

INTERNATIONAL STANDARD

ISO
105-B02

Third edition
1988-05-01



INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
ORGANISATION INTERNATIONALE DE NORMALISATION
МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Textiles — Tests for colour fastness —

Part B02:

Colour fastness to artificial light: Xenon arc fading lamp test

Textiles — Essais de solidité des teintures —

Partie B02: Solidité des teintures à la lumière artificielle. Lampe à arc au xénon

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Reference number
ISO 105-B02:1988 (E)

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. Each 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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.

International Standard ISO 105-B02 was prepared by Technical Committee ISO/TC 38, *Textiles*.

This third edition cancels and replaces the second edition (included in ISO 105-B : 1984), of which it constitutes a technical revision.

ISO 105 was previously published in thirteen "parts", each designated by a letter (e.g. "Part A"), with publication dates between 1978 and 1985. Each part contained a series of "sections", each designated by the respective part letter and by a two-digit serial number (e.g. "Section A01"). These sections are now being republished as separate documents, themselves designated "parts" but retaining their earlier alphanumeric designations. A complete list of these parts is given in ISO 105-A01.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Textiles — Tests for colour fastness —

Part B02:

Colour fastness to artificial light: Xenon arc fading lamp test

1 Scope and field of application

1.1 This part of ISO 105 specifies a method 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 (D_{65}). The method is also applicable to white (bleached or optically brightened) textiles.

1.2 If there is a possibility of the sample being photochromic, then the test for photochromism shall be applied additionally (see ISO 105-B05).

1.3 This method employs two sets of Blue Wool References. The results from the two sets of references may not be identical.

NOTE — General information on colour fastness to light is given in annex C.

2 References

ISO 105, *Textiles — Tests for colour fastness —*

Part A01: General principles of testing.

Part A02: Grey scale for assessing change in colour.

Part B01: Colour fastness to light: Daylight.

Part B05: Detection and assessment of photochromism.

CIE Publication No. 51, *Method for assessing the quality of daylight simulators for colorimetry.*

3 Principle

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

For white (bleached or optically brightened) textiles the fastness is assessed by comparing the change of whiteness of the specimen with that of the references used.

4 Reference materials and apparatus

4.1 Reference materials

Two sets of Blue Wool References may be used. The two sets of references are not interchangeable.

4.1.1 References 1 to 8

Blue Wool References developed and produced in Europe are identified by the numerical designation 1 to 8. These references 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) so that each higher numbered reference is approximately twice as fast as the preceding one.

Table — Dyes for Blue Wool References 1 to 8

Reference	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, 82 Grattan Road, Bradford BD1 2JB, West Yorks., United Kingdom, and by the American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, North Carolina 27709, USA.

4.1.2 References L2 to L9

Blue Wool References developed and produced in America are identified by the letter L followed by the numerical designation 2 to 9. These eight references 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 reference is approximately twice as fast as the preceding reference.

The relationship shown in figures 1 and 2 between the two sets of Blue Wool References is a numerical rather than a performance relationship.

4.1.3 Humidity test control

The humidity test control is a red azoic dyed cotton cloth (see 9.3).

4.2 Apparatus

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

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

The distance from the surface of the specimen and that of the references to the lamp shall be the same.

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

- 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.
- Light filter**, placed between the light source and the specimens and references so that the ultra-violet 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.
- Heat filter**. The spectrum of the xenon arc contains an appreciable amount of infra-red radiation which shall be minimized by heat filters (see 9.1, A.1.1 and A.2.2).

d) **Exposure conditions**. (The light fastness ratings mentioned below are obtained with the Blue Wool References 1 to 8 only):

- Normal conditions (temperate zone): moderate effective humidity (see 9.3); light fastness of the humidity test control: 5; maximum black panel temperature: 45 °C (see 9.2).
- Extreme conditions: For testing sensitivity of specimens to different humidity during irradiation, the following extreme conditions are useful:

- low effective humidity; light fastness of the humidity test control: 6 to 7; maximum black panel temperature: 60 °C (see 9.2);
- high effective humidity; light fastness of the humidity test control: 3; maximum black panel temperature: 40 °C (see 9.2).

