Standard

ĮST 4524122-4

Part I – Glass Units.

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antanas.velicka@bodesa.lt

Table of contents

antanas.velicka@bodesa.lt

1. Introduction.

An insulated glass unit (hereinafter referred to as the IGU) is a product which consists of at least two panes of the glass and a spacer between them. The glass panes are hermetically sealed with the spacer along the perimeter. Such a product is mechanically stable and durable. The construction, dimensions, type of glass and properties of the glass unit are selected basing on calculation taking into account the application and specific performance characteristics.

Glass units are used for installation in doors, facades, roofs and windows, as well as in structural glazing systems with protection from direct sunlight and ultraviolet exposure, in accordance with Annex A to the Standard EN 1279-5. These conditions must be specified when ordering. The structural diagram of the glass unit and the sealing sizes are shown in Figures No. 1 and No. 2.

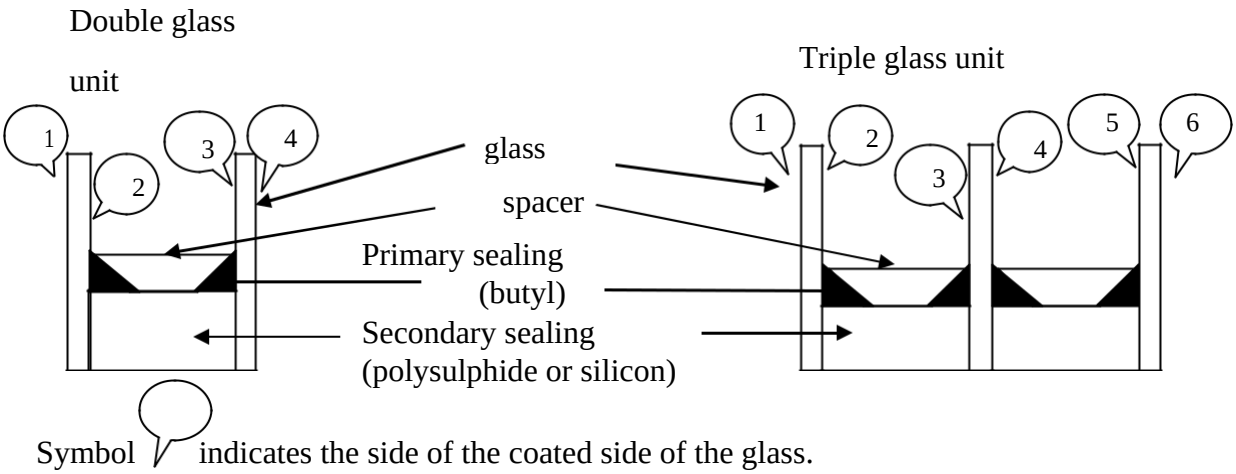
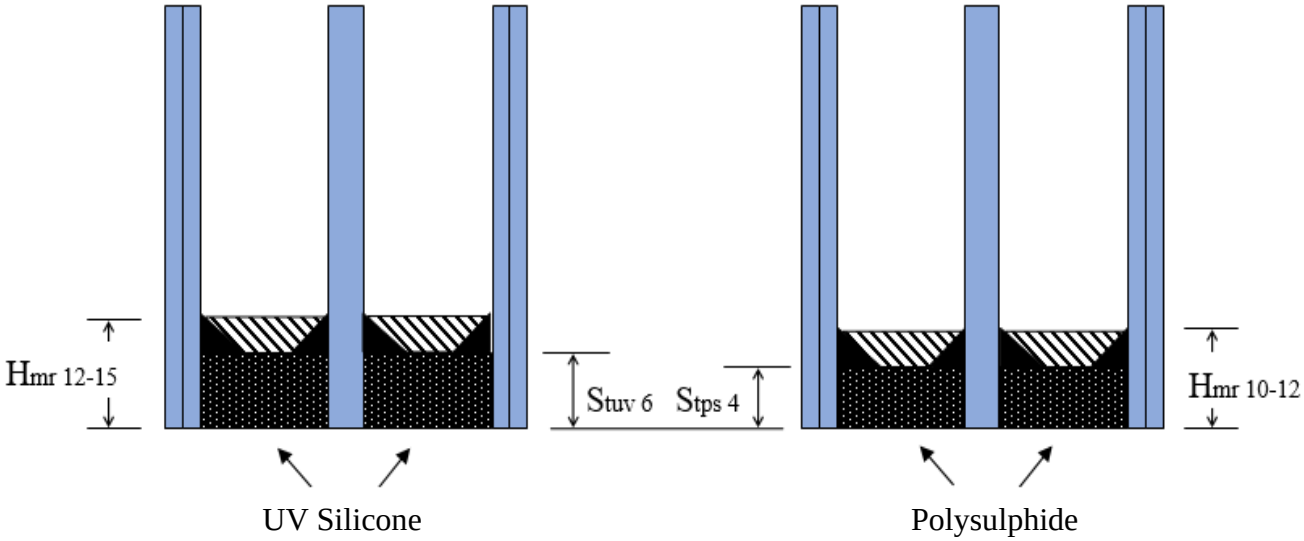


Fig. 1 Structural diagram of the glass unit.



Hmr – total sealing depth;
Stuv – silicone filler depth 6 mm (tolerance -2 mm);
Stps – polysulfide filler depth 4 mm (tolerance -2 mm);

Fig. 2. Structural diagram of a glass unit and sealing sizes.

Warning: For glass units with an area of more than 5 m^2, the secondary sealant-polysulphide filler is increased to 6 mm.

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Gas filling bushings can be built into the glass unit spacer, depending on the production process.

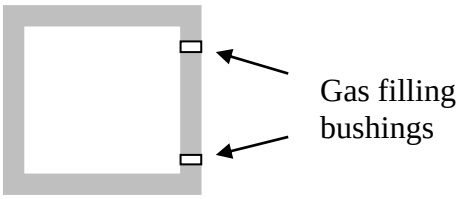

Fig. 3. Gas filling bushings in the spacer of a glass unit.

1.1. Definitions and structures

The nominal thickness of a double glass unit is the sum of the thicknesses of two glass panes, a spacer and a butyl.

The nominal thickness of a triple glass unit is the sum of the thicknesses of three glass panes, two spacers and butyl.

The recommended dimensional structures of glass units are listed in the first table, failure to comply with the following recommendations may result in the disclaimer of warranty for the glass units:

Table 1. Approximate maximum area of glass units*.

Glass thickness, mm	Maximum glass aspect ratio	Maximum glass area, m^2	Maximum edge length, mm.	Minimum width of spacer, mm.	Glass unit structure example
3	1:6	1,5	1500	9	3-9-3
4	1:6	2,00	2000	6	4-6-4
		2,50	2500	9	4-9-4
		3,35	2500	12	4-12-4
		3,35	2500	16	4-16-4
5	1:10	2,50	2500	6	5-6-5
		3,50	3000	9	5-9-5
		5,00	3300	12	5-12-5
		5,00	3300	16	5-16-5
6	1:10	3,00	3000	6	6-6-6
		4,50	3000	9	6-9-6
		7,00	3500	12	6-12-6
		7,00	3500	16	6-16-6
8	1:10	4,00	3000	6	8-6-8
		6,00	3000	9	8-9-8
		8,75	3500	12	8-12-8
		10,00	5000	16	8-16-8
10	1:10	13,50	5000	16	10-16-10
12	1:10	13,50	6000	16	12-16-12

* The process of modeling the structure and dimensions of the desired glass units, using this table, is presented in Annex No. 3.

*When calculating laminated glass thickness, when comparing to thethickness of float glass, the thickness of the laminated glass needs to be multiplied by coefficient og 0,65 and a rounded whole number needs to be used (only glass is used in the calculation component thickness - without film, as e.g. 33.1mm, then it will be 6mm*0.65=3.9 = rounded to whole we will get a number of 4mm). If spacers wider than 16mm are used, the same data as for the 16mm spacers from Table 1 above is applicable.*

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The data provided in Table No. 1 is only recommendation, taking into account the static loads of the glass units. It does not take into account the loads of the building structure or the dynamic loads on the glass. It's not taken into account the loads of the building structure or the dynamic loads on the glass. Before using the suggestions in the Table No. 1, they must be approved by a suitable qualified civil engineer, certified to design in accordance with established construction rules.

Warning: Risky structures of glass units in which the middle glass may break:

33.1 – 4 untempered – 33.1
4 tempered – 4 untempered – 4 tempered
6 tempered – 4 untempered – 4 tempered
6 tempered – 4 untempered – 6 tempered

The specified dimensions of glass units are given for a maximum thickness of a glass unit of 60 mm. The maximum dimensions of glass units given in the Table No. 1 are applicable under the following conditions:

- Glass units are installed vertically, at an angle of 90^{o} degrees position;
- Glass units are installed above ground level, at a height of 0 - 8 m;
- The installation of glass units is performed by fixing in four corners;
- Glass units are not installed in corner structures;
- The average wind pressure to the glass units at the installation site of the glass unit must be evaluated.

According to the production conditions, the maximum length of the short dimension of the glass unit is limited:

1. For clear float glass up to 3000 mm;
2. For toughened glass (ESG), thermally strengthened (TVG) and laminated (VSG) glass up to 2800 mm.

