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FOREWORD

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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.

International Standard ISO 105/VI (originally draft No. 2182) was drawn up by Technical Committee ISO/TC 38, *Textiles.*

It was approved in July 1971 by the Member Bodies of the following countries :

Australia	Hungary	Portugal
Brazil	India	Romania
Bulgaria	Ireland	South Africa, Rep. of
Canada	Israel	Spain
Czechoslovakia	Japan	Sweden
Denmark	Korea, Rep. of	Switzerland
Egypt, Arab Rep. of	Netherlands (Parts 1,3,4,5,6)	Thailand
Finland (Parts 3,4,5,6)	New Zealand	United Kingdom
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Germany	Poland	U.S.S.R.

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Belgium
Finland (Parts 1,2)
France (Part 2)
Netherlands (Part 2)

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Tests for colour fastness of textiles — Sixth series

PART 1
COLOUR FASTNESS TO DRY CLEANING

1 SCOPE AND FIELD OF APPLICATION

This method is intended for assessing the resistance of the colour of textiles of all kinds and in all forms to dry cleaning.

This method is not suitable for the evaluation of the durability of textile finishes, nor is it intended for use in evaluating the resistance of colours to spot and stain removal procedures used by the drycleaner (see 7.1 and 7.2).

2 PRINCIPLE

A specimen of the textile in contact with cotton fabric and non-corrodible steel disks is agitated in perchloroethylene (see 7.2 and 7.3), then squeezed or centrifuged, and dried in hot air. The change of colour in the specimen is assessed with the standard grey scales.

3 APPARATUS AND REAGENTS

3.1 Appropriate mechanical apparatus for shaking the containers (see 7.4 and 7.5)

3.2 Glass or stainless-steel containers, of approximately 550 ml capacity, which can be closed using solvent-resistant gaskets.

3.3 Non-corrodible steel disks, 30 ± 2 mm × 3 ± 0,5 mm, smooth and free from rough edges, of mass 20 ± 2 g.

3.4 Undyed cotton "twill" cloth, of mass 270 ± 70 g/m^2, free from finishes and cut into samples 120 mm × 120 mm.

3.5 Perchloroethylene, which must be stored over anhydrous sodium carbonate to neutralize any hydrochloric acid formed.

3.6 Grey scale, for assessing change in colour[1].

4 SPECIMEN

4.1 If the textile to be tested is fabric, use a specimen 100 mm × 40 mm.

4.2 If the textile to be tested is yarn, knit it into fabric and use a specimen 100 mm × 40 mm.

5 PROCEDURE

5.1 Prepare a bag with inside dimensions of 100 mm × 100 mm using the undyed cotton twill cloth (see 3.4) by sewing together two squares of this cloth around three sides. Place the specimen and 12 steel disks (see 3.3) inside the bag. Close the bag by any convenient means.

5.2 Place the bag containing the specimen and the steel disks in the container and add 200 ml of perchloroethylene at 30 ± 2 °C. Treat the specimen for 30 min at 30 ± 2 °C in the specified equipment (see 7.4).

5.3 Remove the bag from the container, withdraw the specimen, place it between absorbent paper or cloth and squeeze or centrifuge to remove surplus solvent. Dry the specimen freely suspended in hot air at a temperature of 60 ± 5 °C.

1) See ISO/R 105/I, Parts 1 and 2.

5.4 Assess the change in colour of the specimen with the standard grey scale.

6 REPORT

Report the numerical rating for the change in colour of the test specimen.

7 NOTES

7.1 This test covers colour fastness to dry cleaning only; commercial dry cleaning practice normally involves other operations such as water spotting, solvent spotting, steam pressing, etc., for which other standard test methods are available if the full "dry cleanability" of the textile is to be assessed.

7.2 The presence of absorbed water in either the fabric or dry cleaning solution, or the presence of a detergent and water in the dry cleaning solution, has not been found to be a critical factor in assessing colour fastness. This test gives results which correlate satisfactorily with those obtained in commercial dry cleaning.

7.3 In recording fastness to dry cleaning, perchloroethylene must be used, but the results obtained with other solvents may be recorded in addition if this information is required.

7.4 A suitable mechanical device consists of a water bath containing a rotatable shaft which supports, radially, glass or stainless steel containers (75 ± 5 mm diameter X 125 ± 10 mm high) of approximately 550 ± 50 ml capacity, the bottom of the containers being 45 ± 10 mm from the centre of the shaft. The shaft container assembly is rotated at a speed of 40 ± 2 rev/min. The temperature of the water bath is thermostatically controlled to maintain the test solvent at 30 ± 2 °C.

7.5 Other mechanical devices may be used for the test provided the results are identical to those obtained with apparatus conforming to the description given in 7.4.

PART 2
COLOUR FASTNESS TO LIGHT : DAYLIGHT (L-TEST)[1)]

1 SCOPE AND FIELD OF APPLICATION

This method is intended for assessing the resistance of the colour of textiles of all kinds and in all forms to the action of daylight on the basis of light fastness standards, or a mutually agreed-upon standard sample.

The method may be used for rating colour fastness of dyes by applying the dye to textiles by a specified procedure and at a specified depth of colour, and testing the dyed textiles.

