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Inspecting insulating glass

Visual inspection of insulating glass

The summary below is based on Guideline '006 Visuelle Beurteilung von Glas am Bau' (006 Visual inspection of insulating glass in construction)
by the Swiss Institute for Glass in Construction (SIGAB), BF Bulletin 009/2011 Index 1 03/2017 and takes into account EN 1279-1:2018-10 Annex F + G.

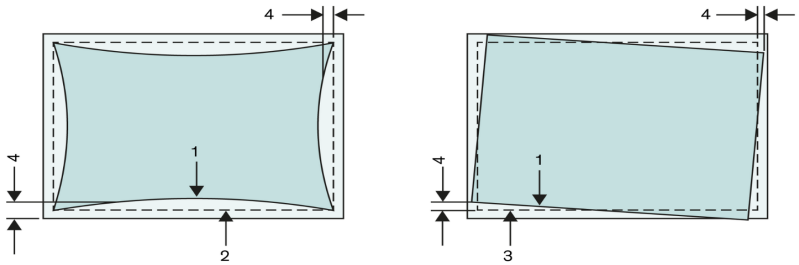
Basis for inspection
The following conditions apply for the inspection of glass:

- Glass should be inspected in the installed state without surrounding components such as frames, glazing beads, joints or other attachments
- Defects should not be marked on the glass during inspection.
- The inspection should be performed perpendicular to the glass surface from the side of main use (i.e. from the inside looking out; with the exception of display windows, which should be inspected from the outside looking in).
- The inspection should be performed from a distance of 3 m
- The inspection should be performed in daylight away from direct sunlight (diffuse daylight) and without artificial light for emphasis

Defects
The different types of defects are as follows:

- Scratches in the form of
  - Hairline scratches: fine, cannot be felt with fingernails and only visible in direct light
  - Moderate scratches: can be felt with fingernails, can be detected according to inspection rules
  - Severe scratches: can be felt, always visible from all angles, with chips
- Inclusions, bubbles, spots, patches, etc.
  - Inclusions and bubbles in the glass itself, originating from the glass production process
  - Spots and patches that occurred during installation, e.g. due to spraying work

Inspecting the edge seal
Individual, non-accumulated residues are allowable on the spacer for each insulating glass element. The spacers may have a slight wave or be slightly out of parallel to the glass edge or to



1 Spacer
2 Theoretical shape of the spacer
3 Theoretical position of the spacer
4 Deviation

3 mm in total for edge lengths of up to 2.5 m, 4 mm in total for edge lengths between 2.5 and 5 m, and 5 mm for
edge lengths of 5 m or more.

Allowable phenomena on the edge seal

Phenomena on the spacer

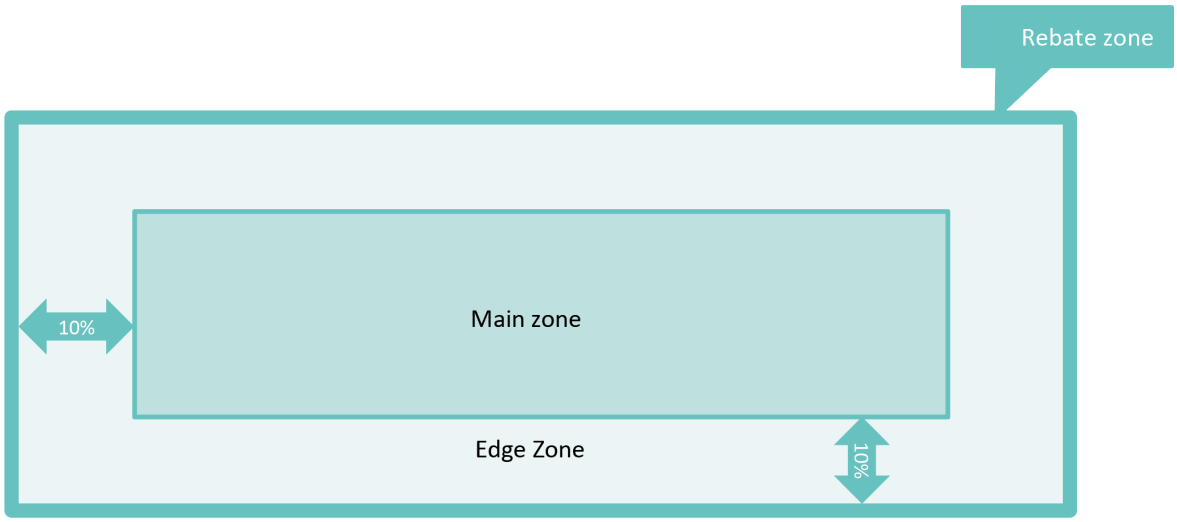
Individual, non-accumulated residues are allowable on the spacer for each insulating glass element. This could be, for example, a desiccant or a foreign body that entered between the panes during production of the insulating glass.
Depending on the structure of the insulating glass and the production process, some allowable phenomena may be visible when looking at the spacer:

