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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

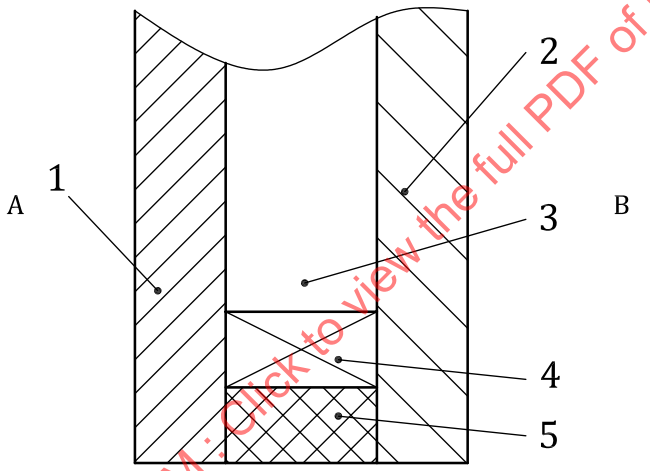
Note 1 to entry: Mounting arrangements can include frames, rubber gaskets, adhesives, etc.

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)

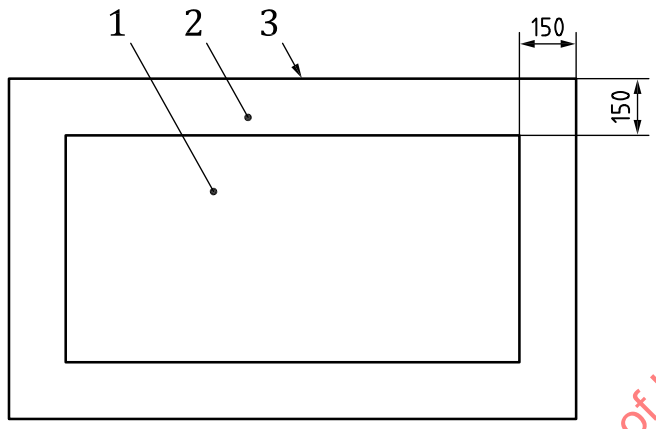
Note 1 to entry: If an area obscured by internal panels is more than 150 mm from the edge of the glass, then the entire obscured area is considered as a peripheral area.

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.

The test performed in accordance with 4.2.4.1 or 4.2.4.2 should be indicated in the technical specification.

If supported by additional justification or evidence, another test option (including another test method or exemption of the test) can also be set out in the technical specification.

4.2.5 Shock resistance

4.2.5.1 Purpose

To demonstrate impact performance, individual sheets of glazing material shall be able to withstand foreseeable impacts.

This gives an indication of the quality of the glazing material fabrication.

4.2.5.2 General

The proposed test is to drop a steel ball with defined mass from a defined height onto the centre of the glazing material.

The mass for the steel ball and corresponding drop heights are set out in 4.2.5.3 and 4.2.5.4.

The shock resistance test shall be conducted on six separate test specimens.

The test specimen shall be 300 mm × 300 mm and representative of the glazing unit.

The supporting fixture should be in accordance with ISO 3537:2015, 6.2.3. Other equivalent supporting fixtures may be used.

4.2.5.3 Test for laminated glass

The test shall be conducted at 20 °C ± 5 °C. The test specimen shall be conditioned at this temperature for at least 4 h before testing. Subject to the technical specification, the test may be conducted over a range of temperatures. For each selected test temperature, the test specimen shall be conditioned at that temperature for at least 4 h before testing.

A solid, smooth steel ball with a mass of 500 g $^{+10}_{0}$ g and a diameter of approximately 50 mm, shall be dropped from a height of 4 m $^{+25}_{0}$ mm.

The drop height shall be measured from the lowest point of the ball to the upper surface of the test specimen.

The shock resistance test on laminated glass shall be conducted on six separate test specimens.

A test specimen shall be deemed acceptable if it meets the following requirements:

a) the steel ball shall not penetrate the test specimen;

b) the mass of glass fragments produced from the opposite side of the impact surface shall not exceed 20 g.

A minimum of five test specimens shall pass the test.

If fewer than five test specimens satisfy the requirements above, an additional test shall be carried out on a further six test specimens from the same production batch. All six of the new set of test specimens shall meet the requirements.

4.2.5.4 Test for tempered glass

A solid, smooth steel ball with a mass of 500 g $^{+10}_{0}$ g and a diameter of approximately 50 mm, shall be dropped from a defined height, depending on the nominal thickness of the glass, as set out in Table 3.

The drop height shall be measured from the lowest point of the ball to the upper surface of the test specimen.

Table 3 — Steel ball drop height for tempered glass

Nominal thickness, t mm	Steel ball drop height m
$t < 4$	0,9
$t \geq 4$	1,1

The shock resistance test on tempered glass shall be conducted on six separate test specimens.

A test specimen shall be deemed acceptable if it is not broken by the steel ball.

A minimum of five test specimens shall pass the test.

If fewer than five test specimens are deemed acceptable, an additional test shall be carried out on a further six test specimens from the same production batch. All six of the new set of test specimens shall meet the requirement.

4.2.6 Fragmentation for tempered glass

4.2.6.1 Purpose

The purpose is to avoid passenger injury when the tempered glass is broken, in extreme cases such as glazing breakage at the interface with passengers, even outside emergency situations.

4.2.6.2 Test procedure

The test shall be conducted on the tempered glass of each nominal thickness installed on the vehicle.

For insulating glazing, each glazing material which contains tempered glass shall be subject to the test.

