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**Road vehicles — Safety glazing  
materials — Test methods for  
resistance to radiation, high  
temperature, humidity, fire and  
simulated weathering**

*Véhicules routiers — Vitrages de sécurité — Méthodes d'essai de  
résistance au rayonnement, aux températures élevées, à l'humidité, au  
feu et aux conditions climatiques simulées*



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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](http://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](http://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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 35, *Lighting and visibility*.

This fourth edition cancels and replaces the third edition (ISO 3917:1999), which has been technically revised.

# Road vehicles — Safety glazing materials — Test methods for resistance to radiation, high temperature, humidity, fire and simulated weathering

## 1 Scope

This International Standard specifies test methods for resistance to radiation, high temperature, humidity, fire and simulated weathering, relating to the safety requirements for all safety glazing materials in a road vehicle, whatever the type of glass or the material of which they are composed.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3536, *Road vehicles — Safety glazing materials — Vocabulary*

ISO 3537, *Road vehicles — Safety glazing materials — Mechanical tests*

ISO 3538, *Road vehicles — Safety glazing materials — Test methods for optical properties*

ISO 4892-2:2013, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3536 apply.

## 4 Test conditions

Unless otherwise specified, the test shall be carried out under the following conditions:

- ambient temperature:  $20\text{ °C} \pm 5\text{ °C}$ ;
- atmospheric pressure: 86 kPa to 106 kPa (860 mbar to 1 060 mbar);
- relative humidity:  $(60 \pm 20)\%$ .

## 5 Application of test

For certain types of safety glazing material, it is not necessary to carry out all the tests specified in this International Standard.

## 6 Radiation test

### 6.1 Principle

Determination of whether exposure to radiation over an extended period of time produces any appreciable decrease in regular luminous transmittance or any pronounced discoloration of the safety glazing material.

## 6.2 Apparatus

### 6.2.1 Radiation source

Radiation source, consisting of a medium pressure mercury arc lamp with a tubular quartz bulb of ozone-free type. The bulb axis shall be vertical and equipped with a suitable filter tube removing radiation below 300 nm. The lamp should operate at a power of  $750 \text{ W} \pm 50 \text{ W}$ .<sup>1)</sup>

Any other source of radiation which produces the same effect as the lamp specified above may be used. To check that the effects of another 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.

In the case of safety glazing material for which there is no satisfactory correlation between this test and the conditions of use, it will be necessary to review the test conditions.

### 6.2.2 Power supply

The power supply shall be capable of supplying adequate power to the lamp.

### 6.2.3 Device for mounting and rotating the test specimens

The device shall be capable of mounting and rotating the test specimens at 1 r/min to 5 r/min about the centrally located radiation source in order to ensure even exposure.

## 6.3 Test specimens

The size of the test specimens shall be 76 mm × 300 mm.

## 6.4 Procedure

Measure the regular luminous transmittance, determined according to ISO 3538, of three test specimens before exposure. Protect a portion of each test specimen from the radiation, and then position the test specimen in the test apparatus 230 mm from, and with its 300 mm dimension parallel to the lamp axis. Maintain the temperature of the test specimens at  $45 \text{ °C} \pm 5 \text{ °C}$  throughout the test.

The surface of each test specimen which would represent the outside face of the safety glazing material when mounted on the vehicle shall face the lamp. For the type of lamp specified in [6.2.1](#), the exposure time shall be 100 h.

After exposure, measure the luminous transmittance again on each test specimen in the exposed area.

## 6.5 Expression of results

The results of the luminous transmission measurement of the exposed test specimen shall be compared with the values obtained for unexposed test specimens of the same material.

Changes in colour shall be evaluated either by

- examining the test specimens placed upon a white background and comparing the exposed area with the area which was protected from the radiation or
- measuring the trichromatic coordinates of the test specimen before and after ageing and by calculating the difference between two colours according to the CIE<sup>2)</sup> prescriptions.

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1) A medium pressure mercury arc lamp which yields radiation spectra in the appropriate range at the specified operating parameters is available under the trade name Heraeus Noblelight Q 701, modified by means of a UV-C filter tube.

2) International Commission on Illumination.

## 7 High temperature test

### 7.1 Principle

Determination of whether the safety glazing material will withstand exposure to high temperatures over an extended period of time without its appearance becoming substantially altered.

### 7.2 Procedure

Heat one or more test specimens of at least 300 mm × 300 mm to 100 °C  $\pm$  2 °C. Maintain this temperature for a period of 2 h, then allow the test specimen(s) to cool to room temperature.