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

- Light source**, in a well ventilated exposure chamber.
Light sources are long-life xenon arc lamps of various sizes depending on the size of the apparatus (see B.1.1 and B.2.1).
- Light filter**. Inner and outer filter glass containing and directing 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).
- Heat filter**. Distilled or deionized water circulating through the lamp assembly between the inner and outer filter glass, cooled by passing through a heat-exchange unit (see B.1.4).
- Exposure conditions**. Black panel temperature 63 ± 1 °C (see 9.2), 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) %.

Effective humidity: low.

Light fastness of the humidity test control: 6-7.

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

4.2.3 Black panel thermometer (see 9.2).

4.2.4 Grey scale for assessing change in colour (see clause 2).

4.2.5 Colour matching lamp, complying with CIE Publication No. 51, for assessment of the change in whiteness.

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 the similar strips of the references may be mounted on one or more cards as indicated in figure 1 or figure 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 shall make close contact with the surface of the unexposed areas of the specimens and the references in order to give a sharp line of demarcation between exposed and unexposed areas but shall not compress the specimen unnecessarily. References shall be exposed on a white cardboard backing. Specimens may also be mounted on white cardboard if desired.

5.4 The specimens to be tested and the Blue Wool References shall 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 a larger pattern as against narrower references (see 7.4).

5.5 When testing pile fabrics, the references 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 for example by using pieces of cardboard as underlay. Note that covers for the unexposed portions shall avoid surface compression.

6 Procedure

6.1 Adjustment of the humidity conditions (see 4.2.1.1 and 4.2.1.2)

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, B.1.1, B.1.2, B.1.3 and B.1.4.)

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 light fastness references, 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 all remaining spaces in the specimen rack with holders containing white cardboard.

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 references 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 light fastness 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 re-adjust 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

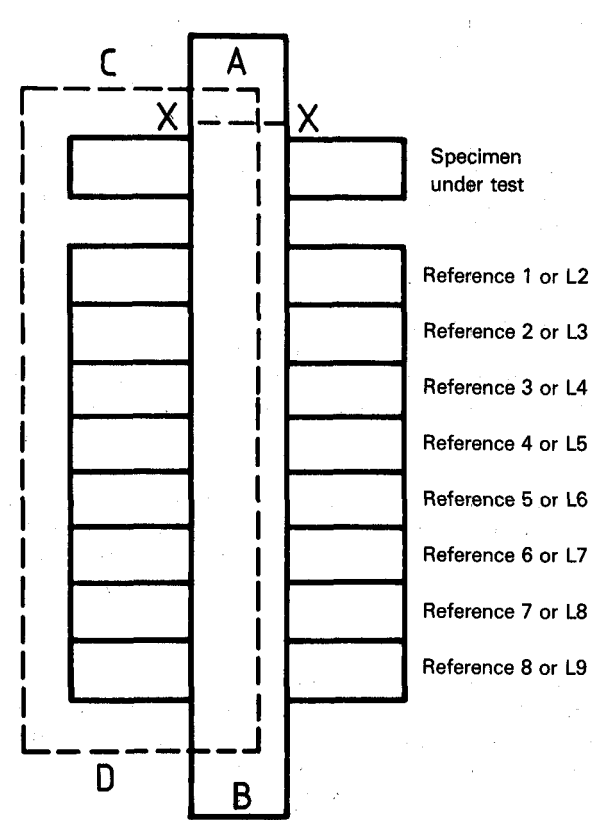
Expose the specimen (or group of specimens) and the references simultaneously, under the desired conditions, in such a manner and for such a time as is necessary to evaluate fully the light fastness of each specimen relative to that of the references, by progressively covering both the specimens and the exposed references during the test (either by method 1 or by 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 period by inspection of the specimen and therefore only one set of references is required for each specimen under test.

6.2.1.2 Arrange the specimen to be tested and the references as shown in figure 1 with an opaque cover AB across the middle one-third of the specimen and references. Expose to the xenon arc light under the conditions enumerated in 4.2.1.1 or 4.2.1.2. Follow the effect of light by removing the cover and inspecting the specimen frequently. When a change can be perceived equal to grey scale 4-5, note the number of the references showing a similar change. (This is preliminary assessment of light fastness.) At this stage attention should be given to the possibility of photochromism (see ISO 105-B05).

For all specimens except for white (bleached or optically brightened) specimens, continue the procedure as described in 6.2.1.3 to 6.2.1.5. For optically brightened textiles, continue with the procedure as described in 6.2.1.6.



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 references.

