Your Dreams, Our Challenge

PRODUCT QUALITATIVE SPECIFICATION

Assessment of optical defects & dimensional tolerances for claim purposes

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1. PRODUCT QUALITATIVE SPECIFICATION
Assessment of optical defects & dimensional tolerances for claim purposes

The quality of glass products is assessed according to the requirements set out in the relevant harmonized European standards EN 1279-1.

Where the standard does not specify relevant manufacturing tolerances, AGC provides its own standard tolerances, which it is able to provide during its normal production operations. Each AGC customer may contact our sales representative to arrange other manufacturing tolerances and product quality assessment criteria to meet their own specific needs.

Here are just the most basic European standards for assessing the acceptable quality of glass products:

For basic glass

EN 572 Glass in building – Basic soda lime silicate glass products, Part 2 for float glass, Part 3 for polished wired glass, Part 4 for drawn sheet glass, Part 5 for patterned glass, Part 6 for wired patterned glass, Part 7 for wired or unwired channel shaped glass, Part 8 for glass supplied to final cut sizes

EN 1096 Glass in building – Coated glass

For semi-worked glass

EN 1279 Glass in building – Insulating glass units

EN 1863 Glass in building – Heat strengthened soda lime silicate glass

EN 12150 Glass in building – Thermally toughened soda lime silicate safety glass

EN 14179 Glass in building – Heat soaked thermally toughened soda lime silicate safety glass

EN 12543 Glass in building – Laminated glass and laminated safety glass

2. Insulating glass – Thermobel and Thermobel TG

The relevant European standard EN 1279-1 regulates the tolerance for the thickness of insulating glass and sets requirements for the optical and visual quality of insulating glass. It describes other possible phenomena, which can or cannot be considered as a glass defect during visual inspection. The standard defines the designation of height and width of insulating glass as a whole, it specifies the thickness tolerances of insulating glass and recommends how to determine the dimension tolerances of insulating glass, which must be clearly defined and described in the manufacturer's insulating glass manufacturing system[1].

2.1. Designation of the insulating glass height and width

Where the dimensions of insulating glass for rectangular panes are given, the first dimension is width (B) and the second dimension is height (H) as shown in Figure 1. It must be clarified which dimension is width (B) and which is height (H) in relation to the installation position.

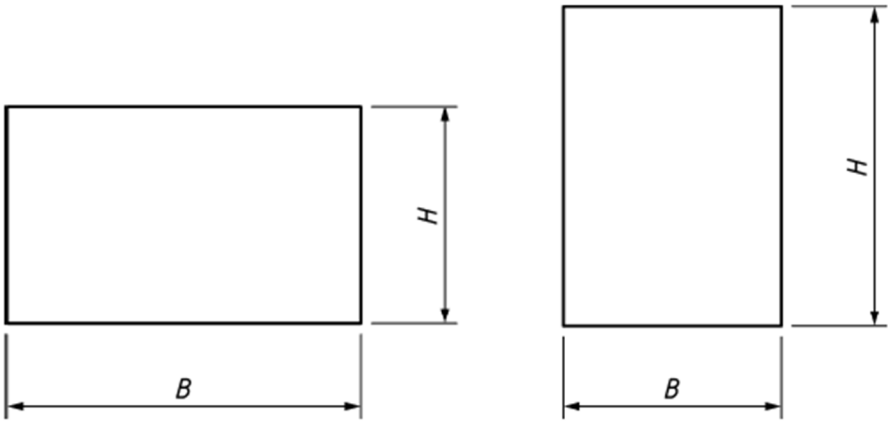


Figure 1 – Examples of width and height in relation to the pane shape

2.2. Thickness tolerance along the perimeter of insulating glass

The actual thickness must be measured as the distance between the outer surfaces of the insulating glass, at all corners and approximately in the middle of the edges.

[1] Manufacturer's standard tolerance – these are dimensional tolerances, which the manufacturer sets himself based on their production possibilities while ensuring normal operation in production.

Table 1 – Thickness tolerances for insulating glass

Glazing	Pane	Thickness tolerances for insulating glass[a]
Insulating double glass	all panes are cooled float glass	±1.0 mm
	at least one pane is laminated, patterned or other non-cooled glass	±1.5 mm
Insulating triple glass	all panes are cooled float glass	±1.4 mm
	at least one pane is laminated, patterned or other non-cooled glass	+2.8 mm / -1.4 mm
[a] If one glass pane has a nominal thickness of more than 12 mm for cooled or toughened glass, or 20 mm for laminated glass, the manufacturer of the insulating glass should be consulted regarding the tolerance.		

Note: For combinations of glass panes other than those listed in the tables, please contact an AGC sales representative.

If fire-resistant glass is used for the production of insulating glass, the thickness tolerance *(Table 1)* is increased by the thickness of the fire-resistant glass *(Table XX on page XX)*.
Example: double glass consisting of (*E6 - 16 - Pyrobelite 7)
double glass ±1.0 + Pyrobelite 7 ±0.9; the resulting tolerance for the given composition is ±1.9 mm
Example: double glass consisting of (*CX6 - 16 – Pyrobel 16)
double glass ±1.5 + Pyrobel 16 ±1.0; the resulting tolerance for the given composition is ±2.5 mm
Example: triple glass consisting of (*CX E10 - 12 - *F8 - 12 - Pyrobel 17 N)
triple glass +2.8 / -1.4 + Pyrobel 17 N ±1.6; the resulting tolerance for the given composition is +4.4 / -3.0 mm

*E = low-emission layer (Low-E); CX = laminated glass; CX E = laminated glass with Low-E; F = float

2.3. Tolerances for insulating glass dimensions

The dimensional tolerances shall be part of the system description and subject to factory production control.