If the safety glazing material has both external surfaces of inorganic material, the test may be carried out by immersing the test specimen vertically in water boiling at 100 °C  $\pm$  2 °C for the specified period of time, care being taken to avoid undue thermal shock.

If specimens are cut from windscreens, one edge of the test specimen shall be part of an edge of the windscreen.

### 7.3 Expression of results

The resistance of the safety glazing material to high temperatures shall be evaluated with reference to bubbles or other defects produced in the test specimen by the test described in [7.2](#).

Any defects within 15 mm of an uncut edge, 25 mm from a cut edge or within 10 mm of any cracks which may develop shall be disregarded.

Any test specimen in which cracks develop to an extent which might confuse the results shall be discarded and another test specimen shall be tested in its place.

## 8 Humidity test

### 8.1 Principle

Determination of whether the safety glazing material will successfully withstand the effects of humidity in the atmosphere over an extended period of time.

### 8.2 Procedure

Keep one or more test specimens of at least 300 mm × 300 mm vertically for two weeks in a closed container in which the temperature is maintained at 50 °C  $\pm$  2 °C and the relative humidity at (95  $\pm$  4) %.

These test conditions should exclude any condensation on test specimens.

In the event that several test specimens are tested at the same time, adequate spacing shall be provided between the test specimens.

Precautions shall be taken to prevent condensate from the walls and ceiling of the test chamber from falling on the test specimens.

If the test specimens are cut from windscreens, one edge of the test specimen shall be part of an edge of the windscreen.

### 8.3 Expression of results

The resistance to humidity shall be evaluated visually by reference to change in the appearance of the safety glazing material after testing, i.e.:

- separation of materials;
- loss of transparency according to ISO 3538.

A waiting period of 48 h after exposure prior to evaluation is permitted, if necessary.

The changes shall be assessed over the whole test specimen and any changes which extend more than 6 mm from an uncut edge or 10 mm from a cut edge shall be reported.

## 9 Fire resistance test

Alternatively, the apparatus and method described in ISO 3795 may be used.

### 9.1 Principle

The purpose of this test is to determine the horizontal burning rate of safety glazing materials, of which at least one surface is plastic, after exposure to a small flame.

### 9.2 Apparatus

- a) The test shall be conducted in a laboratory hood or draft-free enclosure greater than 0,5 m<sup>3</sup> in size and provided with a means for venting the fumes from burning test specimens. If a hood is used, its exhaust fan will be turned off during the test but allowed to run periodically to clear out the fumes between tests.
- b) The test specimen shall be clamped in a suitable holder, at the end farthest from the 25 mm mark, with its longitudinal axis horizontal and its transverse axis inclined at 45 ° to the horizontal. The specimen is held with the plastic surface downward, facing the flame.
- c) Under the test specimen there shall be clamped a 20 mesh per 25,4 mm Bunsen burner gauze, about 125 mm square, in a horizontal position 6 mm below the edge of the test specimen and with about 13 mm of the test specimen extending beyond the edge of the gauze as illustrated in [Figure 1](#).
- d) The flame is provided by a Bunsen burner. The gas supplied to the burner shall have a caloric value of about 38 MJ/m<sup>3</sup> (for example, natural gas).

### 9.3 Test specimens

- a) At least three 150 mm × 13 mm flat test specimens shall be tested. The test specimens shall be marked by inscribing two lines, 25 mm and 100 mm from one end of each specimen.
- b) The specimens shall be conditioned for at least 48 h, at a temperature of 23 °C ± 2 °C and a relative humidity of (50 ± 5) %, and shall be maintained under these conditions until immediately prior to the test.

### 9.4 Procedure

- a) A Bunsen burner with a stable, blue, gas flame 12 mm to 20 mm in height shall be placed under the free end of the test specimen and adjusted so that the flame tip is just in contact with the test specimen.
- b) At the end of 30 s, the flame shall be removed and the test specimen allowed to burn.
- c) A stopwatch shall be started when the flame reaches the first mark, 25 mm from the free end, and the time recorded when the flame reaches the 100 mm mark.



- d) In case the test specimen does not continue to burn after the first ignition, the burner shall be placed under the free end for a second period of 30 s immediately following extinction of the flame burning.

