relative to the plane of the specimens. This option shall not be used for evaluations of glossy or non-matte specimens. The observer shall take care when evaluating specimens not to block the incident light from the source.

5.3.4 Examples (see Fig. 1). Either Option A or B is the preferred viewing position.

5.4 Instrumentation used for Assessing

Table I—Color of Background and Surround

Evaluation Category	Color of Background	Color of Surround	Maximum Munsell Chroma of Background and Surround
Critical	similar to standard	N5/ to N7/	0.2
General	N5/ to N7/	N5/ to N7/	0.3

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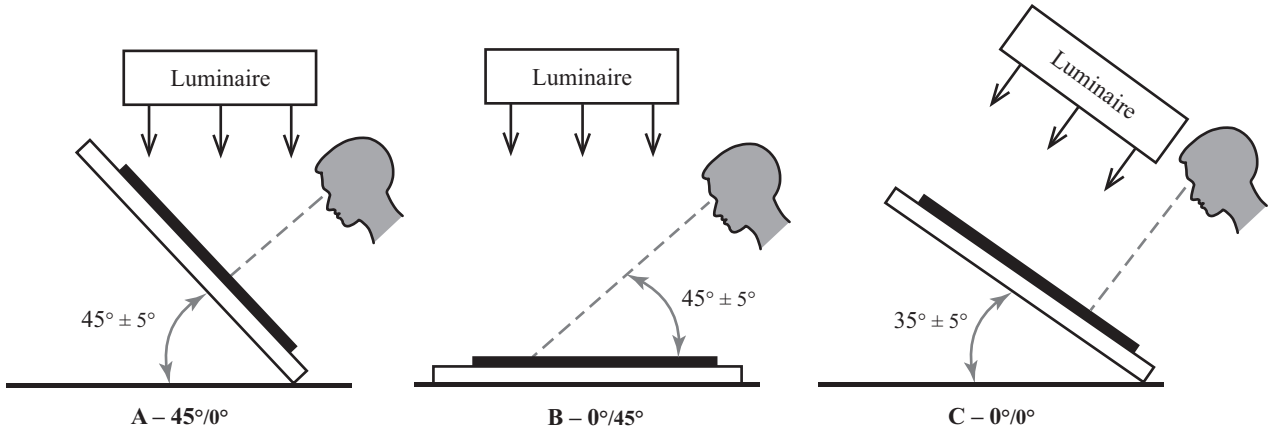

Fig. 1—Viewing positions for Options A (preferred), B (preferred) and C.

Light Intensity and Color Temperature. Equipment must be operated in accordance to manufacturer's specifications. Ensure that the instrumentation used for assessing light intensity and color temperature is within factory calibration specifications. Prior to measurement, the illuminant simulators should be powered on and allowed to stabilize. Generally this may take from 15-30 min. Place the instrument inside the illuminated viewing area. The instrument's sensor should be facing the incident light, placed on the viewing surface and in the center. Without obstructing the path between the incident light and the sensor, measure and record the colorimetric data and/or illuminance data.

6. Test Specimens

6.1 Prior to comparison, all color standards and test specimens shall be conditioned to avoid differences, which may be caused by temperature and humidity (see 10.7).

6.2 Recommended specimen sizes noted below are to be used only if the test method being used does not include specimen size requirements (see 10.6).

6.3 Dyed woven or knitted cloths. The test specimen shall be a representative rectangle of cloth, a minimum dimension of 100 mm in the lengthwise direction by 200 mm wide, whenever possible. Multicolored specimens shall be of size to incorporate all colors in the pattern. All surfaces shall be clean and free from stains or soiling. Remove torn edges, markings, or other marks from the specimen. Specimens shall be cut at least 150 mm from the selvage, and seam areas shall be avoided.

6.4 Narrow cloths, braids, tapes, webbings. The test specimen shall be a minimum of 200 mm in length and full width, as received.

6.5 Loose fiber. The test specimen shall be carded and made into a suitable size lap or pad.

6.6 Threads and yarns. The test specimen shall be in skein form, wound on a card to form a compact area of parallel yarns, or knitted to suitable size. Card windings shall be of sufficient thickness to conceal the card. The card shall not be bowed by tension of the wound yarns.

7. Procedures

7.1 The lighting conditions at the specimen plane shall be tested using instrumentation for assessing light intensity and color temperature to ensure compliance with the specification in 5.1 above. In addition, the user shall test the viewing area for illumination uniformity. The intensity of illumination shall not deviate more than 25% from the center to the viewing edges of the specimen.

7.1.1 The illuminant simulator shall be tested four times per year, or as recommended by the equipment manufacturer (see 10.4).

7.2 Different color difference evaluation procedures, as listed below under 7.2.1 and 7.2.2, may be required for different applications. Each of these procedures may be used with apparatus from Options A, B or C. Observers shall allow their vision to become adapted to the lighting conditions for at least 2 min prior to making an evaluation. This requirement shall apply again if the lighting conditions are changed; i.e., use of another source.

7.2.1 Tolerance range specimen procedure. The reference standard shall be placed on the specimen plane. The tolerance range specimens shall be placed around the edge of the reference standard, contacting it at its edge, with lengthwise directions parallel. The reference standard and specimen shall both face up unless otherwise specified. Any directional specimens shall be oriented in the same direction. Non-directional specimens shall be placed with their lengths in the same or opposite (180° rotation) orientation. The viewing distance shall be 700 ± 150 mm while performing the color difference evaluation.

7.2.2 Test specimen vs. reference standard procedure. The test specimen shall be placed on the specimen plane adjacent to the reference standard with lengthwise directions parallel and adjacent. The reference standard and specimen shall both face up unless otherwise specified. Any directional specimens shall be oriented in the same direction. Non-directional specimens shall be placed with lengthwise directions in the same or opposite (180° rotation) orientation. The observer shall stand in front of, and perpendicular to the specimen plane, taking care to avoid blocking the light. The viewing distance shall be 700 ± 150 mm while performing the evaluation.

7.3 Multiple specimen procedure. Evaluations should be made as quickly as possible, since prolonged viewing affects the observers' ability to evaluate.

8. Evaluation

8.1 Determine the color difference in terms of lightness, chroma and hue relative to the standard.

8.2 Evaluation options:

8.2.1 Tolerance range evaluation. The observer shall determine if the color difference between the reference standard and a test specimen is within the tolerance range, or is greater than the tolerance range.

8.2.1.1 A description of the color difference between the reference standard and a test specimen shall include terms as designated in Table II.

8.2.2 Magnitude evaluation. The observer shall determine the magnitude of color difference between a test specimen and reference standard by assigning val-

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