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Road vehicles — Safety glazing materials — Test methods for properties of electrically heated glazing

Véhicules routiers — Vitrages de sécurité — Méthodes d'essai pour les propriétés des vitrages chauffés électriquement

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Foreword

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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).

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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*.

Road vehicles — Safety glazing materials — Test methods for properties of electrically heated glazing

1 Scope

This International Standard provides the test methods and acceptance criteria for circuit continuity and heating power, driving visibility, electrical attachment bond performance, electrical attachment bending performance, hot spot identification and heating uniformity, defrosting efficiency, high voltage durability, low temperature performance and long term humidity durability, for all electrically heated safety glazing materials in a road vehicle. This International Standard provides test protocols for the static performance of an electrically heated glazing material; it is not representative of in-vehicle performance.

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

IEC 60051–2, *Direct acting indicating analogue electrical measuring instruments and their accessories, Part 2 — Special requirements for ammeters and voltmeters*

3 Terms and definitions

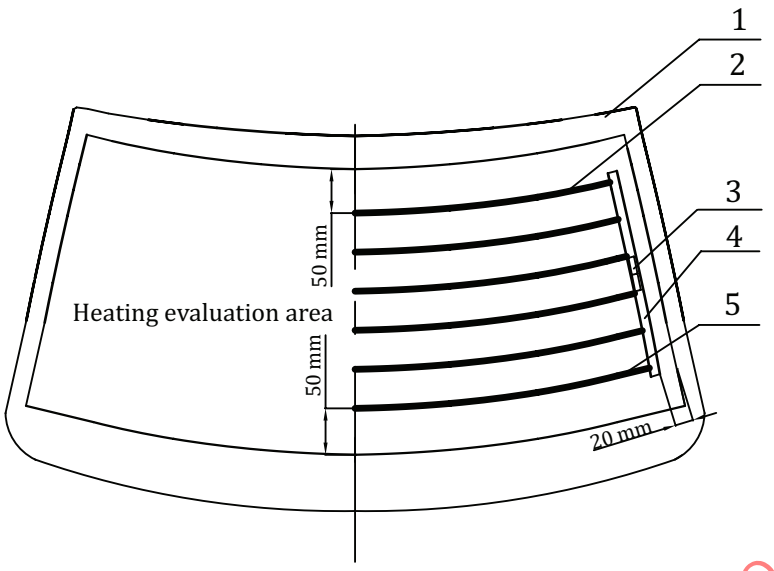
For the purpose of this document, the following terms and definitions apply.

3.1
heating evaluation area
for *Type 1* (3.7), represented by an area formed by outermost conductors at an extended distance of 20 mm wider than the bus bars (along the edges) and extended to 50 mm on both the top and bottom, in the absence of specific requirements and for a glazing equipped with heating circuits formed by evenly distanced conductive lines and bus bars near to the glass edges

Note 1 to entry: If the extended distance is over the edge of the glass, then take the glass edge as the border of evaluation area. The size of this generated area is calculated using CAD, see Figure 1. For other specifically designed heaters with e.g. circular shaped heater, product specification can be referenced for the heating evaluation area.

for *Type 2* (3.8) and *Type 3* (3.9), shall be the same as the area of the heating elements themselves, in the absence of special requirements

Note 2 to entry: No additional area shall be included.



Key

1 glass
2 heating circuits
3 electrical attachment
4 bus bar
5 outmost conductor

Figure 1 — Heating evaluation area of Type 1

3.2
electrical attachment
components used for connecting to the vehicle power supply

3.3
defrosting
elimination of frost from the exterior of the glazing by heating at specified voltage

3.4
melted area
area of the outer glazed surface of the sample having a dry surface or covered with melted frost

Note 1 to entry: Partially melted area is excluded. The melted area shall be determined visually.

