International Standard ISO 105/B

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Textiles — Tests for colour fastness — Part B : Colour fastness to light and weathering

Textiles — Essais de solidité des teintures — Partie B : Solidité des teintures à la lumière et aux intempéries

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Foreword

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General information on colour fastness to light

When in use, textiles are usually exposed to light. Light tends to destroy colouring matters and the result is the well-known defect of "fading", whereby coloured textiles change colour, usually becoming paler and duller. Dyes used in the textile industry vary enormously in their resistance to light, and it is obvious that there must be some method of measuring their fastness. The substrate also influences the light fastness of a dye.

This International Standard cannot satisfy completely all the interested parties (who range from dye manufacturers and the textile industry to wholesale and retail traders and the general public) without becoming technically involved and possibly difficult to understand by many who have a direct interest in its application.

The following non-technical description of the test has been prepared for the benefit of those who find the detailed technicalities of the standard difficult to understand. The method is to expose the pattern being tested and to expose also, at the same time and under the same conditions, a series of light fastness standards which are pieces of wool cloth dyed with blue dyes of different degrees of fastness. When the pattern has faded sufficiently, it is compared with the standards and if it has behaved, for instance, like Standard 4[1], then its light fastness is said to be 4.

The light fastness standards must cover a wide range since some patterns noticeably fade after exposure for 2 or 3 h to bright summer sunshine, although others may withstand several years' exposure without change, the dyes in fact outliving the cloth to which they have been applied. Eight standards have been chosen, Standard 1 being the most fugitive and Standard 8 the most resistant. If it takes a certain length of time for Standard 4 to fade under certain conditions, then the same amount of fading will occur on Standard 3 in approximately half that time, or on Standard 5 in approximately twice that time, provided that the conditions are the same.

It is necessary to ensure that different people testing the same material will fade it to the same extent before assessment against the simultaneously faded standard. The ultimate users of dyed textiles differ widely in what they consider to be "faded articles" and therefore patterns under test are faded to two different degrees which adequately cover most opinions and make assessment more reliable. These required degrees of fading are defined by reference to a collection of standard contrasts (grey scale 5 equals no contrast, grey scale 1 equals large contrast). Thus the use of the grey scale enables fading to be taken to defined extents, and the blue standards enable the light fastness to be rated.

This general principle of assessing on the basis of moderate and severe fading is complicated, however, by the fact that some patterns on exposure undergo a slight change very rapidly indeed but do not change further for a long time. These slight changes are such that under normal conditions of use they would seldom be observed, but in certain cases they become important, as the following example shows.

> Some curtain material is exposed so as to produce a moderate degree of fading and it is found that Standard 7 has faded to the same extent; the general light fastness of the fabric is therefore 7. A retailer has a length of this fabric in his window and on it is a cardboard ticket indicating the price. After a few days the ticket is removed and careful examination reveals the place where it has been resting because the surrounding cloth has changed shade slightly on exposure to light.

The important factor about this slight change is that it can only be detected when there is a sharp boundary between the exposed and unexposed areas, and these conditions rarely occur during normal use. The magnitude of this slight change would be given as an additional assessment in brackets. Thus a rating for a test could be 7 (2), indicating a slight initial change equivalent to the first perceptible fade of Standard 2, but otherwise a high light fastness of 7.

A further unusual colour change is also catered for, namely photochromism. This effect is shown when a dye changes colour rapidly on exposure to strong light but on removal to a dark place the original colour returns more or less completely. The extent of photochromism is determined by a special test included in this International Standard and is shown in the rating by a number following the letter P within brackets; for example 6 (P2) means a photochromic effect equal to a grey scale 2 contrast but permanent fading equal to that of Standard 6.

Finally, there are many patterns which change hue on prolonged exposure to light; for example, a yellow may become brown, or a purple may become blue. In the past there have been many arguments as to whether such patterns could be said to have faded or not. The technique used in this International Standard is unambiguous on this point; it is visual contrast on exposure which is being measured, whether it be loss of colour or change in hue; in the latter case, however, the kind of change is included in the assessments. For example, consider two green patterns which, on exposure, change in appearance at the same rate as Standard 5; one becomes paler and finally white, while the other becomes first a greenish blue and finally a pure blue. The former would be rated "5" and the latter "5 bluer". In this instance also, the technique used in this International Standard tries to present as complete a picture of the behaviour of a pattern on exposure as is possible without becoming excessively complicated.