If there is a possibility of the sample being photochromic, then the test for photochromism shall be applied.

NOTE – Since differences in outdoor fading may be caused by the influence of atmospheric contaminants, gas and ozone fading standards may be exposed simultaneously with the blue wool cloth light fastness standards.

2 PRINCIPLE

A specimen of the textile together with the standard, or standards, is exposed to daylight continuously, 24 h a day, under prescribed conditions including protection from rain. The fastness is assessed by comparing the fading of the textile with that of the standards.

3 STANDARDS AND EQUIPMENT

3.1 Standards

3.1.1 *Grey scale,* for assessing change in colour[2)].

3.1.2 *Blue wool cloth light fastness standards* (see 7.1).

3.2 Equipment

3.2.1 *Exposure rack*

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 latter are firmly held. There shall be free circulation of air 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 glass employed shall be a good grade of clear, flat, drawn sheet glass (see 7.2). It shall be cleaned at least once each day and replaced after one year of use.

The minimum permissible distance between the glass and the specimens is 76 mm. In order to minimize shadows from the sides of the cabinet 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.

3.2.2 *Cardboard* (see 7.3).

3.2.3 *Instruments* suitable for determining maximum, minimum and average daily temperatures and humidities (see 7.4).

4 SPECIMEN

Use an area of textile measuring not less than 30 mm × 60 mm, with the exposed area not less than 30 mm × 30 mm adjacent to an unexposed area having the same dimensions. 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 PROCEDURE

5.1 For exposures employing standards

5.1.1 Mount a set of standards and the specimens to be tested on cardboard as shown in Figure 1 with an opaque cover (see 3.2.2) across one-half of each of the standards and specimens. Where a large number of specimens are to be exposed, they may be mounted in the same manner on as many additional cards as are necessary. As an aid in rating, each standard and specimen to be compared shall have the same area.

1) This test is mostly used in the countries of North America. It differs from the test in ISO/R 105/I, Part 11 – *Colour fastness to light : Daylight*, in several respects but especially in the standard Blue Scale (L2 – L9). The light fastness ratings of the two tests are not directly comparable.

2) See ISO/R 105/I, Parts 1 and 2.

5.1.2 Expose the specimens and standards simultaneously to daylight under the conditions described above. The specimens and standards remain in the cabinet 24 h per day and are removed only for inspection.

5.1.3 Follow the effect of daylight by frequently removing the cover and inspecting the standards. Continue the exposure until the change in colour (see 7.5) of the exposed and covered portions of the standard L2 equals the contrast between the two grey colour chips illustrating Grade 4 on the grey scale. When this occurs, uncover all specimens and remove from the exposure cabinet Standard L2 and those specimens which have a difference in colour between the exposed and covered portions equal to or greater than Grade 4 of the grey scale.

5.1.4 Re-cover the remaining standards and test specimens and continue the exposure until the change in colour of the exposed and covered portions of the next higher numbered standard equals Grade 4 on the grey scale. Uncover all specimens and remove the standard and those specimens which at that time show a difference in colour between the exposed and covered portions equal to or greater than Grade 4 on the grey scale.

5.1.5 Continue the exposure, removing successively higher numbered standards and specimens which show equal or greater colour change whenever the standard shows a difference in colour of Grade 4 on the grey scale until all standards and/or specimens exhibit a difference in colour between the exposed and unexposed portions equal to Grade 4 on the grey scale.

5.2 For exposures employing a standard sample

5.2.1 Mount the standard sample and one or more test specimens on cardboard as shown in Figure 2 with an opaque cover across one-half of each of the standard and test specimens. Where a large number of specimens are to be exposed they may be mounted in the same manner on as many additional cards as are necessary.

5.2.2 Follow the effect of daylight by frequently removing the cover and inspecting the standard. Continue the exposure until the standard sample is equal to the contrast between the two grey colour chips illustrating Grade 4 on the grey scale. Remove both the standard and the specimens.

5.3 Additional recommended practices applicable to all of the above procedures

5.3.1 Alternatively, when desired, a second set of standards and specimens may be exposed until a grey scale Grade 3 colour change is obtained between the covered portion and the exposed area.

5.3.2 Compare the covered portion of each exposed standard and specimen with a corresponding piece which has not been in the exposure cabinet. A difference in colour between original material and the covered portion of the exposed specimen indicates that the textile has been affected by some agent other than light, such as heat or a reactive gas in the atmosphere. Note this fact in the report of the test.

5.3.3 In many cases, high humidity in combination with atmospheric contaminants have been found to produce colour changes as great as those produced by light. It is therefore recommended that a duplicate set of test specimens and standards mounted on cardboard, but not masked, be exposed simultaneously in another cabinet of the same type as used in the daylight exposures but with the glass covered with an opaque material so that the light is excluded. Since there is a combined effect of light, temperature, humidity and atmospheric contaminants, it cannot be assumed that a comparison between specimens exposed in the covered cabinet, and in the uncovered cabinet under glass, will permit separating the effects produced by light only. However, a comparison of the two sets of specimens with a piece of the original textile which has not been in an exposure cabinet will indicate whether a material is sensitive to moisture and atmospheric contaminants and may help to explain why differences occur in the relationship between the specimens and the standards in daylight exposures made at different times and at different locations.