3.5
defrosting efficiency
ratio of the melted area to the heating evaluation area after supplying specified voltage for the specified period of time at specified ambient condition

3.6
hot spot
any area on outer surface of the whole part that exceeds the maximum temperature defined in the product specification after the part is supplied with specified voltage for the specified heating time period at the specified ambient condition

3.7
Type 1
heater circuit consisting of conductors applied to the inside surface of a tempered or laminated safety glass or a plastic safety glazing parts by means of a screen print, ink jet, or other method

3.8
Type 2
heater circuit consisting of discrete conductor lines applied to the inside of a laminated safety glazing by incorporation of metal wires or any other suitable method

3.9
Type 3
heater circuit utilizing a transparent conductive film applied to one of the inner surfaces of a laminated safety glazing

4 Specimens

Test specimens can be production parts or test pieces which are upon the agreement between glass manufacturer and its customer.

5 Conditioning of test specimens

Unless otherwise specified, specimens to be tested shall be conditioned prior to testing under the following conditions for at least 4 h:

— ambient temperature: 23 °C ± 2 °C;

— atmospheric pressure: 86 kPa to 106 kPa (860 mbar to 1 060 mbar);

— ambient relative humidity: 60 % ± 20 %.

6 Application of test

For certain types of safety glazing material, some of the tests specified in this International Standard are not appropriate to be applied. Test items and number of test specimens for a certain type of electrically heating glazing are suggested in Table 1.

Table 1 — Test items and number of test specimens

No.	Test item	Subclause	Type			Number of specimens
			1	2	3	
1	Circuit continuity and heating power	7.1	X	X	X	3
2	Driving visibility	7.2	X	X	X	1
3	Electrical attachment bond performance	7.3	X	X	X	3
4	Electrical attachment bending performance	7.4	X	—	—	3
5	Hot spot identification and heating uniformity	7.5	X	X	X	1
6	Defrosting efficiency	7.6	X	X	X	1
7	High voltage durability	7.7	X	X	X	3
8	Low temperature performance	7.8	—	X	X	3
9	Long term humidity durability	7.9	X	X	X	3

X Test required.

— Test needs not to be carried out.

7 Requirements

7.1 Circuit continuity and heating power

7.1.1 Purpose of test

The purpose of this test is to determine whether the heating system circuit has the correct continuity between elements and heating power conforms to the product specification.

7.1.2 Apparatus

7.1.2.1 Variable direct current (DC) power supply, rated at a minimum of two times the voltage and two times the current specified for the parts to be tested.

7.1.2.2 Voltage meter, conforming to IEC 60051-2, with an Accuracy Class of 1.

7.1.2.3 Ampere meter, conforming to IEC 60051-2, with an Accuracy Class of 1.

7.1.2.4 Heat sensitive paper.

7.1.2.5 Projector, conforming to ISO 3538.

7.1.2.6 Thermal camera, with range of 0 °C to 100 °C, accuracy of ±0,5 °C, capable of measuring and recording surface of the tested area with a spatial resolution of 2 mm. The thermal camera emissivity can be adjusted to a level appropriate to glass substrate.

7.1.3 Procedure

7.1.3.1 Circuit continuity

For Type 1 parts, supply the voltage defined in product specification to the electrical attachments of the part. Lay heat sensitive paper across the heating line/conductor. Optionally, use a thermal camera to check the part after power is supplied.

For Type 2 parts, supply the voltage defined in product specification to the electrical attachments of the part. Set the part vertically between the projector and a display screen. Light is projected through the part to the display screen. Wires with light shadow on the screen are broken wires.

For Type 3 parts, supply the voltage defined in product specification to the electrical attachments of the part, record value of ampere meter.

7.1.3.2 Heating power

In the absence of special requirements, heat the part for 30 min, and read the electrical current value shown on the ampere meter.

7.1.4 Expression of results

7.1.4.1 Circuit continuity

For Type 1 parts, check the colour change in the paper or in thermal camera due to heat. Make record of broken heating line/conductor.

For Type 2 parts, check the shadow of the part on the screen. Make record of broken wire position on the part.

For Type 3 parts, calculate the resistance according to the voltage measured at the attachments and the corresponding current as measured in 7.1.3.2, and determine the continuity.

7.1.4.2 Heating power

Calculate the heating power as the product of the voltage measured at the electrical attachments and the corresponding current measured in 7.1.3.2.