## 9.5 Expression of results

The horizontal burning rate of each test specimen, as well as the average of all specimens tested, shall be recorded in millimetres per minute according to Formula (1):

$$B = \frac{s}{t} \times 60 \quad (1)$$

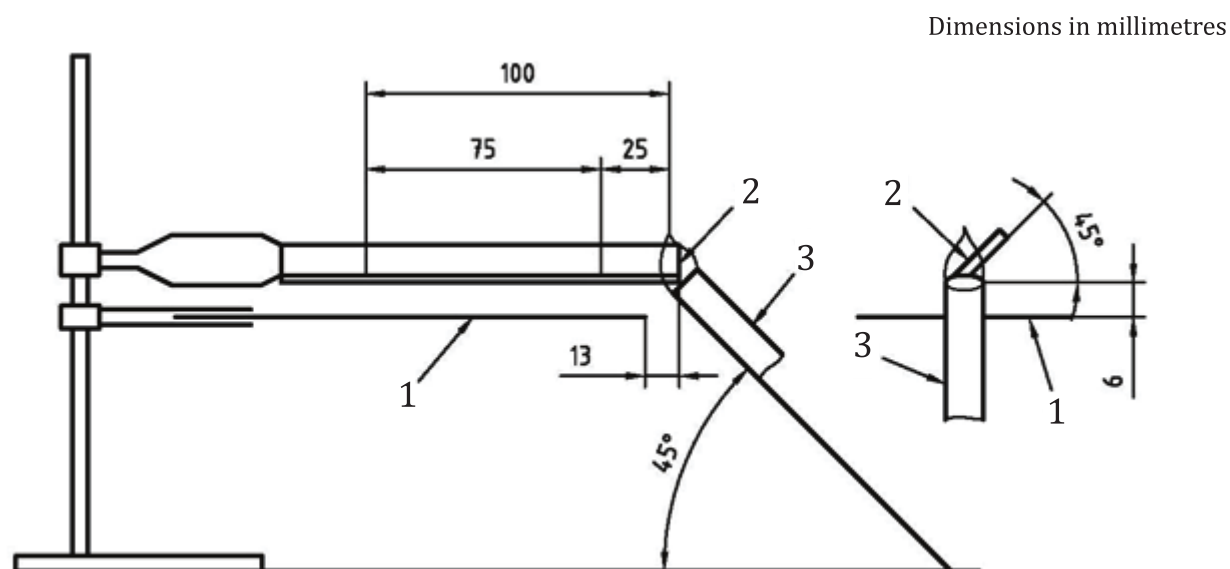
where

$s$  is the burnt distance in millimetres;

$t$  is the time in seconds, taken to burn the distance,  $s$ .

If the specimen does not ignite or does not continue to burn, reaching the first mark, after the gas flame has been removed, a burning rate of 0 mm/min shall be reported.

If a test specimen does not continue burning to the 100 mm mark after a second ignition with the gas flame, it shall be reported as non-sustaining.



### Key

- 1 wire gauze
- 2 test specimen
- 3 burner

Figure 1 — Horizontal burning test

## 10 Resistance to simulated weathering

### 10.1 Principle

Determination of whether safety glazing materials, of which at least one surface is plastic, will successfully withstand exposure to simulated weathering conditions.

## 10.2 Exposure apparatus

The exposure apparatus<sup>3)</sup> shall use a long arc xenon lamp as the source of irradiation, which shall comply with ISO 4892-2:2013, Method A (artificial weathering).

The long arc xenon lamp is advantageous in that it can, when correctly filtered and maintained, yield a spectrum most closely approximating that of natural sunlight. To this end, the quartz xenon burner tube shall be fitted with suitable borosilicate glass optical filter(s)<sup>4)</sup>. The xenon lamps employed shall be operated from a suitable 50 Hz or 60 Hz power supply through suitable reactance transformers and electrical equipment.

The exposure apparatus shall include equipment necessary for measuring and/or controlling the following:

- a) irradiance;
- b) black standard temperature;
- c) water spray;
- d) operating schedule or cycle.

The exposure apparatus shall be made from inert materials which do not contaminate the water employed in the test.

Irradiance shall be measured at the test specimen surface and shall be controlled according to the recommendations of the exposure apparatus manufacturer.

Total ultraviolet<sup>5)</sup> radiance exposure, in joules per square metre, shall be measured or computed and shall be considered the primary measure of test specimen exposure.

## 10.3 Test specimens

The dimensions of the test specimens shall normally be those specified in the appropriate test method for the property or properties to be measured after exposure.

The number of test specimens for each test condition or exposure stage shall be determined, in addition to those required for visual evaluations as specified in [10.5](#) by the number required by the test methods.

It is recommended that visual evaluations be conducted on the largest test specimens tested.

## 10.4 Procedure

**10.4.1** Measure, in accordance with ISO 3538, the luminous transmission of the test specimen(s) to be exposed. Measure, in accordance with ISO 3537, the resistance to abrasion of the plastic surface(s) of the control specimen(s). That face of each test specimen which would represent the surface glazed to the exterior of the road vehicle shall face the lamp. Other exposure conditions shall be as specified in [10.4.2](#) to [10.4.11](#).

