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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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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 105-B02 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 1, *Tests for coloured textiles and colorants*.

This fifth edition cancels and replaces the fourth edition (ISO 105-B02:1994), which has been technically revised. It also incorporates ISO 105-B02:1994/Amd 1:1998 and ISO 105-B02:1994/Amd 2:2000.

ISO 105 was previously published in 13 "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 alphanumeric designations. A complete list of these parts is given in ISO 105-A01.

Textiles — Tests for colour fastness —

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

1 Scope

This part of ISO 105 specifies a method intended for determining the effect on the colour of textiles of all kinds and in all forms to the action of an artificial light source representative of natural daylight (D65). The method is also applicable to white (bleached or optically brightened) textiles.

This method allows the use of two different sets of blue wool references. The results from the two different sets of references may not be identical.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 105-A01, *Textiles — Tests for colour fastness — Part A01: General principles of testing*

ISO 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

ISO 105-A05, *Textiles — Tests for colour fastness — Part A05: Instrumental assessment of change of colour for determination of grey scale rating*

ISO 105-B01:1994, *Textiles — Tests for colour fastness — Part B01: Colour fastness to light: Daylight*

ISO 105-B05, *Textiles — Tests for colour fastness — Part B05: Detection and assessment of photochromism*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 9370, *Plastics — Instrumental determination of radiant exposure in weathering tests — General guidance and basic test method*

CIE[1)] Publication No. 51, *Method for assessing the quality of daylight simulators for colorimetry*

3 Principle

A specimen of the textile to be tested is exposed to artificial light under controlled conditions, together with a set of reference materials. The colour fastness is assessed by comparing the change in colour of the test specimen with that of the reference materials used.

NOTE General information on colour fastness to light is given in Annex D.

4 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

1) Commission Internationale de l'Éclairage, CIE Central Bureau, Kegelgasse 27, A-1030, Vienna, Austria www.cie.co.at.

4.1
test specimen
portions of the textile to be tested and which are representative parts of the item to be tested

Note 1 to entry: This is used for comparison between the exposed and the original (untested) state.

4.2
reference specimen
portion of a reference material that is to be exposed simultaneously with the test specimen

Note 1 to entry: Multiple reference specimens may be required to determine the test results.

4.3
blue wool reference material
one of a series of blue dyed wool textile materials with a known reaction to light

4.4
test chamber
area within the apparatus capable of meeting and maintaining the requirements for temperature, light and humidity

4.5
chamber relative humidity
ratio of the actual water vapour pressure in the test chamber to the saturation water vapour pressure of water at the same temperature, expressed as a percentage

4.6
effective humidity
combination of air and surface temperatures and air relative humidity which governs the moisture content at the surface of the test specimen during exposure

4.7
humidity-test control fabric
a red azoic dyed cotton fabric of known sensitivity to humidity and light

Note 1 to entry: This red azoic dyed fabric is used as a reference material to ensure that the effective humidity requirements are met.

4.8
photochromism
change in colour of a substrate after brief exposure to light, which is substantially returned to its original shade after storage in the dark

4.9
flip-flop mode
mode of operation whereby the specimen holders revolve around the central light source and on alternate rotations the specimen holders are automatically rotated 180° about their vertical axis so that the test specimens face towards the light source only every alternate revolution

5 Materials and apparatus

5.1 Reference materials

5.1.1 General

Either of two sets of blue wool reference may be used. The colour fastness ratings mentioned in this part of ISO 105 are obtained by comparison with either blue wool references 1 to 8 (*preferred* in Europe) or blue wool references L2 to L9 (*preferred* in America). The results from the two sets of references are not interchangeable. Information on the relationship between the two sets of blue wool reference materials can be found in ISO 105-B01:1994, 4.1.

5.1.2 Blue wool reference materials 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 materials dyed with the dyes listed in Table 1. They range from 1 (very low colour fastness to light) to 8 (very high colour fastness to light) so that each higher-numbered reference is approximately twice as fast as the preceding one.

Table 1 — Dyes for blue wool references 1 to 8

Reference	**Dye** (Colour Index designation)[a]
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 Solubilised Vat Blue 5
8	CI Solubilised Vat Blue 8

[a] The Colour Index (fourth edition) is published by the Society of Dyers and Colourists, P.O. Box 244, Perkin House, 82 Grattan Road, Bradford BD1 2JB, West Yorkshire, UK, and by the American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709-2215, USA.