7.2 Driving visibility

7.2.1 Purpose of test

The purpose of this test is to determine whether driving visibility of the heated glass meets the requirements of the product specification.

This test is applicable only for parts whose transparent area is heated.

7.2.2 Apparatus

7.2.2.1 Steel ruler and reading microscope, with respective accuracy of 0,5 mm and 0,001 mm.

7.2.3 Procedure

For Type 1 parts, measure the width and length of heating lines/conductors, and the distance between two adjacent lines/conductors.

For Type 2 parts, measure the wire width or diameter, and calculate the number of wires per centimetre in cross direction.

For Type 3 parts, measure luminous light transmittance according to ISO 3538.

Regardless of the heating conductor type, all parts used as windscreen shall also have secondary image and optical distortion measured according to ISO 3538 while specified voltage being applied.

7.2.4 Expression of results

For Type 1 part, the driving visibility is expressed as the maximum width of conductors, minimum distance between two adjacent conductors, and the ratio of the total opaque wires area to heating evaluation area.

For Type 2 part, driving visibility is expressed as the width or diameter of wire and wire density (wires/cm).

For Type 3 part, driving visibility is expressed as the luminous light transmittance according to ISO 3538.

All windscreen parts shall have the levels of optical distortion and secondary image recorded while the specified voltage is applied.

7.3 Electrical attachment bond performance

7.3.1 Purpose of test

The purpose of this test is to determine whether the electrical attachments meet the requirements of the product specification after being subjected to mechanical forces.

7.3.2 Apparatus

7.3.2.1 Force meter with accuracy of 0,1 N.

7.3.2.2 Stopwatch.

7.3.3 Procedure

Apply the force to the electrical attachment as defined in product specification; maintain the force for 30 s.

Check the circuit continuity and calculate the heating power according to 7.1 after pulling.

7.3.4 Expression of results

Record circuit continuity, heating power, and mechanical damage of the attachment after pulling.

7.4 Electrical attachment bending performance

7.4.1 Purpose of test

The purpose of this test is to determine whether the electrical tag attachments attached directly to the surface of the glass meet the requirements of the product specification after being bent a specified number of times.

This test is only applicable for the flexible tag attachment.

In the absence of customer specific requirements for bending, the following procedure is to be followed.

7.4.2 Procedure

Bend the electrical tag attachments forward or backward in an angle of 45° ± 2° five times within 10 s, but not less than 8 s. Figure 2 gives two examples for one time bending.

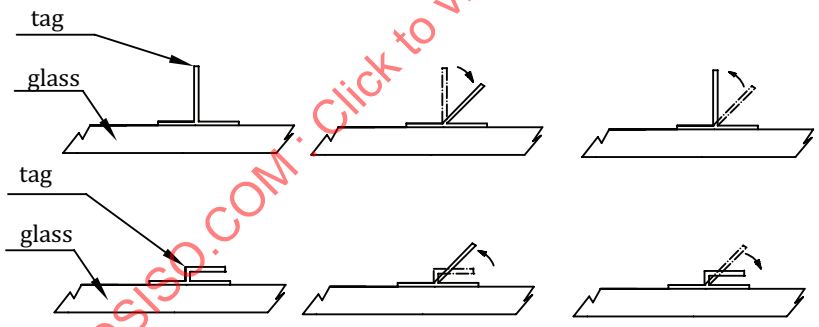


Figure 2 — One time bending (forward and backward)

7.4.3 Expression of results

Record mechanical damage of the tag attachment after bending.

7.5 Hot spot and heating uniformity

7.5.1 Purpose of test

The purpose of this test is to determine whether the test part meets the requirements of the product specification after having been heated for a specified period of time.

7.5.2 Apparatus

7.5.2.1 Thermal camera, with range of 0 °C to 100 °C and accuracy of ±0,5 °C, capable of measuring and recording surface of the tested area with a spatial resolution of 2 mm. The thermal camera emissivity can be adjusted to a level appropriate to glass substrate.

7.5.3 Procedure

This test shall be carried out at ambient temperature of 23 °C ± 2 °C, or as defined in the product specification.

