



Standard Practice for Visual Determination of the Lightfastness of Art Materials by Art Technologists¹

This standard is issued under the fixed designation D 5383; 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 practice covers a method for exposing specimens of colored art materials indoors to sunlight coming through a closed window. A card containing eight Blue Wool References² is exposed simultaneously. Blue Wool References² 3, 6, and 7, are used as controls in determining when to remove test specimens from exposure and rate them. Test specimens are rated by assigning each specimen the number of the Blue Wool Reference that shows the same amount of color change.

1.2 This practice may be used to indicate art materials that will change color within a few months or years in normal indoor exposure and those that will remain unchanged for a period of years. It is not rigorous enough to verify that materials will remain unchanged for more than fifty years in a home or office environment. A major consideration in developing this method was to keep it simple and short enough to be performed without instrumentation in a comparatively short length of time.

1.3 This practice shall only be used to evaluate the lightfastness of art materials not conforming to Specifications D 4302, D 5098 or D 5067 and when it is not feasible to use Test Methods D 4303. Practice D 5398, which is a simpler method, may be used by artists to evaluate the lightfastness of their own materials.

1.4 This practice is not suitable for evaluating materials with a high oil content such as artists' oil, resin oil or alkyd paints.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *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:

D 4302 Specification for Artists' Oil, Resin Oil and Alkyd Paints³

D 4303 Test Methods for Lightfastness of Pigments Used in Artists' Paints³

D 5067 Specification for Artists' Watercolor Paints³

D 5098 Specification for Artists' Acrylic Emulsion Paints³

D 5398 Practice for Visual Evaluation of the Lightfastness of Art Materials by the User³

E 284 Terminology of Appearance⁴

2.2 Other Standards:

ISO/R 105-B Textiles Tests for Colour Fastness Part B: Colour Fastness to Light and Weathering⁵

British Standard 1006 Group B Methods for Colour Fastness of Textiles and Leathers⁶

3. Terminology

3.1 The definitions included in Terminology E 284 are applicable to this practice.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *bloom, n*—a cloudy coating, sometimes appearing on colored pencil drawings due to migration of wax to the surface, that can be made transparent by gentle polishing.

3.2.2 *fugitive color, n*—colorant that changes color in a few days or weeks, or that bleaches white in less than 18 months, when exposed behind glass to sunlight.

3.2.3 *glazing, n*—the transparent glass or plastic sheet placed in front of a picture when it is framed.

3.2.4 *Substrate, n*—the white, pH neutral paper or board on which the art materials are applied.

4. Summary of Practice

4.1 This practice uses as controls three of the eight ISO Blue Wool References developed for use with ISO/R 105-B and British Standard 1006 Group B.

¹ This practice is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.57 on Artists Paints and Related Materials.

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² The Blue Wool Reference Card is available from Talas, Division Technical Library Service, 213 W. 35th St. New York, NY 10001-1992.

³ *Annual Book of ASTM Standards*, Vol 06.02.

⁴ *Annual Book of ASTM Standards*, Vol 06.01.

⁵ International Organization for Standardization, ISO/R 105-B is available from the American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

⁶ British Standard 1006 can be obtained from British Standards Institute, Linford Wood, Milton Keynes MK14 6LE, United Kingdom.

4.2 Specimens are made from the colored materials to be tested and attached to a backing panel along with a card containing the eight Blue Wool References.

4.3 One half of each colored specimen and of the Blue Wool Reference are covered, shielding that half of the specimens and references from light. The test specimens and references are exposed to sunlight through a closed window.

4.4 When Blue Wool Reference 3 shows a color change, the colored specimens are examined visually and any that also show a color change are noted. The cover is replaced and exposure continued until the exposed and unexposed halves of Reference 3 reach a specified contrast and Reference 6 also shows a color change. Three observers rate each specimen by assigning it the number of the Blue Wool Reference that shows a similar color change. The three numbers assigned to a specimen are averaged and this average determines in which of four broad lightfastness categories the specimen belongs.