Table 2 – Tolerances for insulating glass dimensions

Insulating double / triple glass	Tolerances for B and H	Offset
all panes ≤ 6 mm and (B and H) ≤ 2,000 mm	±2 mm	≤ 2 mm
6 mm < thickest pane ≤ 12 mm or 2,000 mm < (B and H) ≤ 3,500 mm	±3 mm	≤ 3 mm
3,500 mm < (B and H) ≤ 5,000 mm and thickest pane ≤ 12 mm	±4 mm	≤ 4 mm
1 pane > 12 mm or (B or H) > 5,000 mm	±5 mm	≤ 5 mm
Thickness means nominal thickness.		

Glass offset – the load-bearing side of insulating glass must always be the one with the minimum offset

Note: For combinations of glass panes other than those listed in the tables, please contact an AGC sales representative.

2.4. Visual quality of insulating glass

The optical and visual quality of insulating glass is governed by standard EN 1279-1, Annex F. The standard defines the inspection zones and the maximum permitted and permissible number and shape of defects. Tables 3, 4 and 5 below refer to insulating glass of type A, B and C. However, the tables do not apply to cases where at least one pane of patterned glass, wired glass, patterned wired glass or fire-resistant laminated glass is present in the composition.

Insulating glass shall be inspected from a distance of at least 3 meters from the inside outwards and at the most perpendicular angle of view to the glass surface for the duration of maximum one minute per square meter. The assessment shall be performed under diffuse daylight conditions (e.g. cloudy sky), without direct sunlight or artificial lighting.

Insulating glass assessed from the outside shall be inspected in the built-in state, considering a normal viewing distance of at least 3 m. The viewing angle shall be as perpendicular to the glass surface as possible.

Defects of insulating glass shall not be marked or highlighted in any way. The responsible person inspecting insulating glass has a maximum time limit of 1 minute per one square meter of glass.

2.4.1. Inspection zones for defect assessment

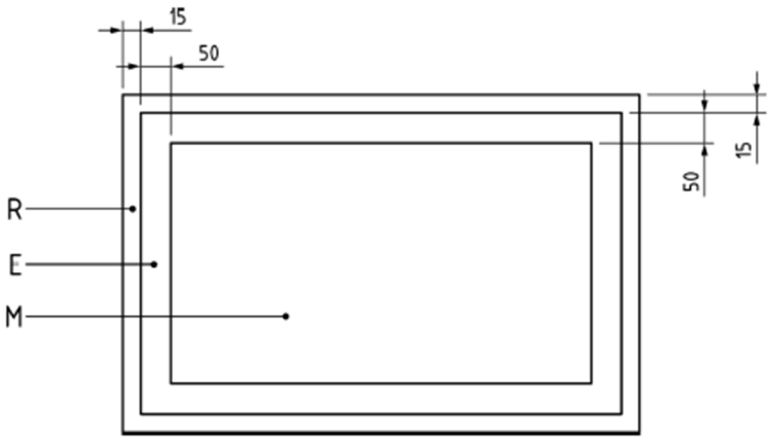


Figure 2 – Glass pane zones for defect assessment

Description:

R zone 15 mm wide, usually covered by a frame or corresponding edge sealing for frameless glazing

E zone along the edge of the visible area 50 mm wide

M main zone

2.4.2. Spot defects in glass

Spot defects interfere with the visual transparency when viewing through the glass. It may involve opaque dots (tin marks, stones...), holes in the coating, bubbles, foreign objects or point inclusions in laminated glass.

Table 3 – Permissible number of spot defects

Zone	Defect size (without the deformation field*) (Ø in mm)	Pane area S (m^2)			
		S ≤ 1	**1 < S ≤ 2**	**2 < S ≤ 3**	**3 < S**
R	All sizes	Without limitation			
E	Ø ≤ 1	Permissible if less than 3 spot defects in an area of ≤ 20 cm			
	1 < Ø ≤ 3	4	1 per meter of circumference		
	Ø > 3	Impermissible			
M	Ø ≤ 1	Permissible if less than 3 spot defects in an area of ≤ 20 cm			
	1 < Ø ≤ 2	2	3	5	5 + 2/m^2
	Ø > 2	Impermissible			

Note: * Deformation field = optically deformed area around the defect

2.4.3. Glass impurities

Glass impurities means a material that remains on the glass surface in a shape of a spot or a stain – for permissible defects see Table 4.

