



# Standard Practice for Visual Evaluation of the Lightfastness of Art Materials by the User<sup>1</sup>

This standard is issued under the fixed designation D 5398; 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 ( $\epsilon$ ) 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. Any color change is compared to fading in a Blue Wool Reference<sup>2</sup> and exposed simultaneously.

1.2 This practice shall only be used by individuals to select materials with satisfactory lightfastness for their own use or to identify materials that require special protection from light. When test information is to be communicated to others, Test Methods D 4303 or D 5383 must be used.

1.3 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.

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

1.5 *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 4303 Test Methods for Lightfastness of Pigments Used in Artists' Paints<sup>3</sup>

D 5383 Practice for Visual Determination of the Lightfastness of Art Materials by Art Technologists<sup>3</sup>

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D-1 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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<sup>2</sup> ISO Blue Wool Reference 3 is available from the Society of Dyers and Colourists, P.O. Box 244, Grattan Road, Radford, West Yorkshire, BD12 1JB, England, or as the third band from the top of the Textile Fading Card from Talas, Division of Technical Library Service, Inc., 213 West 35th St., New York, NY 10001-1996.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 06.02.

E 284 Terminology of Appearance<sup>4</sup>

### 2.2 Other Standards:

ISO/R 105-B Textiles Tests for Colour Fastness Part B: Colour Fastness to Light and Weathering<sup>5</sup>

British Standards Institute (BSI) 1006 Group B Methods for Colour Fastness of Textiles and Leathers<sup>6</sup>

## 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 employs as a control Blue Wool Reference 3 from the series of eight Blue Wool References of known lightfastness that were developed for use with ISO/R 105-B<sup>5</sup> and BSI 1006 Group B<sup>6</sup>.

4.2 Specimens are made of the colored materials to be tested and placed on a backing board along with Blue Wool Reference #3 or a Blue Wool Reference Card containing all eight Blue Wool References.

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

4.4 The test is complete when Blue Wool Reference # 3 fades a specific amount.

4.5 The artist examines the test specimens and decides

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 06.01.

<sup>5</sup> ISO/R 105-B is available from the American National Standards Institute, 13th Floor, 11 W. 42nd St., NY, NY 10036.

<sup>6</sup> British Standard 1006 Group B is available from British Standards Institute, Linford Wood, Milton Keynes MK14 6LE, United Kingdom.

which materials are suitable for use in his or her works of art.

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 for an artist to check the lightfastness of coloring materials to be used in works of art. It may also be used to test the lightfastness of other types of colored materials.

**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. Foam core board, particle board, hardboard, or plywood are suitable.

6.2 *Substrate*, of stiff drawing paper or museum board that is white, acid free (pH 7 to 9), and of medium weight, 72 to 140 lb (33 to 64 kg). Depending on the material being tested, a pH neutral foam core 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 completely cover the substrate with an even coat of the colors. Rough watercolor papers are not suitable.

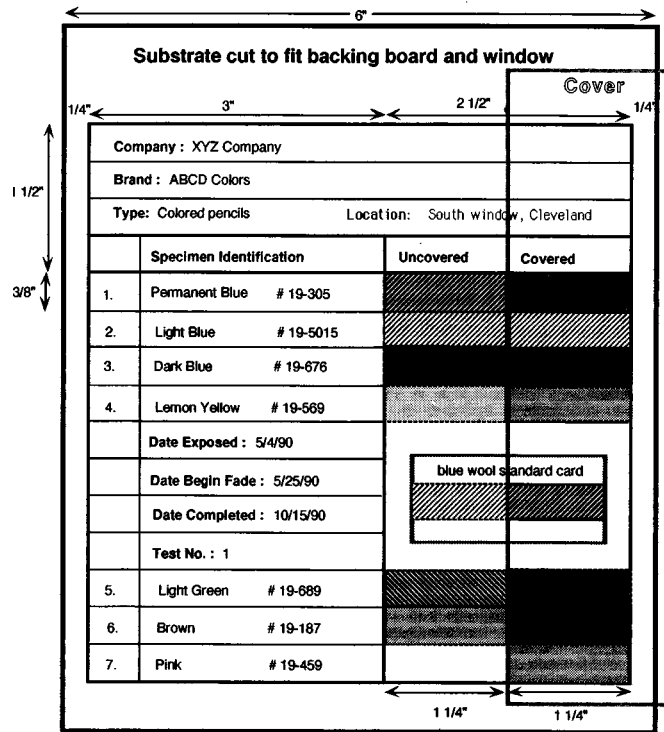
6.3 *Blue Wool Reference* <sup>32</sup>, a horizontal band of blue wool cloth, 3/8 in. (9.5 mm) high and 1 3/4 in. (44.5 mm) wide, glued to a card 1 by 1 3/4 in. (2.5 by 4.4 cm). If the Textile Fading Card from Talas is used, Reference 3 is the third band down from the end of the card with the narrower margin and brighter blue wool bands. Either 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. This cover shall be at least 1 1/4 in. (32 mm) 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 from light (see Fig. 1). 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. Duct or electrical tape is suitable since it is designed to withstand heat.

