International Standard 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

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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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).

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).

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.

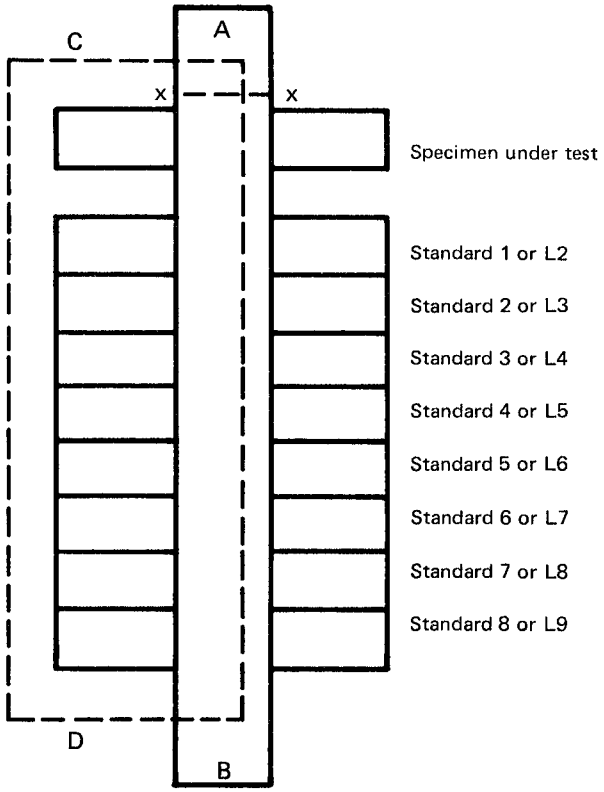
6.1.1 *Method 1*

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).

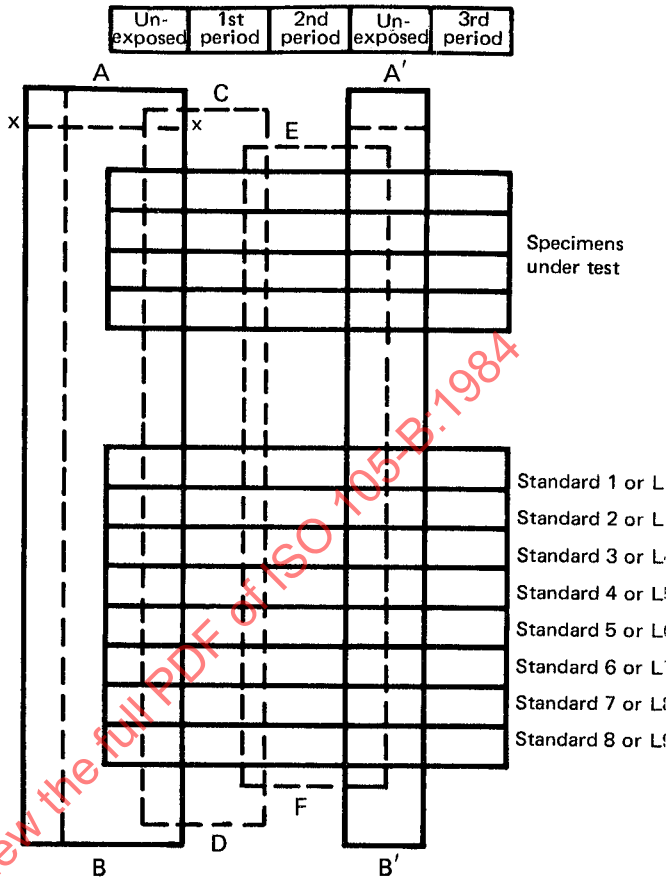
6.1.1.4 Continue to expose until the contrast between the fully exposed and unexposed portions is equal to grey scale grade 3. If Standard 7 or L7 fades to a contrast equal to grey scale grade 4 before the specimen does, the exposure may be terminated at this stage. When a specimen has a light fastness 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.



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.

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

that originally used. The dyeing strengths would, therefore, be misleading and they are intentionally omitted from the listing in the table.

9.2 The L Blue Wool Standards identified by L2 to L9 are available from :

American Association of Textile Chemists and Colorists
P.O. Box 12215
Research Triangle Park, North Carolina 27709
U.S.A.

In the light fastness standards L2 to L9, the two primaries are specially dyed and the blending proportions adjusted so that repeat productions of the standards have the same fading characteristics. It has been found in repeat production of the standards that the amount of each dye and the proportion of the fugitive and fast dyed primaries must be adjusted to obtain the same fading behaviour in the various standards. The dyeing strengths of two primaries and the blending proportions are intentionally omitted.

9.3 References to publications relating to the spacing of standards 1 to 8 are as follows :

Ricketts, R.H., *J. Soc. Dyers & Col.*, 1952, **68**, 200.
Rawland, O., *J. Soc. Dyers & Col.*, 1963, **79**, 697.
Jaeckel, S.M., *et al, J. Soc. Dyers & Col.*, 1963, **79**, 702.
McLaren, K., *J. Soc. Dyers & Col.*, 1964, **80**, 250.