1.2. Main Characteristics of a Glass Unit.

1.2.1. Thermal Properties.

Heat transfer through a glass unit is expressed by the heat transfer coefficient U - heat transfer per 1 m^2 of surface area at 1 degree Kelvin temperature difference between different sides of the surface (W / m^2K). The lower the heat transfer coefficient, the more effective the thermal insulation of the glass unit.

1.2.2. Light Transmittance.

Light transmittance coefficient (LT%) – demonstrates what percentage of light is transmitted through glass or a glass unit.

Light reflectance coefficient (LR) - the percentage of light reflected by glass or a glass unit.

1.2.3. Solar Factor.

The main purpose of solar control glass units is to regulate the characteristics of light entering through the window. This is especially relevant for buildings with a large part of the facade made of glass. Using various solar control glass units, it is possible to adjust the light transmittance (LT), light reflection (LR), solar factor (g).

LT – light transmittance coefficient (this is the ratio of the light transmitted to the room to the incident light flux).

LR – Light reflectance (this is the ratio of the light reflected outwards to the incident light flux).

g – solar factor (this is the total amount of solar energy entering the interior of the room). This is the amount of solar energy directly transmitted and absorbed as well as reflected indoors.

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1.2.4. Advantages and Explanations:

Solar control glass units must have the lowest possible solar factor (g), the lowest possible heat transfer coefficient (U), and the highest possible light transmittance (LT). Table No.2 shows the characteristics of the glass panes used.

Table 2. Characteristics of the Glass Used.

Type of glazing. SN51 / 28 will be replaced by SN51. SN62 / 34 will be replaced by SN63.	**Light transmittance coefficient, LT (%) (EN 410)**	**Heat transfer coefficient, U, (W/(m2K) (EN 673)**	**Solar factor g, (EN 410)**	**Light reflectance coefficient LR e / LR i (%) (EN 410)**	**Solar energy reflection with coating / without coating (%)**	**Sound insulation, db.**
Sunguard SN 51 4 mm	56		0,29	17/10	50/39	
Sunguard SN 51 6 mm	55		0,28	17/10	50/36	
Sunguard SN 63 6 mm	69		0,35	17/10	47/36	
Sunguard SN 70/37 6 mm	77		0,38	5/6	45/37	
Sunguard SN 70/41 4 mm	77	3,2	0,43	4/6	39/31	
Sunguard SNX 60/28 6 mm	66		0,29	7/9	49/39	
Sunguard SN 51/28	56		0,29	17/10	50/33	
LamiGlass 3.3.1		5,7				
LamiGlass ExtraClear 4.4.4	90	5,6	0,74	8	7	
LamiGlass Transwhite 4.4.1		5,6				
LamiGlass Soud Control 4.4.1 SR	89		0,6	6/5	19/27	38
LamiGlass 4.4.2	88	5,6	0,74	8	7	
LamiGlass ExtraClear 3.3.1	90	5,7	0,79	8	7	
LamiGlass ExtraClear 6.6.2	89		0,73	8		
LamiGlass ExtraClear 6.6.8	88	5,4	0,68	8	7	
LamiGlass Extra Clear 3.3.1	90	5,7	0,79	8	79/7	
Satindeco 04 mm	91/85		0,81/0,8	8/8	7/7	
ClimaGuard Premium2 LamiGlass 3.3.1	89	5,7	0,61	5/6	27/20	
ClimaGuard Premium2 LamiGlass 3.3.2	89	5,7	0,61	5/6	27/19	
ClimaGuard Premium LamiGlass 6.6.2	86	3,1	0,54	5/6	28/16	
ClimaGuard Premium2 LamiGlass 4.4.1	89	5,6	0,6	5/6	27/19	
ClimaGuard Premium2 LamiGlass 4.4.2	89	5,6	0,6	5/6	27/18	
ClimaGuard Premium2 LamiGlass 4.4.4	87	3,2	0,55	5/6	28/17	
ClimaGuard Premium2 6 mm	89	5,7	0,64	5/6	27/22	
ClimaGuard Premium2 8 mm	87	5,7	0,56	5/6	28/31	
ClimaGuard 1 4 mm	76		0,5	14/18	40/38	
Float Clear 3 mm	90	5,8	0,86	8	8	
Float Ultra Clear 4 mm	90	5,8	0,84	8	8	
Float Ultra Clear 6 mm	91	5,7	0,89	8	8	

LR e – describes the “mirror” effect of the facade when viewed from the outside.

LR i – describes the “mirror” effect of the facade when viewed from the inside, more noticeable during the dark hours of the day.

antanas.velicka@bodesa.lt

1.2.5. Sound Insulation

The main indicators describing the level of sound insulation of a glass unit:

- Rw – sound reduction index. The ability of the glass unit to insulate airborne noise. This index shows the difference between the sound intensities on different sides of the glass unit. Rw is expressed in decibels (dB).
- C - correction for sound sources with a low amount of low frequency tones in decibels (dB).
- CTR - correction for sound sources with a high amount of low frequency tones in decibels (dB); the higher (Rw), (Rw + C) or (Rw + Ctr), the better the sound insulation of the glass unit.

In order to obtain the highest possible sound insulation index (Rw):
1. Glass units with the thickest possible glass (6 - 19 mm) should be selected.
2. The glass configuration should be asymmetrical (panes of different thicknesses).
3. The distance between the panes should be as large as possible.
4. Use specially laminated glass.

The sound-insulating characteristics of the glass panes used are shown in Table No. 3.

Table 3. Sound Insulation Characteristics of Glass Panes Used.

Type of glazing	**Sound insulation index, Rw (dB) (EN717-1)**	**C (dB) (EN717-1)**	**Ctr (dB) (EN717-1)**	**Heat transfer coefficient, U (W/(m2K)) (EN 673)**
ClimaGuard Premium2 Lami 4.4.(1-6)	33	-1	-4	
Lami glass ExtraClear SoundReduction 4.4.1.; 4.4.2.; 4.4.4.	38	-1	-3	5.6
Lami glass ExtraClear SoundReduction 4.4.3.; 4.4.6.	not determined	not determined	not determined	5.6

1.2.6. Mechanical Properties (Safety, Thermal Resistance).

High requirements are set for the security level of modern windows - they must provide sufficient protection against burglary, acts of vandalism, accidental impacts, must be resistant to fire, in special cases must be protected from bullets and explosion waves.

Tempered glass has 6-7 times greater resistance to mechanical impact, it shatters into small (4-6mm), non-hazardous pieces during impact. The glass is heated to about 650 ° C and quickly cooled with the help of air, which creates huge internal stresses in the glass and makes the glass safe.

Thermally toughened glass. Thermally toughened glass is produced in much the same way as tempered glass, using the same equipment. The glass is heated to about 650 ° C and cooled more slowly, resulting in lower glass surface tension. When such glass breaks, it breaks into large shards. The glass is not safe.

The film inside the laminated glass prevents the damaged glass from breaking and thus maintains mechanical stability. There are no sharp shards of glass. Various combinations of glass and film allow the production of fire, sound and impact resistant glass. Laminated glass with a special film or filler can withstand high temperatures and is used as a fire-resistant partition in areas of buildings where there may be people or may hapen their evacuation during a fire.

2. Marking.

2.1. Identification of the Structure of a Glass Unit.

The following information shall be marked on the spacer of glass units:

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"Bodesa" manufacturer's name; EN 1279 standard number; IGU composition (structure); order number / position; glass dimensions; date of manufacture.

The description of the structure of the glass unit shall be given in the following order:

Type and thickness of the outer glass; spacer type and thickness; the composition of the gas to be filled in the glass unit; the type and thickness of the inner glass; order number; production sequence number and position; glass unit dimensions in millimeters (the first number is the width of the glass, the second number is the height of the glass); date of manufacture.

2.2. Standard Marking Examples for Spacers.

Example No.: 1. "BODESA" EN1279 4sk-AL16Ar-4sel Order 435443/2- # - 47026/7- # -654*1298mm 15/11/02 RAL 9005

Double glass unit made according to EN 1279, manufacturer Bodesa, outer glass is transparent, thickness 4 mm, aluminum spacer, width 16 mm, filled glass unit with argon gas, inner glass is with a selective coating, thickness 4 mm, order number: 435443 / 2, production sequence number and position 47026/7, glass unit dimensions 654 * 1298 mm. RAL 9005 is the color of the spacer, for coloured spacers (according to the buyer's instructions).

Example No: 2. „BODESA" EN1279 4sk-AL16Arsk-AL16Ar-4sel Order 426443/2- # - 47000/4- # - 652*1322mm 15/11/03 RAL 9005

Triple glass unit made according to EN 1279, manufacturer Bodesa, outer glass is clear, thickness 4 mm, first aluminum spacer, width 16 mm, filled with argon gas, inner glass is with a selective coating, thickness 4 mm, second aluminum spacer, width 16 mm, order number: 426443/2, production order number and position 47000/4, IGU dimensions 652 * 1322 mm. RAL 9005 is the color of the spacer, for coloured spacers (according to the buyer's instructions).