**10.4.2** In accordance with ISO 4892-2, the irradiance shall not vary more than  $\pm 10$  % over the whole test specimen area.

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3) Such as Atlas Ci Series and Xenotest Series Alpha or Beta, or Suga X Series. These are trade names. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

4) Borosilicate glass filters such as Atlas Xenochrome 300 and Suga Quartz #275/#295 have been found satisfactory. These are trade names. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

5) Total ultraviolet is considered to be all radiation of wavelength less than 400 nm.

**10.4.3** At appropriate intervals, clean lamp filters by washing with detergent and water. Xenon-arc filters shall be replaced according to the recommendations of the equipment manufacturer.

**10.4.4** The temperature within the exposure apparatus during the dry portion of the cycle shall be controlled by circulation of sufficient air to maintain a constant black standard temperature.

In the xenon arc exposure apparatus, this temperature shall be  $70\text{ °C} \pm 3\text{ °C}$  as indicated by a black standard thermometer<sup>6)</sup> or equivalent. The thermometer is preferably mounted on a support for a test panel in such a way that it receives the same radiation and cooling conditions as a flat test panel surface on the same support. It may also be located at a fixed distance position different from the test specimen distance and calibrated for temperature at the test specimen distance.

**10.4.5** The relative humidity within the exposure apparatus shall be controlled at  $(50 \pm 5)\%$  during the dry portions of the cycle.

**10.4.6** The deionized water used in the spray cycle shall contain less than 1 mg/g silicon dioxide solids and shall leave no permanent deposit or residue on the test specimens which would interfere with subsequent measurements.

**10.4.7** The alkalinity (pH) of the water shall be between 6,0 and 8,0 and the conductivity shall be less than 5  $\mu\text{S}$ .

**10.4.8** The temperature of the water in the line where it enters the exposure apparatus shall be the ambient water temperature.

**10.4.9** The water shall strike the test specimens in the form of a fine spray in sufficient volume to wet the test specimens uniformly, immediately upon impact.

Water spray shall be directed only against the test specimen surface facing the light source. No recirculation of the spray water or immersion of the test specimens in the water is permitted.

**10.4.10** The test specimens shall be rotated about the arc in order to provide uniform distribution of the light. All positions in the exposure apparatus shall be filled with test specimens or surrogates to ensure that a uniform temperature distribution is maintained. Test specimens shall be held in frames with backs exposed to the cabinet environment. However, reflections from cabinet walls shall not be permitted to strike the back surface of specimens. If necessary, samples may be backed to block such reflections so long as free circulation of air at the specimen surface is not impeded.

**10.4.11** The exposure apparatus shall be operated to provide continuous light and intermittent water spray in 2 h cycles. Each 2 h cycle, in accordance with ISO 4892-2, shall be divided into periods during which the test specimens are exposed to light without water spray for 102 min and to light with water spray for 18 min.

## 10.5 Evaluation

After exposure, the test specimens may be cleaned, if necessary, by a practice recommended by their manufacturer to remove any residues present.

Evaluate the exposed test specimens visually with respect to the following properties:

- a) bubbles;
- b) colour<sup>7)</sup>;

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6) The black standard thermometer is described in ISO 4892-1:1999, 5.2.2.1.

7) Colour change may be evaluated optionally by a method given in CIE 15.2:1986, *Colorimetry*.

- c) haze;
- d) noticeable decomposition.

Measure, in accordance with ISO 3537 and ISO 3538, respectively, the resistance to abrasion and luminous transmittance on the exposed side of the specimens.

### **10.6 Expression of results**

Report visual evaluations of exposed test specimens, comparing the appearance of each with that of the unexposed control specimens. If colour is measured instrumentally, compute and report the colour change.

Report the change in luminous transmittance and the change in resistance to abrasion, comparing results of tests on exposed test specimens with results of tests on unexposed control specimens.

### **10.7 Report of test parameters**

Report the following:

- a) the apparatus manufacturer and model number;
- b) the radiation intensity in watts per square meter and wavelength range where this intensity has been determined;
- c) the exposure time, in hours;
- d) the total ultraviolet radiance exposure in joules per square metre;
- e) the temperature within the exposure apparatus during the dry portion of the cycle.

## Bibliography

- [1] ISO 3795, *Road vehicles, and tractors and machinery for agriculture and forestry — Determination of burning behaviour of interior materials*
- [2] ISO 4892-1:1999, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