Connect part to the power supply specified in 7.1.2.1, supply the voltage defined in product specification to the electrical attachments of the part.

In the absence of special requirement, heat the part for 30 min. Observe the temperature on the whole part from the outer surface, and if any hot spots are observed, mark their locations on the whole part, take and save a photograph. Mark the highest temperature and lowest temperature on the heating evaluation area as defined in 3.1, take and save the photograph.

7.5.4 Expression of results

The hot spot, if applicable, is expressed as the location where the temperature exceeds the product specification on the outer surface of the whole part. The heating uniformity is expressed as the difference between the highest and lowest temperature found in the heating evaluation area as defined in 3.1.

7.6 Defrosting efficiency

7.6.1 Purpose of test

The purpose of this test is to determine whether the heating system's ability to remove frost from exterior surface of the glazing, at low temperature, meets the requirements of the product specification.

In the absence of a customer specific requirement, the following procedure is to be followed.

7.6.2 Apparatus

7.6.2.1 Low temperature chamber, having temperature accuracy of 2 °C.

7.6.2.2 Sprayer (see Table 2).

7.6.2.3 Support frame, with thermal insulation and the ability to support the part at the design installation angle.

Table 2 — Spray-gun characteristics

Characteristics	Specifications
Nozzle diameter	1,7 mm
Operating pressure	(350 ± 20) kPa
Nominal flow rate	395 ml/min
Projection cone diameter at 200 mm from nozzle	300 mm
NOTE 1 kPa = 10^{-2}bar.	

7.6.3 Procedure

Install the part on the support frame to match the actual status on the vehicle, put the part together with the support into low temperature chamber.

The air velocity of the cooling chamber shall be measured immediately prior to the test at a point located 300 mm ahead of the part geometric centre. The value of this component shall be as low as possible and in any case less than 3 km/h. In the absence of special requirements, cool the chamber to −18 °C ± 3 °C, maintain the temperature of the chamber and test part for 1,5 h.

Spray water evenly on to the part exterior surface, at a right angle to the part surface, with a 200 mm distance between the nozzle and part. Form an even frost coating of 0,044 g/cm^2 ± 0,004 g/cm^2 on part outer surface and check the homogeneity of the frost coating visually. The water can be sprayed several times. Once the water flow can be seen on the part surface, keep the part at −18 °C ± 3 °C for 5 min, then continue to spray until the sprayer is empty.

The mass of water shall be prepared and sprayed according to the required frost coating, taking care that no water is lost e.g. by dropping from the test piece.

After spraying is complete, keep the part at −18 °C ± 3 °C for at least 1 h.

Connect the part to the DC power specified in 7.1.2.1, in the absence of special requirements, supply the voltage defined in product specification to the electrical attachments of the part for up to 30 min. Photograph the part at the beginning of the test and every minute thereafter. Record the voltage across the part electrical attachments and the current through the part every minute. Record the time at which the heating evaluation area is clear of frost (without the use of a wiper). Stop the test within 1 min after the part has fully defrosted or at 30 min, whichever comes first.

7.6.4 Expression of results

If the heating evaluation area is totally clear of frost before 30 min is reached, the defrosting efficiency is expressed as 100 %. Otherwise, use the photo at 30 min to calculate the defrosting efficiency.

The defrosting efficiency is expressed by the ratio of the melted area to the heating evaluation area, as given in Formula (1):

$$T_D = \left(\frac{D_2}{D_1}\right) \times 100 \quad (1)$$

where

T_D is the defrosting efficiency (%);

D_1 is the heating evaluation area (cm^2);

D_2 is the melted area (cm^2).

7.7 High voltage durability

7.7.1 Purpose of test

The purpose of this test is to determine whether the part meets the requirements of the product specification after being supplied with high voltage for a specified period of time.

7.7.2 Procedure

Connect the part to the DC power specified in 7.1.2.1, in absence of special requirements, supply two times the nominal voltage defined in product specification to the electrical attachments of the part for 1 min.

Check the circuit continuity and calculate the heating power according to 7.1.

