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THE STANDARD IS REVISED

FED. TEST METHOD STD. 191A  
CHANGE NOTICE 6  
June 21, 1990

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FEDERAL TEST METHOD STANDARD

TEXTILE TEST METHODS

The following changes, which form a part of FED. TEST METHOD STD. 191A, dated July 20, 1978, are approved by the Assistant Administrator, Office of Federal Supply Services, General Services Administration for the use of all Federal agencies.

Remove: Standard Test Method 5610 of July 20, 1978  
Add : Standard Test Method 5610.1  
Remove: Standard Test Method 5614 of July 20, 1978  
Add : Standard Test Method 5614.1  
Add : Standard Test Method 5780  
Add : Standard Test Method 5781  
Add. : Standard Test Method 5931  
Remove: Standard Test Method 9010 of July 20, 1978  
Add : Revised Standard Test Method 9010.1

MILITARY INTEREST:

Custodians

Army - GL  
Navy - NU  
Air Force - 11

Review Activities

Army - AR, EA, MD, ME, TE  
Navy - AS, SH  
Air Force - 82, 99  
DLA - CT

CIVIL AGENCY COORDINATING ACTIVITIES:

GSA-FSS  
HHS - NIH

PREPARING ACTIVITY

Army - GL

(Project 83GP-0031)

RETAIN THIS CHANGE NOTICE AND INSERT BEFORE THE TABLE OF CONTENTS

AMSC N/A

FSC 83GP

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METHOD 5610.1  
June 21, 1990

## COLORFASTNESS TO LAUNDERING OF COTTON AND LINEN

### TEXTILE MATERIALS; LAUNDER-OMETER METHOD

#### 1. SCOPE

1.1 This method is intended for determining the colorfastness of cotton and linen or blends of cotton and linen with other fibers to laundering.

#### 2. TEST SPECIMEN

2.1 Standard sample. Unless otherwise specified in the procurement document, when a standard sample has been established, the required specimen from each sample unit of the material to be tested, and one specimen from the standard sample, shall be as follows:

2.1.1 Cloth.  $4 \pm 0.1$  grams of cloth.

2.1.2 Yarn, thread, light cordage, tape, webbing and braid.  $4 \pm 0.1$  grams of the applicable material, so held together to form a unit for testing.

2.2 No standard sample. Unless otherwise specified in the procurement document, when a standard sample has not been established, the required specimens from the sample unit of the material to be tested shall be as specified in 2.1.1 or 2.1.2. One additional specimen shall be taken from each sample unit of the material to be tested and shall be retained, untested, for comparison. All specimens shall be taken from adjacent areas of the sample unit.

#### 3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the procurement document, one specimen per color shall be tested from each sample unit.

#### 4. APPARATUS, REAGENTS, AND METHOD CITED

##### 4.1 Apparatus.

4.1.1 Launder-Ometer. A Launder-Ometer or similar machine having a metal adapter in which tightly capped stainless steel cylindrical containers 5 inches (127 mm) in length by 3 inches (76 mm) in diameter are held with their bases toward a horizontal shaft 2 inches (51 mm) from the center of rotation. The shaft shall rotate at 40 to 45 rpm. Each container shall be equipped with a

## METHOD 5610.1

sealing device having solvent resistant rings. An equal number of stainless steel containers shall be fastened on opposite sides of the rotating shaft in order to maintain balanced and smooth rotation during the test. The containers of the Launder-Ometer or similar machine shall be maintained at a temperature of  $1580 \pm 4^{\circ}\text{F}$  ( $70^{\circ} \pm 2^{\circ}\text{C}$ ). (See 7.1).

4.1.2 Balls. Ten stainless steel balls, 1/4 inch (6 mm) in diameter per container. (See 7.1).

4.1.3 Pressing equipment.

4.1.3.1 Heat press. A flat-bed press maintained at a temperature of 2750 to 302°F (1350 to 150°C).

4.1.3.2 Heat-iron. A hand-iron weighing approximately 3.5 pounds (1.6 kg) maintained at a temperature of 2750 to 302°F (1350 to 150°C).

4.1.4 Extractor. A centrifugal extractor of the laundry type with a perforated basket approximately 11 inches (280 mm) deep by 17 inches (432 mm) in diameter, with an operating speed of approximately 1500 rpm.

4.1.5 Wringer. The wringer shall be equipped with smooth rubber rolls 2-1/8 to 2-1/2 inches (54 mm to 64 mm) in diameter and not less than 11 inches (279 mm) or more than 16 inches (406 mm) in length. The rubber rolls shall have a Shore Durometer Hardness of 70 to 80 (A scale). The load exerted on the specimen shall be uniformly applied by means of a dead weight, attached to the top roller. (See 7.3).

4.1.6 Oven. Circulating-air oven capable of maintaining the required temperature within  $+ 4^{\circ}\text{F}$  ( $\pm 2^{\circ}\text{C}$ ).

4.1.7 Color transfer cloth. A test cloth with a 6-fiber repeat made up of equal 1/3 inch bars of acetate, cotton, nylon 6.6; polyester Type 54 (polyethylene terephthalate) acrylic Type 75 and wool. Each 6-fiber repeat shall measure approximately 2 inches (51 mm) and shall be separated by a waste filling stripe. (See 7.2).

4.1.8 White thread.

4.1.9 Bleached, desized, cotton cloth (see 7.2).

4.2 Reagents.

4.2.1 Detergent solution. Detergent solution containing 0.5 percent by weight, P-D-245, Detergent, Laundry and Hand Dishwashing (Granular) type II, in water of a hardness not over 50 parts per million. (See 7.4).

#### 4.3 Method cited.

Method 9010, Shade Matching of Textile Materials; Visual Method.

### 5. PROCEDURE

5.1 Standard sample. When a standard sample has been established, one specimen of the standard sample shall be laundered at the same time and under the same conditions as the specimen of the material being tested.

5.2 No standard sample. When a standard sample has not been established, one specimen from each sample unit to be tested shall be retained, untested, for comparison.

5.3 Unless otherwise specified in the procurement document, a 2-inch (51 mm) square of the 6-fiber color transfer cloth shall be sewn with white thread to one corner of the test specimen or may be attached by some other suitable means. A 2-inch (51 mm) square of the color transfer cloth shall also be attached to one corner of the specimen from the standard sample when it is used for comparison.

5.4 Laundering cycle and temperature. Unless otherwise specified in the procurement document, the laundering cycle of the Launder-Ometer or similar machine shall be 30 minutes and the temperature of the container and its contents shall be maintained at  $158^{\circ} \pm 4^{\circ}\text{F}$  ( $70^{\circ} \pm 2^{\circ}\text{C}$ ).

