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Railway applications — Bodyside windows for rolling stock

Applications ferroviaires — Fenêtres latérales pour le matériel roulant

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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 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 269, *Railway applications*, Subcommittee SC 2, *Rolling stock*.

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.

Railway applications — Bodyside windows for rolling stock

1 Scope

This document defines the classification, technical requirements, and markings for the following bodyside windows:

a) standard windows:

   1) standard fixed windows;

   2) standard movable windows;

b) emergency windows:

   1) emergency escape windows;

   2) emergency access windows.

NOTE In certain situations, emergency escape windows and emergency access windows are the same window.

This document applies to bodyside windows constructed from glazing materials only.

This document sets out requirements that apply to the glazing with its associated mounting arrangement.

This document applies to all windows mounted to the side of all types of railway vehicles, including heavy and urban rail vehicles. This includes windows mounted on the side of saloons, restaurant/buffet cars, vestibules, toilets, driving cabs, crew compartments and technical rooms.

This document does not apply to on-track machines.

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 3917:2016, *Road vehicles — Safety glazing materials — Test methods for resistance to radiation, high temperature, humidity, fire and simulated weathering*

ISO 7892:1988, *Vertical building elements — Impact resistance tests — Impact bodies and general test procedures*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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/

3.1
bodyside window
glazing unit (3.3) or *window unit* (3.2), with its mounting arrangement, fitted to the side of a vehicle, including the cab

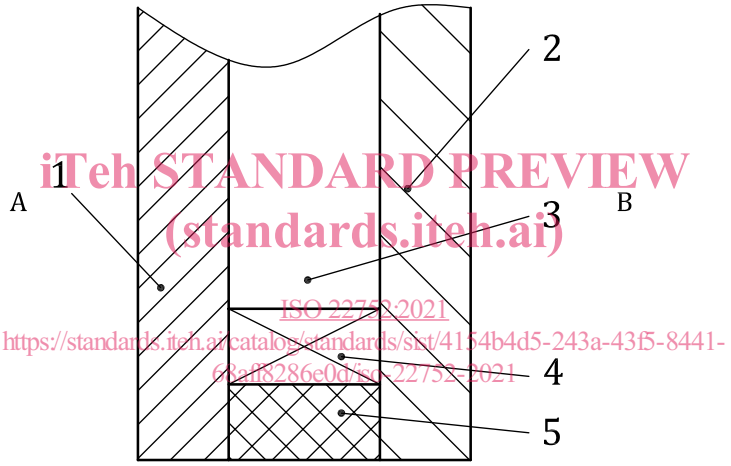
Note 1 to entry: Mounting arrangements can include frames, rubber gaskets, adhesives, etc.

Note 2 to entry: Some types of windows do not have frames. In this case, the *glazing unit* and the *window unit* are the same concept.

3.2
window unit
assembly of a *glazing unit* (3.3) with a set of frames for mounting to the car body shell

3.3
glazing unit
assembly of one or more sheets of *glazing material* (3.4), including any interlayer, *edge seal* (3.10), or spacer bar

Note 1 to entry: An example of a *glazing unit* is given in Figure 1.



Key
A exterior of the vehicle
B interior of the vehicle
1 outer glazing material
2 inner glazing material
3 *cavity* (3.9) (if any)
4 spacer bar (if any)
5 *edge seal* (3.10) (if any)

Figure 1 — Example of glazing unit

3.4
glazing material
material that allows the transmittance of light

3.5
tempered glass
toughened glass
glazing material (3.4) consisting of a single layer of glass which has been subjected to special thermal treatment to increase its mechanical strength and to condition its fragmentation after shatter

Note 1 to entry: Semi-tempered glass is not considered as *tempered glass* or *toughened glass* in this document.

[SOURCE: ISO 3536:2016, 2.2, modified — The term "toughened safety glass" has been replaced by the terms "tempered glass" and "toughened glass"; in the definition, "or chemical" has been deleted before treatment; Note 1 to entry has been added.]

3.6
laminated glass
assembly consisting of one sheet of glass with one or more sheets of glass and/or plastic glazing sheet material joined together with one or more interlayers

Note 1 to entry: The interlayer holds together when the laminated glass is shattered.

[SOURCE: ISO 12543-1:2011, 2.1, modified —Note 1 to entry has been added.]

