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Textiles — Tests for colour fastness — Part A: General principles

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Foreword

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NOTE — International Standard ISO 105 is presented in the form of parts. Each of these parts corresponds to a group and is split up into its different component sections. This form facilitates the replacement of existing sections by successive editions as necessary.

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Textiles — Tests for colour fastness

A01 General principles of testing

1 INTRODUCTION

1.1 This section provides general information about the methods for testing colour fastness of textiles for the guidance of users. The uses and the limitations of the methods are pointed out, several terms are defined, an outline of the form of the methods is given, and the contents of the clauses constituting the methods are discussed. Procedures common to a number of the methods are discussed briefly.

1.2 By **colour fastness** is meant the resistance of the colour of textiles to the different agencies to which textiles may be exposed during manufacture and the subsequent use. The change of colour and staining of undyed adjacent fabrics are assessed as fastness ratings. Other visible changes of the textile material under test, for example surface effects, change in gloss or shrinkage, should be considered as separate properties and reported as such. Any loose fibres from the specimen adhering to the adjacent fabrics shall be removed before assessment of staining.

1.3 The methods may be used not only for assessing colour fastness of textiles, but also for assessing colour fastness of dyes. When a method is so used, the dye is applied to the textile in specified depths of colour by stated procedures and the textile is then tested in the usual way.

1.4 For the most part, individual methods are concerned with colour fastness to a single agency, as the agencies of interest in a particular case, and the order of application, will generally vary. It is recognized that experience and future developments in practice may justify procedures in which two or more agencies are combined.

1.5 The conditions in the tests have been chosen to correspond closely to treatments usually employed in manufacture and to conditions of ordinary use. At the same time, they have been kept as simple and reproducible as possible. As it cannot be hoped that the tests will duplicate all the conditions under which textiles are

processed or used, the fastness ratings should be interpreted according to the particular needs of each user. They provide, however, a common basis for testing and reporting colour fastness.

2 GENERAL PRINCIPLE

A specimen of the textile to be tested, with adjacent fabric attached if staining is to be assessed, is subjected to the action of the agency in question. The extent of any change in colour and that of any staining of the adjacent fabric are assessed and expressed in fastness numbers.

3 OUTLINE OF FORM OF THE METHODS

The headings of the principal clauses of the individual test methods are as follows :

- “Introduction”
- “Scope and field of application”
- “Principle”
- “References”
- “Apparatus and reagents” (or “Standards and apparatus”)
- “Test specimen”
- “Procedure”
- “Test report”
- “Note(s)”

4 “SCOPE AND FIELD OF APPLICATION”

4.1 Under this heading in each method are given intended use of the method, its limitations and the definitions of any terms that may not be clear.

4.2 Details of the principal natural and man-made fibres which can be submitted to each test are given. These lists are by no means exclusive, and any dyed or printed cloth not mentioned in the method (whether manufactured wholly from one fibre or from a mixture of fibres) can be submitted to test. In such cases it is necessary to verify and note whether the procedure is likely to cause any alteration in the fibre under test. This applies particularly to all man-made fibres (acrylic, pure or copolymer; polyvinyl, pure or copolymer, polyester, etc.) currently being developed, of which any list is always likely to be incomplete.

5 "PRINCIPLE" (OF METHOD)

Under this heading in each method is given a concise statement of the principle of the method to enable the user to decide whether the method is the one that he is seeking.

6 "REFERENCES"

Under this heading in each method is given a complete list of other documents which are indispensable for the application of the method.

7 "APPARATUS AND REAGENTS" (OR "STANDARDS AND APPARATUS")

7.1 Under this heading in each method are described the equipment and supplies required for the test.

7.2 **Test solutions** should be prepared using distilled water. The concentrations of baths are given in millilitres per litre (ml/l) or grams per litre (g/l). The qualities of chemicals to be used are given in each method. For crystalline substances the amount of water of crystallization is given and, for liquids, the relative density at 20 °C.