4.5 If it is necessary to determine which materials have excellent lightfastness, continue exposure until Reference 7 shows a color change. Remove the panel from exposure and examine only the specimens that had not changed color at the time Reference 6 faded. Those specimens that still show no color change are placed in the fifth and highest lightfastness category.

NOTE 1—Depending on the test location, the time of year, and the number of cloudy days, it will take from a few days to two months of exposure in a window facing south to reveal fugitive materials that will either bleach white or radically change color in a few years when displayed in a normal home environment. It will take from 4 to 18 months of exposure to determine materials that will show, under normal room conditions, various degrees of color change, and those that will remain unchanged, for a long period of time.

5. Significance and Use

5.1 Artists have available to them a wide variety of art materials such as markers, colored pencils, pastels, colored inks and airbrush colors. Many of these materials are manufactured for temporary artwork and may contain pigments and dyes that fade in a relatively short time. Product labels and manufacturers' literature do not always supply the information necessary to distinguish products that are stable to light from those that are not. This practice makes it possible to check the general lightfastness of coloring materials to be used in works of art; however, Test Methods D 4303 must be used if color measuring instruments and appropriate lightfastness testing apparatus are available. This practice may also be used to evaluate other types of colored materials for lightfastness.

6. Materials

6.1 *Backing Panel*, that is resistant to warping when placed on its edge and exposed to light and heat passing through window glass. Foamcore board, particle board, hardboard, or plywood are suitable.

6.2 *Substrate*, of white, non-coated, acid-free (pH 7 to 9), medium weight, 2.5 to 63.5 kg (72 to 140 lb.) paper or museum board. Depending on the material being tested, a pH neutral foam board may be suitable. It is desirable for the surface of the substrate to be similar to that customarily used with the materials being tested; however, it must be possible to com-

pletely cover the substrate with an even coat of the colors. Rough watercolor paper is not suitable.

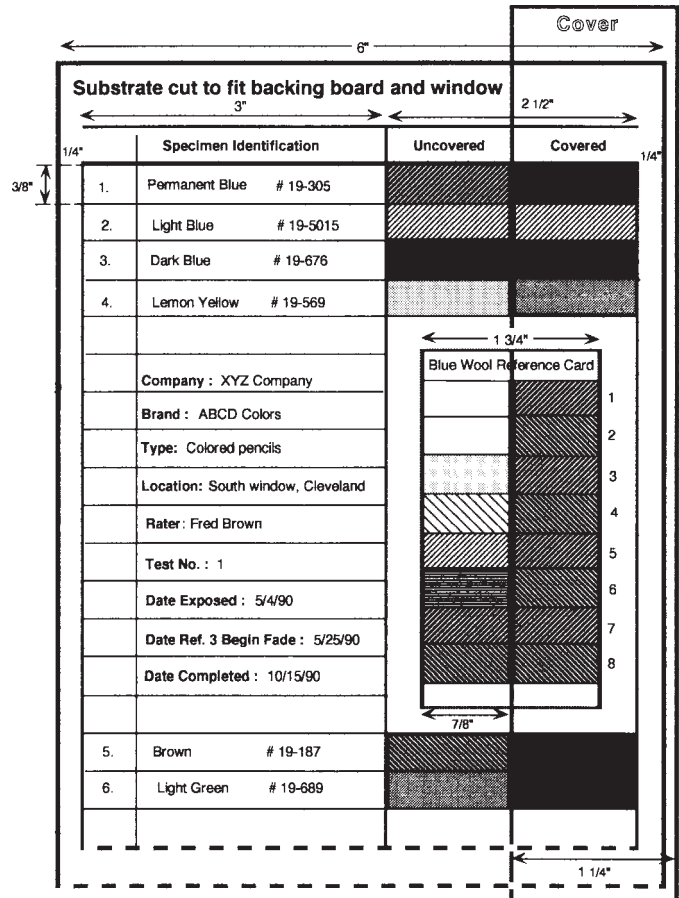
6.3 *Blue Wool Reference Card*,² contains bands of the eight Blue Wool References glued to a card 44.5 by 127 mm (1 3/4 by 5 in.). Each Blue Wool Reference from 1 to 8 takes approximately twice as long to fade as the reference immediately preceding it. The card must be kept in complete darkness until time for the test. It should be wrapped in an opaque covering and stored in a drawer at normal room temperature.