3.7
insulating glazing
glazing unit (3.3) assembled such that the *cavity(ies)* (3.9) are maintained in a permanent state of dehydration

3.8
spacer system
mechanical system between *glazing materials* (3.4) to create the *cavity* (3.9) for *insulating glazing* (3.7)

3.9
cavity
space between two sheets of *glazing material* (3.4) in *insulating glazing* (3.7)

3.10
edge seal
hermetic sealing at the periphery of two glass sheets of *insulating glazing* (3.7) to maintain the gas between them

Note 1 to entry: The terms "weld" and "welding" can be used instead of "seal" and "sealing" respectively, dependent upon the processing method.

[SOURCE: ISO 19916-1:2018, 3.3, modified — In the definition, "of insulated glazing" was added and the word "vacuum" has been changed to "the gas".]

3.11
dew point
temperature at which dew or frost first occurs in the *cavity* (3.9) of *insulating glazing* (3.7)

3.12
poly organics glass
glazing material (3.4) made of transparent plastics such as polycarbonate and polymethyl methacrylate

3.13
display window
glazing unit (3.3) or *window unit* (3.2) with its mounting arrangement which is mounted to the side of the vehicle, through which persons outside the train can receive visual information

3.14
movable window
glazing unit (3.3) or *window unit* (3.2) with its mounting arrangement which can be opened

3.15
peripheral area
area bounded within 150 mm of all edges of a *glazing unit* (3.3)

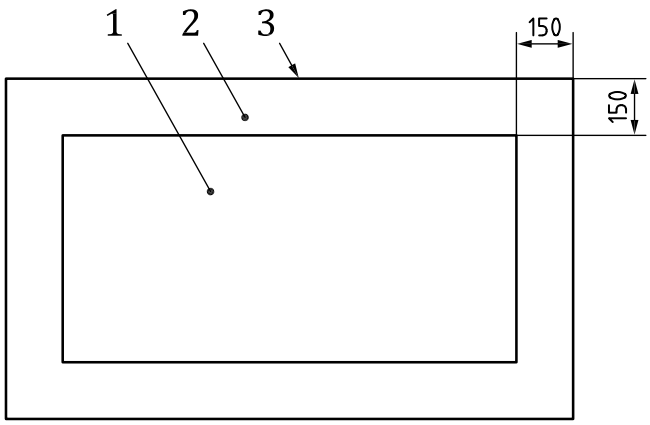
Note 1 to entry: If an area obscured by internal panels is more than 150 mm from the edge of the glass, then the entire obscured area is considered as a peripheral area.

Note 2 to entry: See Figure 2.

3.16
primary area
area of a *glazing unit* (3.3) which passengers and staff can look through

Note 1 to entry: The primary area of a glazing unit is the area bounded within the *peripheral area*. In case of non-transparent windows, the primary area is not applicable.

Dimensions in millimetres



Key
1 *primary area* (3.16)
2 *peripheral area* (3.15)
3 edge of glass

Figure 2 — Primary area and peripheral area

3.17
design speed
maximum operable speed to be established in vehicle performance design defined by the train manufacturer and/or operator

3.18
normal mode
window unit (3.2) or *glazing unit* (3.3) in an undamaged condition

3.19
degraded mode
window unit (3.2) or *glazing unit* (3.3) with broken external *glazing material* (3.4) and scratched inner *glazing material* (3.4)

4 Technical and test requirements

4.1 General

Unless set out in the technical specification, the tests described in this document for a window design to be used in additional designs of a train, or a variation of a train design, do not need to be repeated if the following criteria are met:

— the window design has already been demonstrated to conform with the requirements of this document;

— the window design and its mounting to the train have not changed.

The window design shall include dimensions, mounting arrangements and glass composition.

If specified in the technical specification, the use of simulation to demonstrate conformance with the following test requirements is allowed, provided that simulation process and results have been validated against physical tests.

Table 1 sets out the relevant requirements and clauses for glazing types and window systems.