B02 Colour fastness to artificial light: Xenon arc fading lamp test

In accordance with resolution 5 taken at the eleventh meeting of ISO/TC 38/SC 1 (contained in document 38/1 N 546, the draft report of the eleventh meeting) this method replaces that given in ISO 105 section B02: 1978 and the test under consideration given in document 38/1 N 587 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 in the blue wool standards and the apparatus used.

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 an artificial light source representative of natural daylight (D65).

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

1.3 This method employs two sets of standards. The results from the two sets of standards may not be identical.

2 Principle

A specimen of the textile is exposed to artificial light under prescribed conditions, along with blue wool standards. There are two different sets of blue wool standards which are not interchangeable. The fastness is assessed by comparing the change in colour of the specimen with that of the standards used.

3 References

ISO 105:

Section A01, *General principles of testing.*

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

Section B01, *Colour fastness to light: Daylight.*

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 lightfastness) to 8 (very high lightfastness) (see 9.1) so that each higher numbered standard is approximately twice as fast as the preceding one.

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, PO Box 244, Perkin House, 82 Grattan Road, Bradford BD1 1JB, West Yorks., United Kingdom and by the American Association of Textile Chemists and Colorists, PO Box 12215, Research Triangle Park, North Carolina 27709, USA.

4.1.2 Standards L2 to L9

Blue wool standards developed and produced in the United States 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, Third edition 43830), and wool dyed with CI Solubilized Vat Blue 8 (Colour Index, Third edition 73801), so that each higher numbered standard is approximately twice as fast as the preceding standard.

4.1.3 Humidity test control

The humidity test control is a red azoic dyed cotton cloth (see 9.1 and 9.4).

4.2 Apparatus

4.2.1 Xenon arc lamp apparatus, either air-cooled or water-cooled.

The specimens and the standards are exposed in one of the two types of apparatus (see 4.2.1.1 or 4.2.1.2). The variation of the light intensity over the area covered by the specimens and standards shall not exceed ± 10 % of the mean.

The distance from the surface of the specimen and that of the standards to the lamp must be the same.

4.2.1.1 Air-cooled xenon arc lamp apparatus (see annexes A and C), consisting of the following elements:

a) **Light source,** in a well ventilated exposure chamber.

The light source is a xenon arc lamp of correlated colour temperature 5 500 to 6 500 K.

b) **Light filter,** placed between the light source and the specimens and standards so that the ultraviolet spectrum is steadily reduced. The transmission of the glass used shall be at least 90 % between 380 and 750 nm falling to 0 % between 310 and 320 nm.

c) **Heat filter.** The spectrum of the xenon arc contains an appreciable amount of infra-red radiation which shall be minimized by heat filters (see 9.2 and A.1.1).

d) **Exposure conditions.** (The lightfastness ratings mentioned below are obtained with the blue wool standards 1 to 8 only):

1) normal conditions (temperate zone): moderate effective humidity (see 9.4); lightfastness of the humidity test control 5, black panel temperature maximum 45 °C (see 9.3);

2) extreme conditions: for testing sensitivity of specimens to different humidity during irradiation the following extreme conditions are useful:

— low effective humidity. Lightfastness of the humidity test control 6 to 7, black panel temperature maximum 60 °C (see 9.3);

— high effective humidity. Lightfastness of the humidity test control 3, black panel temperature maximum 40 °C (see 9.3).

4.2.1.2 Water-cooled xenon arc lamp apparatus (see annexes B and C), consisting of the following elements:

a) **Light source** in a well ventilated exposure chamber.

Light sources are long arc xenon arc lamps of various sizes in different size apparatus (see B.1.1).

b) **Light filter.** Inner and outer filter glass to contain and direct the flow of cooling water. An inner filter of Pyrex (borosilicate) glass and an outer filter of clear (soda lime) glass are used so that the irradiation at the specimen has a lower spectral cut-off at approximately that of window glass (see B.1.2).

c) **Heat filter.** Distilled or deionized water circulating through the lamp assembly between the inner and outer filter glass, cooled by passing a heat exchange unit (see B.1.4).

d) **Exposure conditions.** Black panel 63 ± 1 °C (see 9.3), controlled by continuous operation of the blower with thermostatic control of the temperature of a constant volume of air, whose relative humidity is increased by adding moisture to the air as it passes through the conditioning chamber by means of an electrically operated atomizer; the controls of the apparatus are adjusted so that the relative humidity of the air in the test chamber is 30 ± 5 % (see B.2.1 and B.2.2).

Effective humidity low.

Lightfastness of the humidity test control 6 to 7.

4.2.2 Opaque cardboard, or other thin opaque material, for example sheet aluminium or cardboard covered with aluminium foil.

