BRITISH STANDARD

BS EN
15152:2007

Railway applications — Front windscreens for train cabs

The European Standard EN 15152:2007 has the status of a British Standard

ICS 45.060.10

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 15152:2007.

The UK participation in its preparation was entrusted by Technical Committee RAE/1, Railway applications, to Panel RAE/1/-/2, Structural requirements and welding.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

This document (EN 15152:2007) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This document shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2008 and conflicting national standards shall be withdrawn at the latest by February 2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directives 96/48 as modified by EU Directive 2004/50.

For relationship with EU Directive 96/48, see informative Annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies the functional requirements for cab windscreens of high speed trains including testing and conformity assessment. The same requirements can be applied to the windscreens of other types of rolling stock if some of the performance criteria are adjusted to suit the application. Such changes should be based on national standards or infrastructure controller's regulations where they exist.

This European Standard does not specify all interfaces between the windscreen and the vehicle.

This European Standard does not apply to the renewal of windscreens of high speed rolling stock already in operation.

2 Normative references

The following referenced documents are indispensable for the application 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.

EN 2155-9, *Aerospace series — Test methods for transparent materials for aircraft glazing — Part 9: Determination of haze*

EN 50125-1, *Railway applications — Environmental conditions for equipment — Part 1: Equipment on board rolling stock*

EN ISO 4892 (all parts), *Plastics — Methods of exposure to laboratory light sources*

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

ISO 3538:1997, *Road vehicles — Safety glazing materials — Test methods for optical properties*

ISO 6362-2:1990, *Wrought aluminium and aluminium alloy extruded rods/bars, tubes and profiles — Part 2: Mechanical properties*

CIE 15:2004, *Colorimetry*[1)]

CIE 38:1977, *Radiometric and photometric characteristics of materials and their measurement*[1)]

CIE S 004:2001, *Colours of light signals*[1)]

3 Terms and definitions

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

3.1
high speed train
train which is designed to operate at speeds equal to or greater than 190 km/h

NOTE This includes Class 1 and Class 2 high speed trains as defined in the HS TSI RS.

1) To be purchased from: International Commission of Illumination, CIE Central Bureau, Kegelgasse 27, A-1030 Wien.

3.2
windscreen
transparent pane built wholly or partly into external walls or doors positioned transversely to the running direction and used for observing the tracks and signals ahead of the train

3.3
primary vision area (area A)
area of the windscreen through which track and signals shall be visible from the driving position

3.4
secondary vision area (area B)
area of the windscreen outside the primary vision area through which the driver may also be required to look

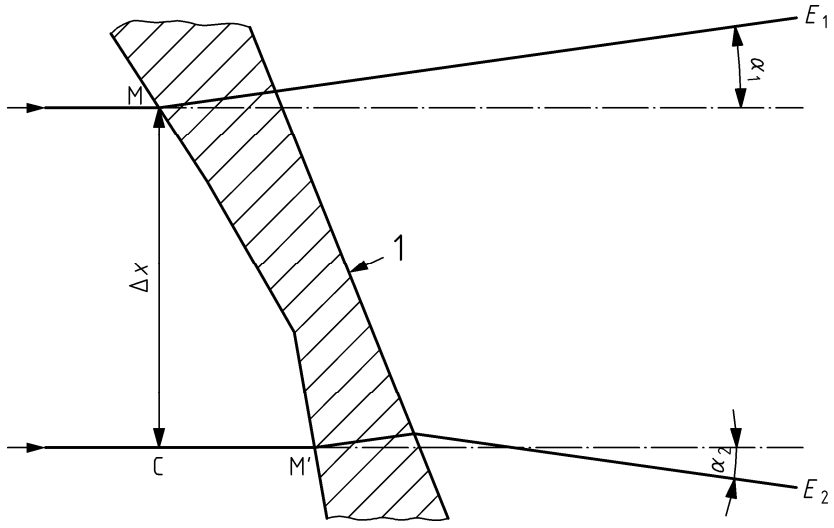
3.5
peripheral area (area C)
area of the windscreen outside the secondary vision area

3.6
secondary image separation
angular separation between the primary and the brightest secondary images (due to internal reflection) of a distant light source or object when viewed through a windscreen

3.7
optical distortion (in a given direction)
algebraic difference $\Delta\alpha$ in angular deviations α_1 and α_2 measured between two points M and M' on the surface of the windscreen, the distance between them being such that their projections on a plane at right angles to the direction of vision are separated by a given distance Δx (see Figure 1).

NOTE 1 α_1 - α_2 is the optical distortion in the direction MM'. The sign of the angles shall be considered to achieve a correct value of $\Delta\alpha$. Δx = MC is the distance between two straight lines parallel to the direction of vision, and passing through the points M and M'.

NOTE 2 Anti-clockwise deviation should be regarded as positive, and clockwise deviation as negative.



Key

1 windscreen

Figure 1 — Diagrammatic representation of optical distortion

[ISO 3538:1997]

3.8
Ultra-Violet radiation
electromagnetic radiation of a wavelength shorter than that of visible light and which, for the purposes of this document, is described as having wavelengths between 200 nm and 400 nm

3.9
spalling
particles or pieces of the inner ply of the windscreen that may be propelled into the cab as a result of an object striking the outside surface

4 Functional requirements

4.1 General

The windscreen shall be able to withstand the normal operational conditions including environmental conditions according to EN 50125-1.

The peripheral area may be deliberately obscured (in whole or in part) e.g. by silk-screen printing for any of the following reasons:

— aesthetic purposes;

— elimination of distracting items from the driver's field of vision;

— for windscreens that are glued into position, to protect the glued area, if necessary, from the effect of Ultra-Violet (UV) radiation. In this case, the obscuration shall not permit more than 0,1 % of incident UV light to reach the glued area.

4.2 Specific performance requirements

4.2.1 General

The windscreen has three optical areas:

— A: primary vision area;

— B: secondary vision area;

— C: peripheral area.

The extent of these areas is described in 5.2.