7.3 By **adjacent fabric** is meant a small piece of undyed cloth of a single or of several generic kinds of fibres to be used during the test for assessing staining.

7.3.1 **Single-fibre adjacent fabrics**, if not otherwise specified, should be of plain weave, medium mass per unit area and free from chemically damaged fibres, finishes, residual chemicals, dyes or fluorescent whitening agents. The fluidity value of cotton adjacent fabric may not exceed 5 rhes when measured by the Cu En method.

7.3.2 Properties and preparation of the single-fibre adjacent fabrics are given under the different adjacent fabric specifications.

7.3.3 **Multi-fibre adjacent fabrics** are made of yarns of various generic kinds of fibres each of which forms a stripe of at least 1,5 cm width providing even thickness of the fabric. The staining properties of generic fibres used in single-fibre and multi-fibre adjacent fabrics must be identical.

7.4 By **standard of fading** is meant a dyed fabric of similar appearance as the test control (see 8.4), showing the colour to which the test control should fade during the test. Test controls are produced by a central organization and are made available through national standards bodies.

7.5 Selection and use of adjacent fabrics

Two alternative procedures for selection of adjacent fabrics are provided, and details of the type of adjacent fabrics used shall be given in the test report, including dimensions.

7.5.1 Types of adjacent fabrics

Either of the following procedures may be used.

a) Two single-fibre adjacent fabrics. The first adjacent fabric should be of the same generic kind of fibre as the material under test or that predominating in the case of blends. The second adjacent fabric should be that indicated in the individual test or as otherwise specified.

b) One multi-fibre adjacent fabric. In this case no other adjacent fabric may be present as this can affect the degree of staining of the multi-fibre fabric.

7.5.2 Dimensions and use of adjacent fabrics

7.5.2.1 When single-fibre adjacent fabrics are used, these shall be of the same dimensions as the specimen under test (normally 10 cm × 4 cm). As a general principle, each surface of the specimen is completely covered by each of the adjacent fabrics. Special requirements are outlined in 8.6.

7.5.2.2 When a multi-fibre adjacent fabric is used, this shall be of the same dimensions as the specimen under test (normally 10 cm × 4 cm). As a general principle, it shall cover the face side only of the specimen.

8 "TEST SPECIMEN"

8.1 Under this heading in each method are given the particular requirements for the specimen to be used in the test.

Definitions of the following terms are given below :

- "specimen";
- "composite specimen";
- "test-control specimen".

General directions for their preparation are also given below.

8.2 By **specimen** is meant a small piece of material that is to be submitted to the test; it is usually taken from a larger sample representing a lot of the dyed or printed textile material.

10.2 Tolerances are given for numerical values of dimensions, temperatures and times that are considered critical. If no tolerance is given, the precision of the measurements need be only that to be expected when using common instruments and reasonable care. The precision is further indicated by the number of significant figures in the values given.

10.3 By **liquor ratio** is meant the ratio of the volume of the liquor used in the treatment, expressed in millilitres (ml), to the mass of the specimen or the composite specimen (specimen plus adjacent fabric), expressed in grams (g).

10.4 Wetting out. When wetting specimens, special care should be taken to ensure that they are uniformly saturated. In particular, when wool or materials containing wool are wetted out, it is necessary for them to be immersed in softened, distilled or deionized water and *either* thoroughly kneaded by hand or with a mechanical device, for example the flattened end of a glass rod, *or* placed in a suitable flask, evacuated using a water suction pump or similar apparatus.

10.5 Spotting. For tests in which the material is spotted with water or a reagent and the surface rubbed with a glass rod to ensure penetration, care should be taken not to raise the surface of the material, otherwise there will be change in the reflection of light and hence in appearance.

10.6 Wetting to 100 % increase in mass. When the material is to be wetted to contain its own mass of liquor, it may be saturated with the liquor and then drawn between two rubber rollers or squeezed by means of a rubber roller on a glass plate, or centrifuged. Wringing by hand does not give uniform wetting.