5.5 Each test specimen assembly shall be placed in a separate stainless steel container together-with 100 mL of-detergent solution at  $158^{\circ} \pm 4^{\circ}\text{F}$  ( $70^{\circ} \pm 2^{\circ}\text{C}$ ) and ten stainless steel balls.

5.6 The containers shall be placed in the Launder-Ometer or similar machine and agitated for the required time and at the required temperature.

5.7 At the end of the laundering cycle, the specimen assembly shall be removed from the container and rinsed thoroughly in running water at a temperature of  $105^{\circ} \pm 5^{\circ}\text{F}$  ( $40^{\circ} \pm 3^{\circ}\text{C}$ ) for 5 minutes.

5.7.1 After rinsing the specimen assembly, the excess water shall be removed by centrifuging, blotting, or passing the specimen through wringer rolls. The specimens shall then be air-dried at room temperature or dried in a circulating air oven at  $1600 \pm 5^{\circ}\text{F}$  ( $71^{\circ} \pm 3^{\circ}\text{C}$ ).

5.8 The specimen assembly shall then be lightly sprayed with water and pressed between clean white cotton cloths using a flat-bed heat press or hand-iron at a temperature of  $275^{\circ}$  to  $302^{\circ}\text{F}$  ( $135^{\circ}$  to  $150^{\circ}\text{C}$ ) for 15 seconds with the color transfer cloth uppermost and in full contact with the specimen.

## METHOD 5610.1

5.9 Evaluation.

5.9.1 Evaluation shall be conducted in accordance with Method 9010.

5.9.2 The color change of the test specimen and the staining of the color transfer cloth shall be evaluated separately to determine the colorfastness to laundering. Unless otherwise specified, after testing evaluate only that stain evident on the stripe of the multi-fiber test cloth that is the same fiber or similar chemical nature as that of the dyed fabric. Wool stripe for wool; acetate stripe for acetate; cotton stripe for either cotton or viscose; acrylic stripe for acrylic. However, evaluate nylon stripe for both nylon and polyester.

5.9.3 Standard sample. The color change exhibited by the tested specimen when compared to the untested specimen retained shall be evaluated against the color change exhibited by the tested standard when compared to the untested standard retained. Unless otherwise specified, the staining of the like fiber (see 5.9.2) on the color transfer cloth of the specimen shall be evaluated against the staining of the like fiber on the color transfer cloth of the standard.

5.9.3.1 Specimen.

Pass : Color change equal to or less than that of the standard sample.  
Fail: Color change greater than that of the standard sample.

5.9.3.2 Color transfer cloth.

Pass: Staining equal to or less than that attached to the standard sample.  
Fail: Staining greater than that attached to the standard sample.

5.9.4 No standard sample. When a standard sample has not been established, evaluation of the test specimen for change in color and staining of the like fiber on the color transfer cloth shall be rated as follows:

5.9.4.1 Test specimen when compared to the specimen retained untested for comparison and color transfer cloth evaluated according to the degree of staining shall be rated as:

Excellent: No perceptible color change and staining.  
Good : Perceptible but not an appreciable change in color and staining,  
Fair: Appreciable but not an objectionable change in color and staining.  
Poor: objectionable change in color and staining.

## METHOD 5610.1

"Appreciable change in color" means a change that is immediately noticeable in comparing the test specimen with the original sample for comparison. If closer inspection or a change of angle of light is required to make apparent a slight change of color, the change is not considered appreciable.

## 6. REPORT

6.1 Standard sample. Colorfastness to laundering shall be reported as "pass" or "fail" when compared with the standard sample. If either the test specimen or the transfer cloth of the test specimen shows failure when compared to the performance of the standard sample, the specimen shall be reported as failing. When failure is reported, the severest departure (i.e., the actual rating "fair" or "poor") of the change of the test specimen or staining of specific fibers of the color transfer cloth, shall be distinguished and reported.

6.2 No standard sample. Colorfastness to laundering shall be reported as "pass" or "fail" when the test specimen and color transfer cloth are evaluated and rated in accordance with the adjective ratings of 5.9.4. Failure of either the test specimen or the color transfer cloth to meet the adjective rating specified in the applicable procurement document shall be reported as failure. When failure is reported, the severest departure (i.e., the actual rating "fair" or "poor") of the change of the test specimen or staining of specific fibers of the color transfer cloth, shall be distinguished and reported.

## 7. NOTES

7.1 A machine and accessories of the type described may be purchased from Atlas Electric Devices Co., 4114 No. Ravenswood Avenue, Chicago, IL 60613.

7.2 Multifiber test cloth (color transfer cloth) and cotton cloth may be obtained from Testfabrics, Inc. , P.O. Box 53, 200 Blackford Ave., Middlesex, NJ 08846.

7.3 A suitable wringer is the Atlas Motorized Laboratory Wringer, available from Atlas Electric Devices, Co., 4114 N. Ravenswood Ave., Chicago, IL 60613.

7.4 The detergent can be purchased from Cosco Enterprises Inc., 137 Skyllman Ave. , Brooklyn, NY 11211, Omega Chemical Corp., 6935 West 62nd St., Chicago, IL 60638, or J.L. Hoffman Co. Inc., P.O. Box 8656, Allentown, PA 18105.

METHOD 5614.1  
June 21, 1990

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COLORFASTNESS TO LAUNDERING OF WOOL, SILK, RAYON AND

OTHER TEXTILE MATERIALS; LAUNDER-OMETER METHOD

1. SCOPE

1.1 This method is intended for determining the colorfastness to laundering of wool, silk, rayon, and other textile materials.

2. TEST SPECIMEN

2.1 Standard sample. Unless otherwise specified in the procurement document, when a standard sample has been established, the required specimens from each sample unit of the material to be tested and one specimen from the standard sample shall be as follows:

2.1.1 Cloth. 4 ± 0.1 grams of cloth.

2.1.2 Yarn, thread, light cordage, tape, webbing and braid. 4 ± 0.1 grams of the applicable material, held together to form a unit for testing.

2.2 No standard sample. Unless otherwise specified in the procurement document, when a standard sample has not been established, the required specimens from the sample unit of the material to be tested shall be as specified in 2.1.1 or 2.1.2. One additional specimen shall be taken from each sample unit of the material to be tested, and shall be retained, untested, for comparison. All specimens shall be taken from adjacent areas of the sample unit.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the procurement document, one specimen per color shall be tested from each sample unit.