5.1.3 Blue wool reference materials 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 prepared by blending varying proportions of wool dyed with CI Mordant Blue 1 (Colour Index, fourth edition, CI Constitution Number 43830) and wool dyed with CI Solubilised Vat Blue 8 (Colour Index, fourth edition, CI Constitution Number 73801), so that each higher-numbered reference is approximately twice as fast as the preceding reference.

Data in Annex C are presented to illustrate the relationship of each of the blue wool references on exposure to fixed amounts of radiant energy.

5.1.4 Humidity-test control

The effective humidity can **only** be measured by determining the colour fastness to light of a specific humidity-test control fabric (see 4.7).

5.2 Laboratory exposure devices

5.2.1 Light source

5.2.1.1 The exposure device shall provide for placement of specimens and any designated sensing devices in positions that allow uniform irradiance from the light source

NOTE The spectral irradiance produced in an artificial accelerated light and weathering device is very important. Ideally, the relative spectral irradiance produced by the device should be a very close match to that of solar radiation, especially in the short wavelength UV region. Annex A provides information about important benchmark solar spectra that can be used for comparing the spectral irradiance produced in the artificial accelerated exposure to that for solar radiation.

5.2.1.2 Exposure devices shall be designed such that the variation in irradiance at any location in the area used for specimen exposure shall not exceed ± 10 % of the mean. Procedures for measuring irradiance uniformity are found in Annex B.

NOTE The irradiance uniformity in exposure devices depends on several factors. The configuration of the lamp with respect to the specimens on exposure, including the differences in distance between the lamp(s) and the samples can affect uniformity of exposure. Deposits which can develop on the optical system and chamber walls, and the type and number of specimens being exposed, can also have an affect on uniformity of exposure.

5.2.1.3 Periodic repositioning of the test specimens in the test chamber is recommended to ensure the most consistent results.

5.2.1.4 Follow the apparatus manufacturer's instructions for lamp and filter replacement.

5.2.1.4.1 Direct radiation from xenon burners contains considerable amounts of short-wavelength ultraviolet radiation not present in daylight. Optical filters shall be fitted to minimize short-wavelength light (less than 310 nm) in accordance with the requirements in Annex A. The xenon arc, when appropriately filtered, produces radiation with a spectral power distribution that is a good simulation of average daylight throughout the UV and visible region.

5.2.1.4.2 Infrared radiation levels can be attenuated by use of filters to allow some control of the sample temperature.

5.2.1.5 It is preferred that the apparatus should be fitted with an irradiance sensing system. The irradiance sensor (if fitted) shall be mounted so that it receives the same radiation as the specimen surface. If it is not positioned in the specimen plane, it shall be calibrated for irradiance at the specimen distance.

5.2.1.5.1 The irradiance sensor (if fitted) shall be capable of measuring irradiance preferably in a specific wavelength range (e.g. 300 nm to 400 nm), or in a narrow bandpass centred around a single wavelength (e.g. 420 nm) and shall be calibrated at the wavelength range or single wavelength, as appropriate. The measured wavelength or wavelength range shall be reported.

5.2.1.5.2 Where irradiance control is available, the irradiance shall be controlled at (42 ± 2) W/m^2 in the wavelength range 300 nm to 400 nm or (1,10 ± 0.02) W/(m^2.nm) at the wavelength 420 nm.

5.2.1.5.3 The irradiance sensor (if fitted) shall be calibrated in the emission region of the light source used. Calibration shall be checked in accordance with the radiation-measuring and instrument manufacturer's instructions with compliance to ISO 9370.

5.2.1.6 The light source shall consist of a xenon arc lamp of correlated colour temperature 5500 K to 6500 K, the size of which will depend on the type of apparatus used.

5.2.1.7 The apparatus shall be fitted with a light filter placed between the light source and the specimens so that the ultraviolet spectrum is steadily reduced. Annex A provides the transmission requirements for the filter system used.

5.2.1.8 The apparatus shall be fitted with a heat filter placed between the light source and the specimens so that the amount of infrared (IR) radiation contained in the xenon arc spectrum is steadily reduced.

5.2.2 Temperature (See A.3)

One of two types of black-coated temperature sensor shall be used, either a *black-standard thermometer* or a *black-panel thermometer* (for more detail see A.3.) and the thermometer shall be mounted in the same plane and orientation as the test specimen(s).

Note The preferred thermometer is the Black Standard Thermometer (BST).

5.2.3 Humidity

The presence of moisture can have a significant effect in accelerated laboratory exposure tests. The apparatus shall have the means for providing and controlling moisture to specimens by humidification of the chamber air. The quality of the water used to create the effective humidity shall be a minimum of Grade 3 in accordance with ISO 3696.