When producing glass units for different companies, the marking of spacers may also differ. Additional characters appear according to the buyer's instruction. The buyer sends and agrees the desired marking sample with the manufacturer of glass units.

In the case of production on the Swedish market, glass units shall be marked with the "P" mark (marking of compliance with the Swedish standard).

3. Requirements.

3.1. Durability of Glass Units.

3.1.1. The following conditions determine the durability of glass units:
- the moisture penetration index (I) must meet the requirements of standard EN 1279-2;
- the sealing of the IGU must comply with the requirements of standard EN 1279-4;
- for gas-filled units, the gas leakage shall comply with the requirements of standard EN 1279-3. At the request of the buyer, glass units can be filled with gas. This must be specified when placing the order.
- Samples, laboratory and stand samples shall not be filled with argon.

3.1.2. The durability of glass units depends on:
- the stability of structures and buildings exposed to various effects (the glass unit must be protected from side damaging effects during operation);
- vibrations of structures and buildings;
- deformations of the spacer exposed to various effects (future stresses during operation must be assessed during the installation of the glass unit);
- improperly constructed or installed spacer (for eg., drainage paths are absent or blocked, the glass units are not protected against direct mechanical impact);
- incorrect fastening of the structure or components;

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- improper packaging;
- unsuitable fasteners in the spacer; spacer quality;
- existing tightness, expansion, movement in the spacer due to moisture penetration of the glass system and heat exposure;
- unsuitable filler, not compatible with the main glazing sealant of the glass unit, used during the installation of the glass unit in glazing structures.

3.2. Shapes, Dimensions and Tolerances of Glass Units.

The values of the dimensions of the rectangular IGU must be expressed as the ratio of the width (the first digit 'B') to the height 'H' (see Figure 4).

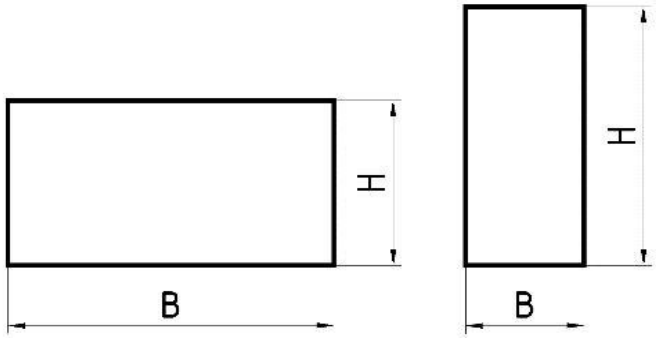

Fig.4. Dimensions of rectangular glass units.

Table 4. Tolerances on glass dimensions and their interchangeability in glass units.

Double and triple glass units.	**Tolerances for width B and height H of the glass unit.**	**Glass overlap, d mm.**
All glasses of a thickness ≤ 6 mm and dimensions (B or H) ≤ 2000 mm.	± 2 mm.	≤ 2 mm.
6 mm <glass thickness <12 mm or 2000 mm <(B or H) ≤ 3500 mm.	± 3 mm.	≤ 3 mm.
3500 mm <dimensions (B or H) ≤ 5000 mm and glass thickness ≤ 12 mm.	± 4 mm.	≤ 4 mm.
1 glass> 12 mm or (B or H)> 5000 mm.	± 5 mm.	≤ 5 mm.
Glass thickness is the nominal glass thickness.		

Data source: *EN 1279-1, section 6.3.2*

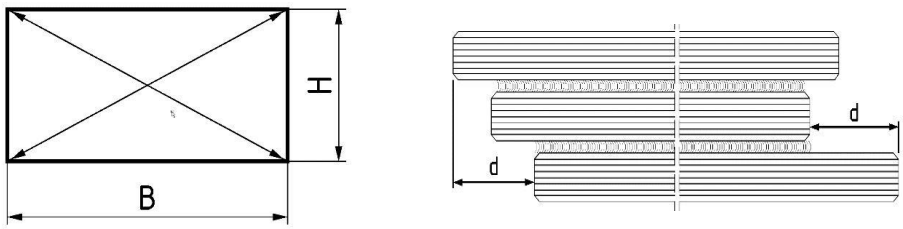

Fig. 5. Glass overlap in a glass unit.

Table 6. Thickness tolerances of double and triple glass units.

Double and triple glass units.	**Glass type.**	**Thickness tolerance.**
Double glass unit.	All annealed “Float” glass	± 1 mm.
	At least one glass is laminated,	± 1.5 mm.

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	patterned or not annealed glass	
Triple glass unit.	All annealed “Float” glass	± 1.4 mm.
	At least one glass is laminated, patterned or not annealed glass	+ 2,8 mm. / -1,4 mm.
If the thickness of the “Float” or tempered glass is more than 12 mm or the thickness of the laminated glass is more than 20 mm.		The buyer shall agree with the manufacturer on the thickness tolerances of the glass unit.

Data source: *EN 1279-1, section 6.3.3*

3.3. Placement of orders for glass units and other non-standard products.

Table 7. Types of glass units.

Glass product name	Definition of product characteristics	Purpose of the product	Remark
Sample	Product with standard tolerances.	Declared future / current product of mass production. Before mass production begins, a sample is made and approved with the buyer.	A buyer-seller agreement has been signed. Claims are accepted if the tolerances of the product exceed the values specified in the manufacturer's standard.
Laboratory sample.	New product with declared properties and tolerances.	Laboratory product integration and adaptation for customer testing.	The buyer submits conclusions and suggestions in writing.
Stand example.	Product with high visual and technical tolerances.	To evaluate the visual properties of the product in exhibitions.	Product properties and tolerances must be agreed upon signed acknowledgement between the buyer and the manufacturer.
Manual assembly glass units.	Glass units that, due to their small size, cannot be assembled semi-automatically on the line.	The characteristics of the product differ from the characteristics of the product declared in the present standard.	Product tolerances exceed those specified in the standard.

The buyer is responsible for the composition of the structure of the glass units rovided in the order and he intends to perform or has performed the necessary resistance calculations, confirming that the glass unit meets the intended operating conditions.

When ordering glass units, the buyer shall indicate the desired type of product and its explotation conditions.

For coated glass, the buyer shall indicate in the order the position of the glass coating in the glass unit.

For glass units with painted glass, it shall be indicated whether the IGU will be installed in a transparent area or in area which is not transparent. At the time of ordering, the buyer shall be informed that the qualitative assessment of the painted part of the glass unit is performed by looking from the unpainted side of the glass to the painted one**. It is always necessary to agree with the buyer on the color sample of the painted glass in kind before starting the production of the order (concerning the paint shade, paint translucency, paint defects).**

One sample remains in the possession of the client, the other of the manufacturer.

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If the buyer does not want to coordinate a sample of painted glass, the warranty for the glass is not available.

Although glass is painted the same colour, the tint of one enamel-coated glass batch may differ from another batch. Because of this, glass which will be placed in a same visibility zone must be ordered at once, and that shall be indicated in the order by the customer.

If a batch, whose glass shall be painted identically, is ordered, the requirements and parameters for the production of the project must be coordinated, which will be followed during the entire production of the project.

When ordering stand samples, the desired visual and technical tolerances of the product must be provided in writing and agreed in writing prior to the start of production. The manufacturer of glass units shall provide the said tolerances to a third manufacturer if the glass is purchased from other manufacturers.

The dimensions of the glass units shall be given in millimeters.

Orders for non-rectangular glass units and individual parts of the glass unit shall be accepted, evaluated and executed only on the basis of drawings in order to avoid production and ordering errors. The drawings shall be clear, legible and signed by the customer. The format of the drawings shall be A4, the font size of the notes shall be 12, the dimensions shall be given in millimeters (mm). Corrections made to the drawings must be signed by the person who corrected them.

For complex figures, drawings in dwg format must be provided.

Together with the order for the production of glass units, the customer shall provide drawings of the glass units and parts (panes) thereof, if necessary.

The set of drawings shall consist of a glass unit / pane assembly drawing with the required dimensions, the structure of the glass unit, separate projections of the glass unit, shown sections, each different IGU shall have a separate dimensional drawing, a separate drawing of the glass unit part (pane) coating with the required dimensions.

The customer shall enter the changes in the drawing and submit a revised final drawing.

The order for execution shall be confirmed only in the presence of drawings.

The drawings for orders shall be made in accordance with the requirements of the design documentation.

The production of glass units and non-standard-shaped glass units measuring less than 250 x 180 mm shall be carried out manually. If it is not possible to produce a glass unit of a certain non-standard shape desired by the customer with the help of equipment, then the customer must produce templates (with the scale 1: 1).

The template for the glass shall be made of plastic or cardboard according to the glass size, and the template for the spacer shall be made of plastic (cardboard) or plywood according to the internal dimensions of the spacer.

The templates shall indicate the sides of the glass unit (outside or inside), the orientation of the glass coating.

The manufacturer shall confirm whether he has technical capacity to complete the order.

When calculating orders for hand-cut glass, an additional technological margin of 60 mm shall be added to 4 mm glass. For 6 mm glass - an additional 80 mm margin shall be added.

By default, the structure of the glass unit is specified in the formula - outer glass - inner glass.