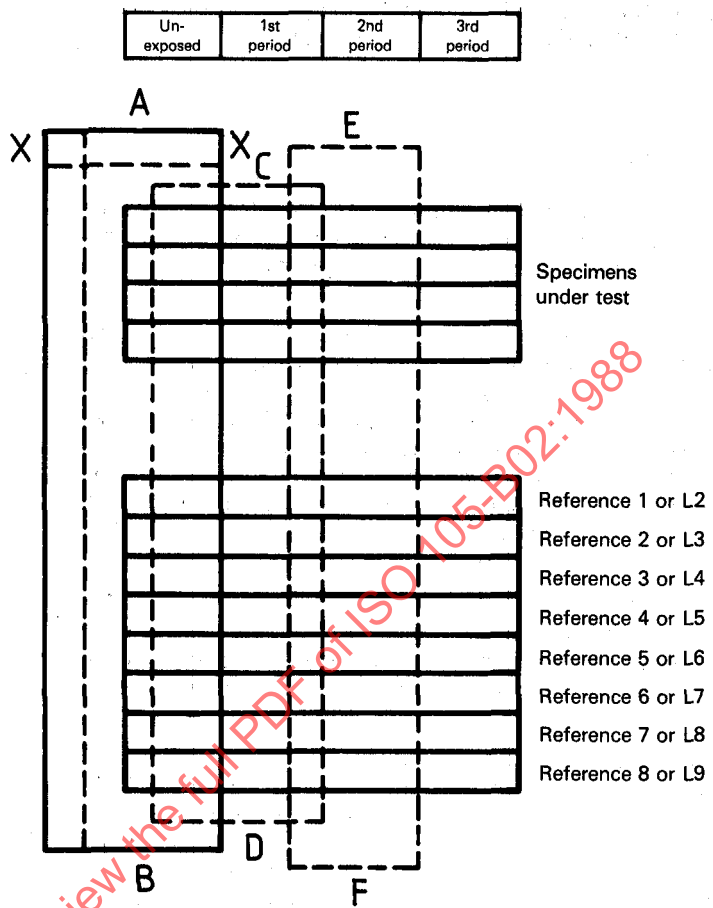
CD: Second cover.

Figure 1 — Mounting for method 1

6.2.1.3 Continue to expose until the contrast between the exposed and the unexposed portions of the specimen is equal to grey scale grade 4. Cover the left-hand one-third of the specimen and references 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 grey scale grade 3.

6.2.1.5 If Reference 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 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 L8. Assessments in the region of 7-8 or L7-L8 are made, therefore, when the contrast produced on Reference 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 references.

CD: Second cover.

EF: Third cover.

Figure 2 — Mounting for method 2

6.2.1.6 For white (bleached or optically brightened) textiles, continue to expose until the contrast between the exposed and unexposed portions of the specimen is equal to grey scale grade 4. If Reference 7 or L7 fades to a contrast equal to grey scale grade 4 before the specimen does, the exposure is terminated at this stage. Assessments in the region of 7-8 or L7-L8 are made, therefore, when the contrast produced on Reference 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 have to be tested simultaneously. The basic feature is the control of the exposure periods by inspection of the references, which allows a number of specimens differing in light fastness to be tested against a single set of references, thus conserving supplies.

6.2.2.2 Arrange the specimens to be tested and the references as shown in figure 2 with the cover AB covering one-quarter of the total length of each specimen and reference. Expose under the conditions enumerated in 4.2.1.1 or 4.2.1.2. Follow the effect of light by lifting the cover AB periodically and inspecting the references. When a change in Reference 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 References 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 ISO 105-B05).

6.2.2.3 Replace the cover AB in exactly the same position and continue to expose until a change in Reference 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 first cover, AB.

6.2.2.4 Continue to expose until a change in Reference 6 or L5 can be perceived equal to grey scale 4-5, 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 Reference 7 or L7 equal to the contrast illustrated by grey scale grade 4; or
- b) a contrast equal to grey scale grade 3 has been produced on the most resistant specimen; or
- c) for white (bleached or optically brightened) textiles, a contrast equal to grey scale grade 4 has been produced on the most resistant specimen;

NOTE — This may occur before the fading defined in 6.2.2.3 or 6.2.2.4 has taken place.

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 references 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 reference. For white (bleached or optically brightened) textiles, continue exposure until a grey scale grade 4 contrast has been produced between separate areas of the minimum reference.