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1) The designations of the light fastness standards referred to here are those of the European set (see section B01, sub-clause 4.1.1). The principles explained are equally valid for the American set (see section B01, sub-clause 4.1.2).

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B01 Colour fastness to light : Daylight

0 INTRODUCTION

This method replaces those given in ISO/R 105/I, part 11, and ISO 105/VI, part 2, by combining the two methods. Certain editorial changes have been made but no significant changes in the technical content of either of the two methods are made. The two previous methods essentially differed only in the blue wool standards used and this difference is reflected in the present text. Consolidation of the two methods will eliminate the confusion of having two methods to evaluate the same property.

1 SCOPE AND FIELD OF APPLICATION

1.1 This method is intended for determining the resistance of the colour of textiles of all kinds and in all forms to the action of daylight.

1.2 If there is a possibility of the sample being photochromic, then the test for photochromism shall be applied, additionally (see section B05).

2 PRINCIPLE

A specimen of the textile is exposed to daylight under prescribed conditions, including protection from rain, along with eight dyed wool standards. The fastness is assessed by comparing the change in colour of the specimen with that of the standards.

3 REFERENCES

ISO 105 :

Section A01, *General principles of testing.*

Section A02, *Grey scale for assessing change in colour.*

Section B05, *Detection and assessment of photochromism.*

4 STANDARDS AND APPARATUS

4.1 Standards

Two sets of Blue Wool Standards may be used. The two sets of standards are not interchangeable.

4.1.1 Standards 1 to 8

Blue Wool Standards developed and produced in Europe are identified by the numerical designation 1 to 8. These standards are blue wool cloths dyed with the dyes listed in the table. They range from 1 (very low light fastness) to 8 (very high light fastness) (see 9.1).

TABLE — **Dyes for Blue Wool Standards 1 to 8**

Standard	Dye — Colour Index — Designation [1]
1	CI Acid Blue 104
2	CI Acid Blue 109
3	CI Acid Blue 83
4	CI Acid Blue 121
5	CI Acid Blue 47
6	CI Acid Blue 23
7	CI Solubilized Vat Blue 5
8	CI Solubilized Vat Blue 8

1) The Colour Index (Third edition) is published by the Society of Dyers and Colourists, P.O. Box 244, Perkin House, 83 Gratton Road, Bradford BD1 2JB, West Yorks., United Kingdom.

4.1.2 Standards L2 to L9

Blue Wool Standards developed and produced in America are identified by the letter L followed by the numerical designation 2 to 9. These eight standards are specially prepared by blending varying proportions of wool dyed with CI Mordant Blue 1 (Colour Index, 3rd Edition 43830), and wool dyed with CI Solubilized Vat Blue 8 (Colour Index, 3rd Edition 73801), so that each higher numbered standard is approximately twice as fast as the preceding standard (see 9.2).

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4.2 Apparatus

4.2.1 Exposure rack, facing south in the Northern hemisphere, north in the Southern hemisphere and sloping at an angle from the horizontal approximately equal to the latitude of the place where the exposure is made. The rack shall be sited preferably in a non-residential, non-industrial area free from dust and automobile exhaust fumes.

The rack shall be placed so that shadows of surrounding objects, including any framing, will not fall on the exposed textiles and constructed so that the latter are firmly held. There shall be adequate ventilation behind the mounted specimens and the rack shall be covered with window glass to protect the specimens from rain and other elements of the weather. The transparency of the glass used shall be at least 90 % between 380 and 700 nm, falling to 0 % betweeen 310 and 320 nm.

The minimum permissible distance between the glass and the specimens is 5 cm. In order to minimize shadows due to the varying angle of the sun, the usable exposure area under the glass is limited to that of the glass cover reduced on each side by twice the distance from the glass cover to the specimen.

4.2.2 Opaque cardboard or other thin opaque material, for example thin sheet aluminium, or cardboard covered with aluminium foil, or, in the case of pile fabrics, a cover that avoids surface compression.

