
**Rubber, vulcanized and thermoplastic —
Resistance to weathering**

Caoutchouc vulcanisé ou thermoplastique — Résistance aux intempéries



Foreword

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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.

International Standard ISO 4665 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Physical and degradation tests*.

This edition cancels and replaces ISO 4665-1:1985, ISO 4665-2:1985 and ISO 4665-3:1987, of which it constitutes a technical revision.

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Introduction

A number of different exposure techniques can be used to provide information on the effects of environmental stresses such as light, heat and water on rubbers. Each of these has its own particular application and relevance. Explanation of, and guidance on, methods for exposure to natural and artificial weathering is given in the introduction to ISO 877 and in ISO 4892-1. Particular guidance on exposure to determine resistance to ozone is given in ISO 1431-1. The methods for exposure to weathering standardized for plastics materials are essentially suitable for rubbers and hence this standard refers to the relevant ISO standards for plastics for the apparatus and procedures.

It is desirable that the procedures for the determination of changes in properties should be the same whatever exposure is used and that the results should be expressed in a uniform manner. Such procedures are specified in this standard.

Exposure to weathering alters 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 and taking into account the fact that degradation may be concentrated at the surface layer. The methods chosen should be capable of measuring change in properties with sufficient precision within the ranges which are important in practice, so as to provide significant criteria of change.

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Rubber, vulcanized and thermoplastic — Resistance to weathering

1 Scope

This International standard specifies methods for the exposure of rubber materials to natural or artificial weathering and methods for the determination of changes in colour, appearance and physical properties resulting from exposure.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 105-A02:1993, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*.

ISO 471:1995, *Rubber — Temperatures, humidities and times for conditioning and testing*.

ISO 877:1994, *Plastics — Methods of exposure to direct weathering, to weathering using glass-filtered daylight, and to intensified weathering by daylight using Fresnel mirrors*.

ISO 1431-1:1989, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static strain test*.

ISO 4892-1:—¹⁾, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*.

ISO 4892-2:1994, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc sources*.

ISO 4892-3:1994, *Plastics — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps*.

ISO 4892-4:1994, *Plastics — Methods of exposure to laboratory light sources — Part 4: Open-flame carbon-arc lamps*.

ISO 7724-1:1984, *Paints and varnishes — Colorimetry — Part 1: Principles*.

ISO 7724-2:1984, *Paints and varnishes — Colorimetry — Part 2: Colour measurement*.

ISO 7724-3:1984, *Paints and varnishes — Colorimetry — Part 3: Calculation of colour differences*.

1) To be published. (Revision of ISO 4892-1:1994)

3 Definitions

For the purposes of this International Standard, the following definitions apply:

3.1 control: In weathering, the term "control" currently has three widespread uses:

- a) A material which is of similar composition and construction to the test material, has a known response to the exposure conditions and is exposed at the same time for comparison.

NOTE 1 A reference material can be used as the control.

- b) A portion of the material to be tested which is stored under conditions in which it is stable and is used for comparison between the exposed and the original state.

NOTE 2 This definition is deprecated in favour of "file test piece".

- c) A portion of the exposed test piece which is protected from light exposure by masking.

NOTE 3 This definition is deprecated in favour of "masked area".

3.2 file test piece: A portion of the material to be tested which is stored under conditions in which it is stable and is used for comparison between the exposed and the original state.

3.3 masked area: A portion of the exposed test piece which is protected from light exposure by masking.

3.4 weathering reference material: A reference material whose weathering degradation properties are well documented and repeatable when exposed to identical conditions.

3.5 exposure stage: The interval of exposure between determinations of change in properties, expressed as time or radiation dose.

NOTE 4 Further relevant definitions are given in ISO 877 and ISO 4892.

4 Principle

Test pieces are exposed to natural or artificial weathering and the resulting changes in colour, appearance and selected physical properties are determined.

5 Exposure to direct weathering, to weathering using glass-filtered daylight and to intensified weathering by daylight using Fresnel mirrors

Carry out the exposure in accordance with the relevant method of ISO 877, with the following additions and modifications:

For tests under strain, prepare the test pieces and place them under strain in accordance with ISO 1431-1.

Condition the test pieces in accordance with ISO 471.

6 Exposure to laboratory light sources

Carry out the exposure in accordance with ISO 4892-1 and, as relevant, ISO 4892-2, ISO 4892-3 or ISO 4892-4, with the following additions and modifications:

For tests under strain, prepare the test pieces and place them under strain in accordance with ISO 1431-1.

Condition the test pieces in accordance with ISO 471.

NOTE 5 The general guidance to weathering of plastics given in ISO 4892-1 is applicable to rubbers.