4.2.3 Black panel thermometer (see 9.3).

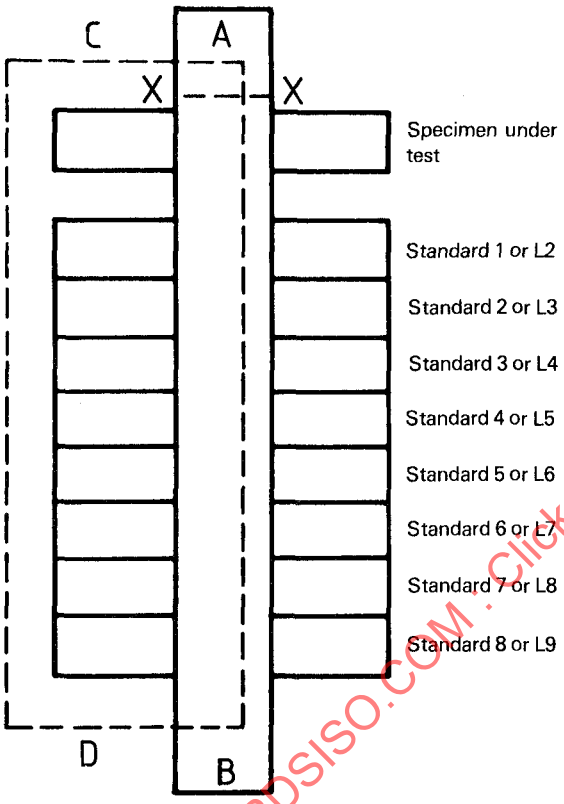
4.2.4 Grey scale for assessing change in colour (see section A02).

5 Test specimens

Depending on the number of specimens to be tested and on the shape and dimensions of the specimen holders supplied with the apparatus, the size of the specimen may vary.

5.1 In apparatus of the air-cooled type, usually an area of the textile not less than 4,5 cm × 1 cm is used when several periods of exposure are made side by side on the same specimen, which is the preferred practice. 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. Each exposed and unexposed area shall be not less than 10 mm × 8 mm.

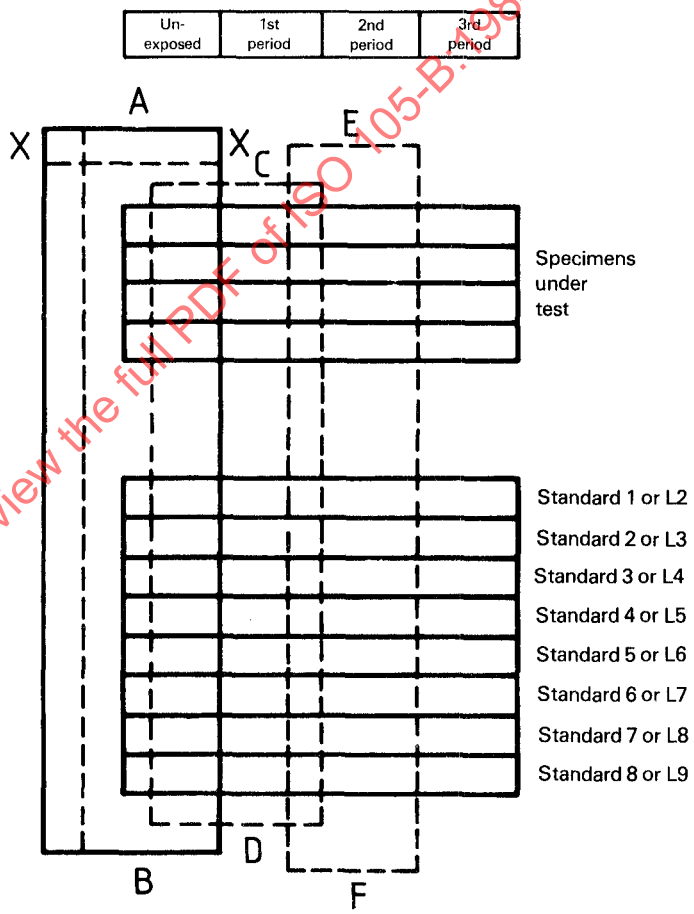
5.2 To facilitate handling, the specimen or specimens to be tested and similar strips of the standards may be mounted on one or more cards as indicated in figure 1 or figure 2.



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: 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.

EF: Third cover.

Figure 2 — Mounting for method 2

5.3 In apparatus of the water-cooled type, specimen holders are fitted to take specimens of approximately 7 cm × 12 cm. When desired, specimens of different sizes to fit alternative sizes of specimen holder may be used. The covers should make close contact with the surface of the unexposed areas of the specimens and the standards in order to give a sharp line of demarcation between exposed and unexposed areas but should not compress the specimen unnecessarily. Specimens may be mounted on white cardboard but L standards should always be exposed on a white cardboard backing.

5.4 The specimens to be tested and the blue wool standards should be of equal size and shape in order to avoid errors in an assessment due to overrating the visual contrast between exposed and unexposed parts on the larger pattern as against the narrower standards (see 7.4).

5.5 When testing pile fabrics the standards shall be arranged in such a way that they are the same distance from the light source as the surface of the pile fabrics. This can be achieved by using pieces of cardboard as underlay. Covers for the unexposed portions shall avoid surface compression.

6 Procedure

6.1 Adjustment of the humidity conditions
[see 4.2.1.1 d) and 4.2.1.2 d)]

6.1.1 Check that the apparatus is in good running order and that it is equipped with a clean xenon burner tube. (Follow the manufacturer's directions and see A.1.3 and clause B.1.)

6.1.2 Place a portion of the humidity test control of an area not less than 4,5 cm × 1 cm, together with the lightfastness standards, on to a card if possible in the middle area of the sample holder (see 5.2).