4.2.3 Grey scale for assessing change in colour (see clause 3).

5 TEST SPECIMEN

5.1 An area of the textile product not less than 1 cm × 6 cm is used for method 1 (see 6.1.1) or 1 cm × 10 cm for method 2 (see 6.1.2) so that each exposed portion is not less than 1 cm × 2 cm. The specimen may be a strip of cloth, yarns wound close together on a card or laid parallel and fastened on a card, or a mat of fibres combed and compressed to give a uniform surface and fastened on a card.

5.2 To facilitate handling, the specimen or specimens to be tested and the similar strips of the standards may be mounted on a card in an arrangement as indicated in figure 1 or figure 2 (see 6.1.1 or 6.1.2).

5.3 The specimens to be tested and the blue strips of the standards should be of equal size and shape in order to avoid errors in assessment due to over-rating the visual contrast between exposed and unexposed parts on the larger pattern as against the narrower standards.

6 PROCEDURE FOR MOUNTING, EXPOSURE AND PRELIMINARY ASSESSMENT OF LIGHT FASTNESS

6.1 Exposure of specimens

Expose the specimen (or group of specimens) and the standards simultaneously to daylight for 24 h per day under the conditions described in 4.2.1, in such a manner and for such times as are necessary to evaluate fully the light fastness of each specimen relative to that of the standards, by successively covering the specimens and exposed standards throughout the duration of the test. Two suggested methods of procedure follow.

6.1.1 *Method 1*

6.1.1.1 This method is considered most satisfactory and should be used in cases of dispute over the numerical rating. The basic feature is the control of the exposure periods by inspection of the *specimen* and, therefore, one set of standards is required for each specimen under test.

6.1.1.2 Arrange the specimen to be tested and the standards as shown in figure 1 with an opaque cover AB across the middle third of the specimen and standards. Expose to daylight under the conditions described in 4.2.1. Follow the effect of light by removing the cover AB and inspecting the specimen frequently. When a change can be perceived, equal to grey scale 4-5, note the number of the standard showing a similar change. (This is a preliminary assessment of light fastness.) At this stage attention should be given to the possibility of photochromism (see section B05).

6.1.1.3 Continue to expose until the contrast between the exposed and the unexposed portions of the specimen is equal to grey scale grade 4. Cover a second one-third of the specimen and standards with an additional opaque cover (CD in figure 1).

6.1.1.4 Continue to expose until the contrast between the fully exposed and unexposed portions is equal to grey scale grade 3. If Standard 7 or L7 fades to a contrast equal to grey scale grade 4 before the specimen does, the exposure may be terminated at this stage. When a specimen has a light fastness equal to or greater than 7 or L7, it would require unduly long exposure to produce a contrast equal to grey scale grade 3; moreover, this contrast would be impossible to obtain when the light fastness is 8 or L9. Assessments in the region of 7 to 8 or L7 to L9 are made, therefore, when the contrast produced on Standard 7 or L7 is equal to grey scale grade 4, the time required to produce this contrast being long enough to eliminate any error which might result from inadequate exposure.