4.2.2 Secondary image separation

In the case of more than one secondary image, a maximum of one secondary image is to be evaluated. The image to be considered is that which appears brightest to an observer looking through the windscreen from the driving position.

The secondary image separation shall not exceed:

— maximum 15 min of arc in area A;

— maximum 25 min of arc in area B.

See 6.2.1 for the test method.

4.2.3 Optical distortion

The limit of optical distortion shall be:

— maximum 2 min of arc in area A;

— maximum 6 min of arc in area B.

See 6.2.2 for the test method.

4.2.4 Haze

The maximum value of haze shall be 2,5 % for a new windscreen.

See 6.2.3 for the test method.

4.2.5 Luminous transmittance

The minimum value of luminous transmittance for areas A and B shall be:

65 % when viewed horizontally through the windscreen in its mounted position.

See 6.2.4 for the test method.

4.2.6 Chromaticity

The windscreen shall not affect the colour of light transmitted through the windscreen to an extent that will cause the driver to misread signals.

The minimum requirement for this European Standard is that the windscreen shall not cause a colour shift so that a red signal lamp observed to lie within coordinates of the CIE 1931 Colour Diagram as illustrated in CIE S 004 (0,700; 0,295), (0,705; 0,295), (0,720; 0,280), (0,715; 0,280) would appear, when viewed through the windscreen, to lie outside a zone with co-ordinates (0,680; 0,305), (0,695; 0,305), (0,730; 0,270), (0,715; 0,270).

See 6.2.5 for the test method.

If an additional requirement to support recognition of yellow signals is specified for the train to which the windscreen is to be fitted, then the further criterion shall be as follows:

The windscreen shall not cause a colour shift such that a yellow signal lamp observed to lie within co-ordinates (0,590; 0,410),(0,575; 0,410),(0,612; 0,382),(0,618; 0,382), would appear, when viewed through the windscreen, to lie outside a zone with co-ordinates (0,560; 0,440),(0,546; 0,426),(0,612; 0,382),(0,618; 0,382).

4.2.7 Impacts

The windscreen shall be able to resist the impact of an object accidentally or deliberately hitting the windscreen.

This shall be demonstrated by the test requirements as defined in 6.2.6.

4.2.8 Residual visibility after breakage

The windscreen, when impacted or cracked under requirement 4.2.7, shall remain in its position and have sufficient residual visibility for the train to be driven to a place of safety.

4.2.9 Spalling

The driver shall be protected from spalling.

This shall be demonstrated by the test requirements as defined in 6.2.7.

4.2.10 Resistance against abrasion

The interior and exterior surface materials of a windscreen shall be able to withstand abrasion. The resulting change of haze after abrasion shall not exceed 2 % for the test of the outside surface and 8 % for the test of the inside surface.

The test requirements are defined in 6.2.8.

4.2.11 Resistance against fire

The design of the windscreen shall be such as to minimise the risk of combustion or production of toxic smoke. If the relevant fire protection requirements of applicable European or national standards are not technically achievable with functionally suitable materials, then it is acceptable to use state-of-art products until and unless a suitable compliant material is developed. The supplier shall demonstrate to a responsible certification body that any such products used are indeed suitable in accordance with this clause.

4.2.12 Resistance to repeated impact from small particles (gravelling)

The risk of this type of damage will vary according to train speed, the aerodynamic conditions on the exterior of the driving cab and the construction of the infrastructure on which the train will operate. It is therefore the choice of the customer whether to demand that resistance to gravelling is demonstrated.

If a resistance to gravelling is required, then the test requirements shall be as defined in 6.2.9.

4.3 Additional requirements

4.3.1 Appearance

4.3.1.1 General

Appearance defects (blemishes) are specifically characteristics of one of the following elements of the windscreen:

— glass;

— interlayer;

— anti-spall layer;

— assembly;

— handling.

To ensure an acceptable quality of vision to the driver, the number and size of such defects shall not exceed the limits listed in 4.3.1.3.

See 6.3.1 for the test methods.

4.3.1.2 Definition and classification of defects

Defects are divided into three categories according to their importance:

— negligible;

— minor;

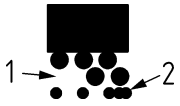
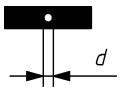
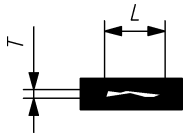
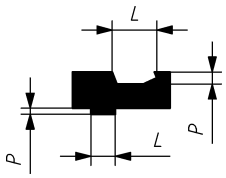
— major.

Table 1 is used to classify defects according to their characteristics.

Table 1 — Classification of defects

	Negligible	Minor	Major
Point defects			
Bubble: Air pocket, sometimes coloured entrapped in glass	$d \leq$ 0,8 mm	0,8 mm < $d \leq$ 2 mm	d > 2 mm
Impurities: Small impurity in glass or interlayer, or an embedded particle	$d \leq$ 0,8 mm	0,8 mm < $d \leq$ 2 mm	d > 2 mm
Spot: Local translucent area on interlayer	$d \leq$ 0,8 mm	0,8 mm < $d \leq$ 2 mm	d > 2 mm
Surface defect: Blemish caused by minor impact or abrasion (e.g. between two sheets of material during storage)	$d \leq$ 0,8 mm	0,8 mm < $d \leq$ 2 mm	d > 2 mm
Anti-spall layer specific defects			
Skin blister: Localised deformation of the transparent surface	$d \leq$ 1,5 mm	1,5 mm < $d \leq$ 3 mm	d > 3 mm
Cord: A relatively thick and very obvious thread of material	$L \leq$ 5 mm	5 mm < $L \leq$ 10 mm	L > 10 mm
Coating drip: Uneven thickness of final coating	$d \leq$ 5 mm	5 mm < $d \leq$ 10 mm	d > 10 mm
Linear defects: Defects where the length to width ratio is high. The dimension given is the direct distance between the extremities of the defect.			
Scratch, chipped scratch: Superficial scratch, rectilinear or curvilinear, with shelling to each side of the scratch	–		All dimensions
Fine scratch or other linear defect detectable by touch	$d \leq$ 13 mm	13 mm < $d \leq$ 40 mm	d > 40 mm
Hairline scratches hardly detectable by touch but visible on the surface	All dimensions	–	
Print of attenuated (repaired) scratch	$d \leq$ 13 mm	13 mm < $d \leq$ 40 mm	d > 40 mm
Lint, fibre, hair: Elongated impurity entrapped between glass ply and interlayer when laminating	$d \leq$ 13 mm	13 mm < $d \leq$ 40 mm	d > 40 mm
Streak, mark (drag) trace: Whitish area in the interlayer, hardly detectable under daylight condition	Any dimension, but one that does not attract the eye at 3 m from the product	If attracting the eye at 3 m from the product and having total surface ≤ 8 cm²	If attracting the eye at 3 m from the product and having total surface > 8 cm²