6.1.3 Place the filled specimen holders on the specimen rack of the apparatus with the holders supported both top and bottom, and in proper vertical alignment. Completely fill the specimen rack with the holders containing white cardboard in all spaces not filled with specimens.

6.1.4 Operate the apparatus with the light on continuously until a test is completed unless the lamp requires cleaning, or the burner, outer filter or inner filter, requires changing because they have reached the maximum number of hours of recommended usage.

6.1.5 Proceed to expose the partially covered strip of the humidity test control and the standards simultaneously until a contrast between the exposed and unexposed portions equal to grade 4 on the grey scale is produced on the humidity test control.

6.1.6 Assess the lightfastness of the humidity test control at this stage and if necessary, adjust the controls on the apparatus to give the selected exposure conditions. Check daily and when necessary readjust the controls to maintain the specified black panel temperature and humidity [see 4.2.1.1 d) and 4.2.1.2 d)].

6.2 Exposure methods

Expose the specimen (or group of specimens) and the standards simultaneously, under the desired conditions, in such a manner and for such time as is necessary to evaluate fully the lightfastness of each specimen relative to that of the standards, by progressively covering both the specimens and exposed standards during the test (either by method 1 or method 2).

6.2.1 Method 1

6.2.1.1 This method is considered most exact 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.

6.2.1.2 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 the xenon arc light under the conditions enumerated in 4.2.1.1 d) and 4.2.1.2 d). Follow the effect of light by removing the cover and inspecting the specimen. When a change can be perceived equal to grey scale 4 to 5 note the number of the standard showing a similar change. (This is a preliminary assessment of lightfastness.) At this stage attention should be given to the possibility of photochromism (see section B05).

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

6.2.1.4 Continue to expose until the contrast between the fully exposed and unexposed portions of the specimen is equal to grade 3 on the grey scale.

6.2.1.5 If standard 7 or L7 fades to a contrast equal to grey scale grade 4 before the specimen does, the exposure is terminated at this stage. When a specimen has a lightfastness 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 lightfastness 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.

6.2.2 Method 2

6.2.2.1 This method should be used when a large number of specimens has to be tested simultaneously. The basic feature is the control of the exposure periods by inspection of the standards, which allows a number of specimens differing in lightfastness to be tested against a single set of standards, thus conserving supplies.

6.2.2.2 Arrange the specimens to be tested and the standards as shown in figure 2 with the cover AB covering one quarter of the total length of each specimen and standard. Expose under the conditions enumerated in 4.2.1.1 d) and 4.2.1.2 d). Follow the effect of light by lifting the cover AB periodically and inspecting the standards. When a change in standard 3 or L2 can be perceived equal to grey scale grade 4 to 5, inspect the specimens and rate their lightfastness 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 lightfastness.) At this stage attention should be given to the possibility of photochromism (see section B05).

6.2.2.3 Replace the 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 to 5; at this point fix an additional cover, CD, in the position shown in figure 2, overlapping the first cover, AB.

6.2.2.4 Continue to expose until a change in standard 6 or L5 can be perceived equal to grey scale 4 to 5, then fix the final cover, EF, in the position shown in figure 2, the other two covers remaining in position.

6.2.2.5 Expose until either

a) a contrast is produced on standard 7 or L7 equal to the contrast illustrated by grade 4 of the grey scale; or

b) a contrast equal to grade 3 has been produced on the most resistant specimen;

whichever occurs first.

6.2.3 Method 3

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.

6.2.4 Method 4

Where the test is to be used to check conformity with an agreed upon reference sample it is permissible to expose the specimens with the reference sample only. Continue exposure until grey scale grade 4 and/or grey scale grade 3 contrasts have been produced on the reference sample. Unless the specimen and reference samples are of the same substrate and dyed with the same recipe, variations in atmospheric conditions may cause inconsistencies with this method.

7 Assessment of lightfastness

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 of 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 section A01, clause 13). The lightfastness 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 the intermediate rating, for example 3-4 or L5-L6, shall be given. If different assessments are obtained at the different degrees of contrast, the lightfastness of the specimen is the arithmetic mean of these expressed to the nearest half or whole grade. When three areas are being rated, take the mean of the contrasts closest to grey scale 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. However, to avoid a misrating of the lightfastness of the specimen due to its photochromism, the specimen should be allowed to condition in the dark at room temperature for 24 h before assessing the lightfastness (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 L2 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 midway between the lighter chips in grades 1 and 2 (approximately Munsell N5) and surrounding the standards in a turn with a similar mask of equal aperture.

7.5 If the lightfastness is equal to or higher than 4 or L3, preliminary assessment based on the contrast equal to grey scale 4 to 5 (see 6.2.1.2 and 6.2.2.2) becomes significant; if this preliminary assessment is 3 or lower or L2 or lower, it shall be included in the rating in brackets. For example, a rating of 6(3) or L6 (L2) indicates that the specimen changes very slightly in the test when standard 3 or L2 just begins to fade, but that on continuing the exposure the resistance to light is equal to that of standard 6 or L6.

7.6 If the specimen is photochromic the lightfastness rating shall include a bracketed P with the rating obtained from the test for photochromism, for example 6 (P3-4), (see section B05).