7 Changes in colour

7.1 Apparatus

7.1.1 Instrumental assessment

A colour or colour change apparatus meeting the requirements described in ISO 7724-1, ISO 7724-2 and ISO 7724-3.

7.1.2 Visual assessment

Grey scale in accordance with ISO 105-A02.

7.2 Test piece

The test piece shall be in any form which allows sufficient flat area for the determination of colour change.

NOTE 6 It is convenient to use a test piece required for determination of change in physical properties.

7.3 Procedure

The choice of instrumental or visual assessment of colour change shall be made by agreement between the interested parties.

7.3.1 Instrumental assessment

Measure the colour of the test piece before and after each exposure stage in accordance with the procedure given in ISO 7724. If required, also measure the colour of a file test piece or a masked area.

7.3.2 Visual assessment

Compare the contrast rating of the exposed test piece and the unexposed file test piece, and if required a masked area, after each exposure stage in accordance with the procedure given in ISO 105-A02.

8 Changes in other appearance properties

Examine the test piece visually after each exposure period for changes in appearance using, if appropriate, the procedure given in a relevant International Standard. Some examples of parameters used to assess change in appearance are listed in annex A.

Ozone cracking shall be assessed in accordance with ISO 1431-1.

NOTE 7 Cracking or crazing in rubber test pieces exposed outdoors can result from light ageing as well as from ozone attack. A distinction is not always possible, particularly with light-coloured rubbers. Sunlight crazing is characterized by shallow cracks and usually occurs independently of strain, whereas a threshold strain must be exceeded for ozone cracking to occur. Where there is doubt, it is useful to expose an unstrained test piece alongside the strained test piece for comparison.

9 Changes in physical properties

The properties measured may be as specified in an International Standard for the material or as agreed between the interested parties. Some suitable properties are listed in annex A.

9.1 Apparatus

Apparatus in accordance with the relevant International Standard for the determination of the properties chosen.

9.2 Test pieces

Test pieces shall comply with the requirements of the relevant International Standard for the determination of the properties chosen.

Test pieces may be cut from an exposed sheet of material. 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 exposed face during test piece preparation.

9.3 Procedure

Condition the test pieces and carry out the property determination in accordance with the procedure given in the relevant International Standard. Determine the initial properties on unexposed test pieces and the properties of exposed test pieces after each exposure stage. If required, also determine the properties of file test pieces or masked areas.

NOTE 8 With some tests, the results depend on which side of the test piece is exposed. For example, in bending fatigue the result will depend on whether the exposed or unexposed surface is placed under tension.

10 Expression of results

10.1 Changes in colour

10.1.1 Instrumental measurements

Determine the colour difference in accordance with ISO 7724.

10.1.2 Visual measurements

Record the contrast rating of the test pieces compared. If the contrast observed lies between two ratings on the grey scale, record an intermediate rating. For example, a rating of 3-4 signifies that the contrast is greater than 3 but less than 4.

Also record the type of colour change using the following terms:

Hue	More blue or less blue
	More green or less green
	More red or less red
	More yellow or less yellow
Purity	Duller
	Brighter
Lightness	Lighter
	Darker

A typical report of colour change by visual assessment would be "More yellow, duller, lighter, grey scale 2-3".

10.2 Changes in other appearance properties

For quantitative methods, calculate the mean change in property from:

$$C = P - P_x$$

where

P = initial property

P_x = property at exposure stage x

For qualitative methods, express on a scale agreed between the interested parties. The following is recommended for properties other than ozone cracking:

0	none
1	barely perceptible
2	moderate
3	substantial

NOTE 9 This scale is arbitrary and, although it is of considerable value when assessing several test pieces at the same time, great care is necessary in interpreting results from different observations.

Surface cracking on test pieces exposed under strain shall be assessed for resistance to ozone in accordance with ISO 1431-1.

10.3 Changes in physical properties

Calculate the result of each measurement in accordance with the relevant international test method standard. The change in property from the initial or file test piece value may be expressed in one of the following ways:

a) as a percentage of the initial or file value:

$$\frac{P_x}{P} \times 100$$

b) as the change in the property:

$$P - P_x$$

c) the change as a percentage of the initial or file value:

$$\frac{P - P_x}{P} \times 100$$

d) as a plot of the property against the time of exposure.

11 Test report

The test report shall include the following information:

- a) a reference to this International Standard;
- b) the sample details:
 - 1) a full description of the sample and its origin,
 - 2) details of the compound and the cure conditions, where appropriate,
 - 3) the method of preparation of the test pieces,
 - 4) details of any weathering reference material used;