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. For white (bleached or optically brightened) textiles, continue exposure until a grey scale grade 4 contrast has been produced on the reference sample.

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 of the specimen. For white (bleached or optically brightened) textiles, the final assessment in numerical ratings is based on a contrast equal to grey scale grade 4 between exposed and unexposed portions of the specimen.

7.2 Remove all the covers, thus revealing on specimens and references 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 references under suitable illumination (see ISO 105-A01, clause 13). For white (bleached or optically brightened) textiles, the use of artificial daylight produced by a colour matching lamp (4.2.5) is recommended and is necessary in cases of dispute, unless otherwise agreed. The light fastness of the specimen is the number of the reference 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 reference midway between any two consecutive references the intermediate rating, for example 3-4 or L2-L3, 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 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 light fastness 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 light fastness (see ISO 105-B05).

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

7.4 Comparison of the changes in the specimen with changes in the references 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 references in turn with a similar mask of equal aperture.

7.5 If the light fastness is equal to or higher than 4 or L3, preliminary assessment based on the contrast equal to grey scale grade 4-5 (see 6.2.1.2 and 6.2.2.2) becomes significant; if this preliminary assessment is 3 or lower or L2, it shall be included in the rating in brackets. For example, a rating of 6(3) or L5(L2) indicates that the specimen changes very slightly in the test when Reference 3 or L2 just begins to fade, but that on continuing the exposure the resistance to light is equal to that of Reference 6 or L5.

7.6 If the specimen is photochromic, the light fastness rating shall include a P bracketed with the rating obtained from the test for photochromism, for example 6(P3-4) (see ISO 105-B05).

7.7 The term "change in colour" includes change in hue, depth, brightness, or any combination of these characteristics of colour (see ISO 105-A02, sub-clause 2.6).

7.8 Exposures based on a performance reference (see 6.2.3) or together with an agreed upon reference sample (see 6.2.4) shall be 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 reference or the reference sample, the light fastness shall be classified "satisfactory"; if the specimen shows a greater change in colour than the performance reference or the reference sample, the light fastness shall be classified "unsatisfactory".

8 Test report

8.1 For method 1 or 2

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

- a) by the figure alone (when using the references designated 1 to 8); or
- b) together with the prefix L (when using the references 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 light fastness shall be followed by a P bracketed together with the grey scale rating.

8.2 For method 3 or 4

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

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

9 Notes

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

9.2 The black panel thermometer shall 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 of and in good contact with the panel. The side of the panel facing the light source shall 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 shall be thermally isolated (see also B.1.5).

9.3 Effective humidity descriptions:

9.3.1 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.

9.3.2 Quantitative

The effective humidity can be measured only by determining the light fastness 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 references 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.

When this control was exposed under the conditions specified in ISO 105-B01 in temperate zones, its light fastness was found to be, on average, 5.

9.4 Pile fabrics, such as carpets, which have fibres that may shift position, or texture which may make evaluation of small areas difficult, shall be tested with an exposed area not less than 5 cm × 4 cm and preferably larger (see 5.4).