5.4 Classification based on light fastness standards

5.4.1 Classify the colour fastness to light of a dyestuff by classifying the fastness of dyeings made from it and indicate the kind of fibre to which it was applied, the method of application, strength of dyeing, and nature of finishing treatments, if any.

5.4.2 Where different classifications are obtained at the grey scale Grades 4 and 3 levels of colour change, report the average of these as the light fastness classification.

5.4.3 Classify the colour fastness to light according to the following :

Less colour change than standard	Equal but no greater change in colour than standard	More colour change than standard	The light fastness is class
–	–	L2	1
–	L2	L3	2
L2	–	L3	2-3
–	L3	L4	3
L3	–	L4	3-4
–	L4	L5	4
L4	–	L5	4-5
–	L5	L6	5
L5	–	L6	5-6
–	L6	L7	6
L6	–	L7	6-7
–	L7	L8	7
L7	–	L8	7-8
–	L8	L9	8
L8	–	L9	8-9
–	L9	–	9

5.5 Classification based upon a standard sample

When the agreed-upon standard sample and the specimen have been exposed together until the standard has a change in colour equal to Grade 4 on the grey scale, the fastness is classified "satisfactory" if the specimen shows no greater change in colour than the standard; "unsatisfactory" if the specimen has a greater change in colour than the standard.

6 REPORT

6.1 Report the numerical ratings for the change in colour for the test specimen, the method employed and the date and location of the exposure.

6.2 When available, include in the report the following :

6.2.1 Daily air temperatures and relative humidities.

6.2.2 Any differences observed between covered portions of the test specimen and the original sample which has not been placed in the cabinet.

6.2.3 The amount of colour change in terms of the grey scale produced by simultaneous exposure in a covered cabinet when compared with the original sample which has not been placed in the cabinet.

6.2.4 Any variation from the specified conditions.

7 NOTES

7.1 The eight Light Fastness Standards[1)] are specially prepared by blending varying proportions of wool dyed with C.I. Mordant Blue 1 (C.I. 43830), and wool dyed with C.I. Solubilized Vat Blue 8 (C.I. 73801), so that each higher numbered standard is approximately twice as fast as the preceding standard. 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 the two primaries and the blending proportions are intentionally omitted.

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

7.2 The glass shall be 2,0 to 2,5 mm thick, free from bubbles or other imperfections, with a lower cut-off at approximately 310 nm with an increase in transmisssion to approximately 90 % at 370 to 380 nm. This glass is described in the manufacturers' catalogues as transmitting a minimum of 77 % ultraviolet, 90 % Illuminant C (average daylight) at 85 % total radiation. Transmittance curves of two panels secured from dealer stock showed no transmittance below 310 nm, close to a straight-line rise to 90 % at 370 to 380 nm and 90 % transmittance in the visible region to 700 nm.

7.3 Cardboard, 41 kg*) White Index Bristol, 160 g/m²**) obtainable from stationery stores and dealers in artists' supplies. The cover must make tight contact with the specimens, and when removed temporarily, must be replaced in exactly the same position as before.

7.4 For use in measuring temperature and relative humidity of the air in the vicinity of test cabinets, any suitable indicating or recording instruments may be used. Continuous recording of temperature and relative humidity is preferable.

7.5 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 :

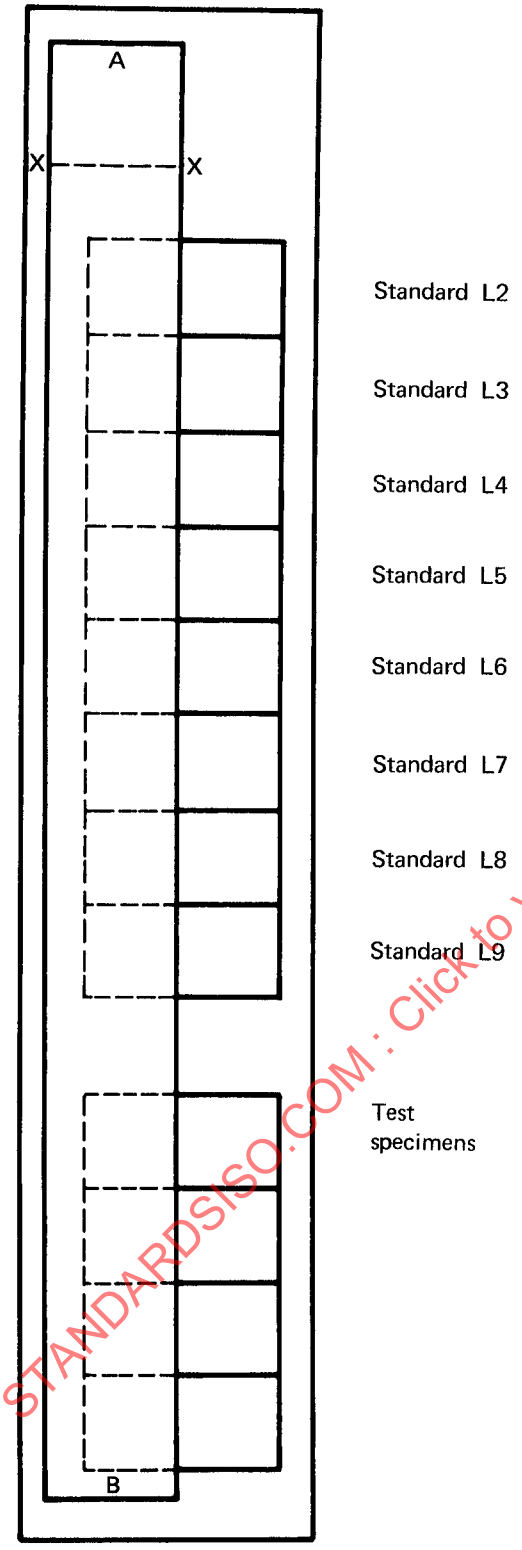
Bl. = Bluer	G = Greener	R = Redder
Y = Yellower	Br. = Brighter	D = Duller