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

7.8 Exposures based on a performance standard (see 6.2.3) or together with an agreed upon reference sample (see 6.2.4) are assessed by comparison of the colour changes of the specimen and the references. If the specimen shows no greater change in colour than the performance standard or the reference sample the lightfastness is classified "satisfactory"; if the specimen shows a greater change in colour than the performance standard or the reference sample the lightfastness is classified "unsatisfactory".

8 Test report

8.1 For method 1 or 2:

Report the numerical rating for the lightfastness. The lightfastness rating shall be expressed either:

a) by the figure alone (when using the standards designated 1 to 8); or

b) together with the prefix L (when using the standards designated L2 to L9.

If this 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 lightfastness shall be followed by a bracketed P along with the grey scale rating.

8.2 For method 3 or 4:

Report the classification "satisfactory" or "unsatisfactory" together with the performance standard or the reference sample used.

8.3 Report the apparatus used, the method and the exposure conditions.

9 Notes

9.1 Sets of the lightfastness standards 1 to 8 and samples of the humidity test control can be obtained from the following sources:

China Association for Standardization, PO Box 820, Beijing, China.

Beuth-Verlag GmbH, Postfach 1145, D-1000, Berlin 30, Germany, F.R.

Japan Standards Association, 1-24 Akasaka 4, Minato-ku, Tōkyō, Japan.

British Standards Institution, 3 York Street, Manchester, M2 2AT, United Kingdom.

Association française de normalisation, Tour Europe, Cedex 7, F-92080 Paris la Défense, France. (Humidity test control only.)

Sets of the lightfastness standards L2 to L9 can be obtained from

American Association of Textile Chemists and Colorists,
PO Box 12215,
Research Triangle Park,
North Carolina,
NC 27709,
USA.

Master sets of these test controls are filed in certain countries for reference.

9.2 If a glass or water filter is used to eliminate excess infrared radiation so as to meet the temperature conditions specified in 4.2, frequent cleaning should be carried out to avoid unwanted filtering caused by dirt (see B.1.4).

9.3 The black panel thermometer [1] should consist of a metal panel at least 4,5 cm × 10 cm whose temperature is measured with a thermometer or a thermocouple with its sensitive portion located in the centre and in good contact with the panel. The side of the panel facing the light source should be black with a reflectance of less than 5 % throughout the spectrum reaching the specimen; the side of the panel not facing the light source should be thermally isolated (see also B.2.1).

9.4 Effective humidity descriptions:

9.4.1 Qualitative

The combination of air and surface temperatures and air relative humidity which governs the moisture content of the surface of the specimen during exposure.

9.4.2 Quantitative

The effective humidity can be measured only by determining the lightfastness of a specific humidity test control such as that described in 4.1.3. This control has been calibrated by exposing it facing south in several West European locations at different times of the year, the exposures being made together with the standards in sealed vessels containing air maintained at constant humidities between 0 and 100 %; the results did not vary greatly and the mean values are shown in figure 3.

9.5 When this control was exposed under the conditions specified in section B01 in temperate zones, its lightfastness was found to be, on average, 5.

1) Black panel thermometers manufactured by the following are suitable:

Atlas Electric Devices Co., 4114 North Ravenswood Avenue, Chicago 13, Illinois, IL 60613, USA.

W.C. Heraeus GmbH, Produktbereicht Original Hanau, Herausstr. 12-14, D-6450 Hanau 1, Germany, F.R.

Suga Test Instruments Co. Ltd., 32 Banshu-chō, Shinjuku-ku, Tōkyō, Japan.