Table 1 (*concluded*)

	Negligible	**Minor**	**Major**
Edge defects: These defects shall never extend beyond the peripheral area.			
Tong marks: Impressions made in glass by the tips of the tongs used to suspend the glass during tempering which induce a local deformation, iridescence and hairline scratches	Disregarded		
Bending tool mark: Impressions made in glass in the peripheral area by the bending tool	Disregarded		
Shell, chips: Small loss of glass fragment, at the edge, not totally eliminated by grinding. However, sharp edges that may cause injury when fitting the windscreen shall not be accepted. The grinding to eliminate these defects can extend up to 10 mm from the edge of the glass	$d \leq$ 1mm	1 mm < $d \leq$ 2mm	$d >$ 2mm
Silk-screen printing special defects			
Impurities under silk screen:	$d \leq$ 1,5 mm	1,5 mm < $d \leq$ 3 mm	$d >$ 3 mm
Dot fade-out: Visual inspection shall confirm that the uniformity of the dot fade-out pattern is acceptable and any irregularity does not attract the eye at 3 m from the product	 **Key** 1 hole, 2 dividing point		
Solid colour surface:			
Circular-type defect: 	$d \leq$ 2 mm	2 mm < $d \leq$ 4 mm	$d >$ 4 mm
Linear defect: $S = L \times T$ 	$S \leq$ 20 mm² with $T \leq$ 0,5 mm	20 mm² < S ≤ 80 mm² with $T \leq$ 1 mm	$S >$ 80 mm²
Defects on the edge of the solid colour surface:			
Inner edge (nearest to vision area): Outer edge:	$P \leq$ 2 mm and $L \geq$ 40 mm $P <$ 5 mm	2 mm < $P \leq$ 3 mm and 10 mm < $L \leq$ 40 mm $P =$ 5 mm peripheral	$P >$ 3 mm and $L <$ 10 mm $P >$ 5 mm

4.3.1.3 Defect acceptance criteria

The level of defect on a new windscreen shall not exceed the limits set out in Table 2.

Table 2 — Defect acceptance limits

Vision area	Classification of defect		
	Negligible	Minor	Major
Area A	Disregarded See [a]	A maximum of 3 defects of any type within any circular area of d = 300 mm	0
Area B	Disregarded See [a]	A maximum of 3 defects within any circular area of d = 100 mm	0
Area C	See [b]	See [b]	See [b]
Printed Area	See [c]	A maximum of 3 defects inside any region of length 100 mm	0

[a] The accumulation of these disregarded defects shall not impair useful vision.

[b] Appearance defects shall only be tolerated provided they do not impair the mechanical properties of the windscreen.

The following defects are allowed in Area C only:

— irregularity in external dimension of individual layers (maximum 5 mm/edge);
— bubbling;
— delamination;
— opacity of the interlayer

with a total surface area of these defects to be less than 2 % of the peripheral zone surface.

[c] In areas used for bonding of glued windscreens the accumulation of disregarded defects shall not permit average Ultra Violet transmittance of more than 0,1 % when a glue protection is specified.

4.3.2 Heating system

4.3.2.1 General

If an integral heating system is specified by the customer, it can be provided by an electric system using:

— coating;

— wires

embedded in the windscreen.

At the minimum such a heating system shall be effective across the primary vision area of the windscreen.

The specification from the customer shall contain either of the following information:

— range of ambient service temperature;

— effective supply voltage;

— variation of supply voltage that the heating system shall sustain without damage;

— time to de-ice at nominal voltage (if requested);

— surface area to de-ice or demist;

— maximum power allowable (if necessary);

or

— specific power;

— nominal supply voltage;

— variation of supply voltage that the heating system shall sustain without damage;

— surface area to de-ice or demist.

Total power (W) is defined by specific power (W/dm^2) multiplied by the heated surface (dm^2).

The windscreen manufacturer shall declare:

— specific power;

— time to de-ice (if requested);

— total resistance (± 15 %) at 20 °C ambient temperature;

— total power.

NOTE All calculations are made assuming that the train is stationary in still air.

4.3.2.2 Coating

4.3.2.2.1 General

In the event that a heating system generates a flux line between two heating zones, a flux line is permitted but shall be colourless and no more than 1 mm width. Location of such flux lines shall be agreed by the customer at the design stage and shown on drawing.

4.3.2.2.2 Defect acceptance criteria

Observable irregularities in the heated area generated by hot points within the coating shall not exceed the figures given in Table 3.

Table 3 — Permitted defects in the heated area

Defect diameter x	Number
x ≤ 5mm	unlimited
x ≤ 10 mm	3
x > 10mm	0
The accumulation of permitted defects shall not prevent useful vision.	

4.3.2.3 Defect acceptance criteria of wires

Irregularities due to defective electrical continuity shall not exceed:

— maximum two non-heated zones ≤ 15 mm wide, at least 45 mm apart or a single non-heated zone ≤ 20 mm wide;

— non heated or over heated zone ≤ 5 mm wide;

The accumulation of permitted defects shall not impair the optical properties or prevent useful vision.