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

W = Weaker Str. = Stronger

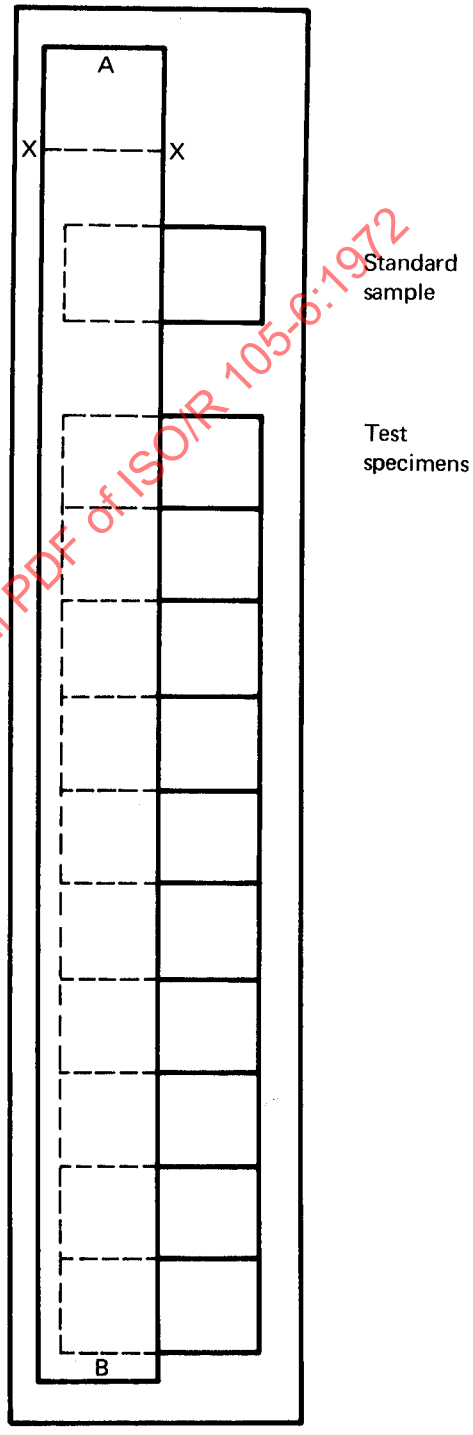
* U.S.A. designation of the mass of the board.

** Designation of the grammage in accordance with ISO/R 536, *Determination of paper substance.*



AB — Opaque cover hinged at X ... X so that it can be lifted and returned to the same place over the standards and specimens

FIGURE 1



AB — Opaque cover hinged at X ... X so that it can be lifted and returned to the same place over the standards and specimens

FIGURE 2

PART 3
COLOUR FASTNESS TO WEATHERING : OUTDOOR EXPOSURE

1 SCOPE AND FIELD OF APPLICATION

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

If there is a possibility of the sample being photochromic, then the test for photochromism shall be applied.

NOTE – Since differences in outdoor fading may be caused by the influence of atmospheric contaminants, gas and ozone fading standards may be exposed simultaneously with the blue wool cloth light fastness standards.

2 PRINCIPLE

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 window glass. The fastness is assessed by comparing the fading of the textile with that of the standards.

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 several exposures.

3 STANDARDS AND EQUIPMENT

3.1 Standards

The standards used in this test are those specified for the test *Colour fastness to light : Daylight*[1].

3.2 Equipment

3.2.1 *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 4.1) is firmly held. There shall be free circulation of the air behind the mounted specimens.

3.2.2 *Exposure rack for standards*

Oriented as in 3.2.1 but designed to take mounted sets of light fastness standards, the racks are covered with window glass as described in the test *Colour fastness to light : Daylight*[1].

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

3.2.4 *Grey scale* for assessing change in colour[1].

4 SPECIMEN

4.1 If the textile to be tested is fabric, two specimens each measuring at least 30 mm × 30 mm are used. The specimens can be attached directly to the exposure rack (see 5.1) or sewn along each side on to a piece of scoured, undyed cloth made of hydrophobic fibre such as polyester or acrylic.

4.2 If the textile to be tested is yarn, it shall be knitted or woven into fabric and treated as in 4.1.

Loose material is not suitable for weathering tests.

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

4.4 Mount strips of light fastness standards on cardboard and cover the middle third as described in the test *Colour fastness to light : Daylight*[1].