Table 4 – Permissible number of spot impurities and stains

Zone	Dimensions and types (Ø in mm)	Pane area S (m^2)	
		S ≤ 1	**1 < S**
R	All sizes	Without limitation	
E	Spots Ø ≤ 1	Without limitation	
	Spots 1 < Ø ≤ 3	4	One per 1 meter of circumference
	Stains Ø ≤ 17	1	
	Spots Ø > 3 and stains Ø > 17	Maximum 1	
M	Spots Ø ≤ 1	Maximum 3 in each area of Ø ≤ 20 cm	
	Spots 1 < Ø ≤ 3	Maximum 2 in each area of Ø ≤ 20 cm	
	Spots Ø > 3 and stains Ø > 17	Impermissible	

2.4.4. Linear / elongated glass defects

Linear or elongated glass defects may have the form of deposits, stains and scratches and occupy a certain length and area. We distinguish two linear defects. A hair scratch or a hair linear defect is a slight mechanical damage on the glass surface having the thickness of a hair. The permissible number of such defects is given in Table 5. The second type of linear defect is a rough scratch, which is a sharp mechanical damage. This type of defect is inadmissible.

Table 5 – Permissible number of linear / elongated defects

Zone	Individual length (mm)	Total sum of individual lengths (mm)
R	Without limitation	
E	≤ 30	≤ 90
M	≤ 15	≤ 45

Tables 3, 4 and 5 above apply to insulating glass consisting of two monolithic panes. When measuring defects on insulating triple glass, the permissible number of defects specified in Tables 3, 4 and 5 shall be increased by 25% for each additional glass pane (it also applies to laminated glass panes, each additional monolithic pane in insulating glass is always counted). The number of permissible defects shall be always rounded up.

2.4.5. Defects of glass edges

Defects of glass edges are defined in the relevant standards for each type of glass pane (see the introduction). External shallow edge damage or shell fractures, which do not affect the glass strength and which do not exceed the edge sealing width, are permissible. Inner shell fractures without loose debris, which are filled with sealing material, are permissible.

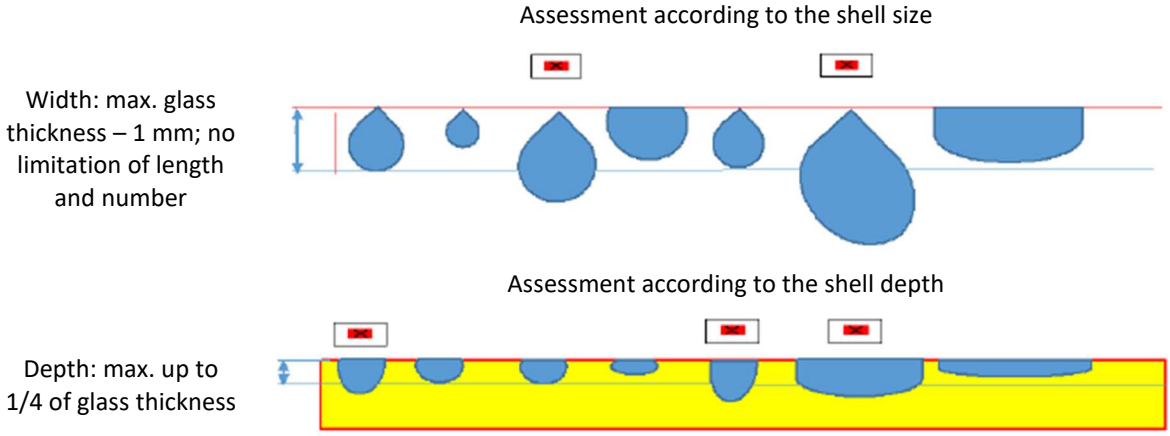


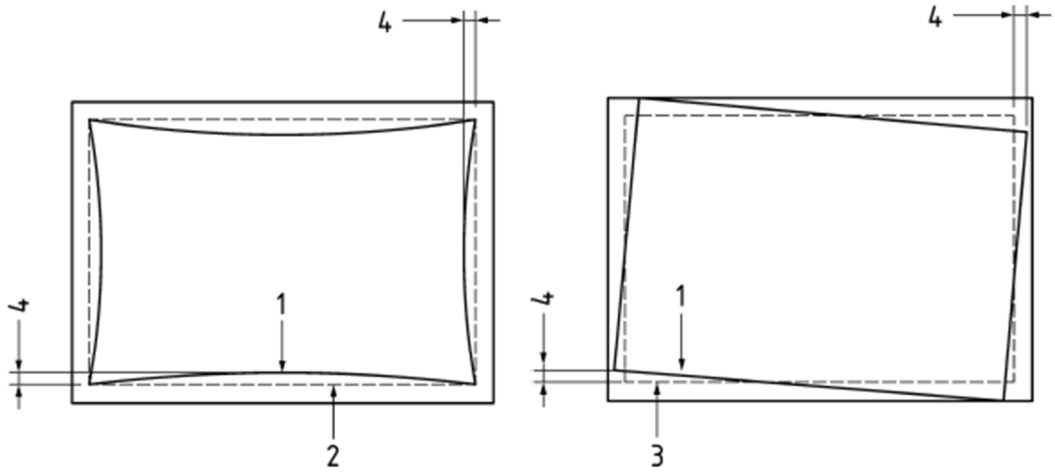
Figure 3 – Assessment of edge defects according to the shell size and depth

2.4.6. Tolerance for the spacer straightness

In insulating double glass, the tolerance of the spacer straightness is 4 mm up to the length of 3.5 m and 6 mm for larger glass. The permissible deviation of a spacer(s) relative to the straight parallel glass edge or another spacer (e.g. in triple glass) is 3 mm up to the length of 2.5 m. For larger edges the deviation of 6 mm is permissible.