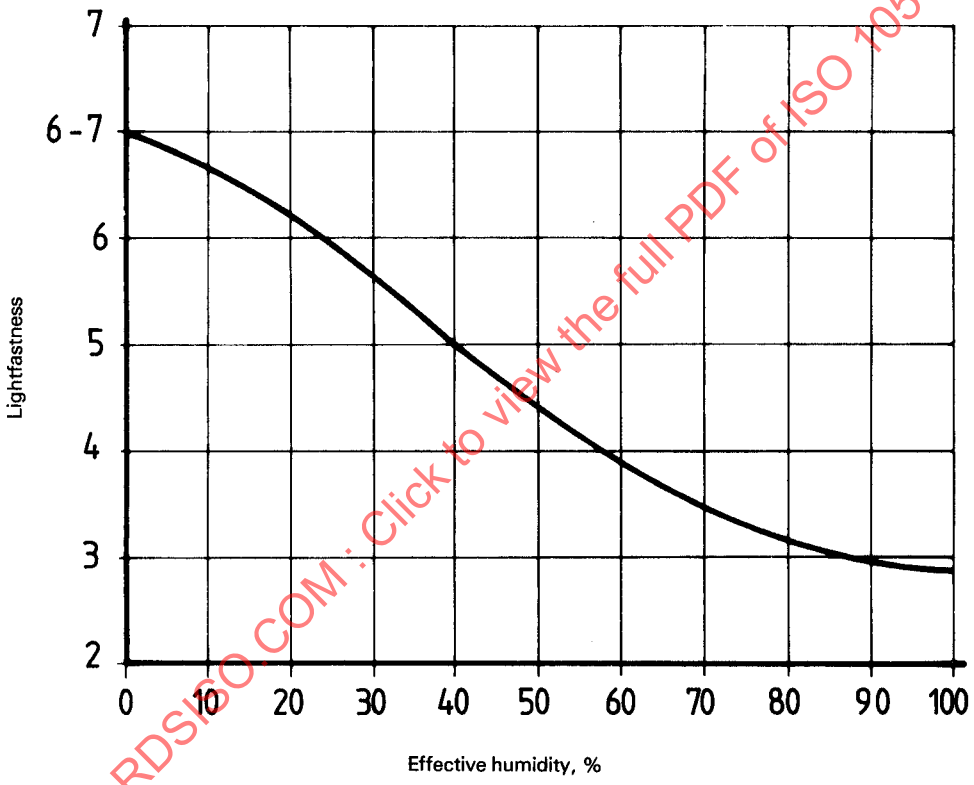


Figure 3 — Mean values obtained from exposures described in 9.4.2

Annex A

Apparatus for determining lightfastness with air-cooled xenon arc lamps

(This annex forms part of the Standard)

A.1 Description and conditions of use

A.1.1 The test apparatus (see clause A.2) is equipped with an air-cooled xenon arc lamp as the source of radiation. There are two different models of the apparatus using xenon arc lamps with a wattage of 1 500 or 4 500. The xenon arc lamp is surrounded by a filter system consisting of a quartz inner cylinder, an additional lamp-chimney of seven heat filters and an outer cylinder of ultraviolet special glass. With this filtering device the requirements given in 4.2.1 are satisfied.

A.1.2 The space between the xenon arc lamp and the filtering device is cooled by a current of air. This cooling air should be discharged in the open.

A.1.3 The decrease in intensity of the air-cooled xenon arc lamps due to ageing is small. After 1 500 h of use, the radiation flux has dropped to approximately 90 % (see TRUBIROHA. Irradiance, temperature and humidity in artificial weathering devices. International symposium *The weathering of plastics and rubber*, London, 1976-06-08 and 09) and replacement of the lamps is recommended.

The change in the transmission properties of the heat filter due to ageing can be eliminated almost entirely by replacing the oldest filter in rotation after 500 h.

A.1.4 Slot in specimen holders are mounted on a revolving rack and at a given distance in circular fashion around the vertical lamp unit. The rack rotates at 5 min^{-1}. After each revolution, the sample holders are turned 180° about their longitudinal axis.

The surface area of specimen radiated at any one time is 450 cm^2 in the case of the test apparatus with a 1 500 W xenon arc lamp and 1 800 cm^2 with a 4 500 W xenon arc lamp.

A.1.5 An air current generated with a blower is directed through the test chamber and over the surface of the sample. In the case of the apparatus with a 1 500 W xenon arc lamp, the test chamber is air conditioned by adding moisture to the air via spray jets, whilst in the case of the apparatus with a 4 500 W xenon arc lamp, water is atomized very finely via an aerosol device and added to the air current. Measurement and control of the relative humidity in the test chamber is carried out by a contact hygrometer.

A.1.6 The exposure conditions for the effective moisture laid down in present specifications are achieved in the test apparatus by regulating the relative humidity of the air within certain values, which are given in the instructions for using the apparatus.

The test chamber temperature and black panel temperature can be influenced by appropriately throttling the air supply. In the case of the apparatus with a 4 500 W xenon arc lamp, it is possible, by connecting to a heating and/or cooling device, to control the test chamber temperature over a wide range.

A.2 Notes

A.2.1 Air-cooled xenon arc lamps are available from

W.C. Heraeus GmbH
Produktbereich Original Hanau
Heraeusstrasse 12-14
D-6450 Hanau 1
Germany, F.R.

A.2.2 Other apparatus giving identical results may be used.

Annex B

Apparatus for determining lightfastness with water-cooled xenon arc lamps

(This annex forms part of the Standard.)

B.1 Description and conditions of use

B.1.1 The test apparatus (see clause B.3) employed utilizes a long-arc water-cooled xenon arc lamp as the source of irradiance. While all of the xenon arc lamps employed are of the same general type, different size lamps operated in different wattage ranges are employed in several sizes and types of apparatus. In each of the various models of exposure apparatus the diameter of the specimen rack, size and wattages of the lamps are varied so that when exposed in standard holders the irradiance at the face of the specimen is appropriate.

B.1.2 The xenon arc lamp used consists of a xenon burner tube, inner filter glass, outer filter glass and the necessary hardware. For colour fastness tests, a borosilicate (Corning 7740) inner and soda lime (Kimble R6) outer filter glass are used so that the irradiation at the specimen has a lower spectral cut-off at approximately that of window glass. Other filter glasses are available with different spectral cut-offs but these should not be used for lightfastness tests. Because of transmission changes (solarization) outer filter glasses should be discarded after 2 000 h of use and inner filter glasses discarded after 400 h of use. Xenon burners, because of a drop off of intensity with continued use, should be discarded when they no longer will produce adequate fading in 25 h of exposure.

B.1.3 All xenon arc exposure apparatus is equipped with suitable starters, reactance transformers and indicating and control equipment for either manually or automatically controlling the wattage of the lamp. In manually controlled units, the wattage of the lamp may require periodic adjustment to maintain adequate fading in 20 ± 5 h of operation.