6.6.1 *Optional—Metal Clamps*, To hold the cover more tightly against the specimen. This will exclude light better,

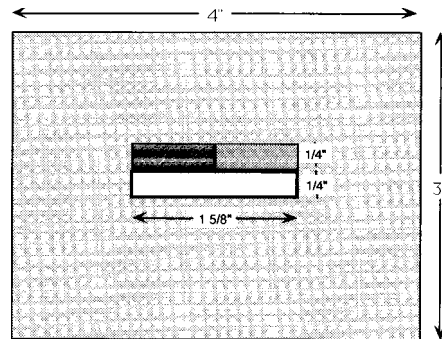


NOTE 1—1 in. = 25.4 mm (exact).

FIG. 1 Suggested Layout for Lightfastness Test Panel

making a sharper edge between the exposed and unexposed sections of the specimens. This will make visual determinations easier.

6.7 *Mask*, shall be made of stiff paper with a slot, 1/4 by 1 5/8 in. (6.4 by 41.3 mm), slightly smaller than the Blue Wool Reference (see Fig. 2). Both sides of the mask shall be a neutral gray approximately Munsell Value 6.5. Side one shall have two blue color chips attached above the slot. One blue chip shall be Munsell 7 PB 4/13, matching the unexposed Blue Wool Reference # 3. The second chip shall be Munsell 5 PB 6/4, the color of the exposed half of Blue Wool Reference # 3 when the test is complete. When the blue chips on Side 1 match the exposed and unexposed halves of Blue Wool Reference 3, the test is complete. The gray Side 2 is used to isolate a specimen when looking for a color change to prevent color changes in neighboring specimens from affecting the decision.



NOTE 1—Side 2 is the same gray.

FIG. 2 Side 1 of the Gray Mask Showing the Slot and Two Blue Color Chips

## 7. Preparation of Specimens

7.1 Cut both the heavy drawing paper to be used as the substrate and the backing panel to the size of 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 the Blue Wool Reference.

7.2 Use Fig. 1 as a general guide in preparing the substrate on which to apply the art materials. The horizontal bands for the art materials must be at least  $\frac{3}{8}$  in. (9.5 mm) high and  $1\frac{3}{4}$  in. (44.5 mm) wide for each art material to be tested. This is the same size as Blue Wool Reference # 3.

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

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 record the type of material, name of the manufacturer, and product line. Record the date the test begins, leaving a space to record the date when the Blue Wool Reference # 3 begins to fade, and the date when the test is complete (see Fig. 1).

7.2.4 Beside each specimen identify the art material as completely as possible. Record the product number and the name of each material, if available.

7.3 Use tape to attach the Blue Wool Reference card by its top and bottom margins to the substrate. Center the Blue Wool Reference directly below the center of the bands of art material specimens. The reference must be in line with the specimens so it will also be half covered when the cover is attached. A separate Blue Wool Reference card shall be included with each set of test specimens that will be exposed in a different window.

7.4 Attach the substrate containing the specimens and the reference to the backing board with the tape.

7.5 Line up the cover with the guide marks and fasten it tightly over the specimens and the Blue Wool Reference with tape or clamps. Tape may need to be replaced during the exposure period due to deterioration.

## 8. Procedure

8.1 Position the prepared panel 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, and the altitude and latitude of the site will also affect the time required for the test. If the specimens can be placed at an angle, normally  $45^\circ$ , in the window so the sun falls directly on the specimens, this also speeds the results. Ensure that no shadows fall across the specimens.

8.2 Record the date exposure begins.

8.3 Remove the cover once a week, isolate the Blue Wool Reference # 3 with the gray Side 2 of the Mask and check the

reference for any color change.

