

	<b>WARRANTY AND QUALITY CONDITIONS</b>	Appendix 1
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## **1. Warranty of Insulating Glasses**

### **Warranty period and scope**

The warranty of Saint Gobain Glass Estonia SE / BU Baltiklaas (hereinafter Baltiklaas) is valid for all insulating glass manufactured by Baltiklaas according to standard EN 1279 "Glass in building: Insulating glass units" and delivered for construction purpose, except for the special products mentioned below. (further "Warranty") Warranty means that Baltiklaas shall guarantee that during warranty period given below no condensed water will appear between the glasses of the insulating glass manufactured by them. Warranty does not cover other defects appearing during the Warranty period

The warranty of Baltiklaas is valid for the buyer of the product.

The warranty period shall be calculated from the date the insulating glass was sold and it will be valid as follows:

- 5 years for insulating glass in buildings (except the exceptions below):
- 2 years for
  - o Insulating glass in inclined roofs/inclined facades;
  - o Insulating glass in cold, unheated buildings;
  - o Insulating glass that have been installed in difficult or aggressive conditions (excessive heat, cold, humidity, UV-radiation, chemical vapors, vibration; e.g. saunas, swimming pools etc.)
  - o Shaped Insulating glasses which contain arc shape.

The date the insulating glass was produced has been printed on each spacer of the insulating glass. In case the unit is changed by way of warranty, the warranty period shall be calculated since the sales date of the original unit and the warranty period shall not prolonged because of the change of insulating glass.

Following insulating glasses are not covered by the warranty, which contain:

- patterned glass (according to EN 572-5)
- wired glass (according to EN 572-3)
- capillary tubes
- insulating glass that has the ratio of sides bigger than 1:6.
- Circle shaped insulating glasses
- Insulating glasses exceeding minimum (150x220 mm) or maximum (2700x4000) production sizes.

Insulating glass that has been installed in the buildings outside Estonia is covered by the warranty of Baltiklaas only in case a corresponding written agreement has been concluded, together with lists of warranty covered countries.

### **Rights arising from the warranty**

In case condensed water appears between the glasses during the warranty period and all the warranty conditions have been fulfilled, the client has the right:

- to receive a replacement unit that Baltiklaas shall deliver at its own expense to client's factory,
- or to receive credit account in the amount of the price of the faulty product bought

In case of mutual agreement Baltiklaas may cover also the replacement costs in amount of previously approved cost calculation.

The warranty of Baltiklaas does not cover expenses or damages that have directly or indirectly been caused to third parties.

Baltiklaas is according to the present warranty obligation responsible only for those warranty cases that have taken place during the warranty period and of which the company has been notified within a reasonable time period (usually 2 weeks) after discovering the fault.

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## Conditions of the validity of warranty

Baltiklaas warranty is valid for the insulating glass if:

- windows have been produced and the insulating glass have been installed in the window frames according to the best window-making conventions and internationally acknowledged standards or constructions drawings approved by Baltiklaas;
- insulating glass have been kept clean and they have not been damaged during installation into the frames;
- insulating glass have not been damaged due to outside influences such as a hit, pressure, shifting of the support structures, vibration, etc.;
- insulating glass have not been damaged due to chemical or abrasive materials and wrong handling, loading or conservation on the construction site or in the factory;
- insulating glass have not been processed by polishing, painting, etching, taping with membrane, decorative listels or tape or any other way of processing glass surface (does not include decorative bars glued on the surface by window frame producer);
- insulating glass have not been stored in outside conditions without being covered and after the transportation of the class units the fixing posts or rods used for fasteners have been removed;
- the window frames, swings and gaskets have been maintained regularly, guaranteeing their cleanliness and weather resistance and preventing too much humidity from getting in contact with insulating glass seal;
- during installation the side of the insulating glass is covered with a glazing bead up to the length of the spacer, except in case of special products which consist in UV-radiation resistant sealant;
- during installation of the insulating glass to the window frames sealants are used that match the sealant of the insulating glass and prevent a chemical reaction from occurring between the sealant of the insulating glass and the glazing materials.
- insulating glass has been installed lower than 900 m from sea level.

## Solving reclamations

In case the insulating glass turns out to be non-hermetic during warranty period, Baltiklaas needs to be notified immediately in a written form within a reasonable time (two weeks) after discovering the fault. In case of necessity (on the demand of Baltiklaas), photos need to be taken of this faulty insulating glass that form the basis for the complaint and add these to the complaint.

In the reclamation, the following items need to be included:

- the producer of the insulating glass;
- the time of production of the insulating glass (month and year, these are printed on the spacer);
- the product name of the insulating glass, configuration (glass types, width and type of the spacer), dimensions and amount;
- explanation of the reason for reclamation;
- name and address of the person filing the reclamation;
- name and address of the producer of windows;
- building or object where the windows with the insulating glass of Baltiklaas were installed.

The person filing the complaint has the obligation to prove that humidity has got in between the glasses of the insulating glass and the insulating glass is foggy in normal conditions.

Before solving the complaint, Baltiklaas shall decide whether it is necessary to investigate the given case separately. On the demand of Baltiklaas the person filing the complaint must allow us to be convinced that the complaint filed is reasonable by way of inspection of the product by our authorized representative. In case the claim is justified, Baltiklaas shall pay for these expenses. The person filing the complaint shall pay for expenses in case Baltiklaas conducted an inspection and it appeared that there was no reason for a complaint. The person filing the complaint may have to pay for expenses by hiring a counter adviser.

Timely, reasonable and correctly presented complaints shall be solved by Baltiklaas whether replacing the faulty product or transferring money back to the account of the client (the person filing the complaint) in the amount of the price of the product bought from Baltiklaas. Replacement of the faulty product means that we will deliver new insulating glass to our client's production unit at our own expense.

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## Reclamations outside the warranty system

### Reclamations about the visual quality of insulating glass:

- The visual defects of the insulating glass have to be evaluated according to the section "The visual quality of the insulating glass".
- The visual quality of the insulating glass must be checked as soon as possible after the insulating glasses have been delivered. In case defects are discovered that according to the guidelines can be reclaimed, Baltiklaas must be notified immediately but no later than 2 weeks after the insulating glass have been delivered.
- The complaint must include a description of the defect as precisely as possible (dimensions, location) and a drawing of the defect (a photo, if possible).
- The solving of the reclamation shall take place similarly to the previous point.
- In case the visible defects are on the outer side of the insulating glass and the product has been delivered to the end user, Baltiklaas shall not compensate the price of the product or prepare a replacement insulating glass without a charge.

### Reclamations about the dimensions of insulating glass:

- The insulating glasses have been produced according to the standard EN 1279 "Glass in building: Insulating glass units". The tolerances of the dimensions presented in the standard have been described in the section "Quality requirements of the insulating glass".

### Reclamations about the breakage of insulating glass during transportation:

- The original control of the quantity and breakage of the products must take place according to the delivery note upon the delivery of the products.
- Information about the missing or broken insulating glass must be written down on the delivery note.
- In case some insulating glasses have broken during transportation, Baltiklaas must be notified immediately but no later than 3 days after the delivery of the products.
- Baltiklaas must also be notified immediately about the missing insulating glasses after the products have been accepted, later complaints shall not be taken into consideration.

### Reclamations about the breakage of insulating glasses after installation:

The producer of insulating glass shall not take any responsibility for the breakage of insulating glasses that have already been installed because the factors that influence this process are no longer controllable by Baltiklaas. These factors can be for example:

- mechanical blow on the unit that may be caused by:
  - Careless handling and storing by the window producer
  - Careless transportation from the window producer to the construction site; transportation and storing in a horizontal position. Glass must always be transported, stored and lifted in a vertical position.
  - Careless and inappropriate storing and handling at the construction site.
  - A blow with a soft or hard object against the glass
- mechanical pressure on the unit that may be caused by:
  - Bending load during the installation of the unit to the window or during the sinking of the house
  - Dot-shaped pressure on the edge of the glass
  - Wrongly installed glass support blocks
  - Deformation of the constructions
  - Very tight frames in case of windows with several layers.
- unequal heating of the glass (temperature difference of 40°C is dangerous to unhardened glass) that may be caused by:
  - Shadows falling on the window that cause big differences in temperature
  - Putting membrane, aluminum foil, profile that is glued or similar things to the whole insulating glass of a part of it
  - Abnormal heating of the glass in case the sun blinds or roller blinds have been installed behind the insulating glass without leaving enough space for air.
- vibration that may be caused by:
  - Vibration arising from the noise made by planes, heavy machines, and explosions

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- Blows, contusions, especially during careless opening of the window that has a window fixator or children's safety latch.