Table 6 – Tolerance for the spacer frame position

Type of glazing	Spacer frame tolerance – straightness A / parallelism B (mm)	Edge dimensions of insulating glass (mm)
double glass	4	≤ 3500
	6	> 3500
triple glass	3	≤ 2500
	6	> 2500



Legend

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

Figure 4 – Examples of spacer deviations

2.5. Other visual aspects of insulating glass

a) General aspects

Certain physical phenomena may appear on the glass surface and should not be taken into account when assessing the image quality. Those are not considered defects.

b) Actual colour

Differences in colour appearance may be caused by the contents of iron oxides in glass, the coating process, the coating itself, variations in the glass thickness and the insulating glass construction. They cannot be prevented.

c) Differences in the insulating glass colour

Facades made of insulating glass containing coated glass may have different shades of the same colour. This effect can be amplified when viewed at an angle. Possible causes of the colour difference include slight changes in colour of the substrate to which the coating is applied and slight changes in the thickness of the coating itself.

An objective assessment of colour differences can be made according to ISO 11479-2.

d) Brewster's Fringes – interference colouration:

When glass pane surfaces are nearly perfectly parallel and the surface quality is high, interference colouration of the insulating glass occurs. These are fringes of variable colour resulting from the light spectrum decomposition. If the source light is the sun, colours vary from red to blue. This phenomenon is not considered a defect, it is the result of the insulating glass construction.

e) Newton's Rings

This optical phenomenon occurs in **defective insulating glass** where two glass panes touch or almost touch in the middle. This optical phenomenon exhibits as a set of concentric coloured rings centred at the point of contact / near contact of two glass panes. The rings are roughly circular or elliptical.

f) Glass colouring caused by different stresses in the glass cross-section

Some processed glass also has a colour characteristic for a product which has been toughened or heat-strengthened, see EN 12150-1 or EN 1863-1. This phenomenon **is not considered a glass defect**.

g) Glass deflection caused by temperature and barometric pressure fluctuations

Fluctuations of temperature in the air or a gas-filled cavity and fluctuations of barometric pressure of atmosphere and altitude cause the air or gas to shrink or expand in the cavity, resulting in deflection of glass panes and, thus, distortion of the reflected image. These unavoidable deflections fluctuate over time. Their size depends partly on the stiffness and size of the glass pane and also on the width of the cavity. These deflections are significantly reduced by small dimensions, glass thickness and/or small cavities. This phenomenon **is not considered a glass defect**.

h) Condensation on external surfaces

External condensation on insulating glass can occur both indoors and outdoors. If it occurs indoors, it is usually caused by high humidity in the room, along with low outside temperature. Kitchens, bathrooms and other areas with high humidity are particularly sensitive. If it occurs outdoors, the condensation is caused by the overnight loss of heat of the outer glass surface emitted by infrared radiation towards the clear sky, together with the high humidity of the outside atmosphere, but never by rain. These phenomena **are not considered glass defects**, they are caused by atmospheric conditions.

i) Natural colour of clear glass

Clear glass has a very faint green appearance, especially at the edges. It becomes more pronounced with greater glass thickness. This phenomenon **is not considered a glass defect**.

AGC also draws attention to other possible defects that are not subject to a claim:

j) Cracks in glass

Glass overloading caused by force due to impact, thermal stress, frame structure movements or contact with the frame may result in a glass fracture, which is not considered a warranty defect. If the glass stress is present during its processing (cutting, grinding), such processing would not be successful.

k) Grating in the glass interspace

Due to temperature fluctuations, the length of the glass partition crosspieces changes, causing clattering sounds that can never be completely avoided, and therefore it is not considered a warranty defect.

l) Thermal shock

This spontaneous phenomenon is not precisely described in any standard concerning glass, only marginally in standard EN 572-1, Section 6.1, Table 1. Glass may break due to thermal shock when there are two places on cooled (unhardened) soda lime silicate glass with a large temperature difference of about 40 °C. Thermal shock is manifested by a characteristic glass fracture where the fracture usually leads from the glass edge perpendicularly. Applying various foils on glass, partial shading of glass with various objects, such as dark furniture, half-closed blinds, curtains etc., should be considered as risky. It is also necessary to avoid situations preventing free air flow between the glass and the rest of the room. The risk assessment of thermal stress shall be carried out by the designer.

m) Wettability of insulating glass

The wettability of the surface on the outer side of insulating glass may differ due to imprints of rollers, fingerprints, labels, residues of smoothing agents, etc. On a wet glass surface caused by dew, rain or water during cleaning, different wettability may become visible.

3. Laminated and laminated safety glass – STRATOBEL

Laminated and laminated safety glass is governed by the relevant harmonized standard EN ISO 12543. The standard specifies uniform tolerances for storage and final dimensions of laminated glass. The customer's requirements for the final dimensions of laminated glass may differ. These are mainly laminated glass formats, which are prepared to a required size and which can be further processed (e.g. by means of edge processing, drilling or face decoration, etc.). Customer's requirements for the final dimensions should be consulted with an AGC sales representative.

3.1. Dimensional tolerance of laminated glass

The tolerances for laminated glass dimensions are governed by standard EN ISO 12543, Part 5. These tolerances are listed in the following tables. The storage and final dimensions are listed in Table 7, the diagonal differences in Table 8, the mutual allowable overlap (displacement of each glass pane against each other) are listed in Table 9 and shown in Figure 5.