5.2.4 Covers

Covers shall be made from thin opaque material, for example high-grade steel, thin sheet aluminium or cardboard covered with aluminium foil, for partial covering of samples and references. The opaque material shall neither react with the test specimens nor the test conditions and shall not itself produce any change in colour of either the test specimen or the reference materials.

5.2.5 Colour matching lamps, in accordance with CIE Publication No. 51.

5.2.6 Assessment cabinet, complying with ISO 105-A01.

5.2.7 Sample mounting card, free of optical or fluorescent brightening agent.

5.2.8 Assessment mask, complying with ISO 105-A01. In order to obtain reliable test results using ISO 105-A02, the test specimen(s) shall be masked with a material that is identical in colour to the sleeve that is used to mask the grey scale (5.2.9).

5.2.9 Grey scale for assessing change in colour, complying with ISO 105-A02.

6 Preparation of test specimens

6.1 The size of the test specimen will depend on the number of specimens to be tested and on the shape and dimensions of the specimen holders supplied with the apparatus.

Attention is drawn to the guidelines given in E.4.

6.2 The specimen may be a strip of cloth, yarn wound close together on a sample mounting card (5.2.7) 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.

6.3 To facilitate handling, the test specimen(s) to be tested and similar strips of the references may be mounted on one or more cards as indicated in Figures 2, 3, 4 or 5.

6.4 The covers (5.2.4) 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.

6.5 The specimens to be tested and the blue wool references shall be of equal size and shape in order to avoid errors in assessment due to overrating the visual contrast between exposed and unexposed parts on a larger pattern as against a narrower reference.

6.6 When testing specimens of appreciable thickness, the references shall be arranged so that they are the same distance from the light source as the upper surface of the test specimens. Covers for the unexposed portions shall avoid surface compression.

Textiles of appreciable thickness 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 50 mm × 40 mm and preferably larger.

7 Exposure conditions

To simulate different environments testing can be carried out under different conditions (see Table 2). The type of conditions should be agreed between parties. The chosen conditions shall be reported.

Table 2 — Exposure conditions

	Exposure Cycle A1	Exposure Cycle A2	Exposure Cycle A3	Exposure Cycle B
Condition:	Normal	Extreme low humidity	Extreme high humidity	—
Climatic condition replicated	Temperate zone	Dry	Semi-tropical	—
Blue wool references	Series 1 to 8			Series L2 to L9
Black Standard Temperature[a]	(47 ± 3) °C	(62 ± 3) °C	(42 ± 3) °C	(65 ± 3) °C
Black Panel Temperature[a]	(45 ± 3) °C	(60 ± 3) °C	(40 ± 3) °C	(63 ± 3) °C
Effective humidity (see 8.2)[b]	Approximately 40 % effective humidity. (Note: This is typically achieved when blue wool reference 5 exhibits a contrast equal to grey scale grade 4)	Less than 15 % effective humidity. (Note: This is typically achieved when blue wool reference 6 exhibits a contrast equal to grey scale grade 3-4)	Approximately 85 % effective humidity. (Note: This is typically achieved when blue wool reference 3 exhibits a contrast equal to grey scale grade 4)	Low (Colour fastness of humidity-test control: L6 to L7)
Relative humidity	As determined by effective humidity requirement			(30 ± 5) %
Irradiance[c]	Where irradiance control is available, the irradiance shall be controlled at (42 ± 2) W/m^2 in the wavelength range 300 nm to 400 nm or (1,10 ± 0,02) W/(m^2·nm) at the wavelength 420 nm			

[a] Air chamber temperature control should not be used as air chamber temperature is a different value from Black Standard Temperature and Black panel temperature.

[b] Effective humidity is based on an assessment of the blue wool references after the humidity-test control fabric has been exposed to give a contrast equal to grey scale grade 4 (8.2.5).

Once a contrast equal to grey scale grade 4 on the exposed humidity-test control fabric has been achieved, effective humidity is based on assessment.

[c] The broadband (300 to 400 nm) and narrowband (420 nm) irradiance control values are based on traditional settings and should not be implied as equivalent in all models of test equipment. Consult with the instrument manufacturer for the equivalent irradiance in other controlling wavelengths or bandpasses.

8 Procedure

8.1 Apparatus set-up

8.1.1 Check that the apparatus is in good running order and set up in accordance with the manufacturer's guidelines.

8.1.2 Fill all unused specimen holders with a non-reflective material such as white card stock. For machines employing flip-flop mode, both faces in the unused specimen holders shall be used.

8.1.3 The black panel thermometer (which has an open back) or black standard thermometer (which has an insulated back) shall be positioned in the same plane and orientation as the test specimens.