6.4 *Colored Art Materials*, to be tested.

6.5 *Specimen Cover*, made from stiff material such as heavy gage aluminum; stainless steel; stiff, opaque plastic; or wooden strips. The cover shall be at least 32-mm (1 1/4-in.) wide and as long as the backing panel. It is used to protect one half of each art material specimen and one half of the Blue Wool Reference Card from light (see Figs. 1 and 2). The side of the cover that touches the art material specimens should be chemically inert to prevent interaction with, or migration of substances onto the test specimens.

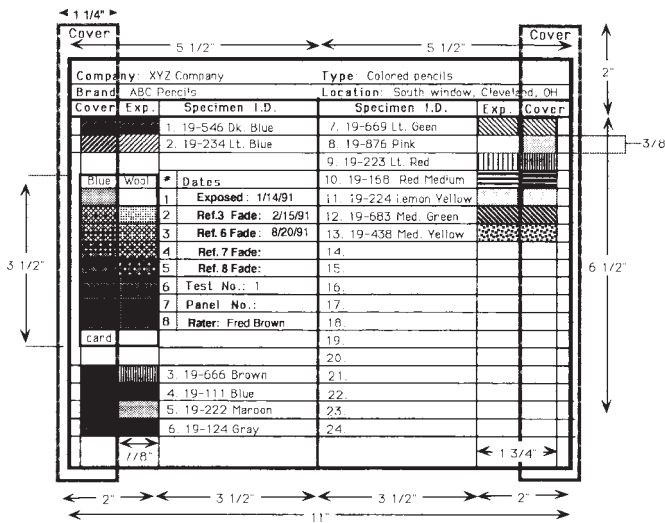
6.6 *Tape*, to fasten the specimen support to the backing board and to fasten the specimen cover over the specimens and the Blue Wool Reference Card. Duct or electrical tape is suitable since it is designed to withstand heat.

6.6.1 *Optional Metal Clamps or Wing Nuts*, to hold the cover more tightly against the specimen, may be used. This



NOTE 1—1 in. = 25.4 mm (exact).

FIG. 1 Suggested Layout for Lightfastness Test Panel



NOTE 1—1 in. = 25.4 mm (exact).

FIG. 2 Example of Two-Cover Layout That Fits on an 8½ by 11 in. sheet

will exclude light better making a sharper edge between the exposed and unexposed sections of the specimens for easier visual judgments.

6.7 *Mask I*, shall be made of stiff, neutral gray paper, approximately Munsell Value 6.5 (reflectance 36.2 %), with a slot, 6.4 by 41.3 mm (¼ by 1⅝ in.) See Fig. 3. This is slightly smaller than an individual Blue Wool Reference. It is used to isolate a specimen when looking for a color change to prevent color changes in neighboring specimens from affecting the decision.

6.8 *Mask II*, shall be made of stiff paper of the same neutral gray and with the same size slot as in Mask I. Side 1 shall have two blue chips mounted adjacent to the slot. One chip shall be Munsell 7.0 PB 4.0/13.0, matching the unexposed Blue Wool Reference 3. The second chip shall be Munsell 5.0 PB 6.0/4.0, the color of the exposed half of the Blue Wool Reference when the test is complete (see Fig. 4). Side 1 of Mask II is used to determine when Reference 3 has faded sufficiently for the second rating (see 8.5.1). Side 2 is used to isolate the individual Blue Wool References when they are being compared with a test specimen isolated with Mask I.

6.9 *Soft Clean Artists' Brush*, to be used to dust off Blue Wool References and specimens following exposure.