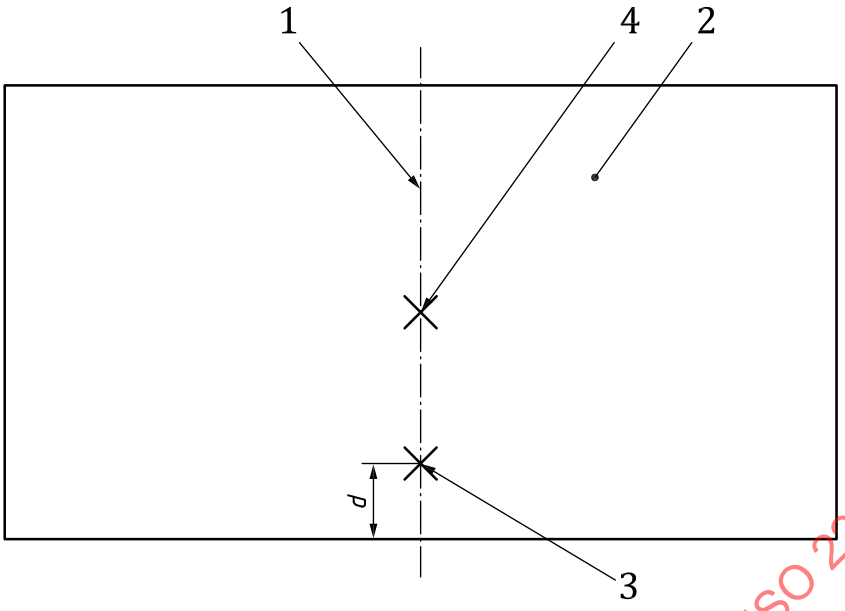
For laminated glass made of tempered glass, it is not necessary to perform separate tests for each layer of tempered glass.

The test shall be conducted on four separate, initial test specimens.

The test specimens shall be full-sized glazing material.

The point of impact shall be 20 mm from the longest edge along the centreline of the glazing material, denoted by Item 3 in Figure 3.

The impact point can be the geometric centre of the glazing material, denoted by Item 4 in Figure 3, if set out in the technical specification.



Key

1 centreline
2 test specimen
3 point of impact at the longest edge
4 point of impact - centre
d 20 mm

Figure 3 — Point of impact

4.2.6.3 Acceptance criteria

A test shall be deemed to have given a satisfactory result if fragmentation meets the following conditions.

a) The number of fragments in any 50 mm × 50 mm square shall not be fewer than 40 for glass with a nominal thickness ≥ 4 mm, and shall not be fewer than 15 for glass with a nominal thickness < 4 mm.

b) For the purposes of a), a fragment extending across a side of a square shall count as half a fragment.

c) Fragmentation shall not be checked in a strip 20 mm wide round the edge of the test specimens. The purpose of this strip is to represent the frame of the window. Fragmentation shall not be checked within a radius of 75 mm from the point of impact.

d) When a fragment extends beyond the excluded area, only the part of the fragment falling outside of the area shall be assessed.

e) Fragments of an area exceeding 300 mm^2 shall not be allowed except in the parts defined in c).

f) No fragment longer than the values in Table 4 shall be allowed except in the areas defined in c).

Table 4 — Maximum length of a fragment

Dimensions in millimetres

Nominal thickness	Fragment length for flat glass	Fragment length for curved glass
< 5	100	100
5	40	45
6	30	45
> 8	20	45

NOTE For tempered glass with a thickness ≤ 5 mm, and which includes sections with flat and curved areas, the quality of tempering is limited by the current technical capabilities of manufacturing facilities. The maximum fragment length for this type of glass is 100 mm.

The test is deemed to be successful if all four test specimens fulfil the criteria set out in Table 4.

The test is deemed successful if three of the four test specimens fulfil the criteria set out in Table 4 and only one test specimen fulfils the criteria as set out in Table 5.

If there are two test specimens that fulfil the criteria set out in Table 5, then two additional test specimens from the same batch shall be tested.

The two new test specimens shall fulfil the criteria as set out in Table 4.

Table 5 — Deviation criteria

Nominal thickness (in mm)	Maximum number of fragments and lengths
5	Maximum of 4 fragments between 40 mm and 75 mm
6	Maximum of 4 fragments between 30 mm and 75 mm
8	Maximum of 4 fragments between 20 mm and 50 mm

4.2.7 Internal soft body impact resistance

4.2.7.1 Purpose

The purpose of the internal soft body impact resistance test is to ensure that the bodyside window is capable of withstanding impacts when a person accidentally crashes against the window unit.

The passenger containment test is an option to check the performance in the scenario that the vehicle rolls over and derails.

4.2.7.2 General

Bodyside windows shall withstand human impacts from the inside on a large impact surface area.

It is mandatory to fulfil the requirements for glazing units or window units installed with rubber mounting.

This requirement is deemed to be fulfilled by performing one of the prescribed tests from 4.2.7.3 or 4.2.7.4.

It may be set out in the technical specification that neither the test from 4.2.7.3 nor 4.2.7.4 needs to be applied if supported by additional justification or evidence.

4.2.7.3 Pendulum test

4.2.7.3.1 Requirements

If a passenger containment test is fulfilled, it is recommended not to undertake this test.

The test shall be conducted on the smallest bodyside window installed on the vehicle, where the shortest dimension is > 400 mm or a standard test specimen of 400 mm × 400 mm. Where the smallest dimension is < 400 mm, this test is not required.

The pendulum test shall be conducted on test specimens that are representative of the mounting of the bodyside window to the vehicle.

4.2.7.3.2 Impactor

The impactor should be a large soft impact body in accordance with ISO 7892:1988, 3.3.

Alternatively, other types of impactor may be used if they are defined in the technical specification, taking into account the intended impact energy derived from the methods specified in this document.

4.2.7.3.3 Test equipment

The test shall be conducted on a specimen mounted to a support which is representative of the mounting of the bodyside window to the vehicle.

The bodyside window and its anchorages shall be fixed such that the fixing points shall avoid any displacement when the bodyside window is submitted to impact.

4.2.7.3.4 Test procedure

The pendulum test procedure shall be conducted in accordance with ISO 7892:1988, 4.1 and 4.5.

The drop height, *H*, shall be 1 200 mm.

4.2.7.3.5 Acceptance criteria

The impactor shall not penetrate the glazing unit.

The glazing unit or the window unit shall not disengage from its mounting structure.

4.2.7.4 Passenger containment test

Annex D shall be applied, if set out in the technical specification.

The objective of this test is to demonstrate acceptable containment performance.