10.7 Temperatures are given in degrees Celsius ($^{\circ}\text{C}$), usually with a tolerance of $\pm 2^{\circ}$. For reliable results, continuous temperature control is essential.

11 FASTNESS OF DYES

11.1 As the fastness of a dye depends on the depth of colour, it is necessary to specify standard depths which are to be used by dye manufacturers. A main range of standard depths, referred to as 1/1 standard depths, is recommended in 18 hues and is to be used whenever possible.

11.2 Supplementary ranges twice as deep (referred to as 2/1 standard depths), and weaker (referred to as 1/3, 1/6, 1/12 and 1/25 standard depths), are also recommended and are to be used whenever additional fastness data are required.

11.3 In the case of navy blues and blacks, only two standard depths are recommended, namely :

Navy blue/light (N/L)	Black/light (B/L)
Navy blue/dark (N/Dk)	Black/dark (B/Dk)

Whenever possible, dye manufacturers' pattern cards should provide fastness ratings at both depths.

11.4 These standard depths should be prepared on a matt material (wool gaberdine or printed card). Master sets of the standards depths are filed in certain countries for reference.

11.5 These standard depths are not subjected to any fastness test, but merely indicate at what depth of colour the fastness figures of dye manufacturers have been obtained, irrespective of dye or fibre.

12 ASSESSMENT OF COLOUR FASTNESS

12.1 Colour fastness is assessed separately with respect to change in colour of the specimen in the test and with respect to staining of adjacent fabrics. Specimens and adjacent fabrics should have cooled after drying and should have regained their normal moisture content before the assessment, except when otherwise specified.

12.2 Colour fastness with respect to change in colour. The change which occurs in a test may be a change in depth of colour (i.e. saturation), a change in hue, a change in brightness, or any combination of these.

Regardless of the character of the change, the assessment is based upon the magnitude of the visual contrast between the specimen after the test and a specimen of the original material. This contrast is compared visually with the contrast represented by the five or nine pairs of colour chips (or swatches of cloth), ranging in both cases from 5, which illustrates no contrast, to 1, which illustrates a large contrast, these scales being specified in section A02, *Grey scale for assessing change in colour*. The fastness rating of the specimen is that number of the grey scale which corresponds to the contrast between the original and the treated specimens in the case of the nine-step scale; in the case of the five-step scale, if the contrast is judged to be nearer to the non-existent half-step, the appropriate half-step rating shall be given. Assessments to less than one-half-step are not permitted. A rating of 5 is given only when there is no difference between the tested specimen and the original material.

In assessing the results of tests for colour fastness to light, the exposed specimens are compared with the scale of eight standard dyed blue wool cloths, which have been exposed simultaneously. In addition the grey scale for assessing change in colour is used as a means of defining the extent to which fading should be carried out in the test (see sections B01 to B04).

In some tests, changes occur in the surface appearance of the specimen (for example pile arrangement, structure, lustre, etc.) in addition to change in colour. In such cases the surface of the specimen shall be restored, if possible, to its original condition by combing or brushing, etc. If this restoration is not possible, then the fact that the resultant rating gives not only the change in colour but also the overall change in appearance should be noted in the test report.

For certain types of textile products, a simple wetting can create an apparent difference in colour compared with a fabric which has not been wetted, and this is not due to a real change in colour. This colour difference should be attributed to a modification of the surface of the fabric or to a migration of the finish. In this case, evaluation should be made by comparison with the original fabric which has been wetted and not with the original fabric. The original fabric, placed horizontally, is wetted superficially and evenly, by spraying with distilled water, avoiding formation of drips, and is left to dry. If this procedure has been conducted, details shall be included in the test report.

12.3 Colour fastness with respect to staining. The degree of staining of the adjacent fabric, either by absorption of dye from the bath or by direct transfer of colour from the specimen, is assessed by visual inspection of the side of the adjacent fabric which was in contact with the specimen; the colour of the bath is ignored if not otherwise specified (for example, in the dry cleaning test).