5 PROCEDURE

5.1 Firmly attach to the exposure rack (see 3.2.1) 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 3.2.2). 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 5.2 and 5.3).

1) See ISO/R 105/I, Parts 1, 2 and 11.

5.2 Method 1

5.2.1 This method is considered most satisfactory and shall be used in cases of dispute. It requires one set of standards for each specimen under test and is therefore impracticable when a large number of specimens have to be tested concurrently; in such cases, Method 2 (see 5.3) shall be used.

5.2.2 Expose the specimens and the standards under the conditions described in 5.1 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.

5.2.3 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.

5.2.4 Both specimens, as well as a portion of the original fabric, shall be washed and prepared for assessment (see 5.4 and 5.5).

5.2.5 Assess the weathering fastness in accordance with the instructions given in 5.6 to 5.8.

5.3 Method 2

5.3.1 This method shall be used when the number of specimens is so large that Method 1 is impracticable. It enables a large number of fabrics differing in weathering fastness to be rated against a single set of standards.

5.3.2 Expose the specimens and the standards under the conditions described in 5.1 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.

5.3.3 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.

5.3.4 Wash and dry the exposed specimens and a portion of the original fabric from each specimen and prepare them for assessment (see 5.4 and 5.5).

5.3.5 Assess the weathering fastness of each specimen in accordance with the methods given in 5.6 to 5.8.

1) See ISO/R 105/IV, Part 8.

5.4 Wash the exposed specimens and a portion of the original fabric measuring at least 30 mm × 30 mm (in the absence of undyed cloth) under the conditions specified in the test *Colour fastness to washing : Test 1*[1].

5.5 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.

5.6 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.

5.7 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, 3-4, shall be given.

5.8 If specimens larger than the standards are exposed, a mask of a neutral grey colour (approximately Munsell N/6) shall be used in the assessment, the mask covering the surplus area of the specimens and leaving an area equal to that of the standards open for comparative evaluation.

6 REPORT

Report the numerical rating for weathering fastness : outdoor exposure. If the two assessments (see 5.6 and 5.7) are different, report only the lower. In addition, report the place of exposure and the time of the year.

7 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	G = Greener	R = Redder
Y = Yellower	Br. = Brighter	D = Duller

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

W = Weaker Str. = Stronger

PART 4
COLOUR FASTNESS TO WEATHERING : XENON ARC LAMP TEST

1 SCOPE AND FIELD OF APPLICATION

This method is intended for assessing the resistance of the colour of textiles of all kinds except loose fibres to the action of weather as simulated by exposure in a cabinet equipped with a xenon arc lamp.

If there is a possibility of the sample being photochromic then the test for photochromism shall be applied.

2 PRINCIPLE

Specimens of the textile are exposed under specified conditions to light from a xenon arc lamp and to a water spray. At the same time, eight dyed wool standards are exposed to light but are protected from water spray by a sheet of window glass. The fastness is assessed by comparing the fading of the textile with that of the standards.

3 STANDARDS AND EQUIPMENT

3.1 Standards

The standards used in this test are those specified for the test *Colour fastness to light : Daylight*[1].

3.2 Equipment

3.2.1 *Light source*

Xenon arc lamp of correlated colour temperature 5 500 to 6 500 K.

3.2.2 *Filter*, placed between the light source and the specimens and standards so that the ultraviolet spectrum is steadily reduced. A special kind of glass is used that possesses a transparency of 90 % at 370 to 380 nm and is opaque between 300 and 320 nm.

3.2.3 *Heat filters*

The spectrum of the xenon arc contains an appreciable amount of infrared radiation which can be minimized by heat filters. The temperature conditions (see 7.2.3) can then be satisfied. The filters shall be cleaned regularly to avoid undesirable reduction in light intensity.

3.2.4 *Exposure chamber*, well ventilated, for exposure of the specimens and standards. The air temperature in the chamber shall be measured with a thermometer whose bulb is shielded from the direct radiation of the arc (see 7.2.2).

The variation of the light intensity over the area covered by specimens and standards shall not exceed 20 %.

3.2.4.1 Exposure of specimens

The specimens shall be subjected to an accurately adjusted, reproducible weathering cycle (see 7.2.4).

For spraying the specimens, only completely ion-free water shall be used. It should be especially noted that this water must not contain any metal salts. Tubing, tanks and spray jets must be of corrosion resistant material.

The specimens shall be mounted on a suitable holder (see 7.2.5). The specimens shall completely enclose the holder and the side to be assessed shall not be in contact with metal plates, other specimens, or backing fabric.

3.2.4.2 Exposure of light fastness standards

The dyed wool standards (see 3.1) shall be protected from the water spray by a shield of window glass whilst being exposed to light in the same xenon arc lamp as the specimens. The window-glass used shall have a transparency of approximately 90 % at 370 to 380 nm and be completely opaque below 300 to 320 nm. The glass case shall be well ventilated, i.e. there shall be an opening on the top and another on the bottom to allow a good circulation of air.

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

3.2.6 *Grey scale*, for assessing change in colour[1].

4 SPECIMEN

4.1 If the textile to be tested is fabric, prepare two specimens each of a suitable size mounted on holders or other equipment which will fit the weathering test equipment.

1) See ISO/R 105/I, Parts 1, 2 and 11.