This test should only be performed on bodyside windows whose glazing units consist of insulating glazing with toughened glass as an external glazing material and laminated glazing material as the interior layer.

This test should only be undertaken on the largest bodyside window.

4.2.8 Emergency function

4.2.8.1 Purpose

An emergency window provides a specific type of emergency exit and/or access on the vehicle. To ensure the emergency window can be used as a clearway for evacuation and/or access within the ruled time, the emergency function test is undertaken.

4.2.8.2 General

Where bodyside windows are equipped with an emergency function, the following requirements shall be fulfilled.

For the emergency window for the driver's cab and staff compartment, it should provide a minimum clearance (free area) of 2 000 cm^2 with a minimum inner dimension of 400 mm.

For the emergency windows for passenger areas, the dimension of the opening should be at least 550 mm × 700 mm.

The tests do not need to be repeated if the main emergency escape function is unchanged for emergency windows with different dimensions.

The glazing units or window units can be mounted to a test frame when the tests are undertaken. It is not necessary for the glazing unit or window unit to be tested as installed to the car body side. The test is not required to be undertaken on a complete vehicle.

4.2.8.3 Emergency escape function

The minimum quantity of test specimens shall be two.

For each test, the opening time (breakage/glazing unit ejection/window unit ejection) of an emergency window from the inside to the outside shall not exceed 60 s.

This shall be demonstrated by a practical test carried out by one male and one female, with the equipment available to passengers onboard the vehicle. In order to make sure that the function is usable for all ranges of people, the height of the female tester should be less than 1 650 mm[1)].

Emergency escape test windows shall be mounted at a height corresponding to the nominal relative height of the installed bodyside window corresponding to the vehicle floor.

4.2.8.4 Emergency access function

The minimum quantity of test specimens shall be one.

The time and method to create an opening suitable for access shall be specified in the technical specification. The time to create an opening suitable for access should not exceed 60 s, using tools typically available to rescue services.

Emergency access test specimens shall be mounted at a height corresponding to the nominal relative height of the installed bodyside window from the minimum station platform height used regularly for the intended service.

4.2.8.5 Acceptance criteria

All specimens tested shall meet the requirements listed in 4.2.8.3 and 4.2.8.4.

4.2.9 Guidance on the application of adhesive films

Where an adhesive film is applied to a single layer of toughened glass on the surface of the window, consideration should be given to ensure that the mechanical and safety performance of the window is not compromised.

1) 1 650 mm is the body height of P95 of smaller type or P5 of larger type of world-wide human body measurements (see ISO 15537:2004, Table 2).

4.3 Quality

4.3.1 Appearance defects

4.3.1.1 General

Appearance defects (blemishes) are characteristics of one of the following elements or processes during manufacture:

— glazing material;

— interlayer;

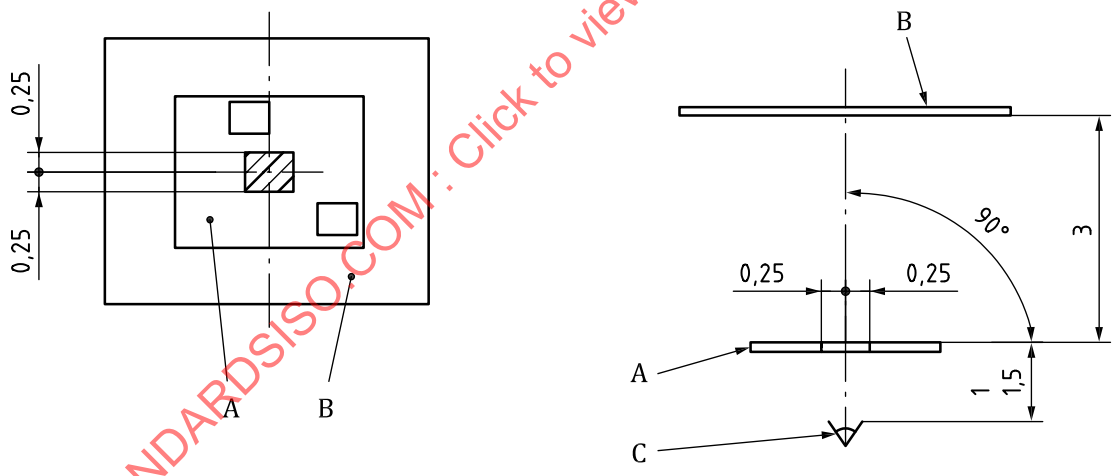
— assembly;

— handling.

4.3.1.2 Visual inspection procedure for appearance defects

Glazing shall be inspected in a darkened test chamber equipped with a vertical luminous screen. Visual inspection of the light from the luminous screen passing through the glazing shall be used to determine if there are defects in the glazing. If defects are found, their type and size shall be recorded and the acceptability of the glazing determined. The typical test arrangement is shown in Figure 4. An alternative method for the visual inspection with a luminous board set up is shown in Annex E. Other testing arrangements which can get equivalent results can be adopted subject to the technical specification.

Dimensions in metres



a) View from the inspector's position

b) Top view

Key

A glazing

B luminous screen

C inspector

Figure 4 — Device for checking the appearance, front view and top view

The luminous screen shall be NCS© S 7502-B[2] grey or equivalent. The use of any other luminous screen arrangement including screen colour shall be part of the technical specification.

The glazing shall be assessed with the following procedure.

— The glazing shall be positioned parallel to the luminous screen at a distance of 3 m or less. The inspector shall inspect the glazing perpendicularly to the luminous screen. Slight inclination of the glazing may be added to prevent the specimen from falling.

— The glazing shall be clean, dry and free of deposits of material or fluid that can affect the inspection.

— The luminous screen shall provide a uniform light level of at least 500 lx measured at the location where the glazing is to be inspected.

— The inspector shall be positioned behind the glazing at a distance between 1,0 m to 1,5 m. Alternatively, the inspector shall be positioned at a distance defined in the technical specification.

— The glazing shall be divided into enough inspection zones to cover the entire surface of the glazing. Inspection zones should be arranged to minimize overlapping.

The recommended size of the inspection zones is 0,5 m × 0,5 m.