- Drilled hole with butyl filling applied later (pressure equalisation)
- Inserted spacers
- Perforations and labels

Inspection zones

Different zones are defined for the inspection:

- Rebate zone: the visually concealed area in the installed state
- Edge zone: the width is 10% of the clear dimension
- Main zone

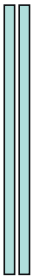
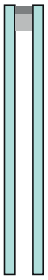
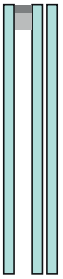
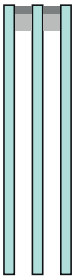
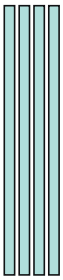
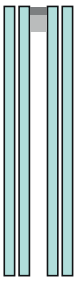
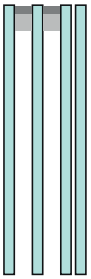
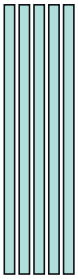
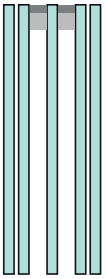


Allowable phenomena in the rebate zone

The different types of defects are as follows:

- Shallow damage on the edges, e.g. craters
- Spots or patches of residue or scratches
- Marks from processing

Definition of categories

Category I: Glass structures with 1–2 individual panes				
Category II: Glass structures with 3 individual panes				
Category III: Glass structures with 4 individual panes				
Category IV: Glass structures with 5 or more individual panes				

Individual pane refers to base glass such as float glass and its derived products, such as toughened safety glass or heat-strengthened glass. Laminated safety glass is considered to be a glass structure with two or more individual panes.

Allowable scratches in the main and edge zones

- Hairline scratches are allowed, provided that they are not concentrated in one area

Individual moderate scratches: allowable lengths according to the table below

	Cat. II: insulating glass on 3 individual panes	**Cat. III: insulating glass on 4 individual panes**	**Cat. IV: insulating glass on 5 individual panes**
	Double insulating glass with laminated safety glass Triple insulating glass	Triple insulating glass with laminated safety glass inside or outside	Triple insulating glass with laminated safety glass inside and outside
Main zone	20 mm	25 mm	30 mm
Edge zone	40 mm	50 mm	50 mm

Multiple moderate scratches: allowable sum of the lengths of the individual scratches according to the table below

	Cat. II: insulating glass on 3 individual panes	**Cat. III: insulating glass on 4 individual panes**	**Cat. IV: insulating glass on 5 individual panes**
	Double insulating glass with laminated safety glass Triple insulating glass	Triple insulating glass with laminated safety glass inside or outside	Triple insulating glass with laminated safety glass inside and outside
Main zone	20 mm	25 mm	30 mm
Edge zone	40 mm	50 mm	50 mm

Individual severe scratches: allowable lengths according to the table below

	Up to 2.5 m²	**Up to 5 m²**	**Up to 10 m²**
Main zone	25 mm	25 mm	25 mm
Edge zone	35 mm	35 mm	35 mm

Multiple moderate scratches: allowable sum of the lengths of the individual scratches according to the table below

	Up to 2.5 m²	**Up to 5 m²**	**Up to 10 m²**
Main zone	25 mm	50 mm	75 mm/100 mm
Edge zone	35 mm	70 mm	105 mm/140 mm

Note:
For scratches in the main and edge zones, each zone is assessed separately

Allowable inclusions, bubbles, spots and patches

The table below shows the maximum spot-shaped phenomena depending on the diameter and zone.

Diameter up to	**Main zone**	**Edge zone**
0.5 mm	Allowable	Allowable
1.0 mm	Allowable except in cases of accumulation (more than 4 within a radius of 20 cm)	Allowable except in cases of accumulation (more than 4 within a radius of 20 cm)
2.0 mm	Max. 3 per pane < 2 m² Max. 5 per pane > 2 m²	Max. 1 per circumferential running metre of edge length
3.0 mm	Not allowable	Max. 1 per circumferential running metre of edge length
$>$ 3 mm	Not allowable	Not allowable

Note:
For inclusions, bubbles, etc. in the main and edge zones, each zone is assessed separately.

Additional information on curved glass according to BF Bulletin 009 /2011-Ä03-2017
Curved glass in construction

In addition to the allowable defects described above, burn marks, coating defects and surface marks are also allowable for curved glass.