The lines of standard patterned glass shall always be parallel to the height of the glass.

When using glass with a selective or special coating, the orientation of the coating is indicated by a mark in this standard (see Figure 1 on page 3).

When ordering glass units with coated glass, the customer shall always indicate the location of the coating on the glass unit. Otherwise, the manufacturer will turn it to the standard side.

The thickness tolerance of manual assembly IGU is + (1-2) mm for double glass units and + (2-2.5) mm for triple glass units. These glass units are manufactured without warranty and without argon filling.

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3.4. Materials

3.4.1. Other Materials

The quality of other materials used in the manufacture of glass units shall meet the requirements of standard EN 1279-1-6.

Primary sealant butyl IGK 511 is intended for gluing spacers to glass, it performs the function of primary sealing.

The secondary sealant is polysulfide Teneglass PS EN / silicone 3362 / silicone 3363. The polysulfide Teneglass is intended for final sealing

of glass units. The silicone 3362/3363 is intended for the final sealing of glass units used for facade glazing. This sealant is resistant to ultraviolet sunlight (UV).

Nedex Zeolan K absorbent fills the inner cavities of the spacers. It is designed to absorb the moisture inside the glass unit.

3.4.2. Spacers

Aluminum spacer. For a long time, spacers made of aluminum were used in glass units. An aluminum profile of a certain width and shape filled with absorbent fixes the gap between the glasses very well and performs the function of a strong spacer. The upper - visible part of the spacer is perforated, and the hollow cavity is filled with absorbent, which is designed to absorb moisture from the space between the glasses. Because aluminum is a good conductor of heat, a cold bridge forms on the edge of the glass unit and condensation problems occur. For this and other reasons, plastic spacers have recently been used more and more in Lithuania. They transmit several times less heat than aluminum, thus reducing the likelihood of the formation of the “cold bridges”.

Thermix spacer. In order to prevent the formation of "cold bridges" on the edge of the glass unit and to avoid the related problems of window fogging or even icing, "warm" spacers are placed in the glass units. The Thermix “warm” spacer is a combination of plastic and steel. It has very good thermal insulation properties. The thermal performance of the low-conductivity plastic profile, reinforced with steel foil, is better than the thermal properties of the aluminum spacer. Thermix spacer is mechanically strong, resistant to ultraviolet, long-lasting. The surface of the Thermix spacer adheres well to sealants.

Chromatech Ultra spacer is a modern, hybrid heat-insulating spacer made of strong plastic and strong stainless-steel construction. The upper plastic surface is extremely strong and resistant to frost. Also, it is almost impossible to disassemble, thus ensuring stability. Low heat loss stainless steel 15.0 W / (mK) + top layer of special plastic 0.17 W / (mK).

The Swisspacer spacer - combination of a glass-fiber-reinforced plastic profile with extremely low thermal conductivity and a completely sealed high-tech foil, the spacers from SWISSPACER are extremely energy-efficient. SWISSPACER spacers have high mechanical resistance, do not change in temperatures even up to 100 ° C. The compressive strength of such partition spacers is even several times higher than that of aluminum, and in terms of elongation coefficient, adhesion to sealing materials, resistance to UV rays and moisture, they are not only equal to the aluminum ones, but sometimes even exceed them. Spacers with a side dimension greater than 2000 mm are not subject to bending. Figurative spacers with a side dimension greater than 1500 mm are not subject to bending.

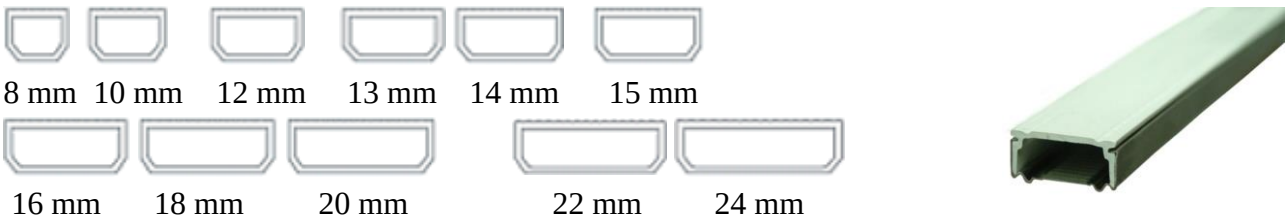

Fig. 8. Glass unit spacer widths available.

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3.5. Production Process.

The technology of production of glass units must ensure the quality of glass units.
The deviations of the glass units are affected by the equipment and tools used

3.5.1. Imposts / Duplexes.

When manufacturing IGUs with decorative elements, the customer must agree with the manufacturer a sample of the future product to assess the colour gamut. The colour of the decorative element can change when it is built into the glass unit because it is distorted by the colour of the glass in the glass unit. Additional decorative elements of various types, colours and dimensions specified by the customer - impost / duplex - can be installed in the glass unit chambers.

The customer shall provide exact drawings with specific dimensions for each different glass unit separately. The customer must take into account that additional decorative elements installed inside the IGUs may vibrate, depending on the external conditions (IGUs are installed in doors or other places exposed to vibrations). For this purpose, transparent shock absorbers are used to reduce vibrations, which are glued in a certain order. Below, there is presented the impost / duplex installation diagram:

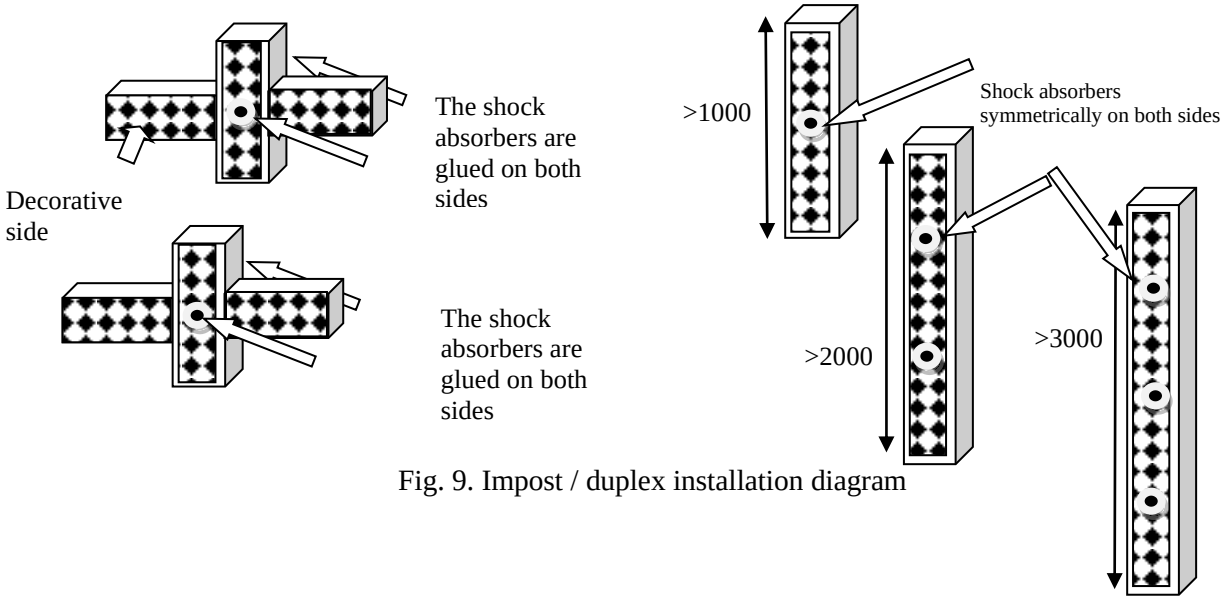

Fig. 9. Impost / duplex installation diagram

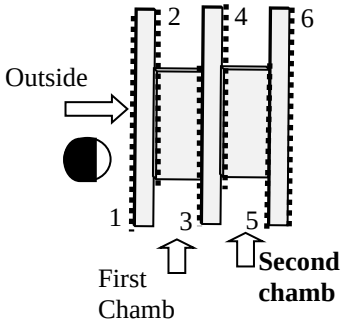

Fig. 10. Marking of glass positions 1-2-3-4-5-6 in the IGU.

Table 8. Standard markings of the components of glass units and the standard position of the components in the glass unit.

Description of the part of the glass unit.	**Location in the glass unit.**	**Comments.**
Glass with corrugated / decorative coating.	Position 2; postinion 3	Double glass unit.
Glass with corrugated / decorative coating.	Position 2; position 4; position 5	Triple glass unit.
Impost / spros.	On the external chamber with the sticker "Outside".	The decorative side faces the outside of the glass unit.

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Duplex.	To the both chambers of the glass unit.	
Glass with Low-E coating	Coating in position 2; position 4	Double glass unit.
Glass with Low-E coating	Coating in position 2; position 6	Triple glass unit.
Glass with Bioclean coating.	Coating in position 1	
Glass with G-Fast coating.	Coating in position 1	Better anti-condensation properties.
Stop Sol glass and other solar control glass	Coating in position 2	
Painted glass	Coating in position 2 or 3 Coating in position 2 or 5	Double glass unit. Triple glass unit.