— The examination duration shall be determined based on the surface area of the glazing and the number of divided inspection zones with approximately 10 s per zone.

— The inspector shall examine the complete glazing surface by looking through each inspection zone in turn. The inspector shall change position while maintaining the distance to the specimen as required to look through each inspection zone perpendicularly to the luminous screen.

— The position of any suspect points identified during the examination shall be noted.

The inspector shall remain in the test chamber for the duration of the visual inspection.

At the end of the visual inspection, if any suspect points have been identified, the inspector shall re-examine the glazing to analyse them and to classify them in accordance with 4.3.1.3.

Only features identified as suspect points during the visual inspection shall be analysed and classified.

The criteria set out in 4.3.1.4 shall be used to determine if the glazing is acceptable.

4.3.1.3 Definition and classification of defects

Tables 6 and 7 are used to classify defects according to their characteristics.

In addition, the following defects are allowed in a 20 mm wide peripheral zone relative to the edge of the laminated glass:

— bubbling;

— interlayer shrinkage;

— opacity of the interlayer;

— impressions made in glazing by the tips of the tongs (local deformation, iridescence and hairline scratches);

— impressions made by bending tools.

2) NCS, Natural Colour System is a trademark of a product supplied by the NCS Colour AB Stockholm, Sweden. This information is given for the convenience of users of this document 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.

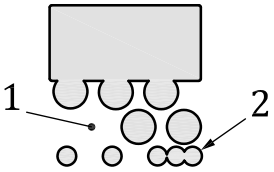
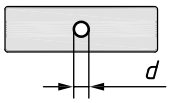
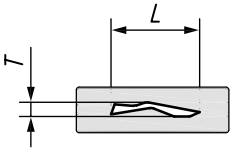
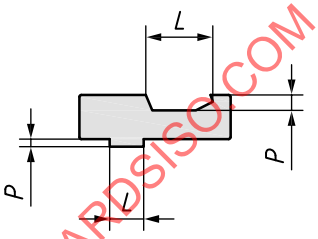
Table 6 — Classification of defects

Defects	Range
Point defects:	
Bubble: Air pocket, sometimes coloured, entrapped in glazing	0,8 mm < d ≤ 2 mm
Impurities: Small impurity in glazing or interlayer, or an embedded particle	0,8 mm < d ≤ 2 mm
Spot: Local translucent area on interlayer	0,8 mm < d ≤ 2 mm
Surface defect: Blemish caused by minor impact or abrasion (e.g. between two sheets of material during storage)	0,8 mm < d ≤ 2 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. There shall be no chipping along the sides of a scratch.	
Fine scratch or other linear defect detectable by touch	13 mm < d ≤ 40 mm
Print of attenuated (repaired) scratch	13 mm < d ≤ 40 mm
Lint, fibre, hair: Elongated impurity trapped between glazing ply and interlayer when laminating	13 mm < d ≤ 40 mm
Streak, mark (drag) trace: Whitish area in the interlayer, hardly detectable under daylight condition	total surface ≤ 800 mm^2
Edge defects:	
Point defects: chips, impacts result of the loss of small fragments from the edges, not totally eliminated by grinding	1 mm < d ≤ 2 mm
Linear defects: chips, burns, lack of grinding	<25 mm per defect, Summation ≤25 mm/m

NOTE Optical distortion is not included in 4.3.1. The requirements for optical distortion are set out in 4.4.3.

Sharp edges that can cause injury when fitting the glazing shall not be accepted. The grinding to eliminate these defects can extend up to 10 mm from the edge of the glazing if it is not visible after final mounting of the glazing.

Table 7 — Classification of screen-printing defects

Defect	Range
Impurities under silk screen:	1,5 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 1,5 m from the product  **Key** 1 hole 2 dividing point	Defect: missing dot or over-lapping
Solid colour surface:	
Circular-type defect: 	2 mm < d ≤ 4 mm
Linear defect: $S = L \times T$ 	20 mm^2 < S ≤ 80 mm^2 with T ≤ 1 mm
Defects on the edge of the solid colour surface: 	Inner edge (nearest to vision area): 2 mm < P ≤ 3 mm and 10 mm < L ≤ 40 mm Outer edge: P < 5 mm peripheral

4.3.1.4 Defect acceptance criteria

The number of identified defects classified according to Tables 6 and 7 shall not exceed the following limits:

— for the visible area of the glazing, a maximum of three defects within any circular area of diameter 100 mm shall be permitted;

— a maximum of six defects within 1 m^2 shall be permitted;

— for the non-visible area of the glazing, no specific defect acceptance limits shall apply.

NOTE Non-visible area is covered when the glazing is in a mounted position.

If the size of a defect exceeds the upper value of the appropriate range defined in Tables 6 and 7, the glazing shall not be accepted.

An accumulation of defects occurs if four or more negligible defects are all at a distance less than 200 mm from each other. An accumulation of defects shall be considered equivalent to a single defect for determining conformity to the acceptance limits given above.

4.3.2 Durability (weather-resistance)

4.3.2.1 General

Durability of the edge seal by climatic test shall be conducted for glazing units containing insulating glazing.

The following durability tests shall be conducted for glazing units containing laminated glass:

— resistance to ultraviolet radiation;

— resistance to high temperature;

— resistance to humidity.

4.3.2.2 Durability of the edge seal by climatic test

The durability of the edge seal by climatic test for insulating glazing may be undertaken in accordance with ISO 20492-1, or as set out in Annex F or similar standards.

The selected test shall be defined in the technical specification.

4.3.2.3 Resistance to ultraviolet radiation test

The resistance to ultraviolet radiation test for laminated glass shall be undertaken on three test specimens in accordance with ISO 3917:2016, Clause 6.

After the ultraviolet radiation test, the luminous transmittance value for each specimen shall be at least 95 % of its original value.

4.3.2.4 Resistance to high temperature test

The resistance to high temperature test for laminated glass shall be undertaken on three test specimens in accordance with ISO 3917:2016, Clause 7.

After the high temperature test, no bubble or other defect shall be observed more than 15 mm from an uncut edge, 25 mm from a cut edge or more than 10 mm away from any cracks which can develop during the test.