4. APPARATUS, REAGENTS, AND METHOD CITED

4.1 Apparatus.

4.1.1 Launder-Ometer. A Launder-Ometer or similar machine having a metal adapter in which tightly capped stainless steel cylindrical containers 5 inches (127 mm) in length by 3 inches (76 mm) in diameter are held with their bases toward a horizontal shaft 2 inches (51 mm) from the center of rotation. The shaft shall rotate at a speed of 40 to 45 rpm. Each container shall be equipped with a sealing device having solvent resistant rings. An equal number of stainless steel containers shall be fastened on opposite sides of the rotating shaft in order to maintain balanced and smooth rotation during the test. The containers of the Launder-Ometer or similar machine shall be maintained at a temperature of 100° ± 4°F (38° ± 2°C). (See 7.1).

## METHOD 5614.1

4.1.2 Balls. Ten stainless steel balls, 1/4 inch (6 mm) in diameter, per container.

### 4.1.3 Pressing equipment.

4.1.3.1 Heat press. A flat-bed press maintained at a temperature of 275° to 302°F (1350 ± 150°C).

4.1.3.2 Hand-iron. A hand-iron weighing approximately 3.5 pounds (1.6 kg) maintained at a temperature of 275° to 302°F (135° ± 150°C).

4.1.4 Extractor. A centrifugal extractor of the laundry type with a perforated basket approximately 11 inches (280 mm) deep by 17 inches (432 mm) in diameter, with an operating speed of approximately 1500 rpm.

4.1.5 Wringer. The wringer shall be equipped with smooth rubber rolls 2-1/8 to 2-1/2 inches (54mm to 64mm) in diameter and not less than 11 inches (279 mm) or more than 16 inches (406 mm) in length. The rubber rolls shall have a Shore Durometer Hardness of 70 to 80 (A scale). The load exerted on the specimen shall be uniformly applied by means of a dead weight, attached to the top roller. (See 7.3).

4.1.6 Color transfer cloth. A test cloth with a 6-fiber repeat made up of equal 1/3 inch bars of acetate, cotton, nylon 6.6, polyester Type 54 (polyethylene terephthalate) acrylic Type 75 and wool. Each 6-fiber repeat shall measure approximately 2 inches (51 mm) and shall be separated by a waste filling stripe. (See 7.2).

### 4.1.7 White thread.

### 4.1.8 Bleached, desized, cotton cloth (see 7.2).

## 4.2 Reagents.

4.2.1 Detergent solution. Detergent solution containing 0.5 percent by weight, P-D-245, Detergent, Laundry and Hand Dishwashing (Granular) Type II, in water of a hardness not over 50 parts per million. (See 7.4).

## 4.3 Method cited.

Method 9010, Shade Matching of Textile Method Materials; Visual Method.



## METHOD 5614.1

## 5. PROCEDURE

5.1 Standard sample. When a standard sample has been established, one specimen of the standard sample shall be laundered at the same time and under the same conditions as the specimen of the material being tested.

5.2 No standard sample. When a standard sample has not been established, one specimen from each sample unit to be tested shall be retained, untested, for comparison.

5.3 Unless otherwise specified in the procurement document, a 2-inch (51 mm) square of 6-fiber color transfer cloth shall be sewn with white thread to one corner of the test specimen or may be attached by some other suitable means. A 2-inch (51 mm) square of the color transfer cloth shall also be attached to one corner of the specimen from the standard sample when it is used for comparison,

5.4 Laundering cycle and temperature. Unless otherwise specified in the procurement document, the laundering cycle of the Launder-Ometer or similar machine shall be 30 minutes and the temperature of the container and its contents shall be maintained at  $100^{\circ} \pm 4^{\circ}\text{F}$  ( $38^{\circ} \pm 2^{\circ}\text{C}$ ).

5.5 Each test specimen assembly shall be placed in a separate stainless steel container containing 100 mL of detergent solution and ten stainless steel balls.

5.6 The container shall be placed in the Launder-Ometer or similar machine and agitated for the required time and at the required temperature.

5.7 At the end of the laundering cycle, the specimen assembly shall be removed from the container and rinsed thoroughly in running water at a temperature of  $100^{\circ} \pm 4^{\circ}\text{F}$  ( $38^{\circ} \pm 2^{\circ}\text{C}$ ) for 5 minutes.

5.8 After rinsing the specimen assembly, the excess water shall be removed by centrifuging, blotting, or passing the specimen through wringer rolls. The specimens shall then be air-dried at room temperature or dried in a circulating air oven at  $160^{\circ} \pm 5^{\circ}\text{F}$  ( $71^{\circ} \pm 3^{\circ}\text{C}$ ).

5.9 The specimen assembly shall then be lightly sprayed with water and pressed between clean white cotton cloths using a flat-bed heat press or hand-iron at a temperature of 2750 to 302°F (135° to 150°C) for 15 seconds with the color transfer cloth uppermost and in full contact with the specimen.

5.10 Evaluation.

5.10.1 Evaluation shall be conducted in accordance with Method 9010.

## METHOD 5614.1

5.10.2 The color change of the test specimen and the staining of the color transfer cloth shall be evaluated separately to determine the colorfastness to laundering. Unless otherwise specified, after testing evaluate only that stain evident on the stripe of the multi-fiber test cloth that is the same fiber or similar chemical nature as that of the dyed fabric. Wool stripe for wool; acetate stripe for acetate; cotton stripe for either cotton or viscose; acrylic stripe for acrylic. However, evaluate nylon stripe for both nylon and polyester.

5.10.3 Standard sample. The color change exhibited by the tested specimen when compared to the untested specimen retained shall be evaluated against the color change exhibited by the tested standard when compared to the untested standard retained. Unless otherwise specified, the staining of the color like fiber (see 5.10.2) on the transfer cloth of the specimen shall be evaluated against the staining of the like fiber on the color transfer cloth of the standard.

5. 10.3.1 Specimen.

Pass : Color change equal to or less than that of the standard sample.  
Fail: Color change greater than that of the standard sample.

## 5.10.3.2 Color transfer cloth.

Pass : Staining equal to or less than that attached to the standard sample.  
Fail: Staining greater than that attached to the standard sample.

5.10.4 No standard sample. When a standard sample has not been established, evaluation of the test specimen for change in color and staining of the like fiber on the color transfer cloth shall be rated as follows:

5.10.4.1 Test specimen when compared to the specimen retained untested for comparison and color transfer cloth evaluated according to the degree of staining shall be rated as:

Excellent: No perceptible color change and staining.  
Good : Perceptible but not an appreciable change in color and staining.  
Fair: Appreciable but not an objectionable change in color and staining.  
Poor: Objectionable change in color and staining.

"Appreciable change in color" means a change that is immediately noticeable in comparing the test specimen with the original sample for comparison. If closer inspection or a change of angle of light is required to make apparent a slight change of color, the change is not considered appreciable.