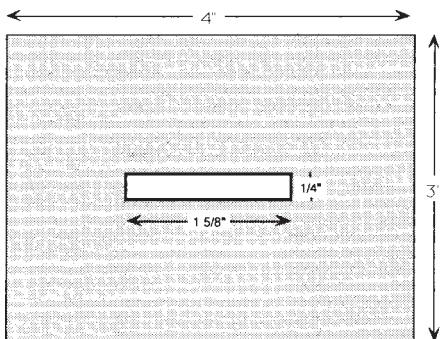
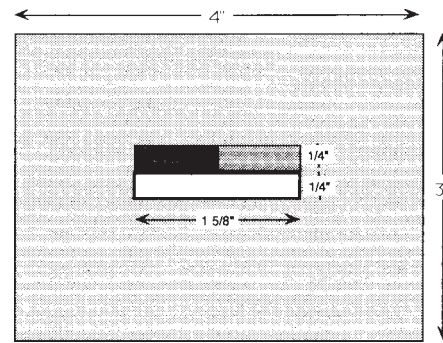


FIG. 3 Mask I Containing a Slot Just Smaller Than the Blue Wool References



NOTE 1—Side 2 is the same as the Gray Mask.

FIG. 4 Side 1 of Mask II with the Slot and Two Blue Color Chips

6.10 *Report and Instruction Sheets.*

6.10.1 A form to record the materials being tested, the date of exposure, the date Reference 3 begins to fade, materials that also show a color change at that time, and the date Reference 6 shows a color change (see Fig. 5 for an example).

6.10.2 A set of instructions, such as is shown in Fig. 6, to be given to the three observers.

6.10.3 Three copies of a form, such as is shown in Fig. 7, to be used by the observers in recording their evaluation of the test specimens.

6.10.4 A final rating form to record and average the observers' ratings and list the lightfastness category for each material (see Fig. 8 for an example of a suitable form).

Manufacturer:		Test Number:			
Brand:		Board Number:			
Type of Material:		Dates - Exposed:			
Location:		Rating 1, Ref. 3 fades:			
Rater:		Rating 2, Ref. 6 fades:			
Date rated:		Rating 3, Ref. 7 fades:			
No.	Specimen Identification Number and Name	Rating 1 Ref. 3 Fades	Rating 2 Ref. 6 Fades	Rating 3 Ref. 7 Fades	Comments
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					

FIG. 5 Example of Technician's Record Sheet

Instructions to Individuals Rating Lightfastness Tests

The Blue Wool References are the narrow bands of blue cloth pasted on the small card attached to the exposure panel. They number from Reference 1 at the top of the card through Reference 8 at the bottom of the card. The colored materials being tested have been applied in similar bands on the panel. The colored specimens are numbered and identified by the name and/or number given them by the company. The right hand side of the colored specimens and the Reference card was covered and the panel was exposed to sunlight through a closed window. References 1 through 5 show decreasing amount of color loss in the half that was exposed to light. Reference 6 shows a barely perceptible color change in the exposed half. References 7 and 8 have not faded.

- Fill in your name and the date on the rating sheet.
- In the appropriate column give the company's complete identification for each specimen you are rating.
- Isolate each specimen with the Gray Mask, while at the same time isolating the Blue Wool References one by one with side 2 (the all gray side) of the Hale Mask. Compare the contrast between the exposed and unexposed halves of the specimen with the contrast between the exposed and unexposed halves of the Blue Wool References.
- Rate the specimens by assigning each specimen the number of the Reference that shows the same amount of color change as the specimen does.
- If the contrast between the two halves of a specimen is judged to fall between that of two of the Blue Wool References, assign it a rating half way between their numbers. Example: If the specimen has faded less than Reference 5, but more than Reference 6, rate it as 5.5.
- If no color change is seen in a specimen, rate the specimen 6+. A rating of 6 indicates you have seen a color change in the specimen equivalent to the small amount of fading seen in Blue Wool Reference 6.