Table 7 – Dimensional tolerances – final and storage dimensions

Limit deviations for width B and/or length H			
Nominal dimensions of B and/or H [mm]	**Nominal thickness of laminated glass ≤ 8 mm**	**Nominal thickness of laminated glass > 8 mm**	
		All glass panes with nominal thickness < 10 mm	**At least 1 glass pane with nominal thickness ≥ 10 mm**
≤ 2000	+3.0 -2.0	+3.5 -2.0	+5.0 -3.5
≤ 3000	+4.5 -2.5	+5.0 -3.0	+6.0 -4.0
> 3000	+5.0 -3.0	+6.0 -4.0	+7.0 -5.0
Note: If the laminated glass contains heat-toughened or heat-strengthened glass, an additional tolerance of ±3 mm shall be considered.			

Table 8 – Limit deviations for the diagonal difference

Limit deviations for width B and/or length H			
Nominal dimensions of B and/or H [mm]	Nominal thickness of laminated glass ≤ 8 mm	Nominal thickness of laminated glass > 8 mm	
		All glass panes with nominal thickness < 10 mm	At least 1 glass pane with nominal thickness ≥ 10 mm
< 2000	6	7	9
< 3000	8	9	11
> 3000	10	11	13

Table 9 – Maximum displacement of laminated glass – standard products

Nominal dimensions of B and/or H [mm]	Maximum permitted overlap on one edge d (mm)	
	Cut, chamfered edge	*Edge ground and polished before lamination
B, H ≤ 1000	2	2
1000 < B, H ≤ 2000	3	2
2000 < B, H ≤ 4000	4	4
B, H > 4000	6	4
***Note:** ** Tolerances are specified by the manufacturer – AGC.		

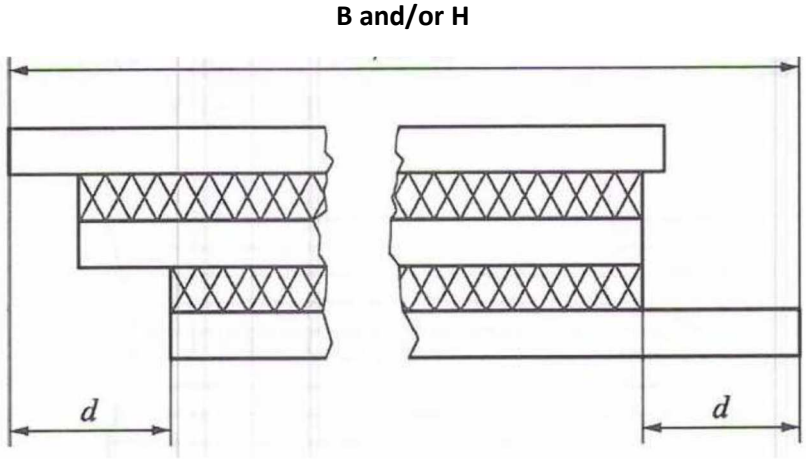


Figure 5 – Maximum displacement of laminated glass (glass overlap d)

3.2. Limit deviations for thickness of film laminated products

Laminated glass and laminated fire-resistant glass shall not exceed the sum of the limit deviations of individual glass panes referred to in basic product standard EN ISO 12543-1, Annex A. The nominal thickness of laminated glass shall be the sum of individual glass thicknesses and PVB interlayers (see points (a) and (b)). The thickness of PVB films is always a multiple of 0.38 mm. The thickness tolerances of fire-resistant glass are listed in Table 11.

a) If the total film thickness is < 2 mm, there is no limitation for film thickness tolerance (e.g. thickness of product 6.6.2 may vary from 12.36 mm (5.8 + 0.76 + 5.8 mm) to 13.16 mm (6.2 + 0.76 + 6.2 mm);

b) If the total film thickness is > 2 mm, the film thickness tolerance is ± 0.2 mm (e.g. thickness of product 6.6.6 may vary from 13.68 mm (5.8 + 2.28 – 0.2 + 5.8 mm) to 14.88 mm (6.2 + 2.28 + 0.2 + 6.2 mm)

Table 10 – Thickness of base glass according to EN 572-8

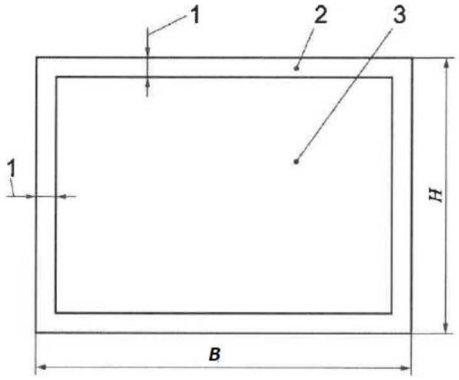
Nominal dimension of glass thickness (mm)	Glass thickness tolerance (mm)			
	Float	Ornamental	Polished wired glass	Ornamental wired glass
2	±0.2	–	x	x
3	±0.2	±0.5	x	x
4	±0.2	±0.5	x	x
5	±0.2	±0.5	x	x
6	±0.2	±0.5	6.2 to 7.4	±0.6
7	x	x	x	±0.7
8	±0.3	±0.8	x	±0.8
9	x	x	x	8.0 to 10.5
10	±0.3	±1.0	±0.9	x
12	±0.3	±1.5	x	x
14	x	±1.5	x	x
15	±0.5	±1.5	x	x
19	±1.0	±2.0	x	x
25	±1.0	x	x	x
***Legend:* X** not produced				

Table 11 – Limit deviation for thickness of fire-resistant glass

Type of fire-resistant glass	Nominal thickness	*Tolerance
Pyrobelite 7	7.9	±0.9
Pyrobel 16	17.3	±1.0
Pyrobel 17 N	17.8	±1.6
Pyrobel 25	26.6	±2.0
Pyrobel 30	30	±2.5
***Note:** ** Tolerances are specified by the manufacturer – AGC.		