8.3.1 *Viewing Conditions*—When visually examining the Blue Wool Reference # 3 or the test specimens, the light source shall be natural sky light (not direct sun light), or an artificial daylight source of 5000 to 7500 K with a Color Rendering Index<sup>7</sup> of 89 or higher. If the source is overhead, the specimens shall be held at about  $45^\circ$  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 the Blue Wool Reference # 3, use the gray Side 2 of the Mask to isolate each art material specimen in turn to check it for color changes.

8.5 Record the date and the materials that show a color change.

8.6 Reattach the specimen cover and continue exposure.

8.6.1 Check the Blue Wool Reference # 3 periodically (usually about once a month is sufficient) by removing the cover and comparing the exposed and unexposed halves of the reference with the blues on Side 1 of the Mask. The darker blue chip matches approximately the unexposed Blue Wool Reference #3.

8.6.2 Place the slot in the mask so that the dark blue chip touches the unexposed half of the Blue Wool Reference # 3 and the lighter blue chip touches the exposed half of the reference.

8.6.3 When the exposed half of the Blue Wool Reference # 3 matches the lighter blue chip the test is complete. Remove the panel from exposure.

8.7 Isolate each color specimen with the gray Side 2 of the Mask and decide which materials have changed color sufficiently to make them unsuitable for use in a permanent artwork, or which materials need added protection from light and ultraviolet radiation (see Note 3).

8.7.1 If the materials exposed were colored pencils, check the specimens that have appeared to change color for 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.

8.8 Record the date and the materials that are deemed suitable for use. It is useful to prepare a record such as the one shown in Fig. 3, noting the materials that have not changed color, those that show a small color change, those that show a large color change, and those that bleached white.

NOTE 2—If it is desired to select materials with superior lightfastness either Test Methods D 4303, if appropriate, or Practice D 5383 must be used. Test Methods D 4303 is an instrumental method for use with artists' oil, resin-oil, alkyd, acrylic emulsion or watercolor paints. Practice D 5383 is a visual practice but requires the eight Blue Wool References as controls, evaluation by three or more observers, and longer exposure.

## 9. Interpretation of Results

9.1 The length of time it takes for a color in a normal room environment to fade depends on how it is displayed. A study has shown that colors that begin to fade when the Blue Wool Reference first shows a color change, and those that bleach white by the time the test is complete, will lose their color in less than 20 years when they are hung on a north wall in a

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

Manufacturer:		Test #:	
Brand:		Dates: Exposed:	
Type:		1st Rating:	
Location:		Completed:	
Rater:		2nd rating:	
#	Specimen I.D.	Rating 1	Rating 2
1	#19-546 Dk. Blue	--	small change
2	#19-234 Lt. Blue	--	no change
3	#19-683 Med. Green	--	small change
4	#19-669 Lt. Green	--	no change
5	#19-876 Pink	F	Fugitive
6	#19-223 Lt. Red	--	large change
7	#19-168 Red Medium	--	small change
8	#19-224 Lemon Yellow	--	no change
9	#19-438 Med. Yellow	--	large change
10	#19-666 Brown	--	large change
11	#19-334 Flesh	--	Fugitive

FIG. 3 Example of an Optional Rating Form

museum under natural daylight at about 150 000 fc/h per year (about 1.5 million lx/h per year). These colors are referred to as "Fugitive." Under these same conditions, colors that show a color change at the time the museum test is completed will show approximately the same change sometime between 20 and 100 years. Colors that showed no color change in the test should remain unchanged for 100 years in the museum environment.<sup>8</sup>

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 more light resistant materials required from 3 to 18 months to change color.<sup>9</sup> Some materials will remain unchanged indefinitely.

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 the pigment is dispersed also affects its lightfastness.

NOTE 3—The periods just given can usually be extended for moderately lightfast materials by using an ultraviolet absorbing glazing. Fugitive materials frequently fade in visible light as well as ultraviolet radiation and therefore do not receive as much protection from this type of glazing.

## 10. Keywords

10.1 art materials; Blue Wool Reference; fading; lightfastness

<sup>8</sup> Feller, R. L., "Speeding Up Chemical Deterioration," *Bulletin de l'Institut royal du Patrimoine artistique*, Brussels, Belgium, Vol XV, 1975, pp. 135-150; 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.

<sup>9</sup> Supporting data are available from ASTM Headquarters. Request RR:D01-1080.

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