For assessing staining, the five- or nine-step scale specified in section A03, *Grey scale for assessing staining*, is used in a manner similar to that described for assessing change in colour in 12.2. Staining is assessed for each type of adjacent fabric in the test, staining at the stitching being ignored. If the adjacent fabric undergoes any visual change when subjected to a test in the absence of a specimen, a sample of the adjacent fabric which has been treated in this manner should be used as the reference sample for the assessment of staining.

12.4 Influence of pre-treatments and after-treatments. It is well known that the fastness of dyeing obtained with a given dyestuff depends on the amount of dye, the substrate and the treatments applied to the textile material before, during or after dyeing. It follows that fastness is not a property of the dye itself, but only of a given dyeing.

12.5 Simple checks on colour fastness. The existence of a simple method of checking the colour fastness of a dyed cloth by reference to a standard dyeing is extremely useful for authorities receiving goods in large quantities, who wish to determine whether these are comparable with an accepted piece.

Where it is not essential to determine the exact colour fastness rating, it may be sufficient to compare the cloth

being investigated with a standard dyeing. This method is used when it is necessary to establish only whether the colour fastness of the specimen to a particular agency is greater than, equal to, or less than that of the reference dyeing.

13 CONDITIONS OF VIEWING AND ILLUMINATION IN ASSESSING COLOUR FASTNESS

In assessing colour fastness, a piece of the original material and the tested specimen, or the undyed and stained adjacent fabrics, are arranged side by side in the same plane and oriented in the same direction. Two or more layers are used if necessary to avoid effects of other backing on the appearance. The appropriate grey scale is placed nearby in the same plane. For optimum precision, the areas of contrast to be compared should be approximately of the same size and shape; if necessary, this can be achieved by the use of a mask of neutral grey colour approximately mid-way between that illustrating grade 1 and that illustrating grade 2 of the grey scale for assessing change in colour (this is approximately Munsell N5) and of a size equal to that of the grey scale steps. The surrounding field is the same uniform grey. The surfaces to be compared are illuminated by north sky light in the Northern hemisphere, south sky light in the Southern hemisphere, or an equivalent source with an illumination of 600 lx or more. The light is incident upon the surfaces at an angle of approximately 45°, and the direction of viewing is approximately along the perpendicular to the plane of the surfaces.

14 "TEST REPORT"

Under this heading in each method is indicated the information to be supplied in the test report. In addition to fastness ratings, information is required to be given on the adjacent fabrics used and any deviations from the test procedure.

15 "NOTE(S)"

Under this heading in each method are given references to literature and other information not considered necessary for inclusion in the body of the test method.

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Textiles — Tests for colour fastness

A02 Grey scale for assessing change in colour

1 SCOPE AND FIELD OF APPLICATION

This section describes the grey scale for determining changes in colour of textiles in colour fastness tests, and its use. A precise colorimetric specification of the scale is given as a permanent record against which newly prepared working standards and standards that may have changed can be compared.

2 PRINCIPLE

2.1 The essential, or 5-step, scale consists of five pairs of non-glossy grey colour chips (or swatches of grey cloth), which illustrate the perceived colour differences corresponding to fastness ratings 5, 4, 3, 2 and 1. This essential scale may be augmented by the provision of similar chips or swatches illustrating the perceived colour differences corresponding to the half-step fastness ratings 4-5, 3-4, 2-3 and 1-2, such scales being termed 9-step scales. The first member of each pair is neutral grey in colour and the second member of the pair illustrating fastness rating 5 is identical with the first member. The second members of the remaining pairs are increasingly lighter in colour so that each pair illustrates increasing contrasts or perceived colour differences which are defined colorimetrically. The full colorimetric specification is given below.

2.2 The chips or swatches shall be neutral grey in colour and shall be measured with a spectrophotometer with the specular component included. The colorimetric data shall be calculated using CIE 1964 supplementary standard colorimetric system (10° observer data) for Illuminant D_{65} .