3.3. Visual quality of laminated glass

The visual quality of laminated glass is assessed according to European standards EN ISO 12543-5 and EN ISO 12543-6. Cut edge is an edge of the basic laminated glass or an edge of the glass cut to the required dimensions, without any subsequent processing. Chamfered edge is a cut ground edge. Ground edge is an edge machine-ground to a straight level. Ground edge may have shiny surfaces. Polished edge is a machine chamfered, ground and subsequently polished edge so that the edge surface has a high gloss. The individual quality assessment criteria are set out in Table 12 and Table 13 below.



Legend for Figure 6	
1	width of the edge area
2	edge area
3	main view zone
B	pane width
H	pane height

Figure 6 – Surfaces of glass laminated for final dimensions intended for glazing

Laminated safety glass panes with an area less than 5 m^2 have the edge area of 15 mm as shown in Figure 6. If the pane area is greater than 5 m^2, width of the edge area increases to 20 mm.

Inspection conditions: According to EN 12 543-6, chap. 4, laminated safety glass panes are inspected from the distance of 2 m perpendicular to the glass. A glass pane shall be placed in front of a grey background and shall be backlit by diffuse daylight. Disturbing errors shall be marked and their eligibility shall be assessed according to the tolerances given in Table 12.

Table 12 – Tolerances of defects at the edges of laminated glass

<table>
<tr><th colspan="3">Tolerance of edge defects according to EN ISO 12543-5</th></tr>
<tr><th rowspan="2">Special defects</th><th colspan="2">Specified values</th></tr>
<tr><th>Storage dimensions</th><th>Final dimensions</th></tr>
<tr><td>Film overflow and run-in[2] without edge difference</td><td rowspan="2">max. 3 mm</td><td>max. 1 mm</td></tr>
<tr><td>Overflow and run-in of film for interiors in the production using a vacuum case</td><td>impermissible</td></tr>
<tr><td>Delamination[3] – cut and chamfered edge</td><td rowspan="2">max. 5 mm from the edge up to 5 mm long</td><td>max. 5 mm from the edge up to 5 mm long</td></tr>
<tr><td>Delamination – ground and polished edge</td><td>Impermissible</td></tr>
<tr><td>Shell – cut edge</td><td>max. up to 1/4 of glass thickness, maximum width: glass thickness (-)1 mm; no limitation of length and number</td><td>max. up to 1/4 of glass thickness, maximum width: glass thickness (-)1 mm; no limitation of length and number</td></tr>
<tr><td>Shell – chamfered edge</td><td></td><td>max. up to 1/4 of glass thickness, maximum width of 3 mm and length of 6 mm; no limitation of number</td></tr>
<tr><td>Shell – ground edge</td><td></td><td>maximum width and length of 0.4 mm</td></tr>
<tr><td>Shell – polished edge</td><td></td><td>maximum width and length of 0.2 mm</td></tr>
<tr><td>Deflection</td><td colspan="2">max. 2 mm/m</td></tr>
<tr><td>Deflection of glass in composition with thermally toughened or strengthened glass</td><td colspan="2">max. 3 mm/m</td></tr>
<tr><td colspan="3">Note: The assessment of shells acceptable on each type of processed edges is a criterion specified by the manufacturer – AGC.</td></tr>
</table>

Table 13 – Spot and linear defects of laminated glass

[2] Film run-in – local setting of film from the edge of laminated glass
[3] Delamination – local detachment of individual glass panes from the film

Permissible spot defects[4] when viewing[5] building glass according to EN ISO 12543-6						
Defect size [mm]		0.5 < d ≤ 1.0	1.0 < d ≤ 3.0			
		For all sizes	A ≤ 1	1 < A ≤ 2	2 < A ≤ 8	A < 8
Number of permissible defects	2 panes	No limitation but without accumulation of defects	1	2	1.0 m^2	1.2 m^2
	3 panes		2	3	1.5 m^2	1.8 m^2
	4 panes		3	4	2.0 m^2	2.4 m^2
	≥ 5 panes		4	5	2.5 m^2	3.0 m^2

Permissible linear defects[6] when viewing building glass according to EN ISO 12543-6	
Pane area [m^2]	Number of permissible defects ≥ 30 mm in length
≤ 5	Impermissible
5 to 8	1
> 8	2
Linear defects < 30 mm long are permissible.	

[4] Spot defect – opaque dots (e.g. tin marks, stones), bubbles, foreign bodies

[5] Viewing area – area for defect assessment: for glass with a cut and chamfered edge with the area ≤ 5 m^2 excluding the width of 15 mm from the edge, with the area > 5 m^2 excluding the width of 20 mm from the edge; for glass with a ground and polished edge, it is the entire glass surface. Max. defect size in the excluded area: Ø 5 mm.