### **Claims regarding suitability of glazed units**

Glazed units sold by Baltiklaas shall meet the requirements stipulated in the sales contract and general quality requirements. The buyer has no right to base the purchase of a glazed unit on the professional skills or knowledge of the seller and the seller is not obliged to verify that the purchased glazed unit suits the application the buyer has stated during conclusion of the contract, since the seller does not possess the required competency. The buyer has no right to issue claims in case it becomes evident after concluding the contract that the glazed unit meeting the requirements stipulated in the sales contract does not suit the application planned by the buyer.

### **2. Warranty of single Laminated Glasses**

The warranty of Saint Gobain Glass Estonia SE / BU Baltiklaas (hereinafter Baltiklaas) is valid for all laminated glasses manufactured by Baltiklaas according to standard EN 1449 "Glass in building: Laminated glass and laminated safety glass" and delivered for construction purpose (further "Warranty") Warranty means that Baltiklaas shall guarantee that during warranty period given below no airbubbles (delamination) will appear between the glasses of the laminated glass manufactured by them. Warranty does not cover other defects appearing during the Warranty period

The warranty period shall be calculated from the date the laminated glass was sold and it will be valid as follows:

- 5 years for laminated glass in buildings

Handling of complaints for laminated glass is similar to the handling of complaints of insulating glass. Also the conditions for the validity of warranty are the same as for insulating glass.

In addition following warranty validity conditions apply:

- laminated glasses are installed so, that their edges are free of standing water
- Edges of laminated glass are not in contact with non suitable materials, which may cause chemical reaction.

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### **3. Measurements and Tolerances of Insulating Glasses**

#### **Insulating glass measurements:**

The tolerances of length of the side of Insulating glass are presented in the table below; these apply to double as well as triple insulating glasses.

		Dimensions		
		Length of the side	Tolerance	
<b>All boards of float-glass</b>				
Thickness of glass not more than 6 mm		Up to 3,0 m	+/- 2 mm	
		Over 3,0 m	+/- 3 mm	
Thickness of glass more than 6 mm		Up to 3,0 m	+/- 3 mm	
		Over 3,0 m	+/- 4 mm	
<b>At least one board of thermally toughened glass, depending on the thickness</b>				
		Up to 2,0 m	+/- 3 mm	
		2,0 to 3,0 m	+/- 4 mm	
		Over 3,0 m	+/- 5 mm	
<b>At least one board of patterned glass</b>				
Thickness of glass not more than 8 mm			+/- 4 mm	
		Thickness of glass more than 8 mm		+/-5 mm
<b>At least one board of laminated glass</b>				
	Length of the side	Lam. glass no thicker than over 8 mm	Lam. glass no thicker than over 8 mm	
			All glass less than 10 mm	One glass over 10 mm
	Less than 1,1 m	+/- 2,0 mm	(+2,5/-2,0) mm	(+3,5/-2,5) mm
	1,1 to 1,5 m	(+3,0/-2,0) mm	(+3,5/-2,0) mm	(+4,5/-3,0) mm
	1,5 to 2,0 m	(+3,0/2,0) mm	(3,5/-2,0) mm	(+5,0/-3,5) mm
	2,0 to 2,5 m	(+4,5/-2,5) mm	(+5,0/3,0) mm	(+6,0/-4,0) mm
	Over 2,5 m	(+5,0/-3,0) mm	(+5,5/-3,5) mm	(+6,5/-4,5) mm

\*the thicknesses are shown in nominal value.

The width B and the height H of insulating glass and cut glass is measured from each side from the distance of 20 mm from the corner the most. The edges of the glass board have to be on the same level as the edge of the insulating glass that it will be set upon during installing the glass.

#### **Insulating glass thickness:**

The thickness of insulating glass is measured from the surface of cleaned glass from the corners of insulating glass and the middle sections of the edges. The tolerances of thickness of double insulating glass are presented in the table.

I glass	II glass	Tolerance of thickness
Float glass, all thicknesses	Float glass, all thicknesses	+/- 1,0 mm
Float glass, all thicknesses	Toughened glass, all thicknesses	+/- 1,5 mm
Float glass, = < 6 mm	Laminated glass, = < 12 mm	+/- 1,0 mm
Float glass, other thicknesses	Laminated glass, other thicknesses	+/- 1,5 mm
Float glass, all thicknesses	Patterned glass, all thicknesses	+/- 1,5 mm
Toughened glass, all thicknesses	Hardened glass, all thicknesses	+/- 1,5 mm
Toughened glass, all thicknesses	Laminated glass, all thicknesses	+/- 1,5 mm
Toughened glass, all thicknesses	Patterned glass, all thicknesses	+/- 1,5 mm
Laminated glass, all thicknesses	Laminated glass, all thicknesses	+/- 1,5 mm
Laminated glass, all thicknesses	Patterned glass, all thicknesses	+/- 1,5 mm

\*the thicknesses are shown in nominal value.

In case of triple insulating glass, the tolerances of overall thickness shall be determined according to the following rules:

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- According to table 2 the thickness tolerances of each layer are determined;
- The squares of these values are calculated;
- The values of the squares are added together;
- Square root is taken of this sum.

#### **4. Visual Quality of Insulating Glasses**

Developed according to the materials by Danish Cooperating Organization of Glass Industry (Glasindustriens Samarbejdsorganisation – GS) and German National Association of Flat Glass Sale and Insulated Glass Production (Bundesverband Flachglas Großhandel, Isolierglasherstellung, Veredlung).

##### **Aim**

The aim of the present guidelines of the visual evaluation of insulated glass is to homogenize the criteria for quality evaluation used by the Producer and the Buyer in order to guarantee the satisfaction of the customers and the fulfilling of corresponding quality norms.

##### **Liability of the producer**

In case of the warranty applications that concern the visual quality of the insulated glass and are based on the criteria hereinafter described the Producer shall be obliged to deliver the replacement glass to the factory of the Buyer for free. The Producer shall solve the warranty applications that concern the quality of the insulated glass and are filed by the Client according to the present guidelines for quality control. The Buyer has no right for the compensation of the replacement expenses in case the glass has visible defects during delivery to the Client.

##### **Filing reclamations**

The Buyer is obliged to check the goods delivered upon receipt for defects that have occurred due to transportation and are clearly visible and he is obliged to file reclamations during reasonable period of time (2 weeks) after discovering the defect.

##### **Requirements for cleanliness and quality**

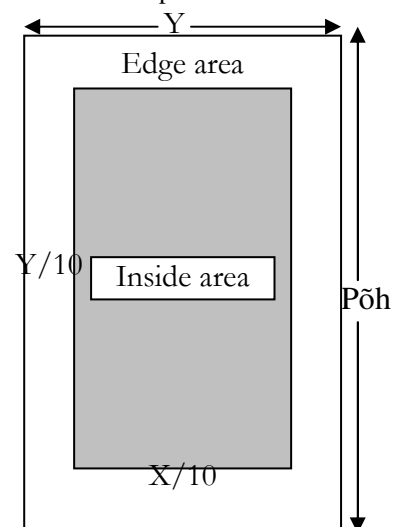
Glass is a product that consists of lime, quartz and sodium carbonate. Even if these raw materials are cleaned very carefully it is not possible to avoid some impurities in the final product. Insulated glass is a product that is produced with a large-scale production process done with utmost carefulness. Despite this, there can still be little scratches and particles of dirt inside the glass as well as on its surface.

Complaints about the dirtiness of the glass shall be checked in the way described here and a decision is made whether the dirtiness of the glass is irrelevant or to what extent this is caused by the natural qualities of the material and therefore does not belong to the warranty applications or to what extent this is as important as to give the right to a replacement glass.

##### **Evaluation criteria**

The glass to be evaluated must be looked at from the distance of 2,0 m from the inside and perpendicularly to the surface of the glass evaluated. The evaluation must take place in diffused light (for example, with a cloudy sky) without direct sunlight or artificial light. Irregularities that are not visible from a 2 m distance shall not be regarded as defects. In order to check the external reflection the distance for observing must be 5 m from the glass.

Table 1 may be used only with certain reservations because glass products come in many different variations. Therefore the evaluation should be carried out according to a concrete product. In this case, for example with security glass, the special qualities of the glass should be evaluated from the time when the glass was taken into use and was installed. In evaluating certain qualities the special features of the given glass need to be taken into consideration.



