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Glass in building — Laminated glass and laminated safety glass —

Part 4:
Test methods for durability

Verre dans la construction — Verre feuilleté et verre feuilleté de sécurité —
Partie 4: Méthodes d'essai concernant la durabilité

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 160, *Glass in building* Subcommittee SC 1, *Product considerations,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 129, *Glass in building*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 12543-4:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

— editorial changes have been made;

— the clause on radiation tests has been revised and a new type of lamp has been added;

— the expression of the results of the radiation tests has been modified.

A list of all parts in the ISO 12543 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Glass in building — Laminated glass and laminated safety glass —

Part 4:
Test methods for durability

1 Scope

This document specifies test methods relating to resistance to high temperature, humidity and radiation for laminated glass and laminated safety glass for use in building.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 9050, *Glass in building — Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors*

ISO 12543-1, *Glass in building — Laminated glass and laminated safety glass — Part 1: Definitions and description of component parts*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12543-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Test specimens

Test specimens should be representative of standard production. Test specimens shall either be specially manufactured to the test size or be cut from larger panes. Test specimens with cut edges shall contain at least one edge from the original pane from which it was cut.

The original edge should be marked.

If the final product has all its edges sealed or protected, the test specimen shall also have all its edges sealed or protected.

The method of supporting the test specimen shall not cover two edges of the test specimen. If the test specimen is cut from a larger pane at least one original edge shall not be covered.

Retesting guidelines for durability testing of laminated glass and laminated safety glass given in Annex A shall be considered.

5 High-temperature test

5.1 Principle

The purpose of this test is to determine whether the laminated glass and laminated safety glass are able to withstand exposure to high temperatures over an extended period of time without their properties becoming substantially altered. The changes in properties are judged by the occurrence of bubbles, delamination and cloudiness (not discoloration).

5.2 Size and number of test specimens

The test specimens shall not be smaller than 300 mm × 200 mm. There shall be three test specimens.

5.3 Procedures

5.3.1 General

The high-temperature test may be carried out using either an oven or boiling water. The test temperature is 100 °C. The tolerances of the test temperature depend on the test method used and are as follows:

a) Oven (100 ± 2) °C: in an oven, the heating-up time is dependent on load and the type and thickness of the laminated glass being tested. Generally speaking, for samples up to 10 mm thickness this should be assumed to be 30 min. For thick samples, i.e. thicker than 10 mm, a heating-up time of 3 min per millimetre glass thickness shall be assumed. The maximum shall be 2 h. Alternatively, the heating-up time for samples thicker than 10 mm may be determined by calibration.

b) Boiling water $100\ (^{0}_{-2})$ °C: to remove the risk of thermal breakage in the boiling water, test samples should be placed in water at 60 °C for 10 min before transferring to the water at 100 °C.

5.3.2 Procedure A (short high temperature test)

Heat the three test specimens to a temperature of 100 °C.

Maintain the test temperature for a period of 2 h.

Take the test specimens out and allow them to cool to room temperature by storing them vertically under natural convection and radiation. The assessment of the test samples may be carried out when the glass surface temperature is lower than 30 °C.

5.3.3 Procedure B (long high temperature test)

Heat the three test specimens to a temperature of 100 °C.

Maintain the test temperature for a period of 16 h.

Take the test specimens out and allow them to cool to room temperature by storing them vertically under natural convection and radiation. The assessment of the test samples may be carried out when the glass surface temperature is lower than 30 °C.

5.4 Expression of results

Inspect the samples at a distance between 300 mm and 500 mm in front of a white diffuse background.

Record the number and extent of the faults occurring in test specimen.

NOTE Bubbles, delamination, haze and cloudiness indicate faults, but discoloration does not.

Disregard all faults within 15 mm from an original edge and 20 mm from a cut edge. Individual bubbles in the immediate vicinity of inlaid wires are permissible.

Disregard a test specimen showing cracks, and perform the test on a new test specimen in its place.

5.5 Test report

The following information shall be given in the test report:

a) reference to this document, i.e. ISO 12543-4:2021;

b) test procedure (5.3.2 Procedure A, or 5.3.3 Procedure B);

c) type and structure of the laminated glass or laminated safety glass, with nominal thickness of the individual constituents, in millimetres;

d) type of test specimens, including cut or special manufacture; type of edge; edge protection; dimensions;

e) unsupported and supported edges by the test frame;

f) for each test specimen, the number and size of the bubbles, delamination, haze or cloudiness occurring;

g) any deviations from the procedure given in in 5.3.2 or 5.3.3.;

h) any unusual features observed;

i) the date of the test.

6 Humidity test

6.1 Principle

The purpose of this test is to determine whether the laminated glass or laminated safety glass are able to withstand the effects of humidity in the atmosphere over an extended period of time without their properties becoming substantially altered. The effects of the humidity are judged by bubbles, delamination, haze or cloudiness.

6.2 Size and number of test specimens

The test specimens shall not be smaller than 300 mm × 200 mm. There shall be three test specimens.

6.3 Procedures

6.3.1 Test with condensation

Keep the three test specimens vertically over water in a closed container for two weeks. Maintain the temperature of the air in the container at 50^{+5}_{0} °C. Adequate spacing between the test specimens shall be provided.

NOTE These conditions give a relative humidity of about 100 % and lead to water condensing on the surface of the test specimen.

6.3.2 Test without condensation

Keep the three test specimens vertically for two weeks in a climate chamber and keep the temperature of the air in the container at 50^{+5}_{0} °C and the relative humidity within the limits of (80 ± 5) %. Adequate spacing between the test specimens shall be provided.

6.4 Expression of results

Inspect the samples at a distance between 300 mm and 500 mm in front of a white diffuse background.