See 6.3.2 for the test methods.

4.3.2.4 Flash test

In order to prove the electrical insulation of the heating zone in relation to the edge of the window, a withstand voltage test is carried out.

The current leakage during the test shall be no more than 5 mA.

See 6.3.2 for the test methods.

4.3.3 Marking

The windscreen shall be permanently marked. The marking shall be readable from inside the cab.

When there are no conflicting requirements, the marking shall be in the upper right hand corner.

As a minimum, the following information shall be included in the marking:

— name or logo of supplier;

— date of manufacturing (month and the last two numerals of the year or a code by which this information can be identified);

— serial number;

— nominal voltage of the heater (if applicable);

— total power of the heater (if applicable).

4.3.4 Resistance against ageing

Tests as specified in 6.3.3 shall be conducted on samples with the same composition as the windscreen material to verify that the structural and optical characteristics of the windscreen will not degrade prematurely when in service.

5 External visibility requirements

5.1 General

The windscreen shall be dimensioned to enable the driver to observe the track and stationary trackside signals correctly.

The windscreen shall be oriented and installed in the driving cab so that it minimizes reflections of the cab interior which may distract or confuse the driver.

The visibility requirements shall be verified at the design stage in conjunction with the design of the driving cab, and at the construction stage when the windscreen is installed in the vehicle standing on straight and level track.

5.2 Optical areas

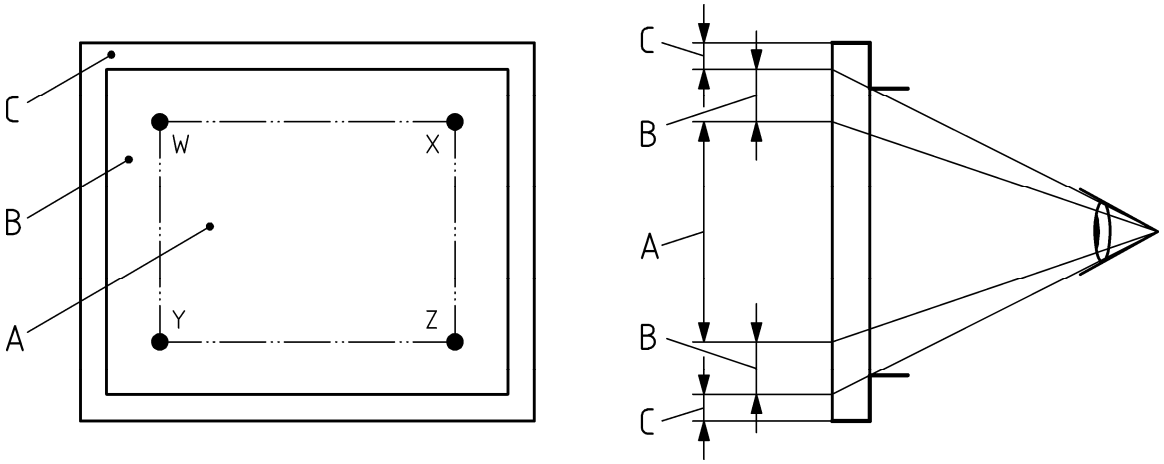
The windscreen has three optical areas as shown in Figure 2:

— A: primary vision area;

— B: secondary vision area;

— C: peripheral area.

The exact shape of these areas can vary according to the geometry of the windscreen design.



Key

Area A primary vision area
Area B secondary vision area
Area C peripheral area

Figure 2 — Windscreen optical areas

The four points W, X, Y and Z are the result of the intersection of the windscreen and the required sight lines between the driver's eyes and the extreme positions of signals that the driver is required to observe. These points are connected to each other by a line as in the diagram above.

6 Test methods

6.1 General

If a windscreen is fitted with a heating device, all tests of optical properties that may be affected by temperature shall be conducted with and without the heating device in use. This requirement does not apply to additional start-up heating provided for use on a stationary vehicle to accelerate the removal of ice or snow.

6.2 Test methods for specific performance requirements

6.2.1 Secondary image separation

Tests are to be conducted according to ISO 3538.

See 4.2.2 for the product requirements.

6.2.2 Optical distortion

Tests are to be conducted according to ISO 3538.

See 4.2.3 for the product requirements.

6.2.3 Haze

Tests are to be conducted according to EN 2155-9.

See 4.2.4 for the product requirements.

6.2.4 Luminous transmittance

Tests are to be conducted according to CIE 38, illuminant A.

NOTE The customer may additionally require that the transmittance is confirmed by measurement in situ in the vehicle or in a test rig at the actual angle of installation.

See 4.2.5 for the product requirements.

6.2.5 Chromaticity

Conformity with the requirements of 4.2.6 may be confirmed either:

a) by direct measurement using a suitable red (and yellow if required) light source(s), or

b) by calculation from a spectrographic analysis of white light.

Colour shift shall be assessed using the CIE 1931 Colour Diagram as illustrated in CIE S 004/E-2001, Figure 1.

The test may be done using a full windscreen or using a sample that has the same composition (including heating system if fitted) as the complete windscreen.

6.2.6 Impacts

6.2.6.1 Standard impact test

The windscreen shall be impacted with a cylindrical projectile with a hemispheric tip, the whole weighing $1\,000_{0}^{+20}$ g and designed as shown in the Annex A.

The test of the windscreen will be deemed satisfactory if the test projectile does not penetrate the windscreen and the windscreen remains in its frame.

A new projectile shall be used for each shot.

For the test, the windscreen shall be fixed in a frame of the same construction as that mounted on the vehicle. The number of tests shall be four and all have to be deemed satisfactory. Two tests shall be conducted with the complete windscreen at (0 ± 0,5) °C and two tests shall be conducted with the complete windscreen at (20 ± 5) °C.

For the tests to be valid it shall be demonstrated that the core temperature of the complete windscreen during each test is within the required temperature range.

The test windscreen shall be mounted at the same angle to the projectile path as it will be to the direction of travel when mounted on the vehicle.