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**Table 1: Criteria for visual evaluation of insulated glass made of float glass**

	<b>Allowed visible irregularities</b>
<b>Seal area</b>  18 mm from the edge	External flat damages to the edge that do not affect the strength of the glass or exceed the closing width of the edge. Inner damages to the edge without open fragments that are filled with sealant. Dot-shaped or flat residues of production and scratches shall not be considered defects. The following damages to the edge are allowed: Max with width ½ of the thickness of glass, 10 mm long and 2 mm deep. If the width of fragment is smaller than 1/5 of the thickness of glass, the allowed depth is 6 mm.
<b>Edge area</b>  10% of the length of the edge of glass measured from the sides of glass	<b>Internal residues of glass– bubbles, dots, spots etc:</b> Surface area of glass < 1 m2: max 4 items à Ø 3,0 mm Surface area of glass > 1 m2: max 1 item à Ø 3,0 mm per running meter of the edge of glass <b>Production residues (dot-shaped) on the area between glasses:</b> Surface area of glass < 1 m2: max 4 items à Ø 3,0 mm Surface area of glass > 1 m2: max 1 item à Ø 3,0 mm per running meter of the edge of glass <b>Production residues (flat) on the area between glasses:</b> Light grey or transparent allowed max 1 item < 3 cm2 <b>Scratches:</b> Max 30 mm x 2 mm per one length, visible from 2 m distance Sum of single lengths max 90 mm <b>Filamentous scratches:</b> Allowed, but not in bulk
<b>Inside area</b>	<b>Internal residues, bubbles, dots, spots etc:</b> Surface area of glass < 1 m2: max 2 items à Ø 2 mm Surface area of glass > 1 m2 and ≤ 2 m2: max 3 items à < 2 mm Ø Surface area of glass > 2 m2: max 5 items à < 2 mm Ø <b>Scratches:</b> Max. 30 mm x 2 mm per one length Sum of single lengths max 90 mm. <b>Filamentous scratches:</b> Allowed, but not in bulk
<b>Edge and inside area</b>	Internal residues, bubbles, dots, spots etc which are no bigger than 0,5 < 1,0 mm are allowed whatever the surface area of glass, except in large quantities. A big quantity is when in one round area with a diameter of < 20 cm there are at least 4 internal residues, bubbles, dots, spots etc. Defects which diameter is smaller than 0,5 mm are allowed. Their maximum halo can be 3 mm.
	<b>Laminated glass:</b> The allowed occurring frequency of visible faults on the edge and inside area is 50% bigger per one glass layer. In case of resin casted laminated glass waves caused by production may occur. <b>Toughened glass:</b> Maximum allowed local bow is 0,5 mm per 300 mm. Maximum allowed overall bow is 3 mm per 1000 mm of the length of the edge of glass (applies to 4-15 mm toughened float glass). <b>cast glass and ornament glass:</b> Casting faults, the faults of the unity of pattern shall be considered deviations that are allowed. <b>Decorative spacers and Georgian bars:</b> Surface area of glass < 1 m2: deviations of location +/- 1 mm to the spacer Surface area of glass < 1 m2: deviations of location +/- 2 mm to the spacer

**The characteristics of the glass product**

The performance declared about a corresponding characteristic of the glass, for example sound and heat insulation and transmission of sound, are connected to the test standards. The concrete measuring results are taken from the test reports. The properties of glass product may differ due to the differences of the measurements and structure of glass, installation and external influences.

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### Coated glasses

There might be “pinholes” on the coating of the glass. The criteria for evaluation of pinholes is given in table 2. The criteria concerning reflection from glass: Different effects like shadowing, double image, slight color differences, deformation and distortion of image are allowed. Tempering waves might be visible in case of tempered glasses.

**Table 2: Coated glass**

<b>Edge area</b>	<b>Pinholes in coating of coated glass:</b> Ø 1 mm – 1,5 mm 5 items / 200 mm Ø over 1,5 mm is not allowed	<b>Inner area</b>	<b>Pinholes in coating of coated glass:</b> Ø 1 mm – 1,5 mm 2 items / m <sup>2</sup> Ø over 1,5 mm is not allowed
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### Cast glass and ornament glass

Casting faults or faults of the unity of pattern shall be considered deviations that are allowed. Faults of parallelism of the wire may occur in wired glass. The wire may not be oxidized.

### Individual color

Glass products have their own individual color that comes from the raw material and depends on the thickness of glass. Glass with surface covering has its own color that differs when looking through the glass or observing the reflections. Individual color and impression of color may among other things differ due to the thickness of glass, content of ferric oxide, type of layer and the process of applying the layer.

### Insulated glass with decorative bars

Due to environment (e.g. double glass effect) and vibration caused by shaking or manually the decorative bars may cause temporary chattering noise. Visible sawing cracks and smaller places where paint has come off arise from production. Also, the insufficiently right-angled decorative spacers must be evaluated, taking into consideration the tolerances of production and installation and the overall impression. The difference in length between the decorative spacers between glasses which is caused by the fluctuations of temperature cannot be avoided.

### Damages to the outer surface

The reasons for the mechanical or chemical damages of the outer surface that come visible after the installation need to be found out. These complaints may also be checked according to the table presented beforehand. Usually the mechanical or chemical damages of the outer surface are not the responsibility of the producer

### Visible edge of insulating glass:

In certain cases (structural glazing, glasses with overlaps) the edge of insulating glass will be visible. On coated glasses, there might be nonhomogeneties in coating removal (especially on wider than 10 mm coating removal). Insulating glass sealants might highlight, the border of coating removal, with colored stripe of left coating on the glass.

### Dirt inside insulating glass:

Production technology may result in a small amount of desiccant residue in the cavity. This cannot be avoided and does not constitute ground for any claim.

### The following irregularities do not give a right for a warranty:

- interference phenomena;
- double glazing effect;
- anisotropies;
- occurrence of condensed water on the outer surfaces (glass gets sweaty);
- humidity patterns on the surfaces of glass;
- built-in elements (leaden glass, alarm systems, blinds, etc);
- thermal breakages.

### Interference phenomena

Occurs in unequal rainbow-colored stripes. They are usually visible only when looking through the glass at a certain angle. In addition, it is characteristic to these stripes to move around if you touch on the window lightly.

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The phenomenon occurs in case of windows made of float glass due to extreme smoothness and parallelism of the glasses.

Light is a wave movement and the length of daylight waves is 0,00035-0,00078 mm. Daylight consists of many colors that can be seen if the light is directed through a prism where the light divided into spectral colors.

When rays of light move through the glass some of them might get shorter or longer distance for movement due to inner reflections. When the waves meet again their phase may not necessarily be the same and if unevenness corresponds for example to the wavelength of red light, the red color will intensify (interference) and therefore occurs on glass as a stripe. The same applies to all other spectral colors.

**Double glazing effect**

Insulated glass is due to the airtight sealing of the edges filled with a mixture of air and gas the pressure of which depends on barometric pressure and the air temperature at the production site. When installing insulated glass in other heights and on different temperatures and barometric pressure (high pressure and low pressure) some of the glasses will inevitably get concavities or convexities and therefore also optical distortions.

Multiple reflections may occur on the surface of insulated glass. These effects will occur especially strongly when the surface behind the glass is, for example, dark or if glasses are with surface coating. This phenomenon is a law of physics that applies to all insulated glass.

**Anisotropies**

Anisotropy is a physical phenomenon in thermally processed glass which is caused by the distribution of the internal pressure of the glass. Depending on the angle you look from, this is seen in polarized light and/or in observing through polarizing glass as dark circles/stripes. Polarized light occurs usually in daylight. The scope of polarization depends on weather, the altitude of the sun and its direction. The phenomenon is visible from a small angle of looking and in case of glass facades that are set from an angle in comparison to each other.

**Condensation on the outer surfaces**

Condensation occurs on the outer surface of glass when the temperature of the glass is lower than the temperature of the surrounding air. The occurrence of condensed water on the outer surface of insulated glass depends on the air humidity, the movement direction of air and the temperature of the outer surface of the glass. The occurrence of condensed water on the outer surface of the insulated glass that is toward the room comes from high level of humidity, strong window lights, curtains, potted plants, flower boxes, blinds and inappropriately installed radiators etc. The insulated glass with great insulation capacity (small U-value) may temporarily get condensed water on outer surfaces if the humidity outside is bigger and air temperature is higher than the temperature of the outer surface of insulated glass.