4.3.2.5 Resistance to humidity test

The resistance to humidity test for laminated glass shall be undertaken on three test specimens in accordance with ISO 3917:2016, Clause 8.

After the humidity test, no change, such as bubbles, separation of materials or loss of transparency according to ISO 3538:1997, 5.1, shall be observed more than 10 mm from an uncut edge or 15 mm from a cut edge.

4.3.3 Adhesive bonding

Where adhesives are used, they shall be compatible with other systems as defined in the technical specification.

Specific requirements for the compatibility of adhesives used to secure the bodyside glazing unit or window unit to the car body are not set out in this document.

The adhesives and sealants shall not generate any adverse effects on the bonding and sealing performance.

Bonding shall be done in accordance with relevant national or regional standards. If no such standards exist, other procedures may be requested in the technical specification.

4.4 Function

4.4.1 Water tightness

4.4.1.1 General

The purpose of the water tightness test on a window unit is to demonstrate its water tightness performance.

The water tightness test shall be undertaken following one of the following methods:

— as set out in 4.4.1.2;

— according to national standards or regulations;

— as set out in the technical specification.

This test is not required if the glazing unit is mounted with adhesive bonding.

The water tightness test shall be undertaken for movable windows regardless of mounting methods.

4.4.1.2 Test parameters and procedure

The entire surface of the window shall be sprayed with water homogenously throughout the entire duration of the test.

Full cone nozzles shall be used for this test.

The water being sprayed onto the test specimen shall overlap with at least one other nozzle.

The water flow rate shall be at least 30 l/min/m^2.

The water's minimum pressure shall be 200 kPa.

The spray angle shall be 60° ± 10°.

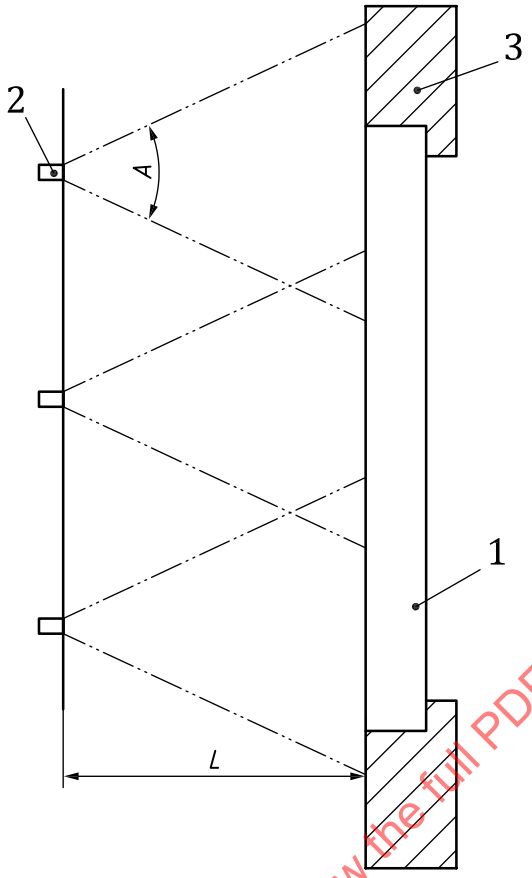
The maximum distance from the end of the nozzle to the surface of the test specimen shall be 500 mm.

The test specimen shall be mounted to the test frame in a manner that will ensure that no water can travel to the internal surface via the mounting locations.

The test specimen is closed and locked as in service. The test ambient temperature shall be above 0 °C.

Requirements for equipment to evacuate water from the bodyside window are not set out in this document.

The test arrangement in Figure 5 can be used as a reference.



Key

A water spray angle
L distance from the nozzle to the test specimen
1 test specimen
2 nozzles
3 vehicle or mock up

Figure 5 — Water tightness test arrangement

The following shall be carried out:

— spray the external surface of the test specimen;

— maintain the water spray for 600 s;

— stop the water spray;

— check the test specimen for water leaks;

— note any defects.

4.4.1.3 Acceptance criteria

There shall be no visible trickles of water on the internal surface of the test arrangement.

4.4.2 Durability test for movable windows

4.4.2.1 Force requirements

The force for opening and closing a movable window shall be measured and recorded separately before the durability test.

The force required to operate the moving window shall meet the following requirements:

a) a maximum force of 100 N to fully open a movable window;

b) a maximum force of 200 N to fully close (e.g. to be able to lock the window, if applicable) a movable window in the passenger and staff area;

c) a maximum force of 100 N to fully close (e.g. to be able to lock the window, if applicable) a movable window in the driver's cab.

NOTE The force values set out can be achieved via one or two-handed operation by staff or passengers.

4.4.2.2 Test procedures

For the durability test, one cycle is defined as one opening and closing operation of the movable window.

Each cycle shall include the movable window's maximum range of operation.

The period for one test cycle of the window shall be not more than 30 s.

Each cycle shall include a minimum pause time of 5 s at the end of the opening movement.

The movable window shall undergo one of the following numbers of test cycles:

a) For movable windows without a locking mechanism: 30 000 cycles.

b) For movable windows with a locking mechanism: 3 000 cycles.

NOTE A locking mechanism requires a staff key to lock or unlock the window to allow operation.

In case of the automatic test equipment, the locking mechanism may be tested separately.

After completing the selected number of test cycles, the following tests shall be undertaken:

— a water tightness test in accordance with 4.4.1;

— the force test as set out in 4.4.2.1.

4.4.3 Optical distortion

4.4.3.1 General

Significant optical distortion can cause passenger discomfort by affecting the appearance of an object or landscape viewed through the window. The test method in this document shall be used to measure the maximum value of optical distortion to control the optical quality of the window.

4.4.3.2 Requirements

The test shall be carried out in accordance with Annex G.

Table 8 sets out the maximum permitted distortion values for the test specimen.

For glazing types not specified in Table 8, the test requirements shall be set out in the technical specification.