## METHOD 5614.1

## 6. REPORT

6.1 Standard sample. Colorfastness to laundering shall be reported as "pass" or "fail" when compared with the standard sample. If either the test specimen or the transfer cloth of the test specimen shows failure when compared to the performance of the standard sample, the specimen shall be reported as failing. When failure is reported, the severest departure (i.e., the actual rating "fair" or "poor") of the change of the test specimen or staining of specific fibers of the color transfer cloth, shall be distinguished and reported.

6.2 No standard sample. Colorfastness to laundering shall be reported as "pass" or "fail" when the test specimen and color transfer cloth are evaluated and rated in accordance with the adjective ratings of 5.10.4. Failure of either the test specimen or the color transfer cloth to meet the adjective rating specified in the applicable procurement document shall be reported as failure. When failure is reported, the severest departure (i.e., the actual rating "fair" or "poor") of the change of test specimen or staining of specific fibers of the color transfer cloth, shall be distinguished and reported.

## 7. NOTES

7.1. A machine and accessories of the type described may be purchased from Atlas Electric Devices Company, 4114 No. Ravenswood Avenue, Chicago, IL 60613.

7.2 Multifiber test cloth (color transfer cloth) and cotton cloth may be obtained from Testfabrics, Inc., P.O. Box 53, 200 Blackford Ave., Middlesex, NJ 08846.

7.3 A suitable wringer is the Atlas Motorized Laboratory Wringer, available from Atlas Electric Devices, Co., 4114 No. Ravenswood Ave., Chicago, IL 60613.

7.4 The detergent can be purchased from Cosco Enterprises Inc., 137 Skyllman Ave. , Brooklyn, NY 11211, Omega Chemical Corp., 6935 West 62nd St., Chicago, IL 60638, or J.L. Hoffman Co. Inc., P.O. Box 8656, Allentown, PA 18105.

METHOD 5780  
June 21, 1990

OPACITY OF TEXTILE MATERIALS TO LIGHT OF COMBINED  
VISIBLE AND NON-VISIBLE WAVELENGTHS

1. SCOPE

1.1 This method is intended for determining the opacity of textile materials to light of both visible, 400 to 750 nanometers (nm), and non-visible, less than 400 nm and greater than 750 nm, wavelengths. The test is a laboratory simulation of observations made through night-vision devices. The method was developed for tentage and other shelter fabrics, but can be used for all textile materials. The opacity testing of textile materials for visible wavelengths is given in Method 5781.

2. TEST SPECIMEN

2.1 The test specimen shall be at least 3 inches by 3 inches (76 mm by 76 mm).

2.1.1 The specimen shall be representative of the sample unit. If the specimen is a print, then testing for opacity of each colored portion in the pattern is required.

2.1.2 If the color of the specimen is a monotone, or the fabric is intended to be reversible and is colored differently on each side, both sides must be tested.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the procurement document, five specimens shall be tested from each sample unit.

4. APPARATUS (SEE figure 5780).

4.1 The apparatus shall consist of a specimen box, light source, and photometer, as shown in figure 5780.

4.1.1 Specimen box. A specimen box is required to collect all light transmitted through the specimen and to exclude stray light. A suitable specimen box can be constructed from plywood, with dimensions of approximately 12 inches by 16 inches by 16 inches (30 cm by 40 cm by 40 cm). The panel closest to the light source shall have a centrally located, circular opening of 1.5 inches (4 cm) diameter. The opening centered in the rear panel shall be circular with a diameter of 4 inches (10 cm) and accommodate the photometer. The interior of the specimen box shall be painted matte black.

## METHOD 5780

4.1.2 Light source. The light source shall be a bare, regular (not diffuse) incandescent 100-watt bulb (1750 lumens nominal) horizontally mounted, and equipped with a parabolic reflector. The tip of the lamp shall be positioned 12 inches (30.5 cm) from the test specimen. A regulated power supply is used to maintain the 100-watt rating on the bulb.

4.1.3 Photometer. The optical measurement shall be conducted with low-level-of-illumination photometer, of sensitivity at least 0.0001 foot-lamberts, and capable of measuring light energy over the wavelength range of 200 to 930 nanometers, or greater. The photometer shall be operated in the "open" mode, so that the full range of wavelengths is detected by the photometer. The collection aperture shall be set at a field of view of 6 minutes. The arrangement of optical components shall be as indicated in figure 5780.

4.2 Specimen mounting. The test specimen shall be mounted on the outside of the specimen box, covering the circular opening facing the light source (see figure 5780). It is critical that the specimen be mounted flat against the panel wall and opening. The specimen shall be fixed to the panel wall with tape or with magnets to prevent light leakage. Light radiated from the source shall be centered on the test specimen, and the fabric side customarily facing illumination shall be facing the source.

4.3 Evaluation area. Evaluation shall be conducted in a room that is completely darkened during measurements, so that the only source of light is that specified in 4.1.2.

## 5. PROCEDURE

5.1.1 Calibrate and operate the photometer according to the manufacturer's instructions.

5.1.2 Align the photometer, box openings, and light source as shown in figure 5780.

5.1.3 Mount the specimen over the panel hole closest to the light source. Tape or use magnets to affix the specimen to the panel to prevent light leakage into the specimen box.

5.1.4 Place the filter on the photometer in the "open" position. The field of view shall be set at 6 minutes.

5.1.5 The room shall be darkened to measure light passing through the test specimen.

5.1.6 Turn on the light source and test five specimens from each sample unit or colored portion of the print.

METHOD 5780

6. REPORT

6.1 Measurement of light transmission. The light transmission per steradian of the sample unit shall be the average of the results obtained from the specimens tested and shall be reported to the nearest 0.001 watts per square centimeter (or equivalent). Each color will be reported separately. The percent transmission (ratio of transmitted to incident light) shall not be measured.

6.2 Each individual value used to calculate the average shall also be reported.

7. NOTES

7.1 Photometers suitable for this test method may be obtained from: (1) EG & G Gamma Scientific Division, 3777 Ruffin Rd., San Diego, CA 93123; or (2) photo Research, a division of Kollmorgen Corp., 3000 N. Hollywood Way, Burbank, CA 91505.