**Humidity patterns on the surfaces of glass**

The gathering of humidity on the surface of glass may vary and cause imprints that may be caused by imprints left by rollers or fingers, labels, working with a suction machine, residues of sealer, lubricants or influence of the environment. Working with such greasy or other organic materials creates a thin layer on the glass that repels water. Usually it is possible to remove these prints with a regular window cleaning detergent. But there may also be stronger imprints on the surface of the glass that form such a chemical bond with the surface of the glass that is difficult to remove. This can be done with an abrasive substance and then later the glass can be polished again. The occurrence of such a pattern on the surface of the glass due to the condensate does not show that the glass is of low quality. This does not influence the mechanical and physical qualities of the glass.

**Built-in elements**

Under no conditions shall the producer take responsibility for the compensation for added and/or built-in elements, for example posters, transparencies, leaden glass, alarm systems, blinds etc nor shall the producer take responsibility for damage of insulated glass if these damages are caused by the aforementioned added and/or inbuilt elements – compare with the conditions of fulfilling the warranty

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## **5. Quality Requirements of Tempered Glasses**

Tempered glasses produced by Baltiklaas confirm to European standard EN 12150 "Building Glass : Thermally toughened soda lime silicate safety glass".

### **Dimensions**

#### **Nominal thickness and tolerances of thickness**

Baltiklaas tempers glass with nominal thickness 4-15 mm. The nominal thickness of glass used for toughening is measured at the center of each four edges. The tolerances of the thickness of glass are as follows:

Nominal thickness, mm	Tolerance of thickness, mm		
	Float-glass	Machine glass	Decorative glass
3	± 0,2	± 0,2	± 0,5
4	± 0,2	± 0,2	± 0,5
5	± 0,2	± 0,3	± 0,5
6	± 0,2	± 0,3	± 0,5
8	± 0,3	± 0,4	± 0,8
10	± 0,3	± 0,5	± 1,0
12	± 0,3	± 0,6	Not produced
15	± 0,5	Not produced	Not produced
19	± 1,0	Not produced	Not produced
25	± 1,0	Not produced	Not produced

#### **Dimensions and tolerances**

The maximum dimensions of glass toughened in Baltiklaas are 2440x4800 mm and the minimum dimensions are 100x250 mm. The tolerances of finished dimensions:

Nominal dimension of width B or length H, mm	Tolerance t, mm	
	Nominal thickness of glass, d ≤ 12	Nominal thickness of glass, d > 12
B or H ≤ 2000	± 2,5	± 3,0
2000 < B or H ≤ 3000	± 3,0	± 4,0
B or H > 3000	± 4,0	± 5,0

#### **Tolerances of diameters of round opening**

The tolerances of the diameters of round openings are shown in the following table:

Nominal diameter Ø, mm	Tolerance, mm
4 ≤ Ø ≤ 20	± 1,0
20 < Ø ≤ 100	± 2,0
100 < Ø	± 2,0

#### **Tolerances on position of round openings**

The tolerances on position of round openings are the same as the tolerances of width B and length H of the glass board. The position is measured in two-dimensional positions from the center of the opening to the edge of the glass.

### **Flatness**

#### **Limits to the sizes of overall and local bow**

The biggest allowed values of the deformations of overall and local bow:

Glass type	Overall bow, mm/mm	Local bow, mm/300mm
Float-glass	0,003	0,5
Other	0,004	0,5

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## Visual quality

### Optical effects

During horizontal toughening the hot glass bends through when touching the rollers and therefore the flatness of the glass decreases. This phenomena is called "roller wave" which is visible in reflection. This effect may cause optical illusions when looking through the glass. In order to lessen the effect, it is advisable to use thicker glass in applications if possible. To a certain extent, changing the parameters of the hardening oven the effect can be lessened.

In case of glass that is thicker than 8 mm (in case of coated glass, starting from 6 mm), patterns or roller imprints can be seen on the surfaces when looking from a certain angle. This is caused by the glass contact with the furnace rollers (May be better visible, when glass is damp or background is with high contrast).

Anisotropy may be seen when the inner tensions of the thermally toughened glass are unequally distributed. Depending on the angle, anisotropy may appear as dark circles and stripes, in case there is polarized light.

To a certain extent, normal daylight always includes polarized light. The degree of polarization depends on the weather and the location of the sun. The double refraction of light is most noticeable in case of flat looking angle or if glass facades are located at an angle toward each other.

### Principles of evaluation

In evaluating the visual quality of toughened glass the following principles must be considered:

- ✓ Defects smaller than 0,5 mm on clear, body tinted and coated float-glass or on toughened glass with surface treatment shall not be considered.
- ✓ Defects smaller than 1,0 mm on clear and body tinted toughened glass made of ornament glass shall not be considered.
- ✓ Evaluation of toughened glass made of clear, body tinted and coated float glass shall take place from a 1 m distance from the surface of the glass.
- ✓ Evaluation of toughened glass made of clear, body tinted ornament glass shall take place from a 1,5 m distance from the surface of the glass at the height of the middle part.
- ✓ Evaluation takes place from the angle that corresponds to conventions of general use of room, generally the method of evaluating perpendicularly to the glass surface is used. Evaluation takes place in normal diffused light (for example, when the sky is cloudy) without direct counter light (for example, sunlight) or artificial light. Crucial is view through the glass and not the focusing on glass surface.

In evaluating the following defects are looked at:

- ✓ Filamentous scratches – not discernible with a fingernail;
- ✓ Bubbles and inclusions;
- ✓ Crystallized inclusion – substance particle of non-melted mass of glass;
- ✓ External flat damage on the arrissed edge of glass;
- ✓ Small chip on the edge of arrissed edge that does not lessen the strength of the glass.

### Evaluation criteria

In order to determine whether the deviations fixed during evaluation are allowed, the area where the defects are located is taken into consideration as well as the size of the defects and the concentration of their occurrence per one unit of toughened glass. The criteria for evaluating defects apply unexceptionally to the toughened products made of clear, mass-painted or coated float and ornament glass.

The evaluation criteria for the defects allowed are presented in the corresponding tables according to the area where they are located and the concentration of their occurrence.

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The allowed defects in different areas of float-glass:

Area*	Filamentous scratches (not discernible)	Closed bubbles	Crystallized inclusions	Flat damage** on the arrissed edge of glass	Small chips** on the arrissed edge of glass
Seal (S)	Allowed	Allowed	Allowed	Allowed	allowed
Edge (E)	Allowed, except when accumulated	$\varnothing \leq 0,5$ mm, allowed area $\leq 3$ mm	$\varnothing \leq 0,5$ mm	Not allowed	Not allowed
				Allowed, if S = E	Allowed, if S = E
Middle part (M)	Allowed if not accumulated or no longer than $\geq 150$ mm	Not allowed	Not allowed	#	#

\*E = is valid only in case glass is installed inside frame from each side. In case of constructions without frame complete glass doors the evaluation criteria apply only to the edges and middle part (the edges have to be at least phase grinded).

\*\* Not more than 15 % of the nominal thickness of the glass.

Due to the thermal tempering process a chemical and mechanical change of the surface texture, such as spot formation and roller imprints, cannot be avoided in case of certain glass types.

The allowed defects per one unit of toughened ornament glass:

Unit	Filamentous scratches (not discernible)	Oval sealing bubble	Closed round bubble	Crystallized inclusions	Flat damage on the arrissed edge of glass	Small chips* on the arrissed edge of glass
1 m <sup>2</sup>	Allowed on the whole surface	Width $\leq 1$ mm, Length $\leq 20$ mm 1 item allowed	$3 \leq \varnothing < 5$ mm 1 item allowed	$3 \leq \varnothing < 5$ mm	Allowed	Allowed
Whole glass surface		Width $\leq 1$ mm, Length $\leq 10$ mm Allowed on the whole surface, except when accumulated	$\varnothing < 3$ mm Allowed on the whole surface, except when accumulated	Allowed on the whole surface, except when accumulated		

\* Not more than 15 % of the rated thickness of the glass.

Since decorative glass involves a special production process, the oval and round inclusions and bubbles are part of the characteristics of the product. Changes in the patterns of decorative glass are not always avoidable and for that reason they cannot be reclaimed.

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## **6. Quality of silkprinted glasses**

Silkprinted glasses produced by Baltiklaas confirm to European standard EN 12150 “Building Glass : Thermally toughened soda lime silicate safety glass”.