Table 8 — Quality classification for glazing types

Dimensions in millimetres

Quality level	Examples of application	Maximum permitted value for primary area	Maximum permitted value for peripheral area
1	Flat monolithic glass panes	7,2	14,4
2	Flat laminated glass panes	7,2	14,4
3	Flat insulating glass panes	7,2	28,8
4	Uniformly curved glass panes [a] with radius ≥ 1 000 mm	9,6	38,4

[a] For uniformly curved glass panes, this can include monolithic, laminated, and insulating glass panes.

4.4.4 Dew point

The dew point test shall be undertaken on a minimum of five insulating glazing units.

The dew point of the cavity shall be less than or equal to −35 °C. The dew point may be less than or equal to −50 °C if set out in the technical specification.

5 Marking

The window shall be permanently marked. The marking shall be readable without viewing aids.

For glazing units or window units of display windows, markings shall be subject to the specific requirements in technical specifications or drawings.

Unless specified in the technical specification, the following information shall be included in the marking, as a minimum:

— the identifiable code or logo of the window supplier;

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

— the type of glass, "L" for laminated glass, "T" for tempered glass, "P" for poly organics glass;

— for insulating glazing, the order of the marking shall be from the exterior to the interior of the vehicle;

EXAMPLE A type of triple layered insulating glazing consisting of laminated glass at the exterior, tempered glass as the intermediate layer, and poly organic glass on the interior of the vehicle: "L - T - P".

— a reference to this document, e.g. ISO 22752:2021.

Annex A
(normative)

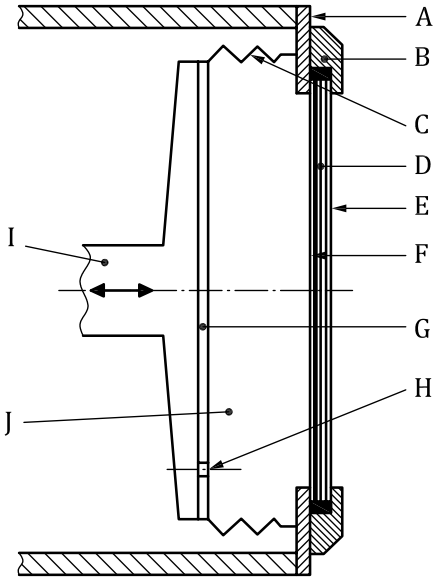
Values for the aerodynamic fatigue loading test

Table A.1 — Values for the aerodynamic fatigue loading test [a]

Design speed of train km/h	Test mode		Pressure Pa	Frequency [b] Hz	Wave shape	Number of cycles	Water spray
$100 < v \leq 160$	normal mode		±1 900	3	sinusoidal	1 200 000	No
$160 < v \leq 200$	normal mode	1	±1 500	6	sinusoidal	100 000	No
		2	±2 500	3	sinusoidal	1 000 000	No
		3	±1 500	6	sinusoidal	100 000	Yes
$200 < v \leq 300$	normal mode	1	±3 000	1,5 to 6	sinusoidal	1 000 000	No
		2	±4 000	1,5 to 6	sinusoidal	200 000	No
		3	±3 000	1,5 to 6	sinusoidal	100 000	Yes
	degraded mode		±4 000	1,5 to 6	sinusoidal	200	No
$300 < v \leq 400$	normal mode	1	±4 500	1,5 to 6	sinusoidal	1 000 000	No
		2	±6 000	1,5 to 6	sinusoidal	200 000	No
		3	±4 500	1,5 to 6	sinusoidal	100 000	Yes
	degraded mode		±6 000	1,5 to 6	sinusoidal	200	No

[a] The values specified in this table may not be applicable if the technical specifications set out requirements for pressure and frequency values.

[b] The test frequency should be set out in the technical specification.



Key

A	fixed plate	F	outer layer
B	frame	G	movable plate
C	bellows	H	breather
D	glazing unit or window unit	I	cylinder
E	inner layer	J	volume of captured air

Figure A.1 — Example of test equipment for aerodynamic fatigue loading test

Annex B
(normative)

Test method of external impact performance (small particles from track)

B.1 General

Table B.1 provides an example of train and recommended projectile speed values. Alternative values can be required in the technical specification.

Table B.1 — Projectile speed based on the vehicle's design speed

Train design speed km/h	Projectile speed
$v \leq 130$	Optional
$130 < v < 200$	126 km/h (35 m/s)
$v \geq 200$	140 km/h (39 m/s)