7.2 Matte black is a lusterless black as shown by color 37038 in FED-STD-595.

METHOD 5780

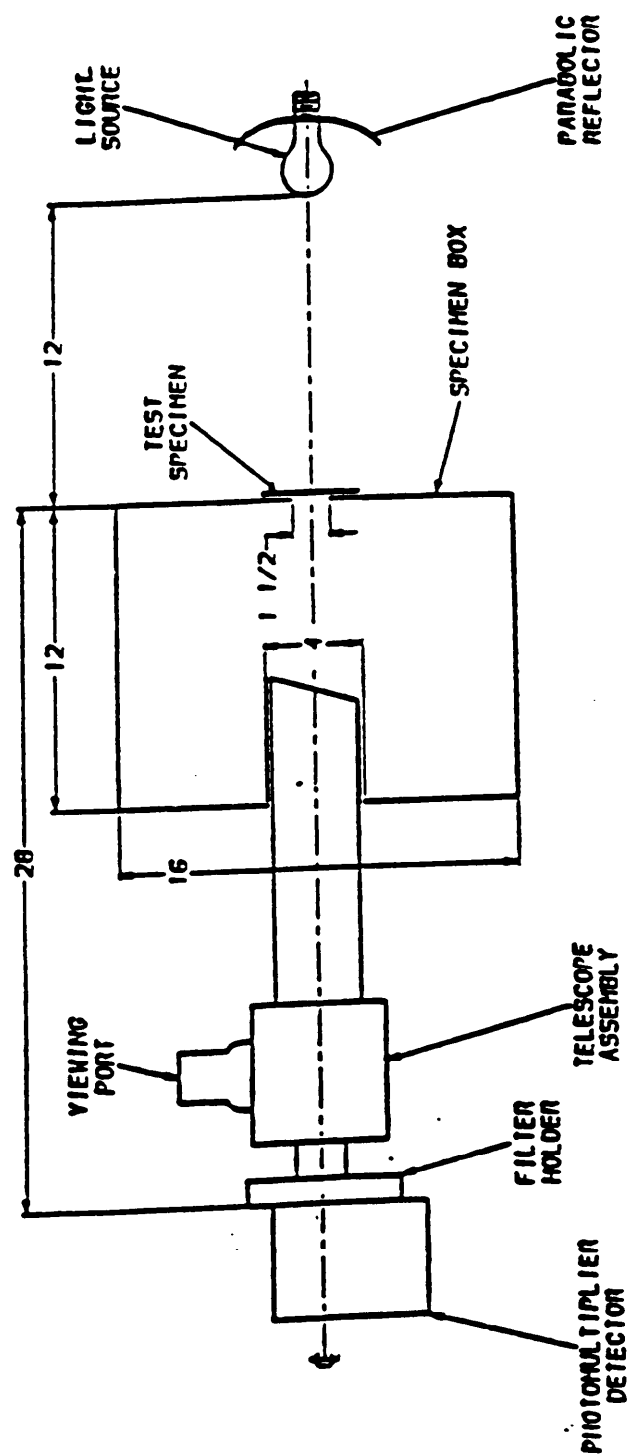


FIGURE 5780

METHOD 5781  
June 21, 1990

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## OPACITY OF TEXTILE MATERIALS TO LIGHT OF VISIBLE WAVELENGTHS

### 1. SCOPE

1.1 This method is intended for determining the opacity of textile materials to light of visible wavelengths, 400 to 750 nanometers (nm). The test is a laboratory simulation of observations made by the human eye. The method was developed for tentage and other shelter fabrics, but can be used for all textile materials. The opacity testing of textile materials for combined visible and non-visible wavelengths is given in Method 5780.

### 2. TEST SPECIMEN

2.1 The test specimen shall be at least 3 inches by 3 inches (76 mm by 76 mm).

2.1.1 The specimen shall be representative of the sample unit. If the specimen is a print, then testing for the opacity of each colored portion in the pattern is required.

2.1.2 If the color of the specimen is a monotone, or the fabric is intended to be reversible and is colored differently on each side, both sides must be tested.

### 3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the procurement document, five specimens shall be tested from each sample unit or colored portion of the print.

### 4. APPARATUS (See figure 5781).

4.1 The apparatus shall consist of a specimen box, light source, and photometer, as shown in figure 5781.

4.1.1 Specimen box. A specimen box is required to collect all light transmitted through the specimen and to exclude stray light. A suitable specimen box can be constructed from plywood, with dimensions of approximately 12 inches by 16 inches by 16 inches (30 cm by 40 cm by 40 cm). The panel closest to the light source shall have a centrally located, circular opening of 1.5 inches (4 cm) diameter. The opening centered in the rear panel shall be circular with a diameter of 4 inches (10 cm), and shall accommodate the photometer. The interior of the specimen box shall be painted matte black.



## METHOD 5781

4.1.2 Light source. The light source shall be a bare, regular (not diffuse) incandescent 100-watt bulb (1750 lumens nominal) horizontally mounted, and equipped with a parabolic reflector. The tip of the lamp shall be positioned 12 inches (30.5 cm) from the the outer surface of the test specimen. A regulated power supply shall be used to maintain a 100-watt rating on the bulb.

4.1.3 Photometer. The optical measurement shall be conducted with a low-level-of-illumination photometer, of sensitivity at least 0.0001 foot-lamberts, and capable of measuring light energy over the wavelength range of 400 to 750 nanometers. The photometer shall be operated with a "Photopic Filter", to approximate the response of the human eye. The collection aperture shall be set at a 6-minute field of view. The arrangement of optical components shall be as indicated in figure 5781.

4.2 Specimen mounting. The test specimen shall be mounted on the outside of the specimen box, covering the circular opening facing the light source (see figure 5781). It is critical that the specimen be flat against the panel and opening. The sample shall be fixed to the panel with tape or magnets to prevent light leakage. Light radiated from the source shall be centered on the test specimen, and the fabric side customarily facing illumination shall be facing the source.

4.3 Evaluation area. Evaluation shall be conducted in a room that is completely darkened during measurements, so that the only source of light is that specified in 4.1.2.

## 5. PROCEDURE

5.1.1 Calibrate and operate the photometer according to the manufacturer's instructions.

5.1.2 Align the photometer, box openings, and light source as shown in figure 5781.

5.1.3 Mount the specimen over the panel hole closest to the light source. Tape or use magnets to affix the specimen to the panel to prevent light leakage into the specimen box.

5.1.4 Position the photopic filter in place over the photometer detector. The field of view shall be set at 6 minutes.

5.1.5 Darken the room to measure light passing through the test specimen.

5.1.6 Turn on the light source and test five specimens from each sample unit or colored portion of the print.

METHOD 5781

6. REPORT

6.1 Measurement of light transmission. The light transmission of the sample unit shall be the average of the results obtained from the specimens tested and shall be reported to the nearest 0.001 foot-lambert. Each color shall be reported separately. The percent transmission (ratio of transmitted to incident light) shall not be measured.

6.2 Each individual value used to calculate the average shall be reported.

7. NOTES

7.1 Photometers suitable for this test method may be obtained from: (1) EG & G Gamma Scientific Division, 3777 Ruffin Rd., San Diego, CA 93123; or (2) Photo Research, a division of Kollmorgen Corp., 3000 N. Hollywood Way, Burbank, CA 91505.