The projectile's impact velocity shall be determined by:

$$v_p = v_{max} + 160 \text{ km/h} \quad (1)$$

NOTE If required by the national safety authority, the 160 km/h may be increased to the maximum speed of passing trains if they operate with side windows that can open.

where

v_p is the velocity of the projectile in km/h on impact;

v_{max} is the maximum velocity of the train set in km/h.

The projectile velocity shall be measured within 4 m of the point of impact.

The point of impact shall be at the geometrical centre of the windscreen.

See 4.2.7 for the product requirements.

6.2.6.2 Use of representative samples for the testing of large windscreens

Testing of windscreens having dimensions greater than 1 000 mm × 700 mm may be undertaken using a flat sample having the same composition as the intended full windscreen. The manufacturer shall demonstrate via a technical report that testing using a flat sample is sufficient to verify compliance of the windscreen with the requirements of this European Standard.

Such sample testing is only permitted if:

— no surface of the windscreen curves in any plane has a radius less than 2 500 mm;

— when a complete, finished, windscreen is laid (convex side uppermost) on a flat horizontal surface, the distance, (measured perpendicularly to the flat surface) between the flat surface and the inside face of the windscreen is not greater than 200 mm.

The minimum size of the sample shall be 1 000 mm × 700 mm.

6.2.7 Spalling

The spalling test is verified during the tests of impacts of projectiles defined in 6.2.6.1.

An annealed aluminium sheet of maximum thickness 0,15 mm and of dimension 500 mm by 500 mm is placed vertically behind the sample under test, at a horizontal distance of 500 mm from the point of impact in the direction of travel of the projectile.

The spalling test shall be deemed satisfactory if the aluminium sheet is not marked.

See 4.2.9 for the product requirements.

6.2.8 Resistance against abrasion

Tests are to be conducted according to ISO 3537. The number of test cycles shall be 1 000 for the outside surface and 100 for the inside surface. A single separate sample shall be tested for each surface.

See 4.2.10 for the product requirements.

6.2.9 Gravelling impact resistance

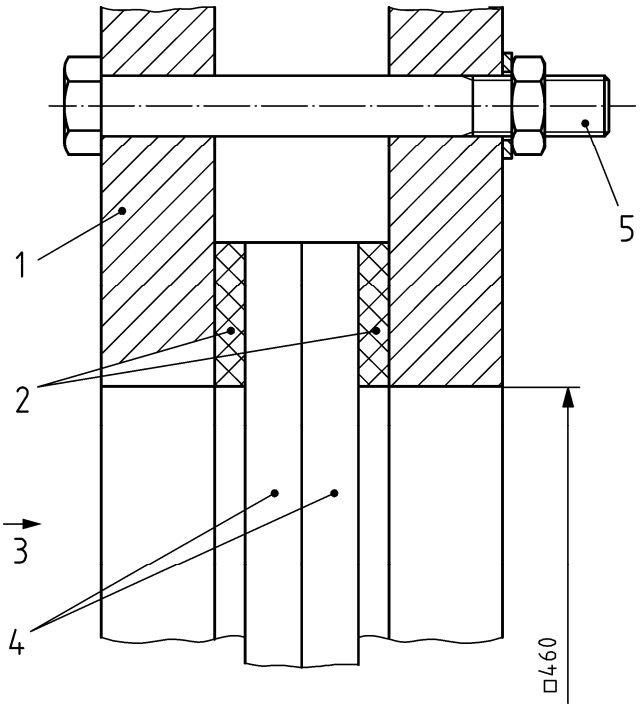
6.2.9.1 Test piece mounting

The test piece shall be placed on a rigid steel mounting with a cut-out of size 460 mm × 460 mm, and an outer frame holding the test piece on all four sides (see Figure 3).

A strip of hard (50 D.I.D.C. or 46 Shore) neoprene 2 mm thick and 20 mm wide shall be placed between the mounting, the outer frame and the test piece. The glass shall be thus secured to a depth of 20 mm.

The outer frame shall be fitted and held in position so as to hold the test piece securely without deforming it, with at least two fastening points on each side.

Dimensions in millimetres



Key

1 outer frame
2 neoprene strips
3 direction of impact
4 test piece
5 mounting

Figure 3 — Test piece holder

6.2.9.2 Projectile

The projectile (see Figure 4) shall be made of aluminium alloy according to ISO 6362-2:1990, grade 2017A, with a nominal weight of 20 g and dimensions as shown in Figure 4.

Dimensions in millimetres

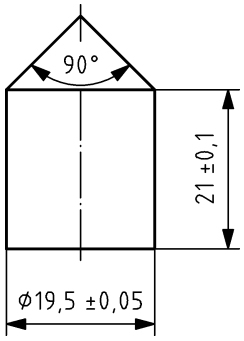


Figure 4 — Projectile

6.2.9.3 Test piece

The nominal dimensions of the test piece shall be (500 mm ± 2,5 mm) × (500 mm ± 2,5 mm).

6.2.9.4 Test method

Three samples shall be tested.

Projectiles shall be fired at the temperature of (20 ± 3) °C, after the test pieces have been kept at 20 °C for 24 h.

The projectile shall be fired at 90° to the laminated glass unit, at its centre, with the point forwards.

The firing distance shall be 5,5 m from the gun muzzle to the point of impact. The projectile's speed shall be measured at 2,5 m from the gun muzzle.

6.2.9.5 Results

The effect of the impacts shall be evaluated visually.

Compliance is demonstrated if the outer layer of the windscreen sample does not break at a projectile speed 20 km/h greater than the design speed of the train: (v_{max} + 20) km/h.

See 4.2.12 for the product requirements.