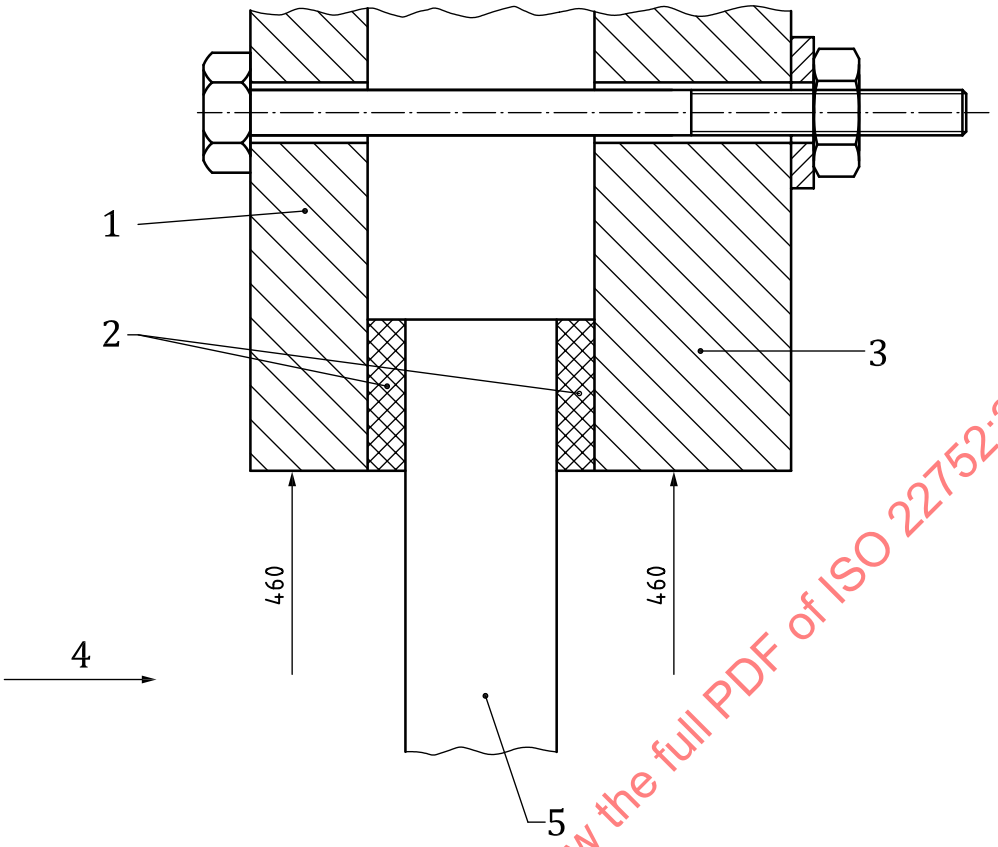
B.2 Apparatus

The specimen is placed on a steel rigid support with a cut-out of 460 mm × 460 mm. A counter-frame, forming a stop, holds the specimen against its four sides (see Figure B.1).

A hard (hardness 46 Shore), 2 mm thick and 20 mm wide rubber (e.g. neoprene) strip is placed between the support, the counter-frame and the sample. The overlap with the edge is 20 mm.

The counter-frame forming a stop is applied and held in place so as to provide moderated clamping of the sample without deformation (6 N · m clamping) by means of at least two attachment points per side.

Dimensions in millimetres



Key

1 counter - frame
2 rubber strips 20 × 2
3 support
4 impact
5 specimen [a]

[a] The specimen can be tempered glass or laminated glass or insulating glazing.

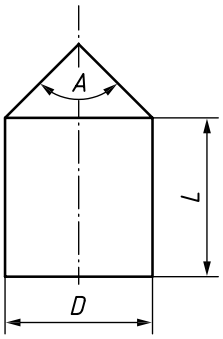
Figure B.1 — Specimen arrangement

B.3 Projectile

The projectile (see Figure B.2) is made of aluminium alloy according to ISO 6362-2, grade AW-2017 A, with a nominal mass of 20 g $^{+0,4}_{0}$ g. The material may be replaced by one with similar properties.

It is defined by the following dimensional characteristics.

Dimensions in millimetres



Key

A 90°

L 21 ± 0,1

D 19,5 ± 0,05

Figure B.2 — Projectile

B.4 Operating mode

Firing occurs at a temperature of 20 °C ± 3 °C once the specimens have been conditioned to a temperature of 20 °C for 6 h. If it is specified in the technical specification, the test can also be undertaken for test specimens at 0 °C ± 3 °C.

NOTE It is possible to measure the temperature using sensors, in order to confirm that the core of the specimen reaches the target temperature. The duration is reduced accordingly.

The projectile is launched perpendicular to the glass, at its centre, with the tip facing forwards.

The firing distance, measured from the mouth of the gun to the point of impact, is 5 500 mm. The projectile speed is measured 2 500 mm from the mouth of the gun.

The impacted face shall be the outer face of the glasses mounted on the vehicle.

B.5 Test specimen

The test specimen shall be an outer glazing material or a glazing unit.

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

The profile of the edges of the specimen shall be identical to that of the glass as it is manufactured.

B.6 Acceptance criteria

The impact resistance shall be inspected visually.

The test shall be conducted on six test pieces, and the results shall be deemed as acceptable if the following conditions are satisfied:

a) no more than one test piece is broken;

b) if there are two test pieces broken, it is necessary to carry out an additional test on another six test pieces from the same production batch, and the number of broken test pieces shall be zero;

c) if the measured projectile velocity is more than 10 km/h higher than the test velocity, the test result may be set aside if the test specimen is broken.

Annex C
(normative)

Test method of external impact performance (small missiles)

C.1 Test conditions

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

Six specimens shall be tested. Three specimens shall be tested at high temperatures and three at low temperatures in accordance with the requirements of C.3.

Three successive test procedures at high temperature and at low temperature that conform with the test requirements shall be required to demonstrate that an acceptable level of performance is achieved for impact by small missiles by the window glass across a representative temperature range.

C.2 Test specimen

The specimens tested shall be an actual glazing unit, which is to be installed in the vehicle.

The specimens shall be tested with both sheets of glazing material installed in a manner representing their installed condition.

Samples that are to be tested shall be mounted for testing in a manner representative of the installed condition for the complete unit.

The geometric centre of the specimens shall be determined. In the case of glazing units which are sub-divided by glazing bars, a worst-case position or positions for the effective geometric centre shall be determined prior to testing.

C.3 Temperature

For the high temperature tests, the specimens for testing shall be heat soaked at a minimum of +35 °C for a minimum period of 6 h immediately preceding the test. The temperature of the inner surface of the glazing unit shall not be lower than +35 °C at the time of the test.

For the low temperature tests, the specimens for testing shall be heat soaked at a maximum of −17 °C for a minimum period of 6 h immediately preceding the test. The temperature of the test specimen, when installed in the test apparatus, shall be allowed to increase to give a nominal temperature of 0 °C of the inner surface. The temperature of the inner surface of the glazing unit shall not be higher than 0 °C at the time of the test.

In these circumstances, “inner surface” refers to the surface of the glazing unit that is exposed to the inside of the vehicle.

C.4 Impact test

The projectile used for these tests should be a solid steel ball of a mass of 0,25 kg ± 2 g. Other types of solid ball may be used taking into account the intended impact energy.

For testing glazing units which contain laminated glass, the steel ball shall be travelling at a speed of 100 km/h ± 3 km/h, at the point of impact.

The specimens tested shall be orientated such that the ball impacts the geometric centre of the specimens.

The specimens shall be tested in such a way that the projectile first strikes the sample perpendicular to the surface of the glazing unit representing the outside of the vehicle.

The total amount of spall from the inner surface of each specimen shall not exceed 40 g.

C.5 Penetration

Under the conditions of the high and low temperature requirements of Annex C, the steel ball shall not fully penetrate the test specimen nor, in the case of laminated windows, rupture the laminating interlayer.