7.2 Matte black is a lusterless black as shown by color 37038 in FED-STD-595.

METHOD 5781

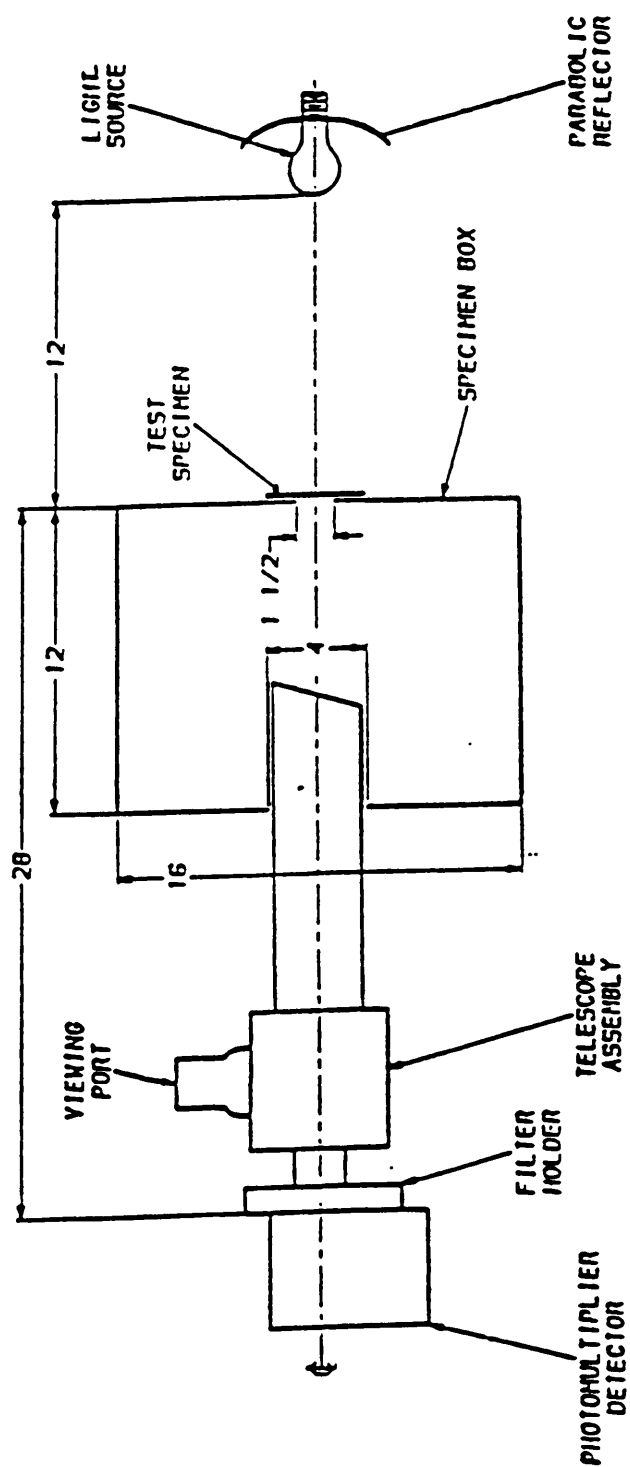


FIGURE 5781

METHOD 5931  
June 21. 1990

ELECTROSTATIC DECAY OF FABRICS;  
DETERMINATION OF

1. SCOPE

1.1 This method is intended for determining the time it takes for a charge on a fabric surface to decay to an electrostatically safe level, This method is appropriate for use on material which may or may not contain conductive fibers or have been treated with an antistat finish. The ultimate purpose is to determine which materials are safe for wear during electrostatic sensitive operations.

2. TEST SPECIMEN

2.1 The specimen shall be a 3 inch by 5 inch rectangular piece of material. The warp or filling yarns shall run parallel to the 5 inch length of the specimen. The direction of test (warp or filling) shall be along the length of the specimen and each specimen shall be labeled accordingly in one corner. Test specimens shall be cut so that no two contain the same set of warp and filling yarns.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the procurement document, six specimens shall be tested, three in the warp direction and three in the filling direction.

4. APPARTUS

4.1 The apparatus shall consist of a humidity test chamber, a meter for measuring relative humidity (RH) and temperature, a faraday cage, a source capable of outputing 5000 volts, and a recorder on which voltage behavior with respect to time may be plotted. The faraday cage shall contain two parallel electrodes, on which specimens may be mounted and charged, and a sensor by which voltage on the specimen surface may be detected. The apparatus shall also include voltage meters to display the applied voltage, and the voltage detected by the sensor.

5. PROCEDURE

5.1 The faraday cage and specimens to be tested shall be pre-conditioned at  $10 \pm 2$  percent relative humidity overnight, and conditioned at  $20 \pm 2$  percent relative humidity for a minimum of 24 hours at approximately  $75 \pm 5^\circ$  F. The specimens shall be tested at  $20 \pm 2$  percent relative humidity and  $75 \pm 50$  F. An air-ionizing blower can be used within the chamber while conditioning, although the blower must be turned off once testing begins.

## METHOD 5931

5.2 Allow test equipment 1 hour of warm-up time. Adjust voltage source for a charging voltage of 5000 volts. Mount a 3-inch by 5-inch aluminum plate across the electrodes in the faraday cage such that it is centered in front of the voltage sensor opening. Apply a charge of 5000 volts, and calibrate the voltage meter designated to indicate detected voltage on the sample equal to 5000 volts. Remove the aluminum plate.

5.3 Mount a specimen tautly across the electrodes, centering it over the sensor opening. The surface of test specimen (back or front) shall face the sensor. A deionizing bar may be used on the specimen before the test to remove residual charge. Apply 5000 volts to the electrodes for a period of 20 seconds. At the end of the 20-second period, the high voltage (5000 volts) shall be turned off and the specimen immediately grounded. The voltage behavior of the specimen with respect to time shall be plotted on the recorder.

5.4 The maximum voltage level reached on the specimen shall be measured from the recorder curve as the difference between the highest level and lowest level of the full decay curve. If the specimen did not reach a maximum voltage of at least 4000 volts during the 20-second charging period, the specimen shall be recorded as non-passing and the reason noted. The time for the charge to decay from the maximum voltage level to 10 percent of the maximum level shall be measured from the voltage plot.

5.5 The specimen is acceptable if the decay time to 10 percent of the maximum voltage is less than 1/2 second, and considered not acceptable otherwise. Record the maximum voltage level and decay time to 10 percent. The reason for any failures shall be noted.