8.2 Adjustment of the effective humidity (see Clause 7 and Annex E)

8.2.1 When using test conditions in which the use of effective humidity is specified, do not rely on machine readings of relative humidity in the test chamber. The correct adjustment of the effective humidity (for tests using blue wool references 1 to 8) is **critical** to obtaining valid results. Figure 1 shows the relationship between effective humidity and the light fastness of the humidity-test control fabric.

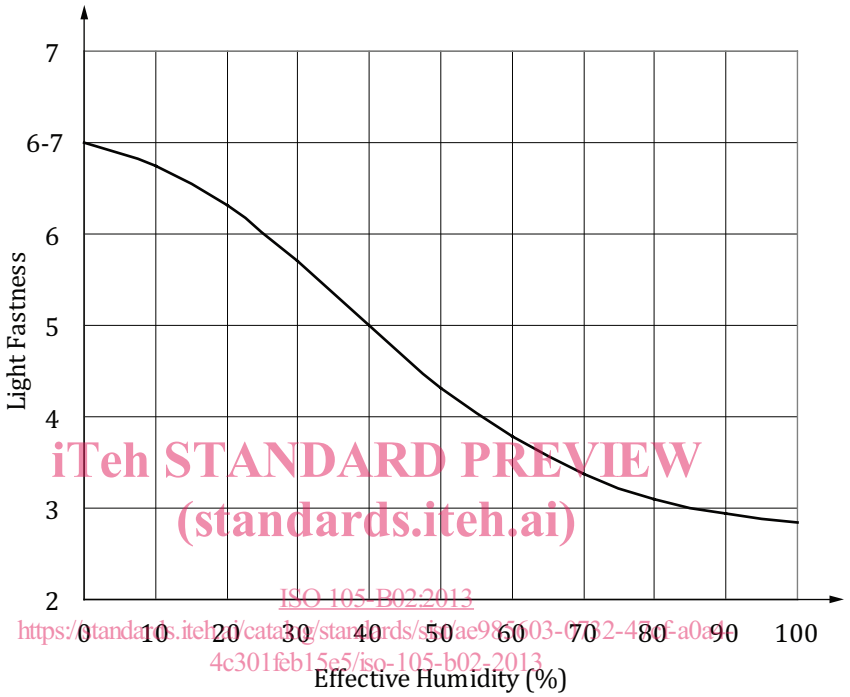


Figure 1 — Mean values obtained from humidity-test control exposures

8.2.2 For the required exposure conditions, determine from Table 2 the required effective humidity then using Figure 1, identify the equivalent light fastness (expressed using blue wool reference series 1 to 8) required to be exhibited by the humidity-test control fabric. (For example, for normal conditions the effective humidity required is 40 % which is equivalent to a light fastness of the humidity-test control fabric of blue wool reference 5).

8.2.3 Place a portion of the humidity-test control fabric (5.1.4) together with the relevant blue wool references (5.1.2 or 5.1.3) on a card. Each of the reference materials (blue wool references and humidity-test control) shall measure not less than 45 mm × 10 mm.

8.2.4 Mask the card prepared in 8.2.3 using an appropriate cover (5.2.4) such that each exposed and unexposed area is not less than 10 mm × 8 mm. Place the masked card in the test chamber.

8.2.5 Expose the masked card until the contrast between the exposed and unexposed portions of the humidity-test control fabric (4.7) is equal to grade 4 on the grey scale (5.2.9).

8.2.6 When the conditions in 8.2.5 have been achieved assess the contrast between the exposed and unexposed portions of the relevant blue wool reference as referenced in Table 2. The contrast should be equal to that specified for the appropriate exposure conditions (see Table 2).

8.2.7 If the necessary contrast in 8.2.5 is not achieved, adjust the controls on the apparatus to give the required selected exposure conditions and repeat 8.2.3 to 8.2.6 using fresh reference materials.

8.3 Exposure methods

8.3.1 General

There are five separate methods given, each of which produce different amounts of information. The user should select the most appropriate method for their application.

For Methods 1 to 4, assessment of fading of test specimens or reference samples is **critical** to obtaining valid results. It is not sufficient to rely on exposure time (hours) to determine the end point of the various stages of each method. For Method 5, the end point is determined by a specified dosage of irradiance and intermediate assessment of fading may not be required.

Attention is drawn to the guidelines given in the annexes in relation to selection of apparatus, test method, and to the recommendations on good testing practice for different types of textile materials.

8.3.2 Method 1

8.3.2.1 This method is considered the most informative 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 one set of blue wool references is required for each specimen under test. This method is especially suitable for determination of colour fastness to light for test specimens of unknown performance.