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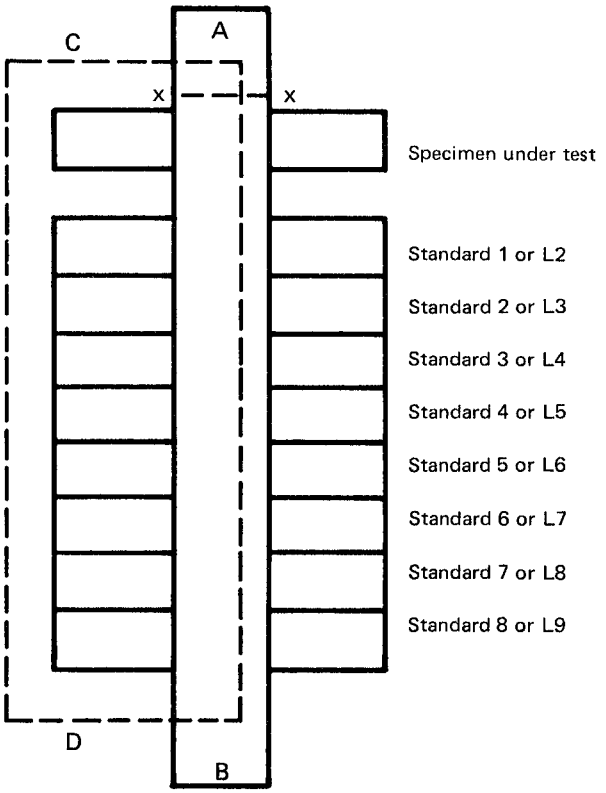
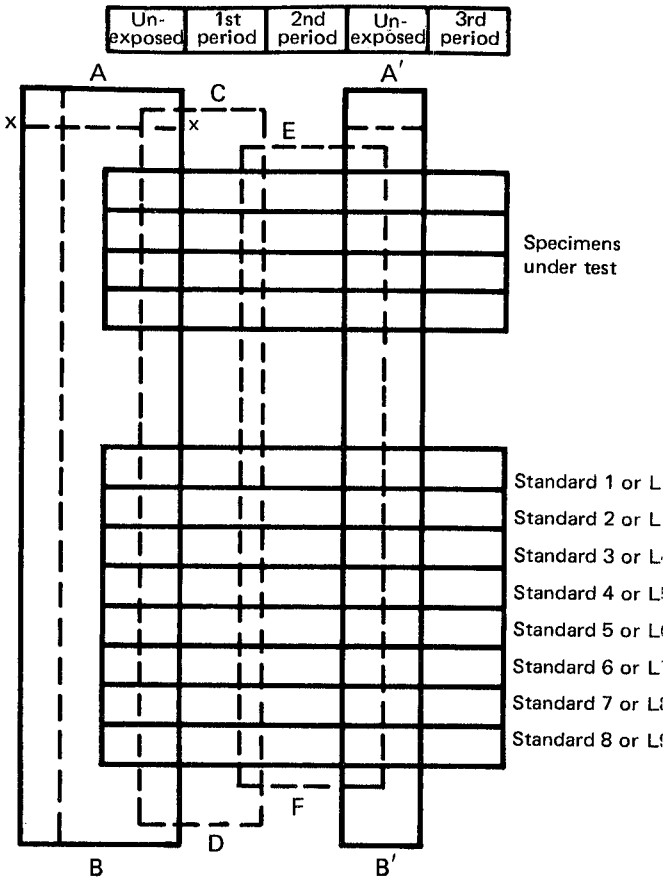


AB : Opaque cover.
May be hinged at x-x so that it can be lifted and returned to the same place over the specimen and standards.

CD : Second cover.

FIGURE 1 — **Mounting for method 1**



AB and A′B′ : Opaque covers.
AB may be hinged at x-x so that it can be lifted and returned to the same place over the specimens and standards.

CD : Third cover.

EF : Fourth cover.

FIGURE 2 — **Mounting for method 2**

6.1.2 *Method 2*

6.1.2.1 This method should be used when a large number of specimens have to be tested simultaneously. The basic feature is the control of the exposure period by inspection of the *standards*, which allows a number of specimens differing in light fastness to be tested against a single set of standards, thus conserving supplies.

6.1.2.2 Arrange the specimens to be tested and the standards as shown in figure 2, with covers A′B′ and AB, each covering one-fifth of the total length of each specimen and standard. Expose to daylight under the conditions described in 4.2.1. Follow the effect of light by lifting cover AB periodically and inspecting the standards. When a change in Standard 3 or L2 can be perceived, equal to grey scale grade 4-5, inspect the specimens and rate their light fastness by comparing any change that has occurred with the changes that have occurred in Standards 1, 2 and 3 or L2. (This is a preliminary assessment of light fastness.) At this stage attention should be given to the possibility of photochromism (see section B05).

6.1.2.3 Replace the lifted cover AB in exactly the same position and continue to expose until a change in Standard 4 or L3 can be perceived, equal to grey scale grade 4-5; at this point fix an additional cover CD in the position shown in figure 2, overlapping the cover AB.