5.6 Remove specimen. Repeat 5.3 through 5.5 for the front and back sides of each specimen of the test fabric.

5.7 Recalibrate periodically, at the minimum between each set of six specimens.

## 6. REPORT

6.1 The test method used, and any alterations to the method, shall be reported.

6.2 Test conditions, including relative humidity, room temperature, and conditioning time, shall be stated.

6.3 Equipment names, model numbers, and manufacturers shall be listed. Special modifications to equipment shall be described. A description of any in-house built equipment shall be included.

6.4 Identification of materials tested, including name, composition, weave, printed/dyed, finishes, manufacturer and any other pertinent information shall be included.

METHOD 5931

6.5 Alterations to materials shall be noted together with the test method used, or description of the process applied; e.g., laundering.

6.6 The average time to decay to 10 percent of the maximum voltage shall be included for each of the warp and filling directions, as well as the overall average, for each fabric tested. It shall be indicated whether the fabric is acceptable, or non-acceptable.

7. NOTES

7.1 Equipment suitable for conducting this test may be purchased from:

Electro-Tech Systems, Inc.  
115 E. Glenside Avenue  
Glenside, PA 19038

(Model 506 Controlled Humidity Test  
Chamber, Model 406C Static Decay  
Meter (includes faraday cage))

ABB Metrawatt, Inc.  
2150 West 6th Avenue  
Bloomfield, CO 80020

(Model SE-561 Memory Chart Recorder)

Solomat Corporation  
Glenbrook Industrial Park  
652 Glenbrook Road  
Stamford, CT 06906

(Model MPM 500 Thermo Hygro  
Tachometer)

METHOD 9010.1  
June 21, 1990  
SUPERSEDING  
METHOD 9010  
July 20, 1978

## SHADE MATCHING OF TEXTILE MATERIALS;

### VISUAL METHOD

#### 1. SCOPE

1.1 This method is intended for determining shade of textile materials by visual comparison against standard shade references and, when available, tolerances.

#### 2. TEST SPECIMEN

2.1 Dyed woven or knitted cloths. The test specimen shall be a representative rectangle of cloth, having a minimum dimension of 5 inches (127 mm) in the warp by 8 inches (203 mm) in the filling direction taken from the bolt, roll, or piece of cloth. Multicolored specimens shall be sufficiently sized to incorporate all color components of the pattern. All surfaces shall be clean and free from stains or soiling of any type. Torn edges, markings, or other marks shall be removed from the matching area. Samples shall be cut at least 6 inches from selvage. For woolen cloths, the shear jump area shall not be included.

2.2 Narrow cloths, braids, tapes, webbings. The test specimen shall be a minimum of 8 inches (203 mm) in length and the full width as received.

2.3 Loose fiber. The test specimen shall be carded and made into a suitable size lap or pad for visual comparison.

2.4 Thread, 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.

#### 3. NUMBER OF DETERMINATIONS

3.1 Woven or knitted cloths, narrow cloths, braids, tapes, and webbings. Unless otherwise specified in the procurement document, one specimen per bolt, roll, or piece of cloth shall be tested. Each bolt, roll, or piece in a lot shall be tested for shade.

3.2 Threads, yarns, and loose fibers. Unless otherwise specified in the procurement document, three specimens shall be tested from each sample unit.

## METHOD 9010.1

## 4. APPARATUS

4.1 Shade board. The shade board shall provide a planed surface with no distortions or depressions. The board shall be painted to Munsell N 8/ (see 7.7) and shall form a platform set at an angle of  $35 \pm 5$  degrees to the horizontal above a table or cabinet placed within an area also painted to Munsell Neutral Color N 8/ having a flat reflectance curve characteristic across the visible spectrum (see 7.1) so that no spectral distortion of the light possibly reflected to the shade board can occur. The shade board shall be shielded from extraneous light. There shall be no reflections on the shade board from surrounding surfaces.

4.2 Color matching lamp (light source, see 7.2). The color matching lamp shall be an assembly of individual filtered tungsten lamps that approximate artificial daylight and that have a correlated color temperature of  $7500 \text{ K} \pm 200 \text{ K}$  (CIE Source D 75, see 7.8.10), incandescent lamplight with a correlated color temperature of  $2300 \text{ K} \pm 200 \text{ K}$  and an independent ultraviolet light source.

4.2.1 The artificial daylight illumination level of the shade board shall be  $100 \pm 20$  foot-candles. The shade board and color matching lamp shall be exactly parallel to each other and shall be so aligned that the light flux centers at the center of the shade board. An offset, only to the degree as to eliminate shadow of the observers, is permitted.

4.2.2 The light flux shall be transmitted to the shade board through water white optical non-color selective diffusing glass with high diffusion efficiency.

4.2.3 The bulbs, filters (see 7.5), and diffusing glass shall be cleaned periodically using a suitable cleaning solution that will not adversely affect the transmission and spectral quality of the glass (see 7.5.1).

4.2.4 A color temperature meter (see 7.3).

4.2.5 A foot-candle meter (see 7.4).

4.3 Standard (cool white) fluorescent light.

4.4 Blotting paper.

## 5. PROCEDURE

5.1 In case of dispute and when obvious finish differences between the standard reference and specimen exist. Preparation of specimens containing wool fiber and those displaying a high degree of finish: The standard shade, tolerances and test specimen shall be wetted by immersion in water containing a



## METHOD 9010.1

small amount of alkylaryl polyether alcohol. No mechanical action shall be used. The specimen shall be removed from the water, blotted free of excess moisture between sheets of blotting paper and dried without mechanical action at a temperature not to exceed 160°F (71°C).

5.2 The shade standard shall be placed on the shade board. The tolerance specimens shall be placed across the upper edge of the standard. The test specimen shall be placed on the shade board adjacent to the standard sample and in the same plane and with the weave design in the same direction. Unless otherwise specified, all samples shall be placed on the shade board with the warp direction running up and down the short dimension of the shade board. The observer, whose vision has been tested and found to be normal by using the ISCC-AO Pseudoisochromatic Plates (see 7.6) and the Farnsworth Munsell 100 Hue Test (see 7.7) or equally accepted method, shall stand before the shade board with his/her eyes at a 90 degree viewing angle and insure a minimum blocking of the light upon the standard. The viewing distance shall be 24 inches + 6 inches (709 mm  $\pm$  152 mm) while performing the test, and the observer shall not move his/her head or change the angle of view. When viewing colorfastness evaluations, a viewing distance of 18 + 6 inches (457 mm + 152 mm) shall be used. Decisions as to whether the test specimen falls within or without the tolerance limits shall be made as rapidly as possible, as prolonged viewing tends to cause blending effects.

5.3 The test specimen shall be compared to the standard under the 7500 K + 200 K daylight source (see 4.2). An evaluation as to its lightness and chromaticity or hue characteristics relative to the standard shall be made. The test specimen shall also be compared to the tolerances. An evaluation as to which tolerance it comes closest to or whether it departs further from the standard than the tolerance in lightness, chroma and hue, shall be made.