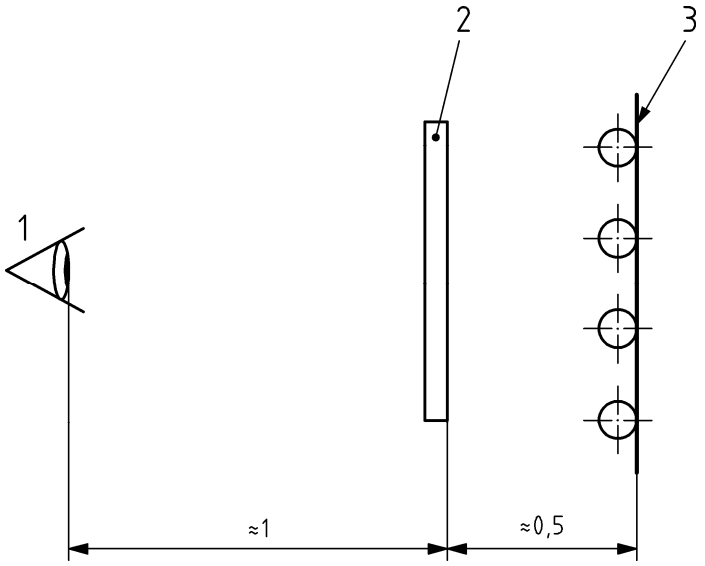
6.3 Test methods for additional requirements

6.3.1 Test methods for appearance

6.3.1.1 Luminous board method

A dark background illuminated by fluorescent tubes 250 mm to 350 mm apart is observed (1 000 Lux to 1 500 Lux). The inspection is made looking from the inside to the outside of the windscreen (see Figure 5).

Dimensions in metres

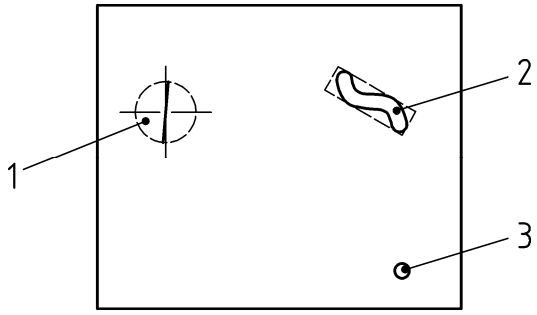


Key

1 observer's eye
2 glass
3 fluorescent tube on dark surface

Figure 5 — Luminous board method

This method is used to identify defects (see examples in Figure 6) which are then measured with a calibrated magnifying glass.



Key

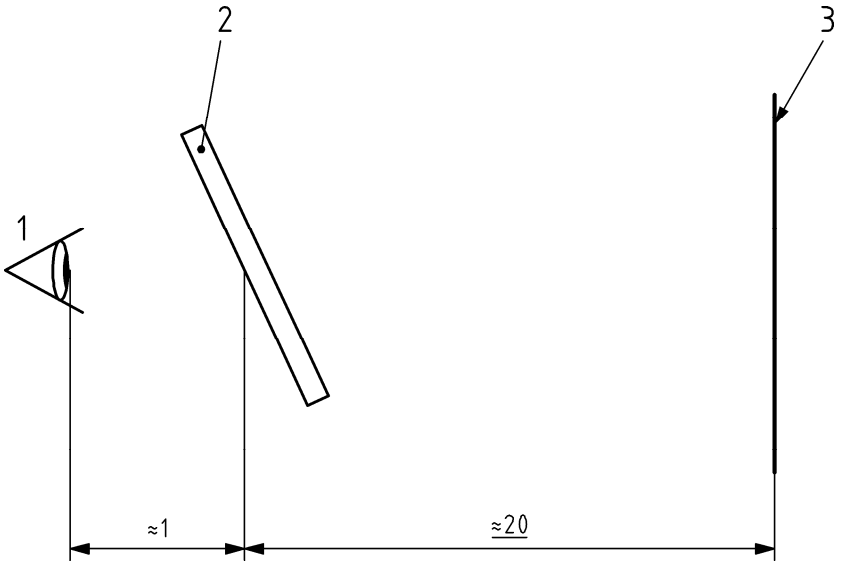
1 scratch inside diameter as specified in Table 1
2 streak, mark trace inside a rectangle as specified in Table 1
3 impurity, bubble inside a diameter as specified in Table 1

Figure 6 — Examples of defects

6.3.1.2 Direct observation of a landscape in daylight

The observation shall be made by looking through the product to a distant landscape with contrasts. The windscreen is inspected as if in its installed position. The observer shall move his head in order to look through all areas being considered.

Dimensions in metres



Key

1 observer's eye
2 glass
3 landscape

Figure 7 — Direct observation of a landscape in daylight

This method is used to check for defects which are difficult to measure (e.g. smear, mark).

The observer's eye should not be distracted by a defect.

6.3.2 Test methods for heating systems

6.3.2.1 Heating homogeneity

The non heating or overheating of a heating system is revealed by carrying out a shadow test in a dark room. The light source can be a slide projector, and the light will be projected on to a white screen.

6.3.2.2 Resistance measurement

The total resistance of the heating element is checked with an electrical meter to confirm conformity to the design figure.

6.3.2.3 Flash test

Withstand voltage testing is carried out by progressively applying a voltage twice as high as the rated voltage (U) plus one thousand ($2\,U$ + 1 000 V) between the heating system terminal and the edge of the window. The rate of voltage increase in this test shall not exceed 500 V/s. The duration of the test at full voltage shall be (60 ± 5) s.

6.3.3 Test methods for resistance against ageing

6.3.3.1 General

The functional requirement is described in 4.3.4. These tests are conducted as type tests for a particular construction and need not be repeated unless the materials, heating system or manufacturing process are changed. These tests are to be performed independently of the other tests in 6.2 and 6.3. It is not necessary to carry out the other tests on aged test pieces.

NOTE The QUV test combines certain aspects of heat and humidity with the Ultra-Violet test on the same sample. Since thermal cycling and humidity are also separately tested it is acceptable to use the alternative Ultra-Violet test set out in Annex C in place of the test set out in 6.3.3.2.