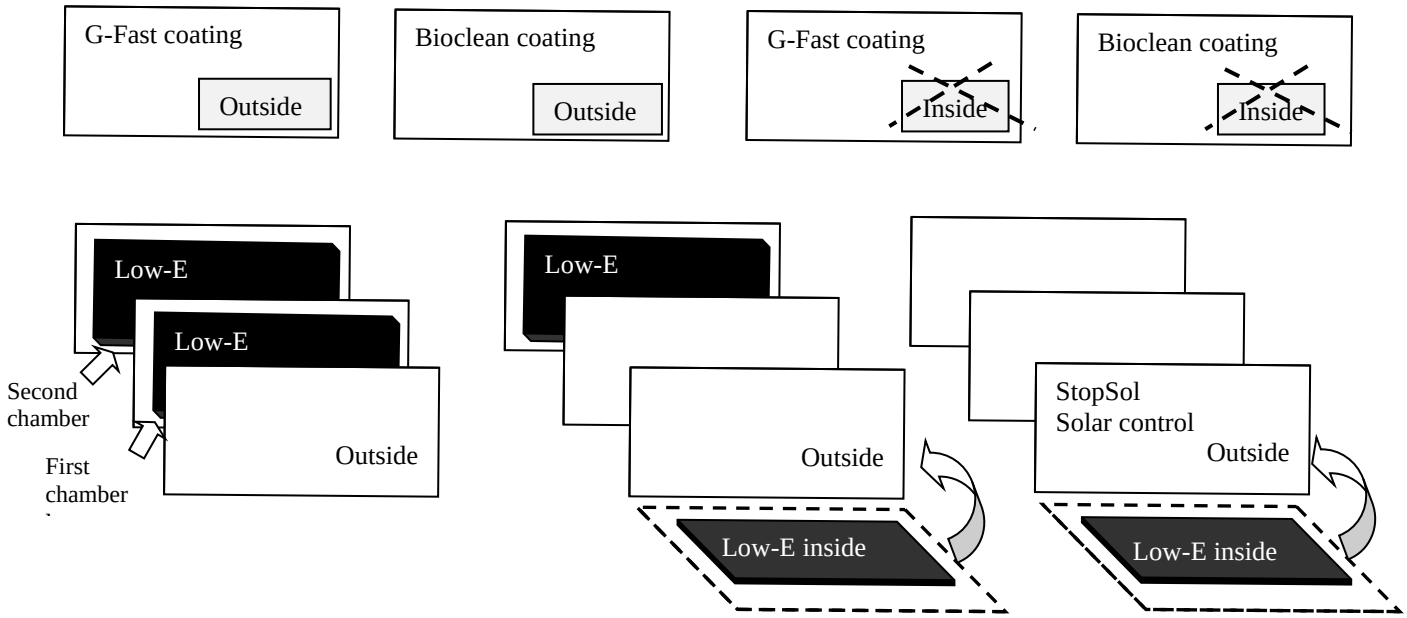
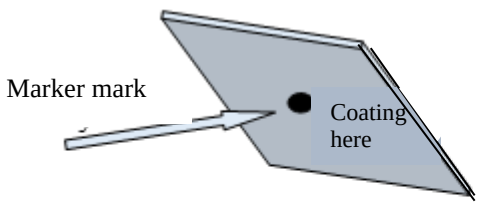
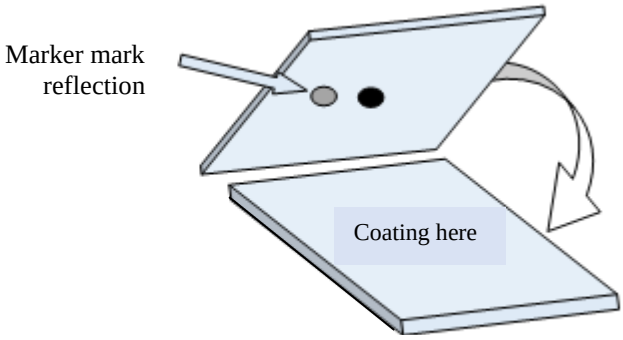


Fig. 11. Standard combinations of panes with coatings in a glass unit.



Mark without reflection- coating is on the observer‘s side.



Mark with reflection – coating is on the other side

Fig. 12. Determination of the side of the glass Stopsol coating.

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3.5.1.1. Arrangement of Imposts / Duplexes in Glass Unit Chambers.

Duplexes are built into the both chambers of the glass unit. The good - decorative side of the impost / duplex is directed to the outside of the IGU.

Imposts are built into the outer chamber of the glass unit.

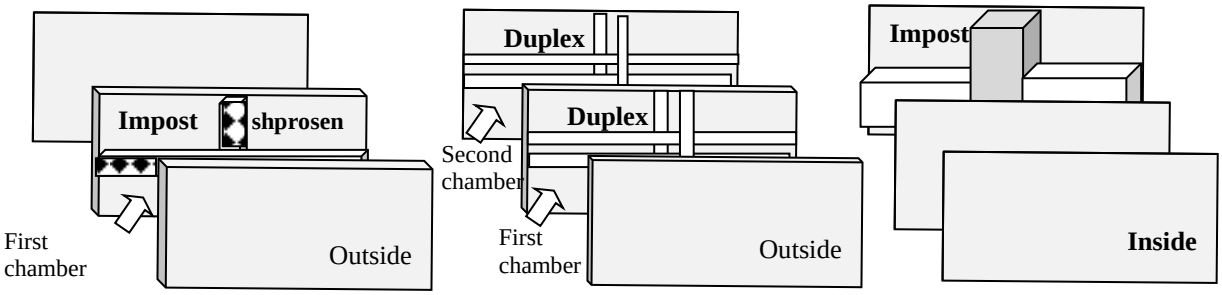

Fig. 13. Installation of imposts / duplexes in a glass unit.

Table 9. Impost / duplex positioning.

Measurements of the glass unit X/Y.	Impost / duplex Positioning accuracy mm.		
	ΔL	Δc	Δp
1 m.	1	1	2
≥ 1 ≤ 2 m.	1,5	1,5	3
≥ 2 m.	3	2	4

duplex parallelism to the edge of the glass up to ΔL;
duplex centering from one edge to the other to Δc;
duplex interchange in chambers up to Δp.

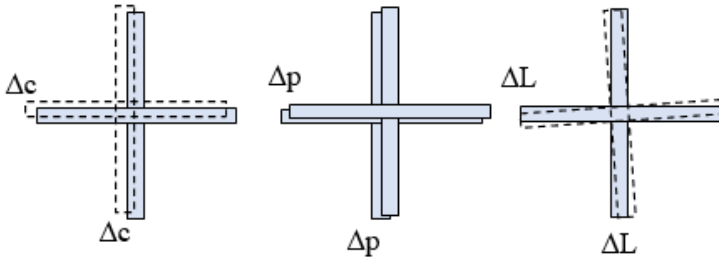

Fig. 14. Impost / duplex positioning accuracy in the glass unit chambers with respect to each other and to the edges of the glass unit.

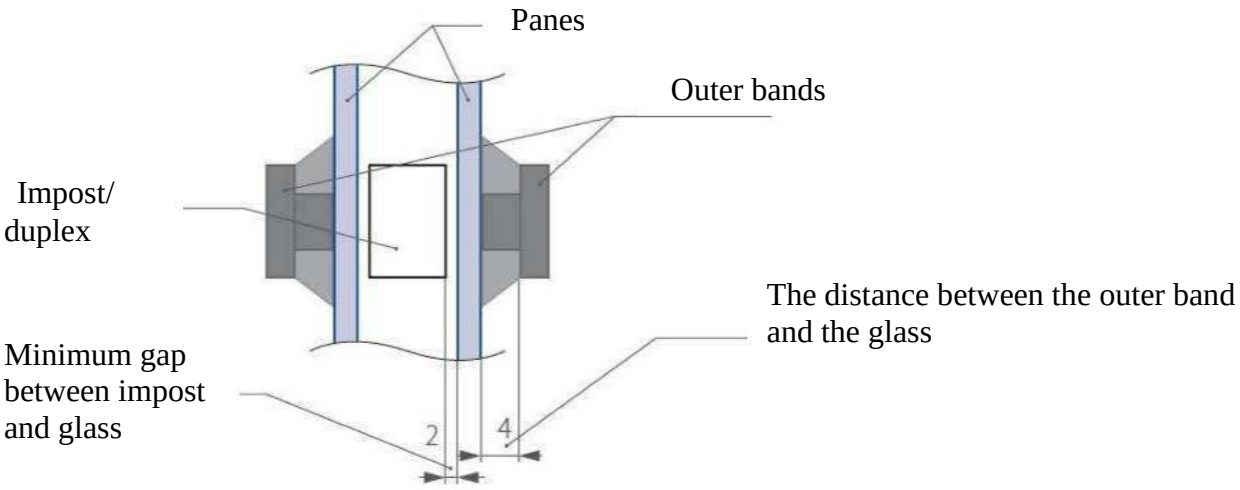

Fig. 15. Impost / duplex installation scheme.

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Warning: if the distance between the panes is more than 18 mm, the use of imposts / duplexes is not recommended.

Table 10. Combinations of imposts / duplexes.