2.3 The Y tristimulus value of the first member of each pair shall be 12 ± 1 .

2.4 The second member of each pair shall be such that the colour difference between it and the adjacent first member is as follows :

Fastness grade	CIELAB difference	Tolerance
5	0	0,2
(4-5)	0,8	$\pm 0,2$
4	1,7	$\pm 0,3$
(3-4)	2,5	$\pm 0,35$
3	3,4	$\pm 0,4$
(2-3)	4,8	$\pm 0,5$
2	6,8	$\pm 0,6$
(1-2)	9,6	$\pm 0,7$
1	13,6	$\pm 1,0$

(Bracketed values apply only to the 9-step scale.)

2.5 **Use of the scale.** Place a piece of the original textile and the tested specimen of it side by side in the same plane and oriented in the same direction. Place the grey scale nearby in the same plane. The surrounding field should be neutral grey colour approximately midway between that illustrating grade 1 and that illustrating grade 2 of the grey scale for assessing change in colour (this is approximately Munsell N5). If necessary to avoid effects of the backing on the appearance of the textiles, use two or more layers of the original textile under both original and tested specimens. Illuminate the surfaces with north sky light in the Northern hemisphere, south sky light in the Southern hemisphere, or an equivalent source with an illumination of 600 lx or more. The light should be incident upon the surfaces at approximately 45° , and the direction of viewing approximately perpendicular to the plane of the surfaces. Compare the visual difference between original and tested textile with the differences represented by the grey scale.

If the 5-step scale is used, the fastness rating of the specimen is that number of the grey scale which has a perceived colour difference equal in magnitude to the perceived colour difference between the original and the treated specimens; if the latter is judged to be nearer the imaginary contrast lying midway between two adjacent pairs than it is to either, the specimen is given an intermediate assessment, for example 4-5 or 2-3. A rating of 5 is given only when there is no perceived difference between the tested specimen and the original material.

If the 9-step scale is used, the fastness rating of the specimen is that number of the grey scale which has a perceived colour difference nearest in magnitude to the perceived colour difference between the original and the tested specimens. A rating of 5 is given only when there is no perceived difference between the tested specimen and the original material.

When a number of assessments have been made, it is very useful to compare all the pairs of original and tested specimens which have been given the same numerical rating. This gives a good indication of the consistency of the assessments, since any errors become prominent. Pairs which do not appear to have the same degree of contrast as the remainder of their groups should be re-checked against the grey scale and, if necessary, the rating should be changed.

2.6 Describing colour changes in fastness tests

2.6.1 In using the grey scale, as outlined in 2.5, the character of the change in colour, whether in hue, depth, brightness or any combination of these, is not rated: the overall difference or contrast, between original and tested specimens, is the basis for the assessment.

2.6.2 If, as in rating dyes on textiles for example, it is desired to record the character of the change in colour of the textile in the test, appropriate qualitative terms may be added to the numerical rating, as illustrated by the following examples:

Rating	Meaning	
	Contrast corresponding to following grades of grey scales	Character of change
3	Grade 3	Loss in depth of colour only
3 redder	Grade 3	No significant loss in depth but colour redder
3 weaker yellower	Grade 3	Loss in depth and change in hue
3 weaker bluer duller	Grade 3	Loss in depth and change in both hue and brightness
4-5 redder	Intermediate between grades 4 and 5	No significant loss in depth but colour slightly redder

2.6.3 When changes in colour occur in two or three directions, it is considered neither feasible nor necessary to indicate the relative magnitude of each change.

2.6.4 When the space available for recording qualitative terms is restricted, as on pattern cards, the following abbreviations may be used:

Abbreviation	Meaning	French abbreviation
Bl	Bluer	B
G	Greener	V
R	Redder	R
Y	Yellower	J
W	Weaker	C
Str	Stronger	F
D	Duller	T
Br	Brighter	P