For this method, opaque covers (5.2.4) masking approximately one-third and two-thirds of the test specimens and blue wool references are required.

8.3.2.2 Arrange the test specimen and the blue wool references on the sample mounting card (5.2.7) in accordance with Clause 6 and as shown in Figure 2. Cover the middle one-third of the test card using an opaque cover (5.2.4) ABCD.

NOTE The blue wool references and test specimen need not necessarily be mounted on the same card and where applicable test cards should be mounted in suitable specimen holders for the apparatus used.

8.3.2.3 Place the masked card in the test chamber and expose the masked card to light under the selected exposure conditions in Table 2.

8.3.2.4 Follow the effect of exposure by periodically removing the masked card from the test chamber, removing the opaque cover (5.2.4) and inspecting the test specimen by comparison with a grey scale (5.2.9). When a change in blue wool reference 2 equal to grey scale grade 3 (or L2 equal to grey scale grade 4) is achieved, inspect the test specimens and assess their colour fastness by comparing any change that has occurred on the test specimens with the changes that have occurred in blue wool references 1, 2 and 3 or L2. This is a preliminary assessment of colour fastness. If it is required to retain visual evidence of the colour change at this preliminary assessment stage terminate this test at this point and repeat the test using fresh test specimens and blue wool references. There is no need to repeat the preliminary assessment on the new specimen.

8.3.2.5 Continue to expose the test specimen and blue wool references until the contrast between the exposed and unexposed portions of the test specimen is equal to grey scale grade 4 (5.2.9). Remove the masked card from the test chamber. At this stage attention should be given to the possibility of photochromism (see ISO 105-B05).

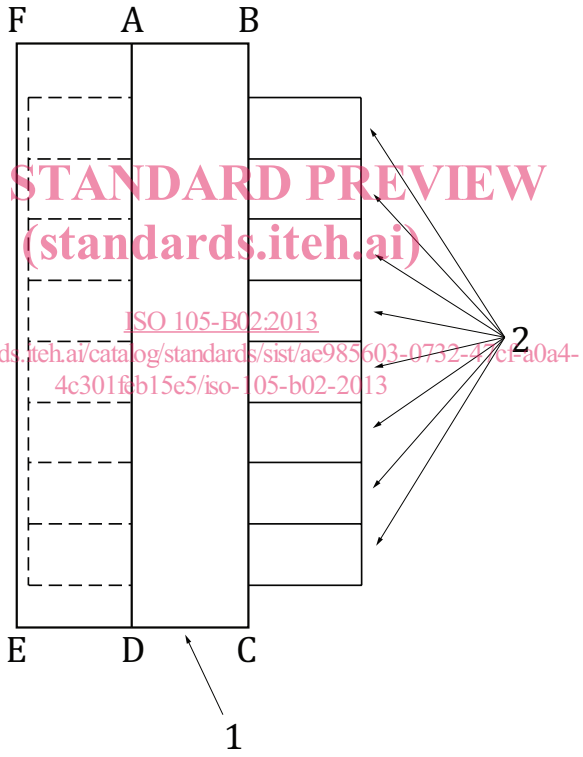
8.3.2.6 For white (bleached or optically brightened) textiles, terminate the exposure of the test specimen at this point and carry out the assessment as described in Clause 9.

8.3.2.7 For all other textiles, apply an opaque cover (5.2.4) FBCE (see Figure 2) such that only the right-hand one-third of the test card(s) remains exposed.

NOTE It is preferable to replace cover ABCD with a new cover FBCE in order to avoid undesired effects from light seepage. If an additional cover is used to cover ADEF then the additional cover should be of sufficient dimensions to overlap the existing cover and prevent any light seepage along the line A–D

8.3.2.8 Replace the masked card in the test chamber and continue to expose the test specimens and blue wool references until the contrast between the exposed and unexposed portions of the test specimen is equal to grey scale grade 3 (5.2.9).

8.3.2.9 If blue wool reference 7 (or L7) fades to a contrast equal to grey scale grade 4 (5.2.9) before the test specimen does, the exposure is terminated at this stage. When a specimen has a colour 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 colour fastness is 8 (or L8). Assessments in the region of 7–8 (or L7–L8) are made, therefore, when the contrast produced on blue wool 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.



Key

1 masked area

2 blue wool references 1 to 8 or L2 to L9 and/or test specimens

Figure 2 — —Mounting of test specimens and blue wool references for Method 1

8.3.3 Method 2

Flat plane exposure devices (see B.2) cannot be used for method 2 until an ISO ring trial is concluded.