This guideline applies to the visual quality assessment of full surface or partial surface enameled and screen-printed glass, which are manufactured as toughened safety glass or heat-strengthened glass by applying and burning in mineral colors.

Also applicable:

- EN 12150 for toughened safety glass
- EN 1863 for heat-strengthened glass
- EN 14179 for HST-TSG
- EN BS 6206
- EN 1096 – 1

For the assessment of product suitability it is required to inform the manufacturer of the definite area of application when ordering. This applies particularly to the following specifications:

- Interior- or outer application
- Requirements for heat-soaking of printed or enamelled FT glass (application in facades)
- Use for vision areas (viewing from both sides e.g. partitions, curtain-wall type facades etc.)
- Application with direct background illumination
- Edge quality and possibly freestanding visible edges (in the case of freestanding edges the edge type must be ground or polished)
- Further processing of the monolithic sheets to insulating glass or VSG (Laminated Safety Glass) (only for approved colours)
- Reference point for screen-printed glass

If enameled and/or screen-printed glass is made into Laminated Safety Glass and/or insulating glass, each sheet is to be assessed individually (same as for monolithic sheets).

## **Explanations/Notes/Terms**

### **Enameled glass and/or screen-printed glass**

The glass surface has been full surface enameled by means of various application methods. Viewing the colour is always effected through the glass pane, which has not been enameled, so that the inherent colour of the glass influences the coloration.

**Should it be intended to view the glass from both sides, we strongly recommend a full-size sample..**

The enameled side is normally the side that is opposite to any weathering exposure. Depending on the production process and colour of an enameled glass, it shows a higher or lower intensity of light transmission and is thus not opaque. Light colours always give a higher transmission than dark colours. In the case of major differences of the luminance or high luminous intensities (daylight) between the normal viewing side and the rear side, optical light- dark shadows become apparent in the glass when viewing from the rear side.

**These are production-related factors due to tolerances of the coating thickness and cannot be avoided, they could however be seen as disturbing, if viewing from both sides is likely or planned.**

In order to achieve the best possible solutions for applications with vision from both sides various production processes are available, which are characterised in detail as described:

### **Screen print:**

- least coating thickness
- highest light transmission (depending on colour)
- best colour homogeneity, however pinholes, shadows and squeegee streaks cannot be ruled out.

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**Continuous rolling:**

- medium coating thickness
- low light transmission (depending on colour)
- good colour homogeneity from the outside but surface structure is oriented in rolling direction due to micro groove system of the roller, which is noticeable when viewed from the rear side - when viewed in backlight they become obvious as fine lines.

**Continuous pouring:**

- highest coating thickness
- least light transmission (depending on colour), good colour homogeneity
- from the outside but due to very large tolerances of the coating thickness formation of shadows is noticeable when viewed in backlight.

The manufacturer must always be consulted with respect to applications in vision areas (viewing from both sides) as enameled glass is generally not suitable for applications with background illumination. Differences and specific details, which are listed below, will result as a function of the manufacturing process.

**Continuous rolling:**

The flat glass sheet passes under a grooved rubber roller, which transfers the enamel paint to the glass surface without the addition of any solvents and thus in an environmentally friendly method. Consequently a homogenous colour distribution is ensured (an absolutely flat surface is a prerequisite for this, i.e. cast glass cannot be rolled as a rule), which is however only adjustable to a limited degree with respect to colour application (colour thickness, covering capacity). Typically the grooved structure of the roller can be seen (coated side). However, normally one can hardly notice these "grooves" from the front (viewed through the glass - see Point for viewing procedure).

It should be taken into account that when bright colours are used, materials (sealants, panel adhesives, insulations etc.) attached directly to the rear side (coated side) may be visible. Roller applied enameled glass is as a rule not suitable for vision areas, and it is thus imperative to consult the manufacturer first with regard to these applications (pinholes). A slight "coating over-run" will occur on all edges as a result of the manufacturing process, this can show slight waving particularly along the edges perpendicular to the roller. However, edge surfaces remain clean as a rule.

**Continuous pouring:**

The glass sheet passes horizontally through a so-called "pouring curtain" (paint mixed with solvent) and covers the surface with paint. By adjusting the thickness of the pouring curtain and the running speed, the thickness of the paint application can be controlled over a relatively large area. Due to slight unevenness of the pouring lip there is, however, the possibility that stripes of different thicknesses may be created in lengthwise direction (pouring direction). The "coating over-run" at the edges is substantially greater than for the continuous rolling process.

**Screen Printing:**

On a horizontal screen printing table the paint is printed on to the glass surface through a close meshed screen using a squeegee, whereby the thickness of the paint application can only be marginally influenced by the mesh size of the screen. The paint application is thereby thinner than for continuous rolling as well as the casting process and appears more or less translucent depending on the selected paint. Materials (sealants, panel adhesives, insulations, fitting etc.) attached directly to the rear side (coated side) may be visible.

It is typical in the production process that, depending on paint and application, slight streaks in the direction of printing but also transverse to it, as well as sporadically occurring "patching" due to screen cleaning during the manufacturing process, which are noticeable.

The location of the screen-print is to be agreed for the particular sheet size and shape (reference point & clear edge). Up to 4mm of unprinted edge may occur due to tolerances with respect to glass and screens. Coating over-run on the edge is process-related.

Printing on lightly structured glass is possible but the manufacturer must always be consulted first.

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### Edge Quality

If coating over-run on edges and arrisses is not required, the customer must ask for this, and this is only possible for polished edges.

### Visual evaluation

The assessment of the visual quality of enameled and screen-printed glass is carried out from a distance of at least 3 m using and perpendicular, in normal daylight without direct sunlight or backlight from the front or rear side in front of an opaque background.

Viewing is always from the untreated glass surface toward the side of the glass, which has been enameled or screen-printed sheet or sheets, which has been ordered for vision areas. The defects must not be particularly marked.

### Defects, which cannot be noticed from this distance, will not be assessed.

For FT glass-specific defects the visual guideline for toughened safety glass applies. When assessing the defects one differentiates between edge zone and main zone according to the following drawing.

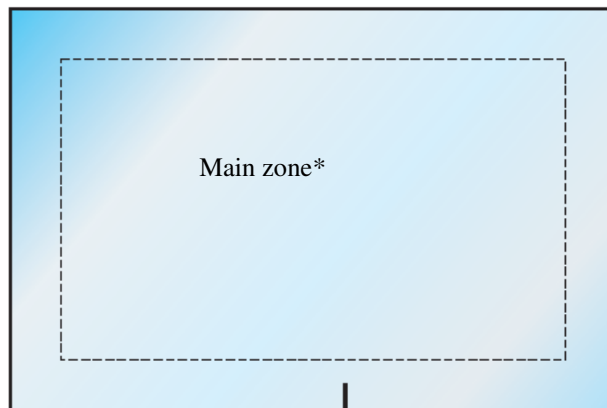


Figure 1.

Edge area  
Around 15 mm

\* If visible edges are requested when the order is placed, the edge zone is omitted and the main zone extends to the glass edge. The visual quality requirements are specified in the following tables

### Type of defects / tolerances for full surface or partial surface enameled glass

Defect type	Main zone	Edge zone
Defects in enamel point-wise and/or linear	Sum of all defects: max. 25 mm <sup>2</sup> Quantity: max. 3, number of those none $\geq$ 25 mm <sup>2</sup>	Width: max. 3 mm, Sporatically 5 mm Length: no restriction
Clouding/Misty areas/Shading	Not permitted	Permitted/no restriction
Water stains	Not permitted	Permitted/no restriction
Enamel over-run at the edges	Not applicable	*Permitted
Dimensional tolerance for edge enamelling and partial enamelling **. See drawing Enamel width:	Depending on width of enamel: Tolerance:	
$\leq$ 100 mm	$\pm$ 1,5 mm	
$\leq$ 500 mm	$\pm$ 2,0 mm	
$\leq$ 1000 mm	$\pm$ 2,5 mm	
$\leq$ 2000 mm	$\pm$ 3,0 mm	
$\leq$ 3000 mm	$\pm$ 4,0 mm	

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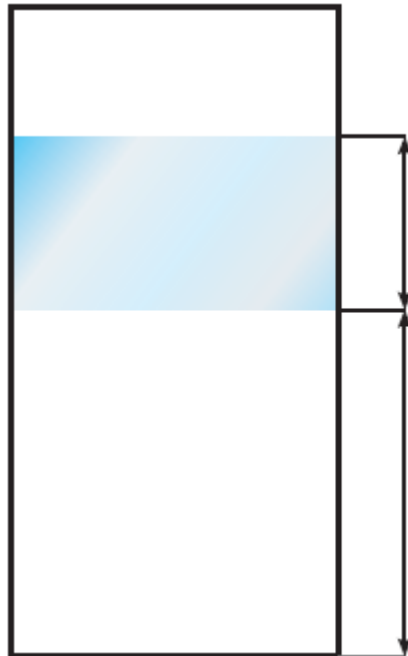
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$\leq 4000$ mm	$\pm 5,0$ mm	
Positional tolerance of enamel** (only for partial enameling)	Print size: $\leq 200$ cm: $\pm 2$ mm Print size: $> 200$ cm: $\pm 4$ mm	
Color deviations	See point on colour evaluations	



\* Defects . 0.5 mm ("Pinholes" = minute defects in the enamel) are permitted and are generally not taken into account

Repairing defects using enamel paint prior to the tempering process or using organic after the tempering process is permitted, however, organic lacquers must not be used, if the glass is further processed to insulating glass and the defect is located in the edge seal of the insulating glass. The repaired defects must not be visible from a distance of 3 meters.