FIG. 6 An Example of an Instruction Sheet to be Furnished to the Observers Who Will Rate the Specimens

7. Preparation of Specimens

7.1 Cut both the paper to be used as the substrate and the backing panel to fit in the window in which the panel will be placed for exposure. Leave enough space around the panel to prevent shadows of the window frame from falling across the specimens or Blue Wool Reference Card.

7.2 Depending on the size and shape of the window to be used, rule the substrate for placement of the specimens and references. Figs. 1 and 2 are examples of the information that must be included and suggest possible formats. The horizontal bands drawn to receive the art materials must be at least 9.5 mm (3/8 in.) high and 44.5 mm (1 3/4 in.) long for each art material to be tested. This is the same size as the references.

7.2.1 Above and below the horizontal specimen bands put guide marks at the midpoint of the bands to guide placement of the specimen cover. Do not draw a vertical line across the bands between these guide marks. When placed on the guide marks the cover will block light from half of each specimen and the references.

7.2.2 Apply the art materials so that each horizontal band is completely and consistently covered with a strong color. It may be necessary to use more than one coat of a watercolor or ink to produce a color in which small amounts of fading can be detected visually.

7.2.3 At the top of the substrate enter the type of material, name of the manufacturer, and product line. Record the date the test begins. Use india ink or pencil unless this part of the panel will be covered during exposure. Leave spaces to record the date when Reference 3 shows a color change, the date Reference 3 matches the color chips on the Mask II (Reference

Manufacturer:			Name:		
Brand:			Date:		
Type of Material:			Test Number:		
Location:			Panel Number:		
Date Panel exposed:					
Date removed from exposure:					
No.	Specimen Identification	Rating	No.	Specimen Identification	Rating
1			29		
2			30		
3			31		
4			32		
5			33		
6			34		
7			35		
8			36		
9			37		
10			38		
11			39		
12			40		
13			41		
14			42		
15			43		
16			44		
17			45		
18			46		
19			47		
20			48		
21			49		
22			50		
23			51		
24			52		
25			53		
26			54		
27			55		
28			56		

FIG. 7 Example of Record Sheet for Observers' Use

Manufacturer: XYZ Company				Test #: 1	
Brand: ABC		Dates: Exposed: 1/14/91			
Type: colored pencils		Rate 1, Ref. 3: 2/15/91			
Location: Dayton, OH SW window		Rate 2, Ref. 6: 8/20/91			
Rater: Fred Brown		Rate 3, Ref. 7:			
#	Specimen I.D.	Obs. 1	Obs. 2	Obs. 3	Rating Category
1	#546 Dk. Blue	5	5	6	5.3 Fair
2	#234 Lt. Blue	5+	6+	6+	6+ Good
3	#683 Med. Green	4	5	5	4.7 Fair
4	#669 Lt. Green	6	6+	6+	6+ Good
5	#876 Pink	1	1	1	Fugitive
6	#223 Lt. Red	6	6+	6	6 Fair
7	#168 Red Med.	3	4	3	3.3 Inferior
8	#224 Lemon Yel.	6+	6+	6+	6+ Good
9	#438 Med. Yel.	5	6	6	5.7 Fair
10	#666 Brown	4	4	4	4 Inferior
11	#334 Flesh	2	2	1	1.3 Fugitive

FIG. 8 Example of Final Rating Form

6 shows a color change), and if desired, the date when reference 7 shows a color change. Beside each specimen

identify the art material as completely as possible. Record the product number and the name of each material, if available. See examples in Figs. 1 and 2.

7.3 Tape across the top and bottom margins of the Blue Wool Reference Card to attach it to the substrate. The bottom of the card has the wider margin and the duller blue reference. To save space, the margins can be trimmed leaving enough margin to tape the card to the panel.

7.3.1 Center the card directly in line with the center of the bands of art material specimens. The card must be in line with the specimens so it will also be half covered when the specimen cover is attached.