4.2 If the textile to be tested is yarn, it shall be knitted or woven into fabric and treated as in 4.1.

Loose material is not suitable for weathering tests.

4.3 Mount strips of light fastness standards on cardboard and cover one third of it as described in the test *Colour fastness to light : Daylight*[1].

5 PROCEDURE

5.1 Place the specimens mounted on the holders (see 4.1 and 7.2.5) in the frame and expose them to weathering for 24 h each day following either Method 1 or Method 2 (see 5.7 and 5.8).

5.2 At the same time, expose the mounted and partially covered blue scale standards (see 3.1 and 4.3) to light in the glass case in the same frame (see 3.2.4.2 and 7.2.6).

5.3 Only one side of the specimen shall be exposed to weathering and light.

5.4 Whilst the specimens are drying, the air in the test chamber must not be moistened.

5.5 The conditions of the weathering test depend on the kind of the test frame used; a detailed description of a suitable apparatus is given in 7.2.

5.6 Contrary to stipulations for the outdoor exposure test, the specimens must not be washed after the weathering test.

5.7 Method 1

5.7.1 This method is considered most satisfactory and shall be used in cases of dispute. It requires one set of standards for each specimen under test and is therefore impracticable when a large number of specimens have to be tested concurrently; in such cases, Method 2 (see 5.8) shall be used.

5.7.2 Expose the specimens and the standards under the conditions described in 5.1 to 5.5 until the contrast between the exposed specimens and portion of the original fabric is equal to Grade 3 on the grey scale. Remove one of the specimens and cover a second one-third of the standards with an additional opaque cover.

5.7.3 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.

5.7.4 Both specimens as well as a portion of the original fabric shall be prepared for assessment (see 5.10).

5.7.5 Assess the weathering fastness in accordance with the instructions given in 5.11 to 5.13.

5.8 Method 2

5.8.1 This method shall be used when the number of specimens is so large that Method 1 is impracticable. It enables a large number of fabrics differing in weathering fastness to be rated against a single set of standards.

5.8.2 Expose the specimens and the standards under the conditions described in 5.1 to 5.5 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 a second one-third of the standards with an additional opaque cover.

5.8.3 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.

5.8.4 Prepare the exposed specimens and a portion of the original fabric from each specimen for assessment (see 5.10).

5.8.5 Assess the weathering fastness of each specimen in accordance with the methods given in 5.11 to 5.13.

5.9 Before the tested specimens are mounted for assessment, they shall be dried in air at a temperature not exceeding 60 °C.

5.10 Trim and mount the tested specimens measuring at least 15 mm × 30 mm, one on each side of a portion of the 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.

5.11 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 halfway between two standards, an appropriate half-rating, for example 3-4, shall be given.

1) See ISO/R 105/I, Part 11,

5.12 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 in colour approximately halfway between two standards an appropriate half-rating, for example 3-4, shall be given.

5.13 If specimens larger than the standards are exposed, a mask of a neutral grey colour (approximately Munsell N/6) shall be used in the assessment, the mask covering the surplus area of the specimens, and leaving an area equal to that of the standards open for comparative evaluation.

6 REPORT

Report the numerical rating for weathering fastness : xenon lamp. If the two assessments (see 5.11 and 5.12) are different, report only the lower. In addition, report the model of the apparatus used for the test.

7 NOTES

7.1 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	G = Greener	R = Redder
Y = Yellower	Br. = Brighter	D = Duller

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

W = Weaker Str. = Stronger

7.2 Test conditions for Xenotest 150[1], Xenotest 450[1] and other suitable apparatus

7.2.1 The Xenotest 150 and Xenotest 450 are suitable for tests for assessing colour fastness of dyed and printed textiles to weathering.

7.2.2 The temperature in the test chamber (see 3.2.4) shall not exceed 40 °C during the drying period.

7.2.3 The temperature of the black panel which is measured in the same position and under the same illumination as the specimens shall not exceed that of the test chamber by more than 20 °C at the maximum drying period (black panel temperature, see *Colour fastness to artificial light : Xenon arc lamp test*[2]).

7.2.4 The specimens shall be exposed in rotating holders to the following weathering cycle :

Duration of spraying : 1 min (rain period)
Duration of drying : 29 min (drying period)

7.2.5 The holders supplied by Quarzlampen-GmbH., Hanau, may be used[3].

7.2.6 A case to protect the standards of the blue scale is manufactured by Quarzlampen-GmbH. and is suitable for the test[4].

1) Made by Quartzlampen-GmbH., Hanau/Main, Germany.

2) See ISO/R 105/V, Part 2.

3) See *Textil-Rundschau*, 18, (1963), 2, 76, photo 2, left.

4) Ibid, photo 1.

PART 5
COLOUR FASTNESS TO NITROGEN OXIDES

1 SCOPE AND FIELD OF APPLICATION

This method is intended for assessing the resistance of the colour of textiles of all kinds and in all forms to the action of nitrogen oxides produced during combustion of gas, coal, oil, etc., and when air is passed over heated filaments.

Two tests differing in severity are provided; one or both of them may be used depending on the requirement.