\*\* The positional tolerance of the enamel is measured from the reference point.

Figure 2

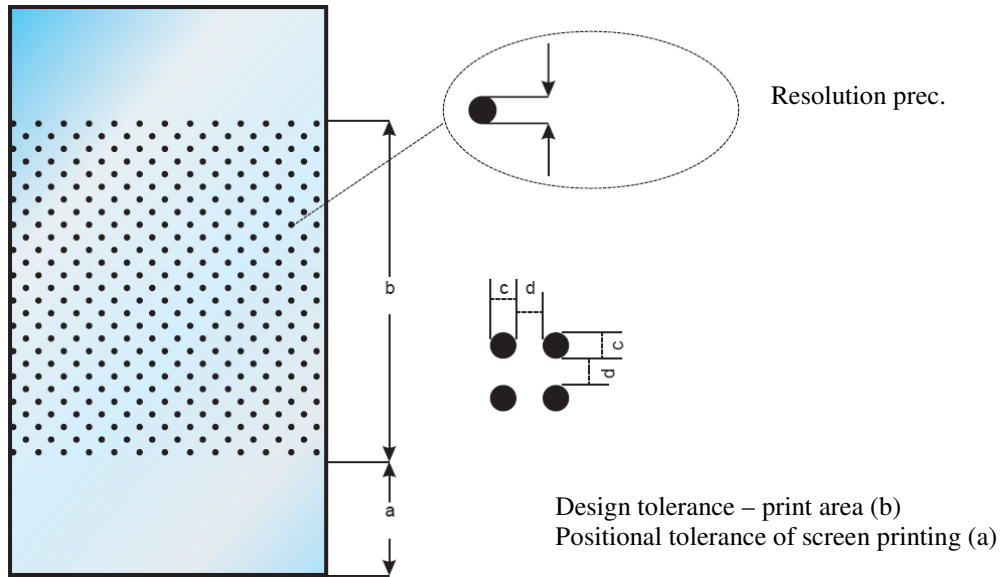
**Type of defects / tolerances for silk printed glass**

Defect type	Main zone	Edge zone
Defects in enamel point-wise and/or linear	Sum of all defects: max. 25 mm <sup>2</sup> Quantity: max. 3, number of those none $\geq 25$ mm <sup>2</sup>	Width: max. 3 mm, Sporatically 5 mm Length: no restriction
Clouding/Misty areas/Shading	Not permitted	Permitted/no restriction
Water stains	Not permitted	Permitted/no restriction
Enamel over-run at the edges	Not applicable	*Permitted
Dimensional tolerance for edge enamelling and partial enamelling **. See drawing Enamel width:	Depending on width of enamel: Tolerance:	No restrictions
$\leq 100$ mm	$\pm 1,0$ mm	
$\leq 500$ mm	$\pm 1,5$ mm	
$\leq 1000$ mm	$\pm 2,0$ mm	
$\leq 2000$ mm	$\pm 2,5$ mm	
$\leq 3000$ mm	$\pm 3,0$ mm	
$\leq 4000$ mm	$\pm 4,0$ mm	
	See Figure 3 and Figure 4	
Defects per figure***		
Positional tolerance of screen print (a)** . See Figure 3	Print size: $\leq 200$ cm: $\pm 2$ mm Print size: $> 200$ cm: $\pm 4$ mm	
Resolution precision (c and d)****. See figure 3	Depending on size of print area:	
$\leq 30$ mm	$\pm 0,8$ mm	
$\leq 100$ mm	$\pm 1,2$ mm	
$> 100$ mm	$\pm 2,0$ mm	
Colour deviations	See point on colour evaluations	

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| <p>* Defects <math>\leq 0,5</math> mm („Pinholes“ = minute defects in the screen print) are permitted and are generally</p> <p>** The tolerance of the design is measured from the reference point</p> | <p>*** Defects must not be located closer than 250 mm to each other. Serial defects are not permitted (recurrence at the same location on sheet after sheet)</p> <p>**** The tolerance can accumulate.</p> |
|--|--|



**Serial defects (Positions of identical sheet dimensions and print):**

Up to 3 sheets per position will not be considered as a serial defect. However, if more than 3 sheets per position show the same defect at the same location, this is considered a serial defect.

**For geometrical patterns and/or so-called aperture masks below 3 mm or graduations from 0% - 100% and so-called film-butting, the aforementioned tolerances can be perceived as disturbing. We recommend a 1:1 sample viewing:**

- Tolerances of the geometry or of the distance in the 1/10 of a millimeter range are considered serious deviations.
- Regarding these applications the manufacturer must be consulted in any case with respect to feasibility.

Table. 2 can principally also be used for the assessment of "misprints".

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Geometry of the pattern (resolution precision) Assessment defects per figure

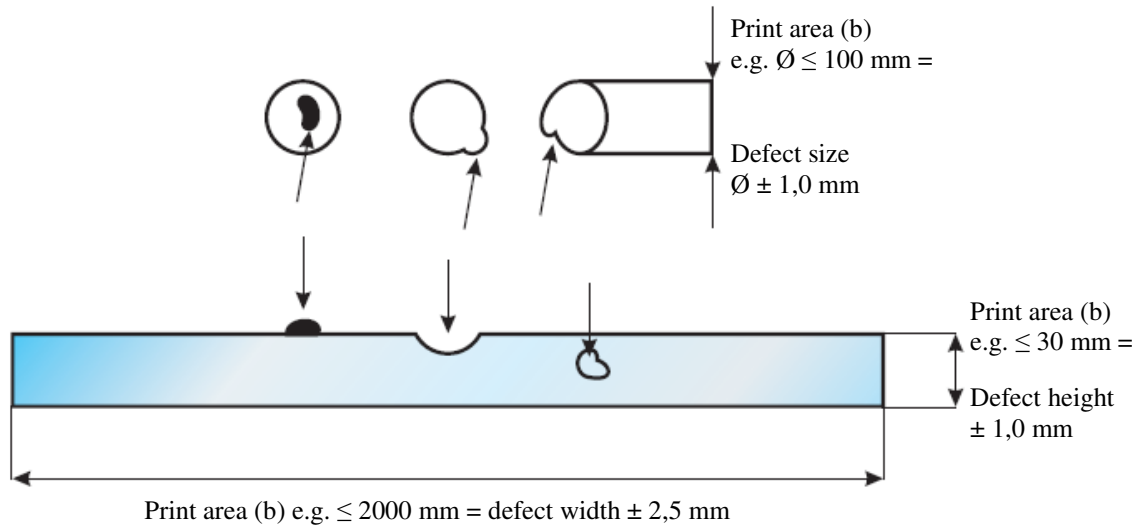


Figure 3 Geometry of the figure (resolution precision) – Assessment: Defects per figure.