7.3.2 Number the Blue Wool References 1 through 8 beginning with the top reference.

7.3.3 A separate Blue Wool Reference Card shall be used with each set of test specimens exposed in a different window.

7.4 Attach the specimen support to the backing board with the tape.

7.5 Line the specimen cover up with the guide marks and fasten it tightly over the specimens and Blue Wool Reference Card with suitable tape, clamps or wing nuts. Tape may have to be replaced during the exposure period due to deterioration.

8. Procedure

8.1 Position the backing panel containing the specimens and Blue Wool Reference Card in a window. In the northern hemisphere, the window should face south or southwest if possible. This will shorten the time required for completion of the test. Tests will be completed sooner in the summer than in the winter. The altitude and latitude of the site and the ambient heat and moisture will also affect the time required for the test. If the specimens can be placed at an appropriate angle, normally 45°, so the sun falls directly on the specimens, this also accelerates color changes.

8.1.1 Insure that no shadows fall across the specimens.

8.2 Record the date the exposure begins.

8.3 Remove the cover once a week, isolate Reference 3 with Mask I and check it for any color change.

8.3.1 *Viewing Conditions*—When visually examining Reference 3 or the specimens, the light source shall be either natural sky light (not direct sun light), or an artificial daylight source of 5000 to 7500 K with a Color Rendering Index⁷ of 89 or higher. If the source is overhead, the specimens shall be held at about 45° from the horizontal to avoid reflections of the source on their surfaces.

8.4 When a color difference can be seen between the exposed and unexposed halves of Reference 3 through Mask I, examine the art material specimens and note on a record form such as is shown in Fig. 5 the date and any specimens perceived to show a color change. These specimens will be rated as “Fugitive.”

8.5 Reattach the specimen cover and continue exposure. Check Reference 3 periodically, usually about once a month is sufficient.

8.5.1 Remove the cover and lightly brush any dust from the surface of Reference 3 with a soft artist’s brush. Compare the blue colors of the exposed and unexposed halves of Reference 3 with the two blue chips on Side 1 of Mask II. The darker blue on the mask matches approximately the unexposed half of Reference 3. Place the mask so that these two blues are one above the other and compare the lighter blue on the mask with the faded half of Reference 3. When the exposed half of Reference 3 matches the lighter blue chip, isolate Reference 6 with Mask I and check that a color change can be seen in Reference 6. If no change in Reference 6 can be seen, continue the exposure until Reference 3 matches the lighter blue on the mask and a change can be perceived in Reference 6.

NOTE 2—It is sometimes difficult to detect a small color change in Reference 6 when it is isolated with Mask I. If uncertain whether there is a slight change in Reference 6, examine it without the mask. The mask is used to prevent a phantom line from appearing to cross a specimen when there are faded specimens above and below it.

8.6 Remove the panel from exposure and record the date. Store panel in the dark until it can be rated.

8.6.1 If practical, brush specimens lightly or tap the specimen board gently on its edge to dislodge any dust. If the materials exposed were colored pencils, check specimens that have appeared to change color due to bloom by rubbing them gently with a small piece of cotton. If the specimen’s color returns to its original appearance, the specimen has not faded.

8.7 Supply a set of instructions similar to those given in Fig. 6 and a rating form similar to Fig. 7 to each of three or more observers with normal color vision.

8.7.1 Have the observers isolate each specimen with Mask I, while isolating the Blue Wool References one by one with Side 2 of Mask II, and rate the specimen by assigning it the number of the Blue Wool Reference that shows the same amount of color change. If the contrast between the exposed and unexposed halves of a specimen is judged to fall between two of the Blue Wool References, assign it a rating half way between their numbers. When no color change is seen in a specimen, the specimen is rated 6+. A rating of 6 indicates a color change equal to the small amount of color change in Reference 6.