Record the number and extent of the faults occurring in the interlayer (bubbles, delamination, haze and cloudiness) for each test specimen. Disregard all faults within 15 mm from an original edge, 20 mm from a cut edge or 10 mm from any crack. Individual bubbles in the immediate vicinity of inlaid wires are permissible.

In the case of fire-resistant laminated glass and fire-resistant laminated safety glass, only delamination shall be considered as a fault.

NOTE The interlayers of fire-resistant laminated glass and fire-resistant laminated safety glass are designed to react at high temperatures. The exposure of test specimens of those glasses to the temperature reached in the humidity test over a long period of time can create bubbles, haze and cloudiness in the interlayer which do not affect the fire-resistant properties so that only delamination will be considered.

6.5 Test Report

The following information shall be given in the test report:

a) reference to this document, i.e. ISO 12543-4:2021;

b) test procedure (6.3.1 Test with condensation or 6.3.2 Test without condensation);

c) type and structure of the laminated glass or laminated safety glass, with nominal thickness of the individual constituents, in millimetres;

d) type of test specimens, including cut or special manufacture; type of edge; edge protection; dimensions;

e) unsupported and supported edges by the test frame;

f) for each test specimen, the number and size of the bubbles, delamination, haze and cloudiness occurring;

g) any deviations from the procedure given in in 6.3.1 or 6.3.2;

h) any unusual features observed;

i) the date of the test.

In the case of fire-resistant laminated glass and fire-resistant laminated safety glass, only delamination information shall be reported under f).

7 Radiation tests

7.1 Principle

The purpose of this test is to determine whether exposure of laminated glass or laminated safety glass to radiation over an extended period of time produces any appreciable change in their properties. The change in its properties is judged by a change in light transmittance and the occurrence of bubbles, delamination, haze and cloudiness.

7.2 Size and number of test specimens

The size of the test specimens for method A shall not be smaller than 300 mm × 150 mm. There shall be three test specimens.

The size of the test specimens for method B and method C shall not be smaller than 300 mm × 75 mm. There shall be three test specimens.

7.3 Simulated solar radiation methods

7.3.1 Method A: Radiation wall

7.3.1.1 Radiation source

A radiation source that emits a spectrum similar to solar radiation shall be used.

NOTE Such a spectral distribution can be obtained by lamps which consist of a combination of a high-pressure mercury-vapour lamp with an incandescent tungsten filament.

To obtain reproducible and comparable test results suitable lamps shall show the following spectral characteristics:

— UVB	(280 nm to 315 nm)	3 % ± 1 %
— UVA	(315 nm to 380 nm)	8 % ± 1 %
— visible range	(380 nm to 780 nm)	18 % ± 1 %
— IRA	(780 nm to 1 400 nm)	24 % ± 2 %
— IRB	(1 400 nm to 2 600 nm)	27 % ± 4 %
— IRC	(>2 600 nm)	20 % ± 3 %

7.3.1.2 Test conditions

The exposure time for the radiation test shall be 2 000 h.

The temperature of the test specimen shall be maintained at (45 ± 5) °C.

The lamps shall be replaced when their irradiance level in the UVA decreases by more than 50 %.

The total irradiance level in the plane of the test samples shall be (900 ± 100) W/m^2.

NOTE For the determination of the total irradiance level, pyranometers according to the specifications laid down in ISO 9060 and a (limited) sensitivity to the spectral range from 305 nm to 2 800 nm can be used. Using these radiation detectors, the measured irradiance level in the plane of the test samples is (730 ± 80) W/m^2.

7.3.1.3 Arrangement of test apparatus

The test samples are mounted vertically in front of the radiation array. The radiation array consists of lamps uniformly separated to give the optimum radiation density in the plane of the test specimens. The minimum distance between the array of the test specimens and the bottom of the test room shall be 400 mm and the air space behind the array shall be at least 500 mm (to obtain undisturbed free natural convection upwards).

In order to obtain a sufficiently uniform irradiance level, the area covered by the test specimens shall not exceed the area of the lamp array, A, in accordance with the following formula:

$$A = n \times l_1^{\,2}$$

where

n is the number of lamps;

l_1 is the distance between the axes of neighbouring lamps.

NOTE Annex B gives further information on possible arrangement of the test apparatus.

7.3.2 Method B: Mercury vapour arc lamp

7.3.2.1 Radiation source

A radiation source consisting of a medium-pressure mercury-vapour arc lamp with a tubular quartz bulb of ozone-free type shall be used. The bulb axis shall be vertical. The nominal dimensions of the lamp shall be 360 mm in length by 9,5 mm in diameter. The arc length shall be (300 ± 4) mm. The lamp shall be operated at (750 ± 50) W.

Any other source of radiation that produces the same effect as a medium-pressure mercury-vapour arc lamp may be used. To check that the effects of another radiation source are the same, a comparison shall be made by measuring the amount of energy emitted within a wavelength range of 300 nm to 450 nm, all other wavelengths being removed by the use of suitable filters. The alternative source shall then be used with these filters.

NOTE A radiation source whose radiation spectrum is comparable with the reference spectrum is:

Radiator Heraeus Noblelight Q 710[1)], modified with a UV-C filter (dipped tube), for which the following operating parameters are used:

— radiation power: 740 W;

— current: 6,8 A;

— voltage: 130 V.

7.3.2.2 Test conditions

The exposure time for the radiation test shall be 2 000 h.

Place the test specimens in the test apparatus 230 mm from and parallel lengthwise to the lamp axis. Maintain the temperature of the test pieces at (45 ± 5) °C throughout the test.

7.3.3 Method C: Xenon arc source

7.3.3.1 Radiation source

A xenon arc type operating light apparatus as specified in ISO 4892-2 shall be used.

1) Radiator Heraeus Noblelight Q 710 is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

