BRITISH STANDARD

BS 903-A55: 1989
ISO 4665-1: 1985

Methods of testing vulcanized rubber —

Part A55: Methods for assessment of changes in properties after exposure to natural weathering or artificial light, for use in determining resistance to weathering

[ISO title: Rubber, vulcanized — Resistance to weathering — Part 1: Assessment of changes in properties after exposure to natural weathering or artificial light]

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Rubber Standards Committee (RUM/-) to Technical Committee RUM/36, upon which the following bodies were represented:

British Railways Board
British Rubber Manufacturers' Association
ERA Technology Ltd.
GAMBICA (BEAMA Ltd.)
Institution of Mechanical Engineers
Institution of Water Engineers and Scientists
Malaysian Rubber Producers' Research Association
Ministry of Defence
National College of Rubber Technology
Rapra Technology
SATRA Footwear Technology Centre

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Contents

National foreword

This Part of BS 903 has been prepared under the direction of the Rubber Standards Committee. It is identical with ISO 4665-1:1985 "*Rubber, vulcanized — Resistance to weathering — Part 1: Assessment of changes in properties after exposure to natural weathering or artificial light*", published by the International Organization for Standardization (ISO).

Terminology and conventions. The text of the International Standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

Wherever the words "part of ISO 4665" appear, referring to this standard, they should be read as "Part of BS 903".

Cross-references

International Standard	Corresponding British Standard
	BS 1006:1978 *Methods of test for colour fastness of textiles and leather*
ISO 105-A01:1984	Section A01 *General principles of testing* (Technically equivalent)
ISO 105-A02:1984	Section A02 *Grey scale for assessing change in colour* (Technically equivalent) BS 903 *Methods of testing vulcanized rubbers*
ISO 471:1983	Part A35:1985 *Temperatures, humidities and times for conditioning and testing of test pieces* (Identical)
ISO 1431-1:1980	Part A43:1982 *Determination of resistance to ozone cracking (static strain test)* (Identical)
ISO 4665-2:1985	Part A53:1989 *Methods for exposure to natural weathering, for use in determining resistance to weathering* (Identical)
ISO 4665-3:1987	Part A54:1989 *Methods for exposure to artificial light, for use in determining resistance to weathering* (Identical)

Additional information. Some physical methods cannot be conducted after artificial light exposure because of the size of test piece imposed by the exposure instrument. Where the physical method requires the determination of some statistical approach, it may be necessary to conduct, in some cases, a greater number of tests in order to obtain a better estimate of the true value of the population, so that the effect of light exposure is not misinterpreted.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 4, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

A number of different exposure techniques have been established to provide information on the effects of weathering or exposure to light on rubber materials. Each of these has its own particular application and relevance. However, it is desirable that the procedure for the determination of the changes in properties should be the same whatever exposure is used and that the results should be expressed in a uniform manner; this part of ISO 4665 has been prepared to meet this requirement, it is the intention that subsequent parts dealing with the different exposure methods should invoke this part of ISO 4665.

Exposure to light may alter the properties of the material, particularly in the surface layer. The test method used to determine changes in properties should be selected after consideration of the properties of the material which are important in its proposed application. The methods chosen should be capable of measuring changes in properties with sufficient precision within the ranges which are important in practice, so as to provide significant criteria of change.

1 Scope and field of application

This part of ISO 4665 describes methods for the determination of changes in colour or appearance and variations in physical or other properties of rubber materials after exposure to natural or artificial light under specified conditions.

2 References

ISO 105, *Textiles — Tests for colour fastness — Section A01: General principles of testing — Section A02: Grey scale for assessing change in colour.*

ISO 471, *Rubber — Standard temperatures, humidities and times for the conditioning and testing of test pieces.*

ISO 1431-1, *Rubber, vulcanized — Resistance to ozone cracking — Part 1: Static strain test.*

ISO 4665, *Rubber, vulcanized — Resistance to weathering — Part 2: Methods of exposure to natural weathering — Part 3: Methods of exposure to laboratory light sources*[1)].