Transparency and colour impression are influenced by the curvature of the glass, because the reflectance of curved glass always differs from that of flat glass due to optical laws.
The optical properties and reflection behaviour are influenced by the following criteria:

- Inherent reflectance of the glass
- Coatings
- Bending radius
- Large bending angle ($>$ 90°)
- Tangential transitions
- Glass thickness
- Base glass

Where several panes of glass are arranged one behind the other, e.g. laminated safety glass or multiple-pane insulating glass, and
especially in combination with curved toughened safety glass, distortions in the transparency
can be more noticeable.

We recommend installing window and façade systems with wet glazing.

The minimum required rebate width = total glass thickness + tolerance from contour accuracy (6 mm).

Laminated safety glass films
The colour of clear, matt and coloured films can change over time due to the effects of UV radiation. This can result in noticeable colour differences in replacement panes, but these are allowable. Colour differences may also occur from one production batch to the next.

Delamination
Any design with unprotected, non-enclosed edges can, under certain circumstances, lead to visual defects (including cloudiness and bubbles) in laminated safety glass panes due to the delayed penetration of moisture over the glass edge into the PVB intermediate film. This can
also occur due to the combined effects of high humidity, high temperatures and increased salt content (e.g. near the coast).
Delamination (e.g. cloudiness or bubbles) does not constitute grounds for complaint.

Inherent colour
All materials used in glass products have an inherent colour due to the raw materials used, which can become more pronounced as the thickness increases. Coated glass is used for functional reasons, but it also has an inherent colour. How noticeable the inherent colour is differs when looking through and/or looking at the surface. Variations in colour are possible and unavoidable due to the iron oxide content of the glass, the coating process and the coating itself, as well as changes in glass thickness and pane structure.

Colour differences with coatings
An objective assessment of the colour difference with coatings requires the colour difference to be measured or tested under precisely predefined conditions (glass type, colour, light type). This type of assessment based on ISO 11479-2:2011-10 cannot be used for visual inspection.

Edge decoating
Depending on the coating system ('low-e coatings'), the coating in the edge seal area of an insulating glass unit is usually removed as far as possible by grinding. This can result in visible processing marks, making this glass surface stand out from areas that have not been
decoated. This also applies to the glass overhang of stepped insulating glass. The contact between the sealant and the layer can result in a noticeable coloured line, referred to as a 'colour line'. Depending on the coating type, this may appear as a red, green or blue line, for example. Likewise, a so-called 'white line' may occur, whereby a clear, uncoated strip is visible between the coating and the primary sealant. These effects are visible when the insulating glass is installed without any edge seal covering or with little edge seal covering.

Physical properties

There are a number of unavoidable and therefore allowable physical phenomena that can be seen in the clear glass surface, for which no inspection criteria are
defined in EN 1279-1:2018-10.

This includes:

- Interference phenomena
- Insulating glass effect
- Anisotropies
- Condensation on the external surfaces of panes (condensation formation)
- Wettability of the glass surfaces

Explanation of terms

Interference phenomena
In the case of insulating glass made of float glass, interference in the form of spectral colours can occur. Optical interference is the superposition of two or more light waves when they meet at a point. They appear as more or less pronounced coloured zones, which change when pressure is applied to the pane. This physical effect is enhanced by the plane parallelism of the glass surfaces. This plane parallelism ensures a distortion-free view. Interference phenomena
are random and can not be influenced.

Insulating glass effect
Insulating glass contains a volume of air or gas enclosed by the edge seal. The state of this gas is largely determined by the barometric air pressure, the altitude of the production site (above sea level) and the air temperature at the time and location of production. When installing insulating glass at different altitudes and due to temperature changes and fluctuations in barometric pressure (high and low pressure), the individual panes will inevitably become concave or convex and thus become visually distorted. Multiple reflections can also occur to varying degrees on glass surfaces. These reflections can be more pronounced if, for example, the area behind the glazing is dark. This phenomenon is a law of physics.

Anisotropies
Anisotropies are a physical effect in heat-treated glass that results from the internal distribution of stresses. Depending on the angle of view, dark-coloured rings or stripes may be visible in polarised light and/or when looking through polarised glass. Polarised light is present in normal daylight. The intensity of polarisation varies depending on the weather and the position of the sun. The birefringence is more noticeable when viewing from a flat angle or when glass surfaces are at right angles to each other.