6.3.3.2 Accelerated weathering test (QUV)

6.3.3.2.1 Definition and apparatus

Accelerated weathering simulates damaging effects of long term outdoor exposure of materials and coatings by exposing test samples to varying conditions of the most aggressive components of weathering: ultraviolet radiation, moisture and heat. A QUV test chamber uses fluorescent lamps to provide a radiation spectrum centred in the ultraviolet wavelengths according to EN ISO 4892. A UV-A lamp is used having wavelengths 315 nm to 400 nm and peak intensity at 351 nm.

Moisture is provided by forced condensation, and temperature is controlled by heaters.

6.3.3.2.2 Test method

Accelerated weathering compares exposed material with unexposed control samples.

Two samples shall be tested, each 100 mm $\times$ 100 mm.

For each sample the yellowness index YI shall be measured using the calculation:

$$YI = 100 \times \frac{(1{,}28X - 1{,}06Z)}{Y} \quad (X,\ Y \text{ and } Z \text{ are as described in CIE 15}) \qquad (2)$$

The samples shall be mounted in specimen racks with the outside surface facing the lamp.

The test shall continue for a minimum of 500 h with a condition cycle as follows:

8 h UV-A at + 60 °C, then 4 h condensation (100 % relative humidity) at + 50 °C (3)

6.3.3.2.3 Interpretation of results

Comparison involves measurements of yellowness index and physical conditions such as bubbling and delamination. The yellowness index difference before and after testing shall not be greater than 0,6 %. Bubbling and delamination shall not extend more than 5 mm from any edge.

6.3.3.3 Thermal cycling

6.3.3.3.1 Definition

The purpose of this test is to check that plastic material(s) and lamination processes for windscreens will withstand the effects of prolonged exposure to extremes of temperature without significant deterioration.

6.3.3.3.2 Test method

Two samples of minimum dimension 500 mm × 500 mm shall be tested. The sample shall be placed into a climatic chamber.

The condition cycle is as follows:

Starting from ambient temperature, the sample shall, within 2 h reach (+80 ± 2) °C with 80 % relative humidity which shall be maintained for 4 h, followed by transition within 2 h to reach (-40 ± 2) °C with 30 % relative humidity which shall also be maintained for 4 h.

This cycle shall be repeated over at least 240 h.

6.3.3.3.3 Interpretation of results

The appearance of the samples is inspected. No significant change (no bubbling, delamination or whitening) shall be observed more than 10 mm from uncut edges and more than 15 mm from cut edges of the samples.

6.3.3.4 Humidity test

6.3.3.4.1 Definition

The purpose of this test is to determine whether laminated windscreens will withstand, without significant deterioration, the effects of prolonged exposure to atmospheric humidity.

6.3.3.4.2 Test method

Two samples of minimum dimension 500 mm × 500 mm shall be tested. The test sample is exposed to the following condition of humid heat for a minimum period of 240 h:

Temperature: + $55\,^{+3}_{0}$ °C, Relative Humidity: 95 % RH.

6.3.3.4.3 Interpretation of results

The appearance of the samples is inspected. No significant change (no bubbling, delamination or whitening) shall be observed more than 10 mm from uncut edges and more than 15 mm from cut edges of the samples.

6.3.3.5 Heating test

6.3.3.5.1 Definition

The purpose of this test is to determine whether the windscreen and heating system will withstand the effects of prolonged operation of the heating system during normal service without damage to the lamination of the windscreen or malfunction of the system.

6.3.3.5.2 Test method

This test consists of permanently feeding the windscreen with the nominal supply voltage for 1 000 h at an ambient temperature of (20 ± 5) °C.

The test shall be conducted on either a complete windscreen or a sample of not less than 1 000 mm × 700 mm.

Alternatively, if a thermostatic control is fitted for the specific application on the train, the heating system can be regulated for the duration of the test in accordance with the thermostatic control.

6.3.3.5.3 Interpretation of results

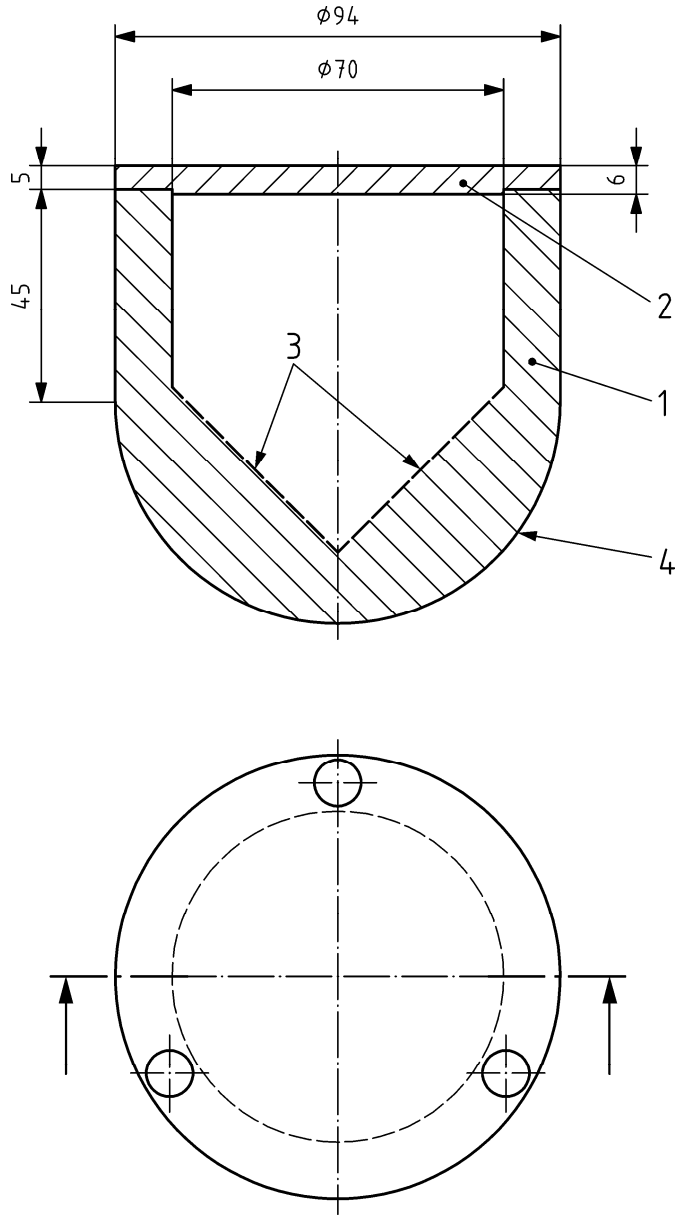
At the end of the test the windscreen and heating system shall continue to provide useful vision and to meet the requirements of 4.3.2.