Impost. / Connection.	8 mm.	18 mm.	26 mm.	45 mm.	Maximum dimensions of the glass unit, mm.
8 mm	+	-	-	-	700 x 700
18 mm	-	+	+	-	1200 x 700
26 mm	-	+	+	-	1200 x 700
45 mm		+	+	+	1200 x 1200

3.5.2. Round Glass Units.

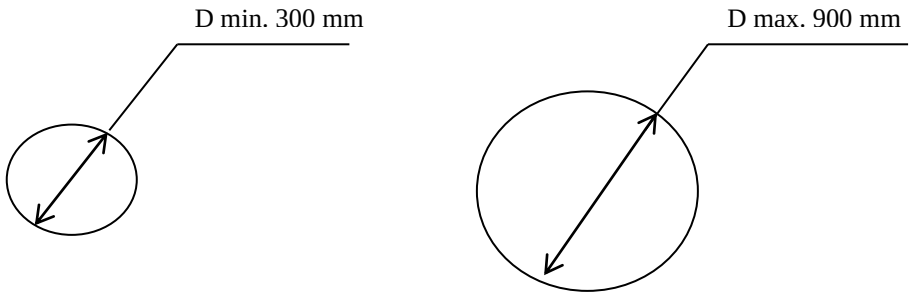


Fig. 16. Minimum and maximum sizes.

3.5.3. Tolerances for Round Glass Units.

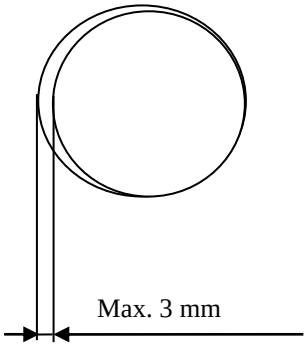


Figure 17. Displacement tolerance of round glass in a glass unit.

1. Glass unit spacer diameter tolerance: ± 2 mm.
2. Spacer displacement tolerance in a triple round glass unit: max. 3 mm.
3. Aluminum and Chromatech spacers can be used for round glass units.
4. Edge processing - manual blunting only.
5. For tempered glass, the maximum glass thickness is 8 mm (for glass 10 mm and thicker, the edges must be ground).
6. Laminated, reinforced and other spec. engraving of round glass is not possible.
7. Production of round glass units – hand-made.

3.5.4. Structural Glass Units with Aluminum U-shaped Profile and Ponzi Rubber.

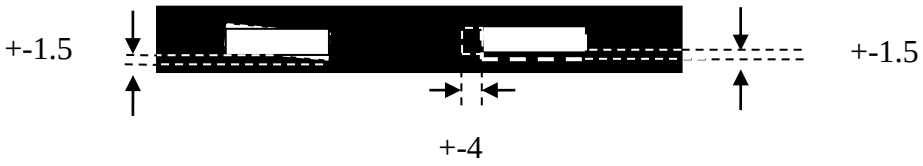


Fig. 14. Accuracy of U-shaped profile mounting in glass units.

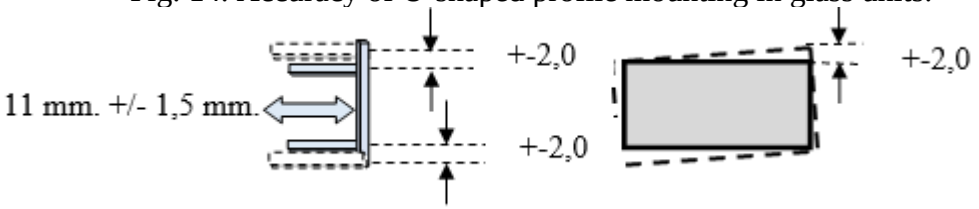


Fig. 19. Depth of Ponzi rubber cavity (11 mm. +/- 1.5 mm) and tolerances (+/- 2.0 mm) in the secondary seal of the glass unit.

3.5.5. Bending the Spacers.

Spacers can be formed by bending them with equipment or by connecting cut-to-length corner joints of a certain length. The minimum dimensions of a **rectangular shape** spacer that can be bent with a BSV bending machine are 300 x 150 mm. The minimum bending dimensions of the SWS type **rectangular shape** spacer are 300 x 200 mm. If the SWS type **rectangular shape** spacer is to be fitted with pressure valves, the minimum bending dimensions of the spacer shall be 400 x 250 mm.

Spacers of different sizes and various non-rectangular shapes can be bent only if agreed separately with the manufacturer.

Cut spacers and connected at an angle with special joints are used in cases without the possibility of bending with a bending machine or special-shaped IGUs which are produced according to the customer's order. The number of connections shall not exceed 4 in each glass unit chamber. The gap between the joints must not exceed 1 mm. The shortest connecting part of the spacer shall be at least 100 mm.

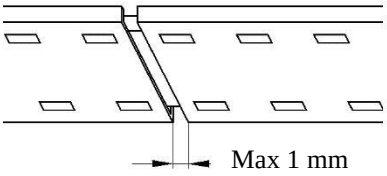


Fig. 20. Example of a spacer and tolerance.

3.5.6. CE Marking and Information Labeling.

The CE marking symbol shall be printed on the inside of the spacer. This means that the characteristics of the glass units meet the requirements of the standard.

4. Packing, Storage, Transportation and Installation.

4.1. Packaging of Glass Units.

Glass units are packed as standard on A- and L-shaped metal pyramids. At the customer's request, the glass units can also be packed on A-shaped wooden pyramids or in wooden boxes. Maximum permissible weight 1 ton - per wooden container. IGUs are placed on the outside of the pyramid with an outer glass as standard. The points of contact of the glass units must be protected by rubber bands or other materials which ensure the protection of the glass against mechanical impact. Glass units, when placed on stands, must be secured with straps. Glass units must be separated from each other by special gaskets, which

must be arranged symmetrically over the entire width and height of the IGU. Additional blue gaskets shall be placed in the top row of the IGUs between the existing cork gaskets, and there shall be two blue gaskets in the corners. The reinforced IGUs shall be wrapped in a layer of white matte polyethylene film. The matte films protect the glass units from thermal shocks. If the customer wishes a different method of packaging, it shall be specified in the customer's order, specifying the conditions for transporting the IGUs.

4.2. Transportation, Acceptance of Glass Products by the Customer.

The Buyer shall be responsible for the correct and safe unloading of the glass units from the vehicle. The consignee, in the presence of the driver or another representative of the manufacturer present at the time, shall visually assess the condition of the visible glass units before unloading the glass units from the vehicle. Bumps or a clearly visible defect in glass products hall be recorded on the pyramid sheets. The form must be completed with the required information, signed by the responsible person of the customer and returned to the manufacturer's representative.

In the event if a defect in the product is detected, it is necessary, without performing any further steps, to fill in the complaint form and take a photo of the defective spot and the glass unit itself on the pyramid, so that the whole IGU is visible.

Failure to do so will result in non-acceptance of claims for defects that should have been observed during acceptance and unloading of the products.

4.3. Storage.

Upon receipt of the products, the customer must ensure IGUs protection from external harmful effects, the effects of air and sun, the effects of atmospheric precipitation and transport them safely to the destination.

Glass units must be stored in a dry, well-ventilated premises protected from rain, direct sunlight and the air temperature must not exceed 40^{o} C. The manufacturer shall not be responsible for defects caused by incorrect storage of the IGUs.

4.4. Installation.

The installation of glass products shall comply with the requirements of Annex B of standard EN 1279-5.

When ordering glass units and during installation, the dimensional tolerances of the glass units and the overlap of panes specified in this standard must be assessed. Also, the possible future tolerances of the structures during operation shall be assessed in order to avoid tightness and cracking of the IGU.

5. Verification and Inspection of Glass Units.

5.1. Periodic Inspections.

External periodic, infrequent inspections are part of the production procedures.

The frequency of inspections shall be once a year, unless important materials for the manufacture of glass IGUs need to be replaced. If an important material needs to be replaced according to EN 1279-1, the test shall be repeated periodically. When such retesting coincides with a scheduled periodic test, then retesting is not necessary.

Area of periodic inspection:

- compliance with sealing geometry according to EN 1279-6;
- moisture penetration index according to EN 1279-2;
- gas leakage value according to EN 1279-3.

Production control parts:

- control of incoming parts and materials;
- constant control of the production process;
- final inspections of glass units in accordance with the established inspection plan.

5.1.1. Verification Methods.

Shapes and dimensions shall be checked using measuring instruments that are metrologically checked and have appropriate certificates of conformity.

Width and height shall be measured with rulers and tape measures.

Thickness shall be measured using electronic sliders.

The amount of argon gas in the glass unit shall be measured with the Sensoline O_2-Handy device according to the requirements of the standard.

5.1.2. Glass Inspection.

Periodic inspections of the dimensions of the cut glass shall be performed. Glass width and height, cutting quality, edge quality, glass defects shall be checked.

The external quality inspection of panes and glass units shall be performed by looking at the surface of the object in the presence of natural, indirect light.