[6] Linear defect – hair scratch; rough scratch – sharp mechanical damage to the glass surface in the shape of a line; hair scratch – mechanical damage to the glass surface in the shape of a line

4. Thermally toughened soda lime silicate safety glass, heat soaked thermally toughened soda lime silicate safety glass (HST) and heat strengthened soda lime silicate glass

The production of thermally toughened safety glass is governed by standard EN 12150. When it is also heat soaked, it is governed by EN 14179, heat strengthened glass is governed by EN 1863.

4.1. Nominal value and thickness tolerances

Nominal thicknesses and thickness tolerances of thermally toughened / heat soaked thermally toughened / strengthened glass are governed by the product standard, such as EN 572-2 for float glass, EN 572-5 for patterned glass. An overview is available in standard EN 572-8.

Table 14 – Thickness tolerances for heat–treated glass

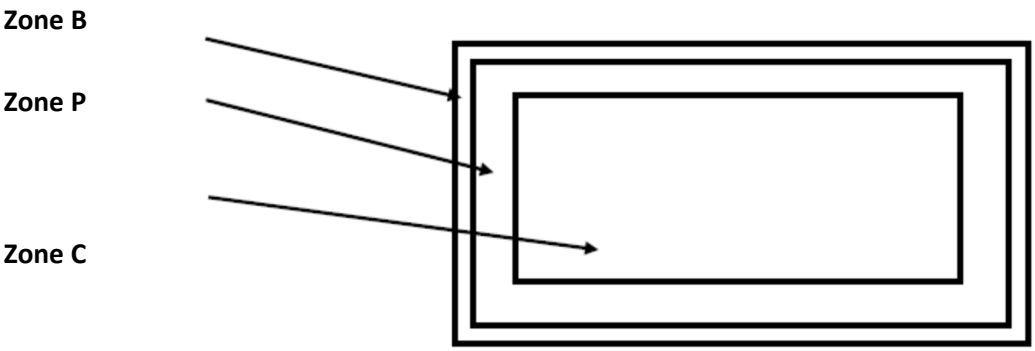
Thickness tolerances are governed by EN 12150 / EN 14179 / EN 1863, which is based on EN 572-8		
Nominal thickness [mm]	Tolerance [mm]	
3-6	Float	Patterned
8	+-0.2	+-0.5
10	+-0.3	+-0.8
12	+-0.3	+-1.0
15	+-0.5	
19	+-1.0	

Table 15 – For length tolerances see EN 12150, Table 2 / EN 14179 or EN 1863, Table 2; tolerances for stamp placement are specified by the manufacturer – AGC

Nominal dimensions of width and height [mm]	Length tolerance and stamp placement tolerance* [mm]	
	Nominal glass thickness d ≤ 12 [mm]	Nominal glass thickness d > 12 [mm]
≤ 2000	+-2.0**	+-3.0
>2000 ≤ 3000	+-3.0	+-4.0
> 3000	+-4.0	+-5.0
Stamp*	+-3.0	+-3.0
Note: * The stamp placement is not governed by a standard, the tolerance is set by the manufacturer – AGC. ** The standard sets a tolerance lower by +-2.5; the tolerance of the manufacturer is stricter.		

Table 16 – Tolerances for dimensions and rectangularity of toughened / heat soaked toughened and heat strengthened flat glass

Tolerances for diameters and positions of holes and cutouts		
Nominal hole diameter Ø [mm]	Tolerance of hole diameter Ø [mm]	
4 ≤ Ø ≤ 20	+-1.0	
20 ≤ Ø ≤ 100	+-2.0	
Ø > 100	Inquiry from the manufacturer	
Nominal dimensions of width and height [mm]	Hole and cutout placement tolerance [mm]	
	Nominal glass thickness d ≤ 12 [mm]	Nominal glass thickness d > 12 [mm]
≤ 2000	+-2.0	+-2.0
> 2000 ≤ 3000	+-2.0*	+-2.0*
> 3000	+-2.0*	+-2.0*
Note: *The tolerance for the position of holes is the same as the length tolerance, see EN 12150/1863, Chapter 7.4.5; however, the manufacturer, AGC, adheres to its own values which are stricter.		



- **Border zone B:** 12 mm
- **Edge zone P:** 75 mm from the edge of the glass pane
- **Central zone C:** the remaining part of the glass pane

Figure 7 – Assessment of defects – Description of zones and their occurrence (according to the manufacturer's internal regulations)