No part of the ball shall be exposed to the area representing the interior of the vehicle during the test.

C.6 Integrity

In the case of insulating glazing units, there shall be no loss of structural integrity in the bonding between the inner and outer glazing materials and spacer bars or any other fixing system between the glazing unit elements.

Annex D
(normative)

Passenger containment test

D.1 Test conditions

Windows that represent the production quality and construction shall be tested.

Three successive test procedures that conform with the test requirements shall be required to demonstrate that an acceptable level of containment performance has been achieved.

D.2 Window test assembly

The window test assemblies shall consist of complete window units including frame (if this is part of the design) installed in an assembly representative of the vehicle installation. The window unit may be installed in an appropriate section of the main vehicle structure where this is available.

The geometric centre of the window shall be determined. In the case of window units which are sub-divided by glazing bars, a worst-case position or positions for the effective geometric centre shall be determined prior to testing.

D.3 Temperature

The temperature at the time of testing shall be between 15 °C and 25 °C. The test temperature shall be recorded for each test.

To ensure that the windows for testing are correctly conditioned, they shall be heat soaked at the specified temperature for a minimum period of 6 h immediately preceding the test.

D.4 Impact testing

To determine the containment performance of the window, each window shall be subjected to the following procedure of tests which shall be undertaken in the following order:

a) the impact of a steel ball on the surface representing the exterior of the vehicle as set out in D.5;

b) a 50 kg pendulum impact from a height of 1 200 mm, with a nominal impact energy of 588,6 J, to the surface representing the interior of the vehicle as set out in D.6;

c) a concentrated perpendicular load of 0,8 kN on the interior surface as set out in D.7.

D.5 Steel ball impact test

D.5.1 Test procedure

The ball shall have a mass of 5 kg and a diameter of approximately 107 mm, and a drop height of 4,5 m ± 0,2 m to the point of impact, or equivalently, a velocity of 34 km/h ± 3 km/h at the point of impact.

The ball shall impact the geometric centre of the glazing unit on the surface of the unit representing the exterior of the vehicle.

The initial impact shall be perpendicular to the surface of the specified pane.

D.5.2 Acceptance criteria

a) The ball shall not fully penetrate the glazing unit. No part of the ball shall be exposed to the area representing the interior of the vehicle during the test.

b) The total amount of spall from the inner surface of the window shall not exceed 10 g.

D.6 Pendulum impact loads

D.6.1 Apparatus and test procedure

The complete pendulum test rig shall be according to the test equipment in 4.2.7.3.3 and the test procedure in ISO 7892:1988, 4.1 and 4.5.

The pendulum impactor design, mass and mechanical characteristics shall be as defined in ISO 7892:1988, 3.3. Where a rigid suspension is used, it is permissible to either reduce the mass of the impactor weights or to reduce the specified drop height to compensate for any change in effective mass due to the suspension. The impact energy shall under all circumstances be within ±1 % of the nominal value of 588,6 J.

The window test assembly shall be installed in the test apparatus and rigidly clamped such that the impactor strikes the geometric centre of the internal face of the window test assembly within a tolerance of 50 mm radially.

The impact shall be perpendicular to the surface of the specified pane. With the impactor hanging freely, the distance between the impactor and the surface of the window test assembly shall be in the range 5 mm to 15 mm.

The impactor shall be raised to the specified height and released to fall with a pendulum movement without initial velocity. The impactor shall strike the test assembly once.

D.6.2 Acceptance criteria

The impactor shall not penetrate the window test assembly.

The glazing unit or the window unit shall not disengage from its mounting structure.

D.7 Concentrated perpendicular load

D.7.1 Test procedure

A concentrated perpendicular load of 0,8 kN shall be applied over an area of 100 mm × 100 mm at the centre of the surface representing the interior of the vehicle.

D.7.2 Requirements

a) The load shall be maintained for a period of 60 s.

b) The glazing unit or the window unit shall remain fixed within its frame or retaining system.

D.8 Integrity

A compliant test procedure shall satisfy the requirements of D.5.2, D.6.2 and D.7.2.

Annex E
(informative)

Alternative visual inspection procedure with a luminous board

E.1 General

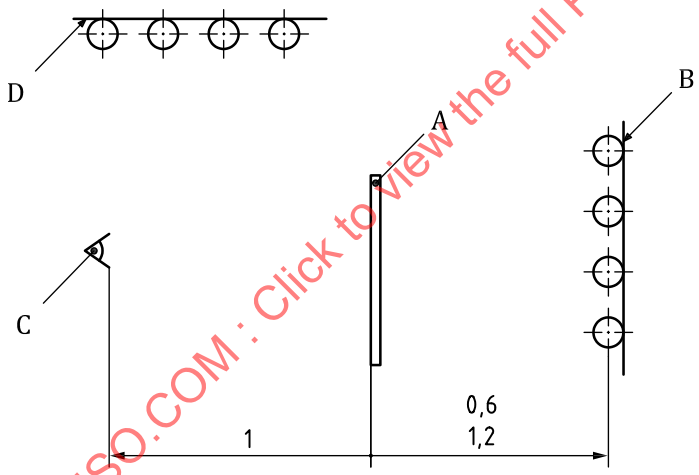
This is an alternative method to the visual inspection method in a darkened chamber set out in 4.3.1.2 and can be undertaken, if set out within the technical specification.

E.2 Visual inspection procedure for appearance defects

Glazing should be inspected using a vertical luminous board behind the glazing with a second luminous source on the ceiling, or beside the inspector.

Figure E.1 shows the side view of a set up with a ceiling-mounted luminous source.

Dimensions in metres



Key

A glazing
B luminous screen
C inspector
D additional luminous source

Figure E.1 — Set up for visual inspection method (side view)

The vertical luminous board should consist of diffused fluorescent tubes spaced 250 mm to 350 mm apart mounted on a matte black background.

The inspector should view the glazing perpendicularly from a distance of 1 m.

A second luminous source should be present on the same side as the inspector to provide illumination.

The second luminous board can be on the ceiling or mounted vertically.