B.1.4 To prevent contamination and minimize the formation of deposits on the burner tube and filter glasses, distilled or deionized water is circulated through the lamp assembly at an approximate minimum flow rate of 378,5 l/h, and is polished by the use of a mixed bed deionizer just ahead of the lamp. The recirculated lamp water is cooled without contaminating it by the use of a heat exchange unit employing either tap water or refrigeration as the heat transfer medium.

B.2 Temperature and humidity control

B.2.1 Accurate, close control of testing temperature, because of the sensitivity to temperature of some fabrics, is extremely important in tests made by this procedure. The temperature is measured and controlled on the basis of a black panel thermometer, which is mounted on the revolving specimen rack so that its face is in the same relative position and subjected to the same influences as the test specimens.

The black panel thermometer consists of a 20-gauge stainless steel panel 7 cm × 14,9 cm to which is mechanically fastened either a stainless steel bimetallic dial type thermometer or a stainless steel resistance thermometer element. The sensitive portion of both are centred on the panel both from top to bottom and side to side. The face of the panel is finished with a black enamel having high absorption of light.

B.2.2 The exposure apparatus is enclosed in an insulated cabinet to minimize the effects of variation in room temperature. A ventilating system provides a constant volume of air through the test chamber and over the test specimens. The temperature of the air is automatically controlled by circulating warm air from the test chamber mixed with cooler room air. Moisture in the amount required to maintain the specified relative humidity of the exit air from the test chamber as measured by wet and dry bulb temperatures may be added to the air stream as it passes through the air conditioning chamber in the base of the instrument.

B.2.3 A cylindrical vertical or inclined frame or rack supporting the specimen holders is rotated at 1 min^{-1} around the lamp which is centred in the specimen rack so that the effective arc is centered both horizontally and vertically in its relationship to the exposure area of the sample holders (see clause B.1).

B.2.4 Apparatus for use in this method is equipped with a countdown time unit for controlling the length of exposure. Some apparatus is also equipped with control equipment for turning the arc lamp on and off to produce predetermined exposures of light and darkness each at a controlled temperature and relative humidity.

B.3 Note

Water-cooled xenon arc lamps are available from

Atlas Electric Devices Co.,
4114 North Ravenswood Avenue,
Chicago 13,
Illinois,
IL 60613,
USA.

Annex C

Long life system air-cooled and water-cooled xenon arc lamps

(This annex forms part of the Standard.)

C.1 Description and conditions of use

C.1.1 The test apparatus (see clause C.2) is equipped with a long life system air-cooled or water-cooled xenon arc lamp as the source of radiation. There are three different models of the apparatus using air-cooled xenon arc lamps with a wattage of 1 500, 2 500 or 4 500 W and two different models of the apparatus using water-cooled xenon arc lamps with a wattage of 2 500 or 6 000 W.

C.1.2 The air-cooled xenon arc lamp is surrounded by a filter system consisting of an outer cylinder of ultraviolet special glass and a lamp-chimney of six heat filters. The water-cooled xenon arc lamp employs an inner Pyrex filter and an outer clear glass filter.

C.1.3 After each revolution of the rack, the sample holders are turned 180° about their longitudinal axis, or always face the xenon arc lamp for the air-cooled 1 500 W type. The sample holders always face the xenon arc lamp for air-cooled 2 500 W and 6 000 W types.

C.2 Note

The long life system air-cooled and water-cooled xenon arc lamps are available from

Suga Test Instruments Co. Ltd.
4-14 Shinjuku 5-chōme
Shinjuku-ku
Tōkyō
Japan.

B03 Colour fastness to weathering : Outdoor exposure

1 SCOPE AND FIELD OF APPLICATION

This method is intended for determining the resistance of the colour of textiles of all kinds except loose fibres to the action of weather as determined by outdoor exposure.

2 PRINCIPLE

2.1 Specimens of the textile are exposed under specified conditions in the open air without any protection from weathering. At the same time and in the same place, eight dyed wool standards are exposed to daylight but are protected from rain, snow, etc. by a sheet of glass. The fastness is assessed by comparing the change in colour of the specimen with that of the standards.

2.2 The wide variations in conditions under which outdoor exposures are usually carried out make it desirable to make replicate exposures starting at different times of the year. The most reliable indication of weathering fastness is obtained by taking the mean of the assessment of several exposures.

3 REFERENCES

ISO 105 :

Section A01, *General principles of testing.*

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

Section B01, *Colour fastness to light : Daylight.*

Section C01, *Colour fastness to washing : Test 1.*

4 STANDARDS AND APPARATUS

4.1 Standards

The standards used in this test are those specified in sections A01 and A02, and sub-clause 4.1.1 of section B01.

4.2 Apparatus

4.2.1 Exposure rack for specimens, facing due south in the Northern hemisphere, due 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 will not fall on the exposed textiles and constructed so that the specimens or the cloth on which the specimens are sewn (see 5.1) is firmly held. There shall be free circulation of the air behind the mounted specimens.

4.2.2 Exposure rack for standards, oriented as in 4.2.1 but designed to take mounted sets of light fastness standards, the racks being covered with glass having a transmission of at least 90 % between 380 and 750 nm, falling to 0 % between 310 and 320 nm.