Table 17 – Definition of defects according to the zones of their occurrence

Zone	**Hair scratches**
B,P,C	Permissible without limitation of length if not in a cluster
	Rough scratches
	Impermissible
	Spot defects of float glass (bubbles, metal admixtures, stones), including optical deformations
B,P,C	Permissible: max. size of 3 mm, max. 3 defects
	Pressure marks from rollers, including optical deformations with thickness ≤ 8 mm
B	Permissible: no restrictions on number and size
P	≤ 3mm: permissible without clusters
	> 3 mm: impermissible
C	≤ 1.5 mm: permissible without clusters
	> 1.5 mm: impermissible
	Stains and pressure marks – low visible area on the glass surface (fingerprints, dry traces of water, baked dirt ...)
P	Impermissible if visible from the distance of 2 m
C	Impermissible if visible from the distance of 1 m
	Colour defects
	Permissible: max. size of 1 mm without clusters, no restrictions on number
B,P,C	Permissible: max. size of 2 mm, max. 3 defects
Inspection conditions	Defects on glass are assessed by looking at the glass, not in the vista
Zone P	Impermissible if visible from the distance of 2 m
Zone B,C	Impermissible if visible from the distance of 1 m
Position of print	+-1.0 mm
Overflows of colour on polished edges	Impermissible
	Shells on edges
Chamfered edge	Permissible: max. width of 3 mm, max. length of 6 mm, max. depth of 1/4 of glass thickness, no restrictions on number
Ground edge	Permissible: max. width and length of 0.4 mm, no restrictions on number
Polished edge	Permissible: max. width and length of 0.2 mm, no restrictions on number
	Shells around a hole / cutout
Cut holes, cutouts	Permissible: max. width of 3 mm, max. length of 6 mm, max. depth of 1/4 of glass thickness, no restrictions on number
Embedded holes	Impermissible on the face side; permissible on the non-visible side: max. width and length of 2 mm, no restrictions on number

Table 18 – Total and local deflection of horizontally treated thermally toughened or heat strengthened glass

Total and local deflection according to EN 12150 / EN 14179 / EN 1863, Chapter 6, Table 3	
Type of glass for horizontal machining	**Total maximum deflection**
Float with nominal thickness ≥ 3 mm	3 mm/m
Patterned glass with nominal thickness ≥ 3 mm	4 mm/m
Type of glass and type of horizontal machining	**Local maximum deflection**
Float 3–19 mm; heat strengthened (semi-hardened)	0.3 mm/300 mm
Float 3–19 mm; thermally toughened (hardened)	0.5 mm/300 mm
Patterned glass 3–19 mm; heat strengthened or thermally toughened	0.5 mm/300 mm
Note: Inspection conditions – observer in a distance of at least 1 m, angle of 0° - 60° from the perpendicular view (the perpendicular view represents the angle of 0°).	

4.2. Optical and visual quality

a) **Natural colour of clear glass:** clear glass has a very faint green appearance, especially at the edges. It becomes more pronounced with greater glass thickness.

b) **Thermally toughened and heat soaked thermally toughened glass:** The mechanical properties of thermally toughened soda lime silicate safety glass do not change when heated to at least 250 °C and are not affected by temperatures below zero. Thermally toughened soda lime silicate safety glass is able to withstand sudden temperature changes in both directions and temperature differences up to 200K.

c) **Heat strengthened glass:** The mechanical properties of heat strengthened soda lime silicate glass do not change when gradually heated to at least 200 °C and are not affected by temperatures below zero. Heat strengthened soda lime silicate glass is able to withstand sudden temperature changes in both directions and temperature differences up to 100K.

d) **Spontaneous explosion of thermally toughened soda lime silicate safety glass:** The presence of NiS inclusion is an inherent property of thermally toughened glass and may lead to spontaneous glass explosion. The manufacturer is not liable for any damage caused by this property of heat-treated glass. Spontaneous explosion of glass can be minimized by performing the Heat Soak Test (HST).

e) **Labelling:** Heat-treated glass complying with European standards must bear a permanent label. The label must include the following information - name and trademark of the manufacturer and the number of the relevant standard. If the stamp is not required, this must be stated in the order.

f) **Optical deformation:** It is a phenomenon of heat-treated glass where the surface deformation is visible in reflection along with small imprints (pressure marks) into the glass surface.

g) **Anisotropy (irisation):** During the toughening process, surfaces with different stresses in the glass cross-section are formed. When thermally toughened soda lime silicate safety glass is viewed in polarized light, the stress areas appear as coloured zones, sometimes known as "leopard spots". Polarized light also occurs in normal daylight. The birefringence effect is more noticeable when viewed at an acute angle.

COLORBEL & ARTLINE

Colorbel and Artlite glass are made by the screen-printing technology when coloured glass frits are applied over a screen-printing matrix to the glass, which must be subsequently thermally toughened. Due to the high temperature in the quenching furnace, the colour subsequently acquires considerable mechanical and chemical resistance. ARTLITE is partially enamelled glass, COLORBEL is fully enamelled glass.

a) It is not recommended to apply enamelled glass produced by the screen-printing technology to structures using silicone sealants as it may possibly show through.

b) In order to reduce the risk of silicone visibility, it is possible to apply printing in two layers (but the suitability and application of the sealant shall always be discussed with the sealant manufacturer).

c) It is not recommended to orient the enamelled side of glass towards the exterior (i.e. position 1).

d) All developed shades are close to RAL shades and are developed in combination with Planibel clear glass, 6 mm thick (with green tint).

e) For technological reasons, it is not always possible to obtain the shade absolutely identical with the same colour.

f) In order to avoid possible differences between the desired and obtained colour (shade, transparency, etc.), we recommend producing a sample first.

g) Due to the possible occurrence of dark streaks and so-called “star sky” when illuminating printed glass, we do not recommend installing such glass where there is a need to see through it.

h) All the information on screen printing applies also to enamelled glass in other products (Thermobel, Stratobel).