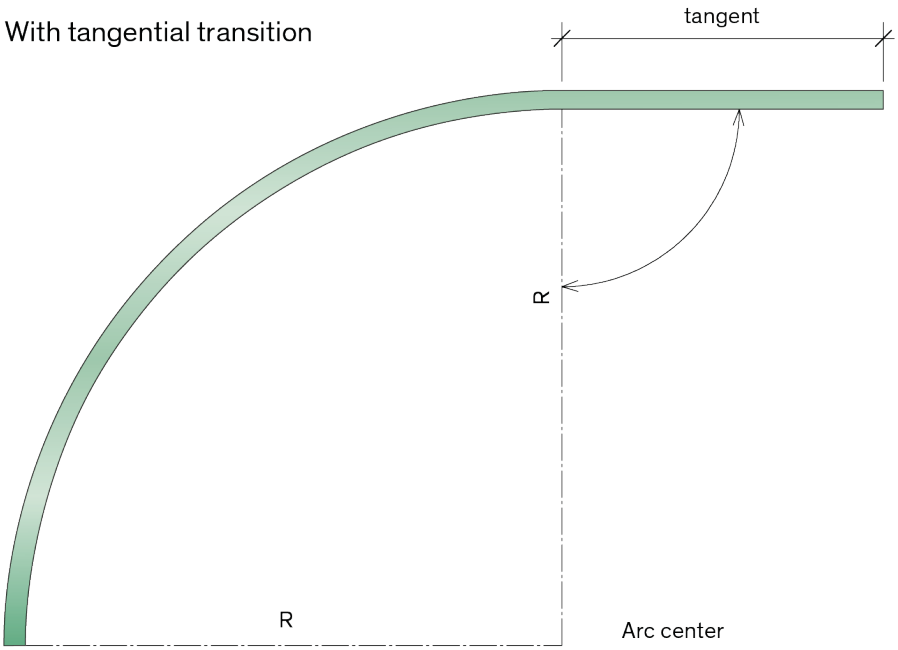
Condensation on the external surfaces of panes (condensation formation)
Condensation can form on the external glass surfaces when the glass surface is colder than the surrounding air (e.g. steamed-up car windows). The formation of condensation on the outer surfaces of a glass pane is determined by the U_g value, humidity, air flow and the indoor and outdoor temperatures.
In the case of insulating glass with high thermal insulation, condensation can temporarily form on the weather-facing glass surface when external humidity (relative humidity outside) is high and the air temperature is higher than the temperature of the pane surface.

Wettability of the glass surfaces
The wettability of glass surfaces can vary due to a number of factors, including imprints from rollers, fingers, labels, paper grains, vacuum suction cups, sealant residues, silicone compounds, smoothing agents, lubricants or environmental influences. This can become evident when the glass surfaces are wet by condensation, rain or cleaning water.
The formation of condensation on the room-side surface of the pane is caused by obstructions to air circulation (such as deep reveals, curtains, flower pots, flower boxes and blinds), unfavourable
positioning of the radiators, lack of ventilation or similar factors.

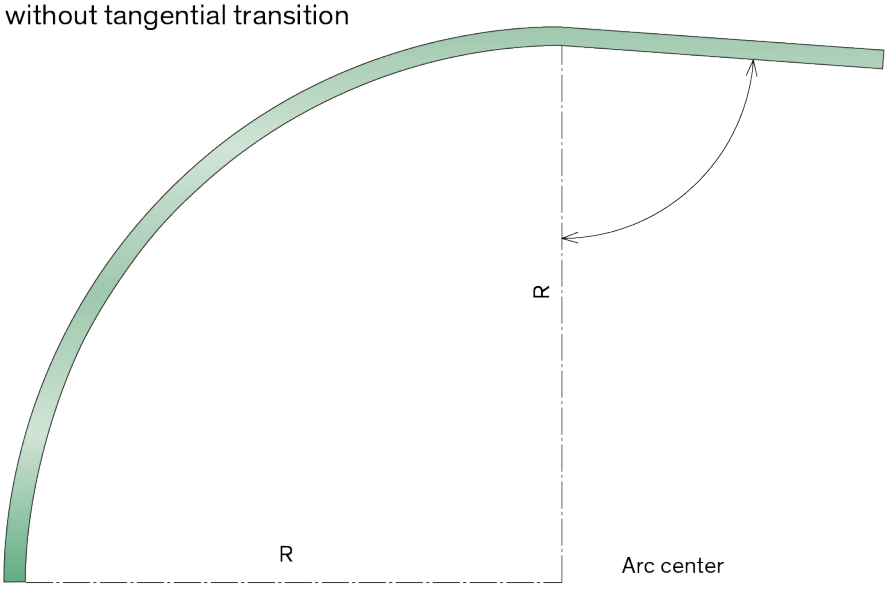
Tangential transitions

A tangent is a straight line that touches a given curve at a specific point.
The tangent is perpendicular to the radius of the curve.
Without this tangential transition, there would be a sharp angle at this point. While this is technically possible, it is not recommended.
Tolerances at a sharp angle are greater than at a tangential transition.

With tangential transition



without tangential transition



Subject to change / 04/2025

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