Table 1 — Requirements and clauses for glazing types and windows

No.	Test type	Requirements		Tempered glass	Laminated glass	Insulating glazing	Window [a]
1	Safety	Static strength of window (4.2.2)					M [b]
2		Aerodynamic fatigue loading (4.2.3)					M [c]
3		External impact performance (4.2.4)	Impact of small particles from track (4.2.4.1)	O			
4			Impact of small missiles (4.2.4.2)			O [d]	O
5		Shock resistance (4.2.5)	for laminated glass (4.2.5.3)		M		
6			for tempered glass (4.2.5.4)	M			
7		Fragmentation for tempered glass (4.2.6)		M			
8		Internal soft body impact resistance (4.2.7)	Pendulum test (4.2.7.3)				M [b]
9			Passenger containment test (4.2.7.4, Annex D)				O [e]
10		Emergency function (4.2.8)					M [f]
11	Quality	Appearance defects (4.3.1)		M [g]			
12		Durability (4.3.2)	Durability of the edge seal by climatic test (4.3.2.2)			M	
13			Resistance to ultraviolet radiation test (4.3.2.3)		M		
14			Resistance to high temperature test (4.3.2.4)		M		
15			Resistance to humidity test (4.3.2.5)		M		
16		Adhesive bonding (4.3.3)					M
17	Function	Water tightness (4.4.1)					M [h]
18		Durability test for movable window (4.4.2)					M
19		Optical distortion (4.4.3)		M [g]			
20		Dew point (4.4.4)				M	

M mandatory

O optional

[a] Depending on the type of glazing used, the individual tests are added to the test on a completed window.

[b] In case of rubber mounting. Optional for all other cases.

[c] It is not necessary for trains whose design speed is ≤100 km/h. It is optional for trains whose design speed is from >100 km/h to ≤140 km/h.

[d] The test procedure set out in Annex C is primarily undertaken for windows consisting of tempered glass on the exterior side and laminated glass on the interior side of the vehicle.

[e] The test should be carried out if the window is in the form of rubber mounting.

[f] The test shall be carried out if the bodyside window is equipped with an emergency function.

[g] For finished glazing composition.

[h] It is not necessary if the window is sealed to the car body with adhesive bonding.

4.2 Safety

4.2.1 General

There shall be no sharp edges in exposed (accessible) areas in order to avoid injury to personnel and passengers.

4.2.2 Static strength of window

4.2.2.1 Purpose

The bodyside windows shall not be pushed out of its mounting by leaning or impact of persons. In the case of bodyside windows, where passengers can fall out of the vehicle due to their positioning or design (e.g. rubber mounting systems), it shall be demonstrated that these bodyside windows can withstand the loads. Static strength test shall be applied to rubber mounting bodyside windows.

4.2.2.2 Test specimen

This test shall be conducted on the window with the largest surface area mounted on the vehicle.

The test shall be conducted on the window in its installed state representative of its mounting on the vehicle.

4.2.2.3 Test procedure

A pressure of 5 000 Pa shall be applied uniformly on the glazing unit. The direction of the pressure applied for this test shall be set out in the technical specification.

The pressure shall be applied for a period of 60 s.

4.2.2.4 Acceptance criteria

The window shall remain in its mounting arrangement without any disengagement during application of the pressure.

If the window is composed of laminated glass, fractures of one or more sheets of glass is acceptable.

4.2.3 Aerodynamic fatigue loading

4.2.3.1 Purpose

The purpose of this test is to:

— demonstrate the performance of the window in service when subject to aerodynamic loads induced by tunnels and passing trains;

— check that there is no damage to the spacer bar and the edge seals of the insulating glazing;

— check that there is no defect on the mounting arrangement, caused by repeated pressure loading.

4.2.3.2 Requirements

The window shall withstand alternating positive and negative pressure loads.

The test shall be undertaken subject to the technical specification or as set out in Annex A.

If the test is undertaken as set out in Annex A, the pressures, stages, including the application of the water spray, and degraded mode (where applicable), shall be based on the vehicle's design speed.

The pressures and the number of cycles defined in Annex A are intended to represent the whole design life of the window.

4.2.3.3 Test specimen

The aerodynamic fatigue loading test shall be undertaken for the largest window. Each type of window (fixed window, window with emergency function, movable window) shall be taken into account.

The determined test specimen(s) shall be defined in the technical specification.

4.2.3.4 Test equipment

The test equipment shall be configurable to apply the required pressure loads, signal type and frequencies.

The test equipment shall be capable of measuring deflection of the glass and the frame during the loading tests.

The test equipment shall be capable of spraying water during the loading tests, where applicable.

An example of the equipment that can be used is shown in Figure A.1.

4.2.3.5 Test procedure

4.2.3.5.1 Normal mode

The aerodynamic fatigue loading test shall be undertaken for the window in normal mode.