5.4 The test specimen shall then be compared to the standard under the 2300 K + 200 K source. An evaluation as to its lightness, chroma, and hue characteristics relative to the standard shall be made.

5.4.1 When bleached whites, fluorescent materials, or materials containing fibers suspected of being optically brightened are being tested, they shall be evaluated under a 7500 K  $\pm$  200 K source (see 4.2). When specified, an ultraviolet source shall be added to the 7500 K + 200 K source. An evaluation as to its lightness and chromaticity characteristics relative to the standard shall be made under the combined source. The test specimen shall then be compared to the tolerances. An evaluation as to which tolerance it comes closest to or whether it departs further from the standard than the tolerance in lightness, chroma, and hue, shall be made.

## METHOD 9010.1

5.4.2 When specified, a further evaluation shall be made under a standard cool white fluorescent light.

5.5 When specified, specimens shall be checked for total fluorescence, chroma, and hue against the standard of reference using the ultraviolet source only.

5.6 In case of dispute only, to eliminate any questions as to possible slight aberrations in color vision that might occur due to human factors, at least two observers shall perform the evaluation and agree.

5.7 Unless otherwise specified, deviations from the standard procedure, i.e., tilting of the specimens, changing of the angle of view of the observer, may not be performed in evaluating the specimen.

## 6. REPORT

6.1 Tolerance range available. Unless otherwise specified in the procurement document, when a tolerance range is available, shade matching of each individual specimen shall be reported as "pass" or "fail" for lightness, chroma, and hue with respect to the standard and related established tolerances. A passing result which is approaching borderline conditions, i.e., failure, shall be reported to serve as a guide for future production.

6.1.1 In the event of failure, the report shall state the specific nature of the failure and the applicable direction of the failure to enable production personnel to bring the shade within the acceptable limits.

6.2 No tolerance range available. Unless otherwise specified in the procurement document, when a tolerance range is not available, shade matching shall be reported as "pass" or "fail" as compared to the standard sample for lightness, chroma, and hue.

6.3 Fluorescent materials. When fluorescent materials are tested, the test report shall indicate use of the ultraviolet source or additional fluorescent lights.

## 7. NOTES

7.1 The nominal calorimetric specifications for a suitable neutral gray are as follows:

x = 0.314

y = 0.331

Y = 59.1%

Source D65, reference MgO

## METHOD 9010.1

7.2 A suitable lamp meeting these requirements may be obtained from Kollmorgen, Macbeth Division, Newburgh, NY 12550 and is called the Macbeth Spectralight Luminaire SPL75L-2.

7.3 Check with lamp manufacturer for method and instrument used for accurate color temperature measurements.

7.4 A suitable foot-candle meter may be obtained from the Weston Electrical Instrument Corporation, Newark, NY 07102, and is called the Model 614 Weston Foot-Candle Meter.

7.5 Filters vary in thickness and the color temperature achieved is dependent to a degree on this factor. The relationship between the color temperature of the illuminant and the effective color temperature of the filtered radiation that follows, is to a close approximation:

$$\frac{1}{T_1} - \frac{0.1}{T_2} = Kt$$

where:  $T_1$  = color temperature of the illuminant  
 $T_2$  = effective color temperature of the filtered radiation  
 $t$  = thickness of the glass filter  
 $K$  = constant characteristic of the melt

The artificial daylight source for the level of color matching required under this method shall be required to have a conformity index of  $\pm 127.3$  (see 7.8.11).

7.5.1 Clean gloves should be worn when changing or cleaning lamp unit. Hand contact will significantly reduce the service life of the bulbs. Follow the manufacturer's instructions for cleaning the entire unit.

7.6 ISCC-A0 Pseudoisochromatic Plates may be obtained from the American Optical Co., Instrument Division, Southbridge, MA 01550.

7.7 A sample of Munsell Neutral Color N 8/1 or the Farnsworth-Munsell 100 Hue Test may be obtained from the Munsell Color Company, Inc., 2441 No Calvert Street, Baltimore, MD 21218.

7.8 Three forms of language are generally used in the textile industry; the standard psychophysical terminology, psychological terminology, and the idiom confined to use by the practical dyer. All three forms are utilized to define shade and color properties as follows:

## METHOD 9010.1

7.8.1 Dominant wavelength or hue. Terms that psychophysically and psychologically, respectively, denote the attribute of color by which an object is judged to be red, blue, yellow, etc. The idiom of the trade is hue.

7.8.2 Lightness. That attribute of color which defines amount of light reflected from a material or the attribute of color perception by means of which a surface is judged to reflect more or less light than another surface, "i.e., depth of shade; darker or lighter is the idiom of the trade.

7.8.3 Purity or chroma. The proportion of spectrally pure color in the shade or perceptually the attribute that expresses the degree of departure from the gray of the same lightness, i.e., brighter or duller is the idiom of the trade. The term "flat" may also be used to indicate an extreme low order of saturation or purity. A comparable term often used is "chroma".

7.8.4 Metamerism. The attribute of two colored bodies, matching well under one light source and to one observer, to become a mismatch when exposed to light of a different spectral distribution. In the idiom of the trade, this property describes the shade change that occurs when viewing the sample pair in daylight and then in artificial or unfiltered tungsten light. Color constancy is the term used to define the stability in shade of a single sample when viewed under two separate light sources of different spectral distributions. A change in shade under these illuminant conditions is usually defined as "flare" in the trade.

7.8.5 Photochromism. That attribute of a colored body to progressively change shade with time of exposure to a given illuminating source. This attribute is usually reversible upon placing the specimen in the dark.

7.8.6 Specular or glossy. A surface that reflects strongly in a direction opposite the incident beam, is highly reflective and acts somewhat as a mirror. Usually derived from severe finishing and processes such as decating, calendering, and schreinerling.

7.8.7 Standard sample. A material that defines the specific shade to be color matched in production. It may also define other properties as specified, i.e., colorfastness or degree of finish.

7.8.8 Tolerance range. A selected group of shades closely allied to the standard sample but deviating from it either in hue, lightness, chroma, or combinations of the three, which define the outer limits of acceptability for conformance to the required shade.

7.8.9 Shading. That attribute of a cloth surface wherein the color varies across the width of cloth or from one end of a roll or bolt to the other. Side to side and end to end shadings are usually indications of defects in processing or equipment maintenance.

METHOD 9010.1

7.8.10 CIE. Stands for Commission International d'Eclairage, or International Commission on Illumination.

7.8.11 See ASTM Method D-1729-82 (Standard Practice for Visual Evaluation of Color Differences of Opaque Materials) for conformity index calculation method.