3 Determination of changes in colour or appearance

3.1 Changes in colour

3.1.1 *Principle*

Determination of changes in colour of rubber test pieces exposed in accordance with ISO 4665-2 or ISO 4665-3, either by visual assessment by means of a contrast scale, or by instrumental methods.

3.1.2 *Apparatus*

3.1.2.1 *Grey scale*, for assessing change in colour in accordance with ISO 105-A02 (see also the Annex).

In this scale grade 1 corresponds to the strongest contrast and grade 5 to zero contrast (two samples with identical colour).

3.1.2.2 *Instrumental means of measuring colour or change in colour*

A suitable means will be specified in a future International Standard.

3.1.3 *Test piece*

The test pieces shall comply with the requirements of the appropriate part of ISO 4665.

3.1.4 *Procedure*

Determine the changes in colour in accordance with either **3.1.4.1** or **3.1.4.2**.

NOTE The determination of the colour changes may be carried out as specified in the appropriate part of ISO 4665 either at different exposure stages, or at a single exposure stage.

3.1.4.1 *Visual assessment*

Carry out a visual assessment of the colour changes following the principles established in ISO 105-A01, by comparing, with the rating on the grey scale, as described in ISO 105-A02, the contrasts existing between the exposed test piece and the reference test piece. The rating of colour change is the grade on the grey scale which shows an equivalent contrast to that existing between the exposed test piece and the reference test piece.

If the contrast observed lies between two ratings on the grey scale, it will be characterized by an intermediary degree. For example, a 3–4 rating signifies that, at the given exposure stage, the contrast between the exposed test piece and the reference test piece is greater than that of rating 4 on the grey scale, but less than rating 3.

[1)] At present at the stage of draft.

Report the extent of the colour change in terms of the rating on the grey scale. The type of colour change shall also be recorded. Thus any changes in hue, brilliance, lightness or combinations of these changes shall be described by adding terms to the numerical colour rating as follows:

Hue changes	Changes in brilliance	Changes in lightness
More blue or less blue	Duller	Lighter
More green or less green	Brighter	Darker
More red or less red		
More yellow or less yellow		

The report will then be of the form, for example "more yellow, duller, lighter, grey scale 2–3".

3.1.4.2 *Instrumental assessment*

Instrumental assessment of colour changes is carried out on the test piece before and after exposure, and if necessary on the reference test piece.

The procedure followed shall be in accordance with the relevant International Standards.

3.2 Other visible changes of appearance

Record any changes in appearance, other than colour, in accordance with the relevant International Standards or make a note of visual assessment (see **5.2**).

Particular examples of visible change are

a) variation in transparency, opacity, gloss or matt appearance;

b) development of cracks, crazes, pits, holes, porous appearance, delamination, or warping;

c) appearance of material easily removed by rubbing, or of exudation.

Measurement of resistance to cracking under natural weathering conditions shall be determined in accordance with ISO 4665-2.

4 Determination of physical properties

4.1 Principle

Determination of physical properties under the same test conditions on a series of test pieces as follows:

a) initial determination of the properties of the test pieces (prior to exposure);

b) exposure of the test pieces for periods chosen in accordance with the appropriate part of ISO 4665;

c) storage of control test pieces in the dark for the same period as the corresponding test pieces are exposed.

4.2 Apparatus

As described in the appropriate International Standards for the determination of the properties chosen.

4.3 Test pieces

As required by the appropriate part of ISO 4665.

It is sometimes necessary to cut test pieces for the particular test from an exposed specimen which is the form of a sheet. In such cases, the test pieces shall be taken not less than 20 mm from fixtures holding the material or from supports that are not intended to simulate the conditions of exposure of the material in service. In no circumstances shall any of the material be removed from the front exposed face during test piece preparation.

4.4 Procedure

4.4.1 *Determination of initial properties*

Unless otherwise specified, condition the test pieces for the determination of initial properties in one of the atmospheres and for the appropriate period specified in ISO 471.