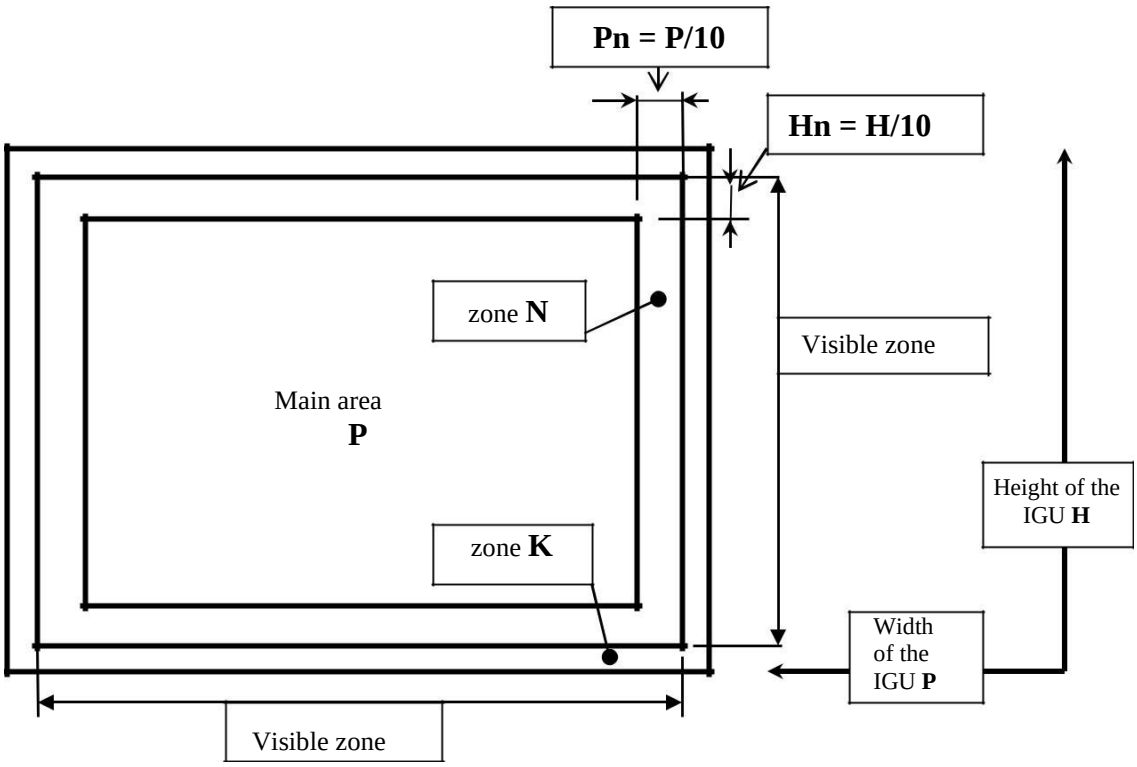
Defects that are not visible from a distance of 2 m (3 m for coated glass) shall not be considered as defects.

5.1.3. Quality Assessment of Glass Units During Production.

Visual assessment of the quality of glass units shall be performed by all employees involved in the production process. Each employee at the line must evaluate the quality of the work performed in the previous procedure. In each operation, the worker performs a visual inspection and, if necessary, uses measuring instruments to check the parameters of the glass or spacer. A glued package in the line shall be visually inspected for glass defects and gluing quality before being placing it on the pyramid. The final inspection shall be carried out by the packing staff before packing or loading the glass units. Periodic inspection shall be performed by the quality controller using appropriate means.

5.2. Defects in Glass Units.

5.2.1. Permissible Defect Zones of a Glass Unit.



K = edge - a connecting zone with a width of 15 mm. Defect assessments are not applicable here, except for mechanical edge damage.

N = the area of the visible part of the glass unit in which strict assessments of visual defects are not applied.

P = the main area where rigorous visual defect assessments are applied.

Fig. 21. Permissible defect zones.

When inspecting the defects of a glass unit, the quality shall be assessed by looking at the IGU at a right angle, the distance between the inspector and the glass must be at least 3 meters. Evaluation shall be performed in daylight, and the glass shall be dry. Daylight is light in the presence of constant clouds and without direct sunlight.

5.2.2. Permissible Defect Rates for Double Glass Units.

Table 11. Permissible spot defects

Zone	All defect sizes, Φ mm, except halos	Glass area of the glass unit S, m^2			
		S ≤ 1	1 < S ≤ 2	2 < S ≤ 3	3 < S
K	All sizess	Not limited			
N	Φ ≤ 1	Allowed if less than 3 spots Φ ≤ 200 mm area			
	1 < Φ ≤ 3	4	1 spot per 1 meter of the perimeter		
	Φ > 3	Not permissible			
P	Φ <1	Allowed if less than 3 spots Φ ≤ 200 mm area			
	1 < Φ ≤ 2	2	3	5	5+2/ m^2
	Φ > 2	Not permissible			

Table 12. Foreign bodies between the panes of the glass unit and stains on the glass.

Zone	Defect size, Φ, mm	Glass area of the glass unit S, m^2	
		S ≤ 1	1 < S
K	All sizes	Not limited	
N	Spots Φ ≤ 1		
	Spots 1 < Φ ≤ 3	4	1 spot per 1 meter of the perimeter
	Stains Φ ≤ 17	1	
	Spots Φ > 3 and stains Φ > 17	Max 1	
M	Spots Φ ≤ 1	Max 3 spots Φ ≤ 200 mm area	
	Spots 1 < Φ ≤ 3	Max 2 spots Φ ≤ 200 mm area	
	Spots Φ > 3 and stains Φ > 17	Not permissible	

Table 13. The number of linear defects allowed. Hair-sized scratches are allowed if there are no accumulations of them.

Zone	Defect length, mm	Total defect length, mm
K	not limited	
N	≤ 30	≤ 90
P	≤ 15	≤ 45

Table 14. Permissible norms for glass units of other structures.

Defect sizes according to table No: 13 shall be increased by 25% for an additional glass component or laminated glass component.
Triple glass unit with three monolithic panes - defect sizes according to Table No. 13 shall be increased by 1.25%.
Double glass unit with two laminated panes - defect sizes according to table No.13 shall be increased by 50%.
The IGU is non-standard shape according to the template provided by the buyer or the glass unit is smaller than 250 x180 mm produced by hand - the defect sizes according to table No.13 shall be increased by 50%.
Tempered glass with or without HST and heat-strengthened glass in a glass unit shall meet the requirements of this standard.
The deflection of tempered-glass panes must not exceed 3 mm per 1 000 mm of length, a greater deflection being allowed for close square-shaped panes up to 1: 1.5 or for single panes less than 6 mm thick.
The visual quality of curved glass units and their components must meet the requirements of ISO 11485-1 and ISO 11485-2.

5.2.3. Glass defect assessment position.

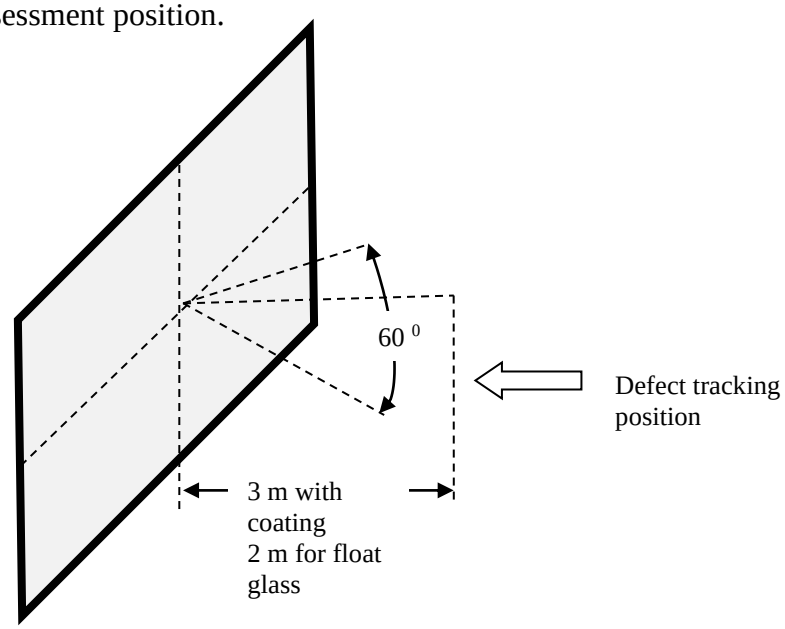


Fig. 22. Scheme for the Assessment of Visual Defects of a Glass Unit.

5.2.3.1. The evaluation of defects on enamel painted glass.

Defects must be visible from a distance of 3 meters from the examined surface at a 90° viewing angle in scattered daylight or under artificial lighting (without exposure to direct sunlight and additional lighting). If it was not indicated otherwise, defects are evaluated only from the clear / non-painted side of the glass. If the evaluation of enamel painted glass should be conducted from both sides, then it shall be coordinated at the time of submitting the order.

Defects of ≤ 0,5 mm are not evaluated (including their optically distorted area).
Lighting, viewing conditions and tints characteristic for clear glass may determine slight variations in the tint of the same batch of painted glass.
The tint of one batch of enamel-coloured glass may differ from another batch, even though glass is painted in the same colour. That is why glass which will be placed in a same visibility zone must be ordered at once, and that shall be indicated in the order by a customer.
If a batch, whose glass shall be painted identically, is ordered, the requirements and parameters for the production of the project must be coordinated, which will be followed during the entire production of the project. When submitting orders for production, reference samples of enamel shall be coordinated.
One sample remains in the possession of the client, the other of the manufacturer.