2 PRINCIPLE

Specimens of textiles are exposed to nitrogen oxides in a closed container until either one or three subsequent test-control specimens exposed simultaneously with the test specimens have changed colour to a predetermined extent. The change in colour of the specimen is assessed with the standard grey scale.

3 APPARATUS AND REAGENTS

3.1 Exposure chamber (see 8.3).

3.2 Nitric oxide, from a commercially supplied cylinder or a generator (see 8.4). Nitric oxide and nitrogen oxides are toxic. The maximum concentration in a working room must not exceed 5 parts per million.

3.3 Sulphuric acid, containing 1 100 g of H_2SO_4 ($d = 1{,}603$) per litre.

3.4 Saturated solution of sodium nitrite ($NaNO_2$) in distilled water.

3.5 Dilute solution of sodium hydroxide (approximately 100 g of NaOH per litre).

3.6 Urea solution, containing 10 g of $NH_2.CO.NH_2$ per litre, buffered at pH 7 by the addition of 0,4 g of sodium dihydrogen orthophosphate ($NaH_2PO_4.2H_2O$) and 2,5 g of disodium hydrogen orthophosphate ($Na_2HPO_4.12H_2O$) and 0,1 g or less of a rapid wetting surface-active agent, for example, sodium dioctyl sulphosuccinate.

3.7 Test control (see 8.1).

3.8 Standard of fading (see 8.2).

3.9 Syringe, for injection (see 8.5).

3.10 Undyed cloth of the same kind of fibres as the specimen.

3.11 Grey scale, for assessing change in colour[1].

3.12 Means for providing the standard atmosphere[2] specified in section 4.

4 CONDITIONING AND TESTING ATMOSPHERE

The standard atmosphere for testing textiles[2], i.e. a relative humidity of 65 ± 2 % and temperature of 20 ± 2 °C, shall be used for conditioning and testing.

5 SPECIMEN

5.1 If the textile to be tested is fabric, use a specimen 100 mm × 40 mm.

5.2 If the textile to be tested is yarn, knit it into fabric and use a piece 100 mm × 40 mm or wind it closely round a piece of cardboard 100 mm × 40 mm to form a layer having only the thickness of the yarn.

5.3 If the textile to be tested is loose fibre, comb and compress enough of it to form a sheet 100 mm × 40 mm and sew the sheet on a piece of cotton cloth to support the fibre.

5.4 Cut a specimen 100 mm × 40 mm of the test control dyeing (see 3.7) and cut specimens 100 mm × 40 mm of the undyed cloth (see 3.10).

6 PROCEDURE

6.1 Mount each specimen by fastening the shorter side to a radial arm of the frame of the apparatus (see 8.3 and Figure 1) by means of an adhesive or clips. When an adhesive is used, this must be allowed to dry properly.

6.2 Up to 12 specimens, each 100 mm × 40 mm, may be mounted in this way for one test. If fewer specimens are to be tested, fill up with cuttings of undyed fabric of the same kind to the total number of 12. The test control specimen is fastened to the test control holder. Condition the test specimens and control for at least 12 h in the atmosphere specified in section 4.

1) See ISO/R 105/I, Parts 1 and 2.

2) See ISO/R 139, *Standard atmospheres for conditioning and testing textiles.*

6.3 Place the frame with the specimens inside the glass cylinder and then place the bell-jar on top, put the holder with the test control specimen through the top plug hole at the side and adjust the propeller as described in 8.3.

6.4 Adjust the speed of rotation of the propeller to 200 to 300 rev/min and shield the apparatus from bright light.

6.5 Inject 0,65 ml of nitric oxide for each litre of exposure chamber capacity into the bell-jar (see 8.4).

6.6 Testing

6.6.1 *Mild test*

Observe the test control specimen and when it has faded to the extent shown by the standard of fading (see 8.2), lift the bell-jar immediately and plunge the specimens and the test control specimen into the buffered urea solution (see 3.6). Immerse a portion of the original textile in the buffered urea solution. Follow the procedure described in 6.7 to 6.9.

6.6.2 *Severe test*

In cases where the mild test does not show the effect of nitrogen oxides in actual practice, it is desirable to submit specimens which are unchanged on completion of the mild test to an extended exposure. In such cases, a fresh specimen is exposed for a period as determined by three subsequent exposures of test control specimens, each until it has faded to the extent shown by the standard of fading (see 8.2). In order to maintain the concentration of nitrogen oxides in the exposure chamber, inject an additional 0,2 ml of nitric oxide for each litre of exposure chamber capacity after each replacement of test control. Lift the bell-jar immediately and plunge the specimens into the buffered urea solution after the third test control has changed to the extent shown by the standard of fading. Also plunge each test control specimen into the urea solution immediately after it has been taken out. Follow the procedure described in 6.7 to 6.9.

6.7 After immersion in the buffered urea solution for 5 min, squeeze, rinse and dry the specimens and the test control specimen in air at a temperature not exceeding 60 °C.

6.8 Assess the change in colour of the specimen against the portion of the original textile which has been treated with buffered urea solution, with the grey scale.