6.1.2.4 Continue to expose until a change in colour in Standard 6 or L5 can be perceived, equal to grey scale grade 4-5; then fix the final cover EF in the position shown in figure 2, the other three covers remaining in position. Expose until either

a) a contrast is produced on Standard 7 or L7 equal to the contrast illustrated by grey scale grade 4, or

b) a contrast equal to grey scale grade 3 is produced on the most resistant specimen,

whichever occurs first.

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6.2 Other permissible exposure

Where the test is to be used to check conformity with a performance specification, it is permissible to expose the specimens with two standards only : that specified as minimum and the one below it. Continue exposure until grey scale grade 4 and grey scale grade 3 contrasts have been produced on separate areas of the minimum standard.

7 ASSESSMENT OF LIGHT FASTNESS

7.1 The final assessment in numerical ratings is based on contrasts equal to grey scale grade 4 and/or grade 3 between exposed and unexposed portions on the specimen.

7.2 Remove all the covers, thus revealing on specimens and standards two or three areas, depending on the method used, which have been exposed for different times, together with at least one area which has not been exposed to light. Compare the changes of the specimen with the relevant changes of the standards under suitable illumination (see clause 13 of section A01). The light fastness of the specimen is the number of the standard which shows similar changes in colour (visual contrast between exposed and unexposed parts of the specimen). If the specimen shows changes in colour which are nearer to the imaginary standard midway between any two consecutive standards than they are to either of the two consecutive standards, the intermediate rating, for example 3-4, shall be given.

If different assessments are obtained at the different degrees of contrast, the light fastness of the specimen is the arithmetic mean of these expressed to the nearest whole or half grade. When three areas are being rated, take the mean of the contrasts closest to grades 4 and 3. Assessments, however, shall be confined to whole or midway ratings only. When the arithmetic mean gives a quarter or three-quarter rating, the assessment is defined as the next higher half or whole grade.

In order to avoid a misrating of the light fastness of the specimen due to photochromism, the specimens shall be allowed to condition in the dark at room temperature for 24 h before the light fastness is assessed (see section B05).

7.3 If the colour of the specimen is more fugitive than that of Standard 1 or L2, a rating of 1 or L1 is given.

7.4 Comparison of the changes in the specimen with changes in the standards may be facilitated by surrounding the specimen with a mask of neutral grey colour (approximately the shade of the *lightest* chip of the grey scale for assessing change in colour; see clause 3), and the standards in turn with a similar mask of equal aperture.

7.5 If the light fastness is equal to or higher than 4 or L3, any preliminary assessment based on the contrast equal to grey scale 4-5 (see 6.1.1.2 and 6.1.2.2) becomes significant; if this preliminary assessment is 3 or L2, it shall be included in the rating in brackets. For example, a rating of 6 (3) indicates that the specimen changes very slightly in the test when Standard 3 just begins to fade, but that on continuing the exposure the resistance to light is equal to that of Standard 6.

7.6 If the specimen is photochromic, the light fastness rating shall include a bracketed P with the rating obtained from the test for photochromism, for example 6 (P 3-4) (see section B05).

7.7 The term "change in colour" includes changes in hue, depth, brightness, or any combination of these characteristics of colour (see sub-clause 2.6 of section A02).

8 TEST REPORT

Report the numerical rating for light fastness. The light fastness rating shall be expressed either

a) by the figure alone (in the case of using the standards designated "1 to 8"), or

b) by the figure together with the prefix "L" (in the case of using the standards designated "L2 to L9").

If the rating is equal to or higher than 4 or L3 and the preliminary assessment is equal to or lower than 3 or L2, report the latter figure in brackets. If the specimen is photochromic, the light fastness shall be followed by a bracketed P along with the grey scale rating.

9 NOTES

9.1 The Blue Wool Standards identified by 1 to 8 are available from the following sources :

a) British Standards Institution
10 Blackfriars Street
Manchester M3 5DT
United Kingdom

b) Beuth-Vertrieb GmbH
Burggrafenstrasse 4–7
D-1000 Berlin 30
Germany, F.R.

c) Japanese Standards Association
1–24 Akasaka 4
Minatoku
Tokyo
Japan

The light fastness standards 1 to 8 are specially dyed to match a master set of standards in colour and in fading behaviour. It has been found that, when repeated dyeings of the blue dyed standards are made, the amount of dye required to match the previous lot is often different from

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