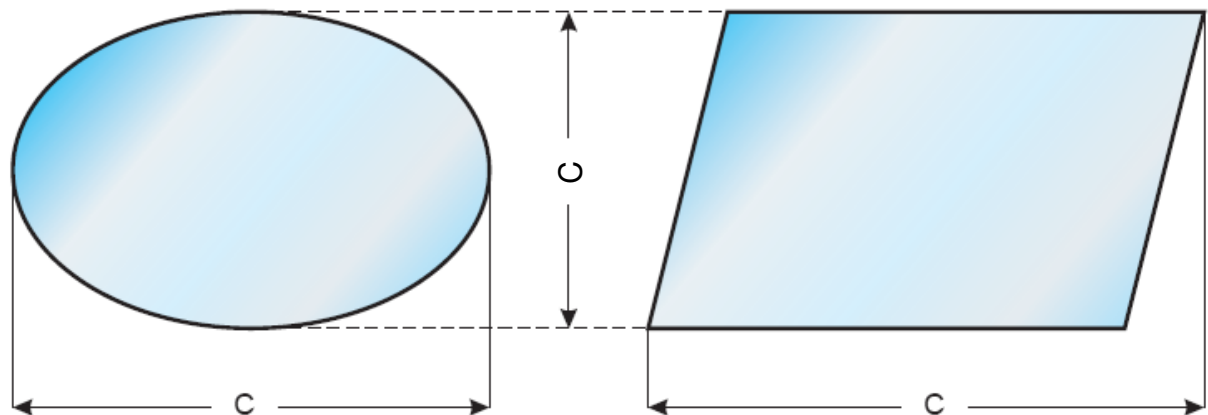


Figure 4

### Special enamels

Metallic paints, acid-etch type tints, slip resistant coatings or multi-coloured prints can be produced. The respective particular properties or the product's appearance must be clarified with the manufacturer. The following tolerances are not valid for these applications. We recommend a sample viewing.

Metallic colours may, as a result of the manufacturing process and pigmentation, lead to obvious differences in colour-rendition, which does not allow a uniform appearance of adjacent glass units. This is a product-specific characteristic of metallic paints and one which leaves a lively fa.ade image even at differing viewing angles.

### Assessment of the perceived colour

In principle, colour deviations cannot be ruled out, as these may occur due to several influences, which cannot be avoided. Due to influences mentioned in the following, a noticeable colour difference, which can be rated very subjectively by the viewer as either "disturbing" or "non disturbing", between two enameled glass sheets can predominate in certain lighting and viewing situations.

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#### **Type of base glass and influence of colour**

Generally the base glass is float glass, i.e. the surface is flat and high light reflection occurs. In addition, this glass may have a variety of coatings such as solar control layers (increasing the light reflection of the surface), coatings which reduce reflection, or it can also be slightly embossed such as for example in the case of structured glass.

Adding to this is the so-called inherent colour of the glass, which is essentially dependent on the thickness and type of glass (e.g. body-tinted glass, de-coloured glass etc).

#### **Note on later deliveries::**

Enamel paint consists of anorganic substances, which are responsible for the coloration and are subject to minor fluctuations. These substances have been mixed with "glass flux" so that the colour "fuses" with the glass surface during tempering and thus creates an inseparable connection with it. The final coloration can only be seen subsequent to this "firing".

Paints are "adjusted" such that they "melt into" the surface within 2 - 4 minutes at a glass surface temperature of approx. 600 - 620 .C. This "temperature window" is very narrow and cannot always be constantly maintained particularly for glass sheets that have different sizes.

Furthermore the type of application is also critical for the perceived colour. Due to the thin coating, screen printing provides less paint covering capacity than a product manufactured using continuous rolling with thicker and therefore denser paint application.

#### **Type of light in which the object is viewed**

The lighting conditions are constantly different depending on the season, time of day and prevailing weather. That means that the spectral colours of the light, which are incident on the paint through various media (air, first surface, glass body), occur in varying intensities in the range of the visible spectrum (400 - 700 nm). The first surface will reflect part of the occurring light more or less depending on the angle of incidence.

The "spectral colours" falling on the coating will be partially reflected or absorbed by the paint (colour pigments). Thus the colour appears different depending on the light source.

#### **The viewer or the method of viewing**

The human eye reacts very differently to various colours. While a very small colour difference becomes drastically noticeable in the case of blue tints, colour differences with green tints will be less obvious.

Additional variable influences include the viewing angles, size of the object and particularly also how close two objects to be compared are positioned to each other.

An objective visual estimation and assessment of colour differences is not possible due to the aforementioned reasons. The introduction of an objective assessment standard therefore requires the measurement of the colour difference under previously precisely defined conditions (glass type, colour, illuminant.) In cases, in which the customer demands an objective assessment standard for the defined colour, the procedure must be coordinated with the supplier beforehand. The basic process is defined in the following:

- Sampling of one or more colours
- Selection of one or more colours
- Predefinition of tolerances per colour by the customer e.g. permitted colour deviation:  $\Delta L^* \leq \dots \Delta C^* \leq \dots \Delta H^* \leq \dots$  in the CIELAB Colour system measured for illuminant D 65 (daylight) using d/8° sphere geometry, 10° standard colorimetric observer, gloss included.
- Checking for feasibility on the part of the supplier with respect to adherence to the default tolerance (order size, availability of raw materials etc.).
- Producing a 1:1 production sample and approval by the customer
- Manufacturing the order within the defined tolerances. If no particular assessment standard has been agreed upon,  $\Delta E^* \leq 3,00$  applies as measured using the measuring procedure described above.

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**Application Notes**

- Applications with enameling or partial enameling and screen printing or partial screen printing at the interlayer of laminated safety glass must be checked with the manufacturer for feasibility. This applies particularly, if acid-etch tone is used at the interlayer, as the optical density of acid-etch tone can be drastically reduced and the effect of acid-etch tone only remains when used on surface 1 or 4.
- Enameled and screen-printed glass can only be manufactured as toughened safety glass or heat-strengthened glass.
- Any subsequent processing of glass of any type influences the product's properties possibly substantially and is not permitted.
- Enameled glass can be used as monolithic sheets or in combination as laminated safety glass or insulating glass. In this case the respective regulations, standards and directives must be observed by the user.
- Enameled glass as HST Toughened safety glass can be heat soak tested. The respective necessity of the FT heat soak test must be checked by the user and the manufacturer must be informed. The structural performance values of enameled glass must not be equated with an unprinted or non-enameled glass..

**Side 1 enameled**

This new colour system has been specially developed for decoration of float glass on surface 1. The colours have an increased resistance to chemical and weathering. Generally, the guideline for evaluation of screen printed glass is applicable. The inspection is to take place from the screen-printed side or from both sides if the glass is ordered for visions areas.

A colour difference of  $\Delta E^* \leq 3,0$  applies only at the time of delivery. The weathering will cause change in the appearance of the colour and will depend on the colour. Therefore, the following additional colour tolerances are allowable after installation - they are divided into 3 colour groups:

- Light tones: White enamel  $\Delta E^* \leq 3$  (Stripes  $\leq 10$  mm , Dots  $\leq 12$  mm)
- Mid tones: Blue, Yellow, green, red enamel  $\Delta E^* \leq 5$  (Stripes  $\leq 2$  mm , Dots  $\leq 4$  mm)
- Dark tones: Grey, Black (Proportion of dark base colour at least 10 %)  $\Delta E^* \leq 10$ .

Claims will generally not be acknowledged, when in addition to our general recommendations for cleaning the following particular conditions for "printed on weathered glass side - surface 1" are not complied with. The facade must be cleaned at least twice per year. Should the facade be subject to soiling to a level greater than normal environmental conditions (e.g. major city centre or an industrial area), then the printed glass surface is to be cleaned twice per year

Claims for colour changes are accepted only in cases when, changes have been caused by ordinary environment influences on part of the building and purchaser has followed following cleaning procedures

- At least twice per year the facade should be cleaned with industrial cleaning detergents. Cleaning detergents containing fluoric acid are not allowed.
- Should the facade be subject to soiling to a level greater than normal environmental conditions (e.g. major city centre or an industrial area), then the printed glass surface is to be cleaned twice per year using an abrasive glass cleaner (e.g. Radora Brillant).

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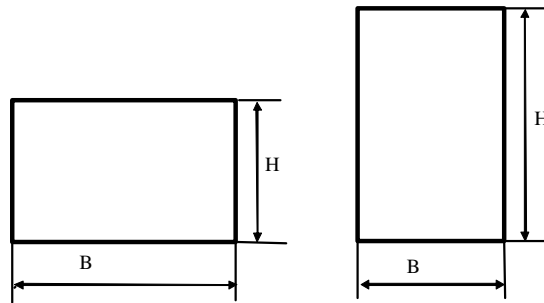
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## 8. Quality requirements of laminated glasses

Laminated glasses produced by Baltiklaas confirm to European standard EN 14449 “Building Glass : Laminated glass and laminated safety glass”.

### Measurements

When laminated glass is rectangle, then first measurement is width B and second measurement is height H. like shown on the drawing



Dimensions shall be given in millimetres. Each dimension shall be within the limit deviations specified.