referred to frequently in normative text in ISO 105-B06

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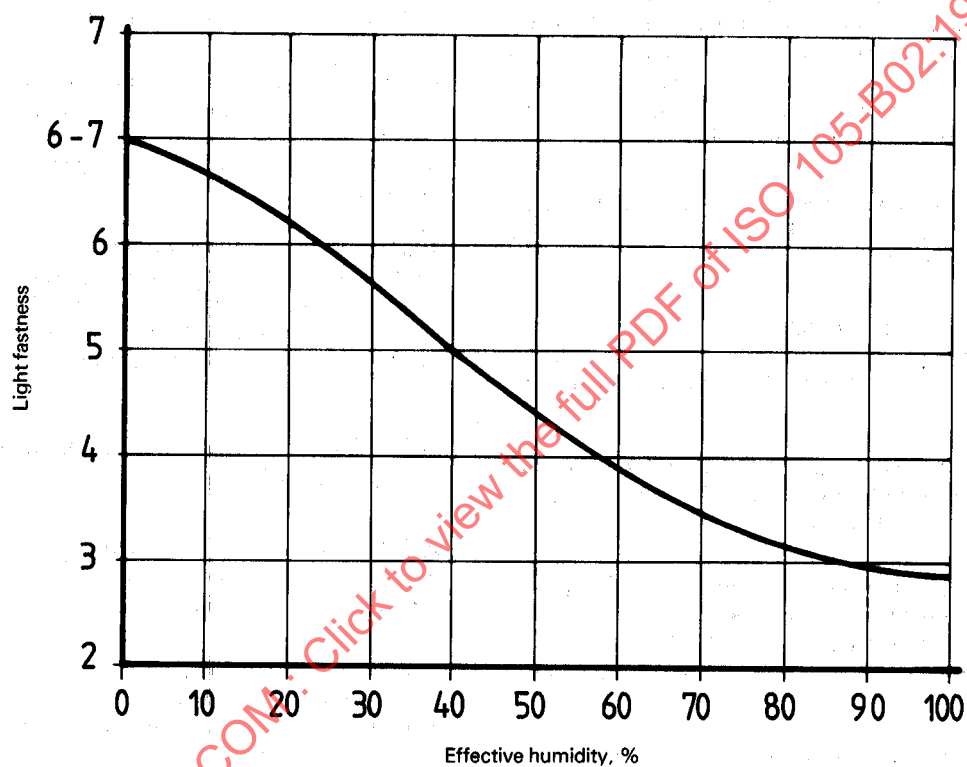


Figure 3 — Mean values obtained from exposures described in 9.3.2

Annex A

Apparatus for determining light fastness with air-cooled xenon arc lamps

(This annex forms an integral part of the standard.)

A.1 Description and conditions of use

A.1.1 The test apparatus (see also 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 W or 4 500 W. 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 ultra-violet 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 into the open.

A.1.3 The decrease in intensity of air-cooled xenon arc lamps due to ageing is small. After 1 500 h of use, the radiation flux has dropped to approximately 90 % 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 of the rack, the sample holders are turned 180° about their longitudinal axis.

The surface area of specimen radiated at any one time is 450 cm² in the case of the test apparatus with a 1 500 W xenon arc lamp and 1 800 cm² 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 or by means of an ultrasonic humidification device, 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 either by a contact hygrometer or by electronic means.

A.1.6 The exposure conditions, relative to effective humidity, laid down in the 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 Description and conditions of use of an alternative system

A.2.1 Except for the changes given in A.2.2 and A.2.3, the description and conditions of use of this apparatus are similar to those given in clause A.1.

A.2.2 There are three different models of the apparatus, with a wattage of 1 500 W, 2 500 W or 4 500 W. The xenon arc lamp is surrounded by a filter system consisting of an outer cylinder of ultra-violet special glass and a lamp-chimney of six heat filters.

A.2.3 After each revolution of the rack, the sample holders are either turned 180° about their longitudinal axis or always face the xenon arc lamp for the 1 500 W type. The sample holders always face the xenon arc lamp for the 2 500 W and 4 500 W types.

Annex B

Apparatus for determining light fastness with water-cooled xenon arc lamps

(This annex forms an integral part of the standard.)

B.1 Description and conditions of use

B.1.1 The test apparatus (see also clause B.2) employed utilizes a long-arc water-cooled xenon arc lamp as the source of radiation. 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 and the size and wattage of the lamp are chosen so that when the specimens are exposed in holders the irradiance at the face of the specimen is at the appropriate level.

B.1.2 The xenon arc lamp used consists of a xenon burner tube, an inner filter glass, an 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 light fastness 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 380 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 refrigerant as the heat-transfer medium.

B.1.5 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 in each case is centred on the panel both from top to bottom and from side to side. The face of the panel is finished with a black enamel having high absorption of light.

B.1.6 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.1.7 A cylindrical vertical or inclined frame or rack supporting the specimen holders is rotated at 1 min⁻¹ around the lamp, which is located centrally with respect to the specimen rack so that the effective arc is centred both horizontally and vertically relative to the exposure area of the sample holders.

B.1.8 Apparatus for use in this method is equipped with a timer 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 periods of light and darkness each at a controlled temperature and relative humidity.

B.2 Description and conditions of use of an alternative system

B.2.1 Except for the changes given in B.2.2 and B.2.3, the description and conditions of use of this apparatus are similar to those given in clause B.1.

B.2.2 There are two different models of the apparatus, with a wattage of 2 500 W or 6 000 W.

B.2.3 After each revolution of the rack, the sample holders are turned 180° about their longitudinal axis.