Determine the required property or properties chosen in accordance with the appropriate test method(s).

4.4.2 *Storage of control test pieces*

Store the control test pieces in the dark under normal laboratory conditions, preferably in one of the standard atmospheres given in ISO 471.

4.4.3 *Determination of the properties at each agreed exposure stage*

Condition the exposed test pieces and the appropriate control test pieces under the same conditions as those used for the determination of the initial properties.

Determine the same property (or properties) on both exposed and control test pieces as was determined on the initial test pieces.

NOTE With some tests, the results depend upon which side of the test piece is exposed. For example in bending tests different results are obtained according to whether the exposed surface or the unexposed surface of the test piece is placed under tension.

5 Expression of results

5.1 Change in colour

Report the change of colour determined visually (see **3.1.4.1**) or by means of instrumental measurements (see **3.1.4.2**).

5.2 Change of appearance

Report the changes of appearance (see **3.2**). Changes in appearance and surface properties which have been estimated qualitatively should be expressed on a scale agreed between the interested parties. The following is recommended:

0 — none

1 — barely perceptible

2 — moderate

3 — substantial

NOTE 1 This scale is arbitrary and, although it is of considerable use when assessing several test pieces at the same time, great care is necessary in interpreting results from different observations.

NOTE 2 For assessment of ozone cracking, attention is drawn to the methods described in ISO 1431-1.

5.3 Changes in physical properties

For each property calculate the value at each exposure stage in accordance with the relevant International Standard.

Numerical results on exposed test pieces are preferably expressed as percentages of both the initial property value and of the property value of control test pieces that have been stored in the dark for the same period of time as the exposure period of the exposed test pieces.

The change, expressed as a percentage, in a property from the initial value is given by the formula

$$\frac{x_a - x_o}{x_o} \times 100$$

The change, expressed as a percentage, in a property from the control value is given by the formula

$$\frac{x_a - x_c}{x_c} \times 100$$

where

x_a is the value obtained on the exposed test pieces;

x_o is the initial value;

x_c is the value obtained on the control test pieces.

In the case of hardness measurements, the changes shall be expressed as $x_a - x_o$ and $x_a - x_c$, respectively.

6 Test report

The test report shall contain the following information:

a) sample details:

1) full description of the sample and its origin,

2) compound details, and cure time and temperature, where appropriate;

b) test methods:

1) the reference of this part of ISO 4665,

2) the reference of the relevant part of ISO 4665 for the type and conditions of exposure,

3) the reference(s) to the relevant test method(s) for the determination of properties;

c) test details:

1) information relating to the exposure (type, exposure stages, etc.),

2) conditions of storage of the control test pieces,

3) any non-standardized procedures adopted;

d) test results:

1) colour change at each exposure stage (see **5.1**),

2) other changes in appearance at each exposure stage (see **5.2**),

3) the individual values obtained for each test piece and the value for each property at each exposure stage, calculated in accordance with the relevant test method,

4) the change in properties at each exposure stage (see **5.3**);

e) date of test.

Annex Suppliers of grey scale

(This annex does not form an integral part of the Standard.)

The grey scale for assessing change in colour can be obtained from the following organizations:

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

Society of Dyers and Colourists
PO Box 244, Perkin House
82 Gratton Road
Bradford BD1 2JB
West Yorks
United Kingdom

Beuth-Vertrieb GmbH
Burggrafenstrasse 4-7
D-1000 Berlin 30
Germany, F.R.

Association pour la détermination de la solidité
des teintures et impressions sur textiles
12, rue d'Anjou
F-75008 Paris
France

Eidgenössische Materialprüfungs-und Versuchsanstalt
Unterstrasse 11
CH-9000 St Gallen
Switzerland

Japanese Standards Association
1-24 Akasaka 4
Minato-ku
Tokyo
Japan

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

Publications referred to

See national foreword.

BS 903-A55: 1989
ISO 4665-1: 1985

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