Annex A
(normative)

Diagram of projectile

Figure A.1 shows a diagram of the projectile.

Dimensions in millimetres



Key

1 projectile in aluminium alloy (ISO 6362-2:1990, grade 2017A)
2 steel projectile cover
3 material may be removed for adjustment purposes
4 milled surface of hemispheric tip (1 mm)

Figure A.1 — Projectile

Annex B
(informative)

Summary of testing requirements

Table B.1 contains a summary of the tests defined in this European Standard.

Table B.1 — Summary of tests

	Tests required for homologation		Test of production material
Feature to be tested	Test on material sample	Test on sample windscreen mounted as if in situ on train	
Secondary images		X	X
Optical distortion		X	X
Haze	X		X [b]
Transmittance	X		X [b]
Chromaticity	X		
Abrasion resistance	X		
Heating		X	X
Appearance tests		X	X
Impact tests (including spalling)		X [a]	
Gravelling test (if required)	X		
Ageing test	X		

[a] Test on samples may be permitted in accordance with 6.2.6.2.

[b] Periodic.

Annex C
(informative)

Alternative method for testing resistance to Ultra Violet radiation

C.1 General

The following test method may be used as an alternative to that described in 6.3.3.2.

C.2 Test method

Two samples, 100 mm × 100 mm, shall be subjected to radiation by simulated UV light and their transmission of various wavelengths of light measured before and after exposure. The equipment used shall have a xenon light source and the samples shall be irradiated with a power of 1 500 W/m^2. There shall be continuous exposure to the light source combined with an intermittent water spray.

— Each test cycle shall consist of 102 min of light exposure followed by 18 min of light exposure plus water spray.

— The samples shall be subjected to a total specific radiant energy of (1 100 ± 50) MJ/m^2 (this corresponds to a total test duration of 204 h).

— The maximum temperature of the samples during the test will be (+63 ± 5) °C (measured with a black body thermometer).

— Relative humidity (when spray not in use) shall be (65 ± 5) %.

— Temperature of the water when sprayed (+20 ± 5) °C.

C.3 Interpretation of results

At the completion of the test cycles the samples shall be inspected for the transmission of light in the following ranges:

Ta = average light transmission;

Tr = red light transmission;

Ty = yellow light transmission;

Tg = green light transmission.

The value of light transmission for each colour given above shall not be less than 95 % of the value obtained before the test.

When inspected after exposure, the samples shall not have delamination, opaque areas or bubbles further than 10 mm from the edge of the sample.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of Directive 96/48/EC, as amended by Directive 2004/50/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission to provide a means of conforming to Essential Requirements of the Directive 96/48/EC[2)] as amended by Directive 2004/50/EC[3)], which is based on the principles of the New Approach, on the interoperability of the trans-European high speed rail system.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

2) Official Journal No L 235 of 17.9.1996.

3) Official Journal No L 164 of 30.4.2004.

Table ZA — Correspondence between this European Standard and Directive 96/48/EC

Clause / sub-clause of this European Standard	Chapter / §of TSI Rolling Stock	Corresponding text, annex / § of the Directive 96/48/EC	Comments
4-Functional requirements 4.1 General 4.2 Specific performance requirements 4.2.1 General 4.2.2 Secondary images 4.2.3 Optical distortion 4.2.4 Haze 4.4.5 Luminous Transmittance 4.2.7 Impacts 4.2.8 Residual visibility after breakage 4.2.9 Spalling 4.2.11 Resistance against fire 4.3 Additional requirements 4.3.2 Heating system and the all corresponding and relevant test methods dealt with within this European Standard	4.2.2.7 Windscreen and front of the train 5.3 – List of declared interoperability constituents ANNEX D Assessment of interoperability constituents ANNEX E Assessment of the Rolling Stock subsystem. ANNEX J Windscreen properties	ANNEX III § 1.1.1 – General requirements - Safety The design, construction or assembly, maintenance and monitoring of safety-critical components … must be such as to guarantee safety …… § 1.1.3 – The components used must withstand any normal or exceptional stresses……	The references to the TSI RST are given in this table for the revised version of the TSI RST dated May 2005. They must be checked, and eventually updated, after the finalisation of the revised HS TSI RST.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] GM/RT2161, *Requirements for Driving Cabs of Railway Vehicles*[4)]

[2] GM/RT 2456, *Structural Requirements for Windscreens and Windows on Railway Vehicles*[4)]

[3] DIN 5566-2, *Schienenfahrzeuge — Führerräume — Teil 2: Zusatzanforderungen an Eisenbahnfahrzeuge*[5)]

[4] DIN 5036-3, *Strahlungsphysikalische und lichttechnische Eigenschaften von Materialien — Meßverfahren für lichttechnische und spektrale strahlungsphysikalische Kennzahlen*[5)]

[5] NF F15-818, *Matériel roulant ferroviaire — Vitres frontales*[6)]

[6] NF F31-250, *Matériel roulant ferroviaire — Verres feuilletés*[6)]

[7] UIC 651, *Layout of driver's cabs in locomotives, railcars, multiple-unit trains and driving trailers*

4) To be obtained free of charge from RSSB website (www.rssb.co.uk)

5) To be purchased from Beuth Verlag (www.din.de)

6) To be purchased from AFNOR (www.afnor.fr)

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