### Methods of measuring dimensions and squareness

The nominal dimensions for width B and length H being given, the pane shall not be larger than a prescribed rectangle resulting from the nominal dimensions increased by the upper limit deviation t or smaller than a prescribed rectangle resulting from the nominal dimensions reduced by the lower limit deviation t. The sides of the prescribed rectangles are parallel to one another and these rectangles shall have a common centre. The limits of squareness shall be prescribed by these rectangles (see figure)

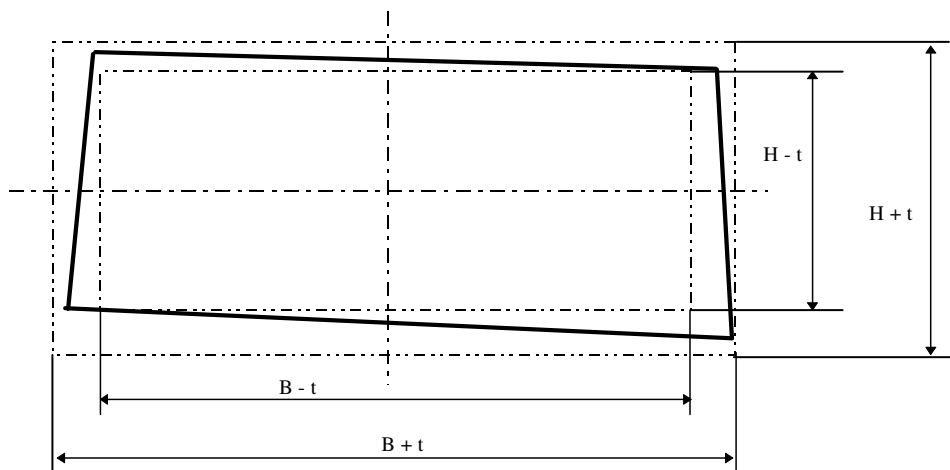


Figure. Limit deviations for dimensions of rectangular panes

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### Measurement tolerances

Limit deviations on width B and length H are given in table 1 for finished sizes and in table 2 for stock sizes.

Table 1. Tolerances for finished sizes.

Limit deviations t on width B or length H mm			
Nominal dimension B or H mm	Nominal thickness $H \leq 8$ mm	Nominal Thickness > 8 mm	
		Each glass pane < 10 mm	At least one glass pane $\geq 10$ mm
< 1100	+2,0 -2,0	+2,5 -2,0	+3,5 -2,5
< 1500	+3,0 -2,0	+3,5 -2,0	+4,5 -3,0
< 2000	+3,0 -2,0	+3,5 -2,0	+5,0 -3,5
< 2500	+4,5 -2,5	+5,0 -3,0	+6,0 -4,0
> 2500	+5,0 -3,0	+5,5 -3,5	+6,5 -4,5

Table 2. Tolerances for stock sizes

Limit deviations t on width B or length H mm			
Nominal dimension B or H mm	Nominal thickness $H \leq 8$ mm	Nominal Thickness > 8 mm	
		Each glass pane < 10 mm	At least one glass pane $\geq 10$ mm
Kuni 6000x3210	+5,0 -3,0	+6,0 -4,0	+8,0 -6,0

### Displacement

Displacement d (see figure) is the misalignment at any one edge of the constituent glass panes or plastic glazing sheet material making up the laminated glass

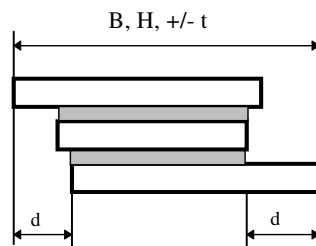


Figure. Displacement

The maximum displacement d shall be as given table 3. Width B and length H shall be considered separately.

Table 3. Maximum displacement.

Nominal dimension B or H mm	Maximum allowed displacement d, mm
B, H < 1000	2,0
1000 < B, H $\leq$ 2000	3,0
2000 < B, H $\leq$ 4000	4,0
B, H > 4000	6,0

### Thickness

#### Nominal thickness

The nominal thickness of laminated glass shall be the sum of the nominal thickness of the constituent panes of glass and plastics glazing sheet material and the interlayers.

#### Thickness tolerances

The tolerance on thickness of laminated glass shall not exceed the sum of the limit deviations of the constituent glass panes as specified in the basic products standards : EN 572-2 to EN 572-6, EN 1748-1 and EN 1748-2. The

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limit deviation of the interlayer shall not be taken into account if the total interlayer thickness is  $< 2$  mm. If the total interlayer thickness is  $> 2$  mm a limit deviation of  $\pm 0,2$  mm applies.

EXAMPLE: A laminated glass made from two sheets of float glass of 3 mm nominal thickness and an interlayer of 0,5 mm. From EN 572-2, the limit deviation of 3 mm float glass is  $\pm 0,2$  mm. Therefore, the nominal thickness is 6,5 mm and the limit deviation is  $\pm 0,4$  mm.

#### Measurement of thickness

The thickness of the pane shall be calculated as the mean of measurements taken at the centres of the four sides. The measurements shall be taken to an accuracy of 0,01 mm and the mean is then rounded to the nearest 0,1 mm.

### Visual quality

#### Evaluation methods

The laminated glass to be evaluated is to be viewed in front of and parallel to a grey background and in diffuse daylight or equivalent lighting conditions. The viewer is to stand at a distance of 2 m from the glass and look at the glass at an angle of  $90^\circ$  (whereby the matt background is on the other side of the glass) Defects are allowed if they are not visible in those conditions at that distance.

External glazing with free weathering of the glass edges may result in the hygroscopic nature of the PVB interlayer causing colour changes (usually grey) up to 15 mm in edge zone. This is product specific and is permissible.

#### Spot defects in the vision area

The admissibility of spot defects depends on the following:

- size of the defect;
- frequency of the defect;
- size of the pane;
- number of panes as components of a laminated glass.

NOTE: Admissibility of spot defects in laminated glass is independent of the individual glass thickness. Defects less than 0,5 mm are not considered. Defects greater than 3 mm are not permitted.

Table 4. Permissible spot defects in the vision area.

Size of defect, mm		0,5<d≤1,0	1,0<d≤3,0			
			A≤1	1<A≤2	2<A≤8	A>8
Size of pane, m <sup>2</sup>		For all sizes				
Number of permissible defects	2 panes	No limitation, however no accumulation of defects	1	2	1/m <sup>2</sup>	1,2/m <sup>2</sup>
	3 panes		2	3	1,5/m <sup>2</sup>	1,8/m <sup>2</sup>
	4 panes		3	4	2/m <sup>2</sup>	2,4/m <sup>2</sup>
	≥ 5 panes		4	5	2,5/m <sup>2</sup>	3/m <sup>2</sup>

NOTE: An accumulation of defects occurs if four or more defects are at a distance of  $< 200$  mm from each other. This distance is reduced to 180 mm laminated glass consisting of three panes, to 150 mm laminated glass consisting of 4 panes and to 100 mm laminated glass consisting of five or more panes.

The number of permissible defects in table shall be increased by 1 for each individual interlayer which is thicker than 2 mm.

#### Linear defects in the vision area

Glass panes, which area is smaller than 5 m<sup>2</sup>, linear defects are not allowed. Glass panes with area between 5 and 8 m<sup>2</sup>, is allowed 1 linear defects. Glass panes with area greater than 8 m<sup>2</sup> are allowed 2 linear defects.

Linear defects less than 30 mm in length are allowed.

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**Defects in the edge are for framed edges**

When inspected according to the test method given in clause 9, defects which do not exceed 5 mm in diameter are permitted in the edge area. For panes sizes  $\leq 5 \text{ m}^2$  the width of the edge area is 15 mm. The edge area width is increased to 20 mm for pane sizes  $> 5 \text{ m}^2$ . If bubbles are present, the bubbled area shall not exceed 5 % of the edge area.

**Vents**

Vents are not allowed.

**Defects in the interlayer**

Pullback of interlayer is allowed 6 mm from the edge.

Vahekile tagasitõmbumine on lubatud kuni 6 mm äärest. Creases and streaks are not allowed in the visual area.

**Defects on the edge which will not be framed**

Laminated glass is usually installed in frames; when it is unframed, its edges may be

- ground edges;
- polished edges;
- bevelled edges.

In such conditions shells, bubbles, interlayer defects and retractions are permissible if they do not become obvious when subjected to the test method

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