8.7.2 During the rating process prevent an observer from seeing the ratings given by other observers.

8.8 Record the date and average the individual ratings for each specimen on an appropriate form, such as that in Fig. 7. Designate as “Fugitive” those art materials with an average rating of 0 through 2.1, and also designate as “Fugitive” the art materials that showed a color change at the first rating, when Reference 3 faded as described in 8.4. Designate as “Inferior” those that have an average rating of 2.2 through 5.4. Designate as “Fair” those that have an average rating of 5.5 through 6.0. Designate as “Good” those specimens that are rated as 6.1 through 7.0. Designate as “Very Good” those that have an average rating of 7.1 through 8.0 by the majority of the observers, indicating that they could not detect any color change.

8.9 Record the ratings and the date on a final rating form such as shown in Fig. 8.

8.10 To determine which materials have superior lightfastness, continue exposure until Reference 7 shows a significant

⁷ Color Rendering Index for a lamp may be obtained from the distributor or manufacturer of that lamp.

color change after being brushed with a soft artist's brush and isolated with Mask I. A color change and demarcation line should be clearly seen between the exposed and unexposed sections of Reference 7.

8.10.1 Have three or more observers with normal color vision isolate the test specimens that were rated 6+ and note on a separate report form whether or not a color change is seen. Raise the rating from "Good" to "Superior" for materials that are judged by a majority of the observers to show no change.

8.11 Record the adjusted rating for these materials and the date on the final rating form such as shown in Fig. 8.

9. Interpretation of Results

9.1 The length of time it takes for a color in a normal room environment to exhibit the color changes shown in this test depends on how it is displayed. When hung on a north wall in a museum at about 150 000 fc/h per year (about 1.5 million lx/h per year), materials rated as "Fugitive" will change color in less than 20 years; "Inferior" and "Fair" materials will fade in 20 to 100 years; and "Good" materials are predicted to remain unchanged for 100 years.⁸

⁸ Feller, R. L., "Speeding Up Chemical Deterioration," *Bulletin de l'Institut royal du Patrimoine artistique*, Brussels, Belgium, Vol XV, 1975, pp. 135 to 150; Feller, R. L. and Johnston-Feller, R., "Use of the International Standard Organization's Blue-Wool Standard for Exposure to Light. Part 1: Use as an Intergrating Light Monitor for Illumination Under Museum Conditions," *American Institute for Conservation Annual Meeting*, Ft. Worth, TX, 1978. Off print available from Information Services, Conservation Analytical Laboratory, MSC, Smithsonian Institution, Washington, DC 20560; Feller, R. L. and Johnston-Feller, R., "The International Standard Organization's Blue-Wool Fading Standard (ISO R105)," *Textiles and Museum Lighting*, Harpers Ferry Regional Textile Group, 1985, pp. 41-57.

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9.1.1 In a normal home environment these times can be expected to be shorter, especially if the artwork is located near a window, or in direct sunlight or fluorescent illumination, or is located in tropical or subtropical climates. When this practice was conducted in different locations and at different times of year, "Fugitive" materials took from a few days to 2 months to fade, while materials rated as "Inferior" and "Fair" took from approximately three months to eighteen months to change color. Materials rated as "Good" showed no color change when Reference 6 faded but some of these showed a color change before Blue Wool Reference 7 faded.⁹

9.1.2 It is to be expected that artworks displayed in a normal room will show color changes somewhere between those that result from exposure in a museum environment and the changes found in this practice.

9.2 In the case of some pigments, the thickness of the layer of the colorant affects its lightfastness. Thick coats of a paint are often more resistant to fading than thin films, such as watercolor washes or oil glazes. In many cases, the addition of white to a paint, or its inclusion in a material, causes fading in colorants that show no color change at full strength. The medium in which a pigment is dispersed also affects its lightfastness.

NOTE 3—Under some conditions a barely perceptible change can be detected in Reference 7 shortly after Reference 6 fades. Exposure must continue until Reference 7, which fades very slowly, has received significantly more exposure.

10. Keywords

10.1 art materials; ISO Blue Wool References; lightfastness

⁹ Supporting data are available from ASTM International Headquarters. Request RR:D01-1080.