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

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

5 TEST SPECIMEN

5.1 If the textile to be tested is fabric, use two specimens each measuring at least 10 cm × 4 cm. The specimens can be attached directly to the exposure rack (see 6.1) or sewn along each side on to a piece of scoured, undyed cloth made of hydrophobic fibre such as polyester or acrylic.

5.2 If the textile to be tested is yarn, knit or weave it into fabric and treat it as described in 5.1.

Loose fibres are not suitable for weathering tests.

5.3 Reference samples identical to those to be tested are required for comparison with the specimens during weathering.

5.4 Mount strips of light fastness standards on cardboard and cover the middle one-third as described in sub-clause 6.1 of section B01.

6 PROCEDURE

6.1 Procedure common to methods 1 and 2

Firmly attach to the exposure rack (see 4.2.1) the specimens or the cloth to which the specimens have been sewn. Place the mounted and partially covered standards on the glass-covered rack (see 4.2.2). Expose the specimens and standards simultaneously, 24 h per day, for such times as are necessary to evaluate the weathering fastness, using either method 1 or method 2 (see 6.2 and 6.3).

6.2 Method 1

6.2.1 This method is considered most satisfactory and is mandatory 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. It is therefore impracticable when a large number of specimens have to be tested concurrently; in such cases, method 2 (see 6.3) shall be used.

6.2.2 Expose the specimens and the standards under the conditions described in 6.1 until the contrast between the exposed specimens and a portion of the original fabric is equal to grade 3 on the grey scale. Remove one of the specimens and cover the left-hand one-third of the standards with an additional opaque cover.

6.2.3 Continue the exposure until the contrast between the remaining specimen and a portion of the original fabric is equal to grade 2 on the grey scale. If Standard 7 fades to a contrast equal to grade 4 on the grey scale before the contrast between the specimen and a portion of the original fabric is equal to grade 2 on the grey scale, the exposure may be concluded at this stage and the remaining specimen and the standards removed.

6.2.4 Wash both specimens, and a portion of the original fabric, and prepare them for assessment (see 6.4 and 6.5).

6.2.5 Assess the weathering fastness in accordance with the method given in 7.1 to 7.3.

6.3 Method 2

6.3.1 This method should be used when the number of specimens to be tested simultaneously is so large that method 1 is impracticable. The basic feature of this method is the control of the exposure period by inspection of the *standards*, which allows a number of specimens differing in weathering fastness to be tested against only one set of standards, thus conserving supplies of the latter.

6.3.2 Expose the specimens and the standards under the conditions described in 6.1 until the contrast between the exposed and unexposed portions of Standard 6 is equal to grade 4 on the grey scale. At this stage remove one specimen from each pair and cover the left-hand one-third of the standards with an additional opaque cover.

6.3.3 Continue the exposure until the contrast between the fully exposed and unexposed portions of Standard 7 is equal to grade 4 on the grey scale. Remove the remaining specimens and the standards.

6.3.4 Wash and dry the exposed specimens and a portion of the original fabric from each specimen and prepare them for assessment (see 6.4 and 6.5).

6.3.5 Assess the weathering fastness of each specimen in accordance with the method given in 7.1 to 7.3.

6.4 Wash the exposed specimens and a portion of the original fabric measuring at least 10 cm × 4 cm (in the absence of adjacent fabrics) under the conditions specified in section C01.

6.5 Trim and mount the washed specimens, one on each side of the washed original fabric which has been trimmed to the same size and shape as the specimens. The specimen exposed for the shorter length of time shall be mounted on the left.

7 ASSESSMENT OF WEATHERING FASTNESS

7.1 Assess the magnitude of the contrast between the specimen exposed for the *shorter* time and the original fabric in terms of the contrasts produced on the standards exposed for the same period : the assessment is the number of the standard showing the contrast closest to that of the specimen. If the specimen shows changes in colour approximately half-way between two standards, an appropriate half-rating, for example 3-4, shall be given.

7.2 Assess the magnitude of the contrast between the specimen exposed for the *longer* time and the original fabric in terms of the contrasts produced in the standards exposed for the same period : the assessment is the number of the standard showing the contrast closest to that of the specimen. If the specimen shows changes approximately half-way between two standards, an appropriate half-rating, for example 5-6, shall be given.

7.3 If specimens larger than the standards are exposed, a mask of a neutral grey colour approximately midway between that illustrating grade 1 and that illustrating grade 2 of the grey scale for assessing change in colour (approximately Munsell N5) shall be used in assessment, the mask covering the surplus area of the specimens and leaving an area equal to that of the standards open for comparative evaluation.

8 TEST REPORT

Report the numerical rating for weathering fastness : outdoor exposure. If the two assessments (see 7.1 and 7.2) are different, report only the lower. In addition, report the place of exposure and the time of the year.

9 NOTE

The term "change in colour" includes not only true "fading", i.e. destruction of dyes, but also changes in hue, depth, brightness or any combination of these characteristics of colour. If the difference in colour is a change of hue or brightness, this can be indicated by adding abbreviations, as follows, to the numerical colour fastness rating :

Bl = bluer
Y = yellower
G = greener
R = redder
D = duller
Br = brighter

If the change in hue is accompanied by a change in depth, this can also be indicated :

W = weaker
Str = stronger