NOTE 1 Normal mode refers to the window specimen tested without any damage.

The following procedure should be followed:

— measure the dew point in accordance with 4.4.4;

— mount the test specimen in a manner which is representative of the mounting arrangement of the window on the vehicle;

— the test equipment shall undergo a period of stabilization before commencement of the test;

— load the test specimen according to the values of the specific test stage as set out in Table A.1;

— each pulse shall start with a zero-pressure differential across the test specimen;

— there shall be no dwell period at the points of maximum and minimum relative pressure on the test specimen;

— it is permissible for the first 200 pulses in the test sequence to deviate by up to 5 % from the specified limit values;

— measure the deflection of the inner glazing material of the specimen at its centre when stability has been reached at each test stage for 2 min;

— where applicable, spray the test specimen with water during the final hour of the test;

— the volume flow rate for the water spray shall be 2 l/min/m^2;

NOTE 2 The water spray test is not required if the window is sealed to the car body with adhesive bonding.

— measure the dew point of the specimen at the end of the test;

— check and record any defects or failures for each layer of the glazing unit and its mounting arrangement after the test.

The test report shall include the following elements, as a minimum:

— a time history of the pressure pulses;

— a time history of the central deflection of the glazing material.

4.2.3.5.2 Degraded mode

The aerodynamic fatigue loading test may be undertaken for the window in a degraded mode.

The degraded mode test can be carried out after the normal mode test. The test for the window in the degraded mode can be carried out as set out in the technical specification or as set out in Table A.1.

4.2.3.6 Acceptance criteria

4.2.3.6.1 Normal mode

The window shall not break at any point during and upon completion of the test.

The glazing unit or the window unit shall not disengage from its mounting at any point during and upon completion of the test.

The maximum deflection values of the centre of the glazing are set out in Table 2.

Table 2 — Deflection

Dimensions in millimetres

Minor dimension of the glazing unit (length or width)	Maximum central deflection
≤ 350	5
350 to 600	7
600 to 1 000	10
> 1 000	$\frac{\text{Minor dimension}}{100} + 1$

There shall be no water ingress if the water spray test is conducted.

The dew point of the specimen shall meet the requirements according to 4.4.4.

4.2.3.6.2 Degraded mode

There shall be no deterioration in the constituent elements of the window, with the exception of those completed for test purposes.

With regard to the degraded elements for test purposes, the inner glazing material shall not crack or break if it is monolithic tempered glass. If the inner pane consists of laminated glass, the propagation of cracks is allowed but the pane shall not detach from the window.

The propagation of cracks on the outer glazing material is permitted.

No glazing material shall detach from the window unit throughout the test.

4.2.4 External impact performance

4.2.4.1 Impact of small particles from track

4.2.4.1.1 Purpose

The purpose of the test defined in Annex B is to assess the anti-fracture performance of the window, when subjected to frequent external impacts (e.g. small particles, gravel or ballast).

4.2.4.1.2 General

Bodyside windows shall withstand external impacts from projectiles, which can include ballast from the track.

This requirement is deemed to be fulfilled by performing the prescribed test in Annex B.

4.2.4.1.3 Test procedure

If the test of external impact from track small particles is conducted, it shall be conducted on the outer glazing material in accordance with Annex B.

4.2.4.1.4 Acceptance criteria

The acceptance criteria of tests are set out in Annex B.

4.2.4.2 Impact of small missiles

4.2.4.2.1 Purpose

The purpose of the test defined in Annex C is to assess the window's external impact performance when subjected to external impacts from small missiles, for passenger protection. The test is intended to represent a large projectile thrown by a strong adult.

4.2.4.2.2 General

Bodyside windows shall withstand external impacts from projectiles.

This requirement is deemed to be fulfilled by performing one of the prescribed tests from Annex C.

The test procedure set out in Annex C is primarily undertaken for windows consisting of tempered glass on the exterior and laminated glass on the interior of the vehicle.

4.2.4.2.3 Test procedure

If the test of external impact from small missiles is conducted, it shall be conducted on a complete window in accordance with Annex C.

Where a window is tested, the projectile shall strike the external glass surface.

4.2.4.2.4 Acceptance criteria

The acceptance criteria of tests are set out in Annex C.

4.2.4.3 Choice of tests

It is not necessary to perform both tests.