6.9 The test shall be conducted in the standard atmosphere for testing as specified in section 4. If no conditioning room is available in which the complete test can be carried out, the specimen may be conditioned in the standard atmosphere in a suitable apparatus and tested at room temperature. In this case, conditioned air (20 °C, 65 % relative humidity) has to be aspirated through the chamber for 15 min before introducing the nitrogen oxide. The conditioned air can be provided by passing air through a wash bottle containing a saturated solution of ammonium nitrate (NH_4NO_3) in contact with the solid phase at 20 °C. The inlet and outlet are closed during the test.

7 REPORT

Report the numerical rating for the change in colour of the specimen and state which procedure (mild or severe) has been used.

8 NOTES

8.1 Test control

Secondary cellulose acetate is uniformly dyed in an open width dyeing machine with 0,4 % (on mass of fabric) Celliton Blue FFRN (Colour Index Disperse Blue 3) in a dye-bath containing 1 g/l of a neutral non-ionic dispersing agent at a liquor ratio of 10:1.

The dyeing begins at 40 °C and the temperature is raised to 80 °C within 30 min. The dyeing is continued for a further 60 min. The fabric is rinsed in cold water and dried.

The colour co-ordinations of this dyeing are x 0,1 988, y 0,1 904, Y 23,20 using Illuminant C.

The tolerance may be maximal 2 AN(40) units.

8.2 Standard of fading

This is a fabric of similar appearance dyed to match a faded specimen of the test control. Both the test control and the standard of fading can be obtained from the national standards bodies.

8.3 Suitable testing apparatus is shown in Figures 1 and 2 and consists of a 15 l capacity bell-jar having two plug-holes on the top and one plug-hole near the bottom. Inside the bell-jar are placed : a glass cylinder, 165 mm in diameter and 225 mm in height, standing on three supports made of inert material (for example, silicone rubber or glass), and a stainless steel frame for suspending the specimens. Through one of the top plug-holes passes a spindle bearing a stainless steel or plastics propeller, 140 mm in diameter, adjusted so that its lower edge is approximately 20 mm from the upper rim of the cylinder. A stainless steel rod is let through the other top plug-hole and holds the test control specimen. This holder is located between the glass cylinder and the bell-jar. A ground stainless steel stopper is inserted in the

bottom plug-hole and contains a screwed insert within which a silicone-rubber membrane is fitted, the gas being introduced through this membrane.

NOTE – Any other apparatus yielding the same results can also be used. Care must be taken to carry out the test under identical conditions, i.e. the ratio between number of specimens, space in the test chamber and amount of gas must always be the same.

8.4

CAUTION. The filling, emptying, dismantling and cleaning of the apparatus must be carried out with great care under an exhaust hood or out-of-doors and with the hands and eyes suitably protected against the concentrated acid.

Suitable apparatus for the generation of nitric oxide is shown in Figure 3. Nitric oxide gas is generated by slowly running a cold saturated solution of sodium nitrite from a dropping funnel with discharge tube into sulphuric acid, containing 1 100 g of H_2SO_4 per litre, contained in a double-necked glass flask of 1 000 ml capacity. The gas from either the generator or a commercial cylinder is conveyed into a triple-necked glass flask equipped with a displacement vessel (gas reservoir) after having passed over diluted sodium hydroxide solution (see 3.5) in a safety trap flask. Gas is taken from the reservoir by means of a medical syringe, the needle of which is passed through a silicone-rubber membrane which is located in a stainless steel stopper; the needle is then passed through the silicone-rubber membrane in the bottom plug-hole of the bell-jar (see 6.5). The apparatus is operated as follows.

8.4.1 *Starting up the apparatus*

Fill up the gas reservoir with water. Pour about 300 ml sulphuric acid, containing 1 100 g of H_2SO_4 per litre, into the gas generator. Pour 100 ml of saturated solution of sodium nitrite into the dropping funnel and approximately 100 ml of diluted sodium hydroxide solution into the safety trap flask. Close cock 2, open cock 1, allow nitrite solution to flow slowly and dropwise through cock 1, at the same time letting the gas formed escape through the discharge tube with cock 5 open. After about 30 s, open cocks 2, 3 and 4, and close cocks 1 and 5, fill the gas reservoir to about 75 % with gas. Re-open cock 5, and again allow the gas to escape. This procedure shall be repeated five times to ensure that the nitric oxide is free of air.

8.4.2 *Continuous operation*

After the gas reservoir has been filled and emptied five times, it shall be filled with gas to only 50 % of its capacity, whereupon cock 3 is closed, while cocks 4 and 5 are left open in order to prevent excess pressure in the generator. The gas may now be taken. Further gas is supplied to the reservoir by allowing a few more drops of sodium nitrite solution to react. It is permissible to fill the gas reservoir up to 90 % of its capacity only when a further supply of gas is prevented by closing cock 3, but the gas generator must then be kept open to the atmosphere via cocks 1 and 2.

8.4.3 *Refilling the gas generator*

8.4.3.1 The pressure in the gas generator is released by closing cock 3 and opening cock 5, so that it can then be dismantled, cleaned and refilled.

8.4.3.2 After re-assembly and re-stocking with nitrite solution and sulphuric acid, the procedure described under 8.4.1 is repeated.

8.5 A medical syringe is best suited to the injection of the nitric oxide. For a larger exposure chamber, the gas can also be measured and transferred from the gas reservoir to the exposure chamber by means of a gas burette.