Roughness of enamel layer:

- thickening of the paint layer, which is not visible on the non-painted side of the glass, is possible for glass painted along the perimeter, at the intersection areas of the enamel and in the inner perimeter.

Enamel runs on the edges:

- paint runs, which are not visible on the non-painted side of the glass, are permitted on the painted surface and in the area of edge intersection.

5.2.4. Errors in the Assembly of Glass Units.

The inner seal covers the surface of the spacer along the spacer, possible twisting of the seal seam. It is possible for the sealant to spread no more than 2 mm from under the dividing spacer to the inside of the glass unit during the production of the glass unit (see figure No 23). Further spread of inner sealant into IGU area after production process is not regulated. For glass units with an area of more than 4 m^2, the

non-uniformity of the butyl seam to the edge of the spacer is allowed. The joint of the spacer shall be installed in such a way that the absorbent and its dust do not enter the inside of the glass unit. The joint spacing of the distance spacer ends is allowed up to 1 mm. (see figure No 24). The butyl dispersion of the glass unit is influenced by the operating conditions of the IGU (exposure to heat, direct sunlight), as well as the structure of the building, therefore its leakage during operation is not regulated and claims shall not be accepted.

The tilt of the pressure valve is allowed within the width of the spacer. (see figure No 25).

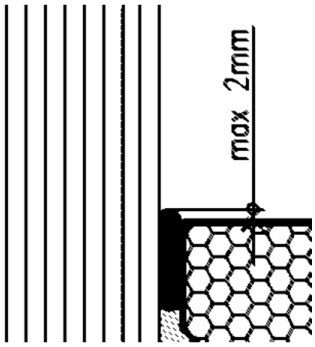


Fig. 23. The ingress of butyl inside the IGU during the production of the glass unit is allowed up to 2 mm. Not regulated later.

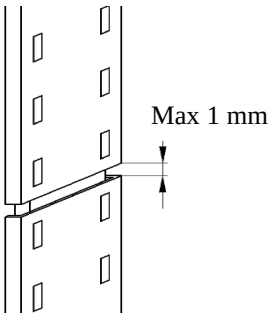


Fig. 24. The joint spacing of the distance spacer ends is allowed up to 1 mm.

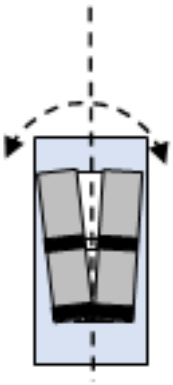
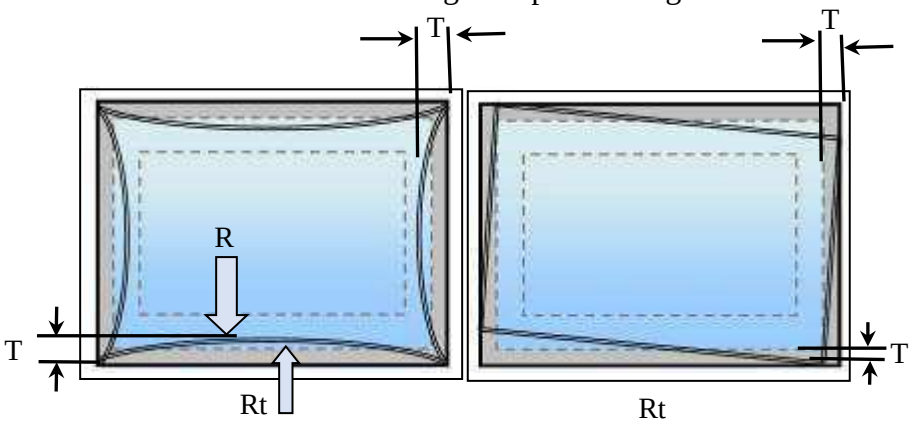


Fig. 25. Tilt of the Pressure Valve.

Straightness tolerances for the spacers of glass units. In double glass units, the spacer straightness tolerance shall be 4 mm for edge lengths up to 3.5 m and 6 mm for the longer edges. The permissible deviation of the spacer (s) from the parallel straight edge of the glass or the interchangeability of the spacers in glass units shall be 4 mm for side lengths up to 2,5 m. If the edge of the glass is longer, the permisable tolerance shall be 6 mm. The image of spacer straightness tolerances is presented in example No.:26.



Explanations:
Rt - the actual shape and position of the spacer.
R – spacer.
T – tolerance.

Fig. 26. Image of spacer straightness tolerances.

5.3. Maintenance of Glass Units.

The glass surface shall be cleaned only using the appropriate chemicals and soft fabric. Do not use sharp or abrasive materials to remove dirt. Glass is vulnerable and scratches can cause thermal cracking.

Glass deteriorates and its surface (usually the outer one) becomes more susceptible to damage. Stained (tinted) glass surfaces heat up on a sunny day. Do not apply dark-coloured films or other heat-absorbing details to such surfaces. Different temperature segments cause glass to break. Even shadows on large glass are undesirable because they cause thermal cracks. Temperature differences create additional stresses on the glass. Do not place domestic heating, ventilation or refrigeration appliances near the glass.

Tempered glass is more resistant, so the customer should use tempered glass after assessing the operating conditions of the glass unit (location of the glass unit in the building, its full or partial illumination), which may affect its damage.

The cleaning of special glass is regulated by the glass manufacturer's instructions, which may be requested by the manufacturer of glass units from the manufacturer of glass, upon the buyer’s request.

6. Procedure for Processing of Claims Concerning Glass Products.

After receiving claims of the products quality, the producer’s quality department assess whether these are manufacturing defects or damage caused by improper transportation, storage and use. It shall be checked that visible defects do not exceed the tolerances specified in this standard.

The surface of glass can be damaged by mechanical, thermal and chemical factors. The manufacturer is not liable for defects in glass units and panes that have occurred after glazing if the operating rules for glass units have not been observed. The inspection of glass products must be carried out at a distance of 3 metres from the glass surface. The inspection shall be carried out in diffused daylight without direct sunlight or under artificial backlighting.

Any claims concerning breakages and/or cracks of glass units which have occurred after the installation of the glass units shall not be acceptable because the manufacturer cannot influence the further use and handling of the glass units.

6.1. Physical Phenomena in Glass Units.

The following physical phenomena may occur in glass units. All these phenomena are typical of glass units and shall not be considered as defects:

6.1.1. The Effect of Interference.

In glass units with polished glass, the interference effect may occur in areas of the visible light spectrum on the glass surface. The interference effect results from the superposition of two or more light waves at one point. This effect occurs in more or less intense coloured areas that change when the panes are pressed. The effect may be enhanced in the case of parallel glass surfaces.

6.1.2. The Effect of a Glass Unit (Double Glazing).

A hermetically sealed glass unit contains air or other gases between the panes. The density of gas or air in a glass unit is determined by the ambient air pressure and temperature at the production site of the glass units. When the glass unit is transported to another location or simply the weather conditions (pressure, temperature) change, these environmental changes can lead to a pressure difference between the glass unit and the environment, which can lead to some deformation of the panes of the glass unit, i.e. convex or concave. In this case, more or less distorted image reflection occurs.

Warning. In the event of large pressure differences, two-way valves (see figure No. 28) shall be installed in the glass units to compensate for pressure differences. The customer must assess the future operating and transportation conditions of the glass units and specify the need for pressure valves in the order. The valve opens at a pressure difference of 70 mbar and closes at a pressure difference of 90 mbar. Swisspacer spacers use open type valves that constantly compare the pressure between the outside and the inside of the IGU (see Figure No. 27). Recommendations for the use of valves in glass units are given in Annex 1 of this Standard.
At the customer's request, as an alternative to using a pressure valve, the pressure inside the glass unit can be adjusted with a special device. The conditions of use and possible risks are presented in Annex 4 of this Standard.

Fig. 27. Open type valve of the Swisspacer spacer.

Fig. 28. Two-way valve.

6.1.3. Multiple Reflection.

Multiple reflection can occur as the intensity of the incident light on the glass surface changes. This reflection can be seen particularly well if there is a dark background or coated glass is used. This effect is a physical property of all glass units.

6.1.4. Anisotropy.

Anisotropy is a phenomenon characteristic of tempered glass due to the internal stresses that occur during the process of tempering the glass. Due to anisotropy, dark wheels or bands may be observed, which vary depending on the viewing angle, if the glasses are exposed to polarised light or a viewer viewes through polarised glasses. Polarised light is produced in normal daylight. The degree of polarisation depends on weather conditions and the position of the sun. The effect of double refraction is more pronounced when looking at planes at a sharp angle or in facades where glass units are installed at right angles.

6.1.5. Condensation Formation.

Condensation may form on the outer glass surface if the glass surface temperature is lower than the ambient air temperature. The formation of condensate on the outer surface of the glass unit is determined by the heat transfer coefficient of the glass unit, relative air humidity, movement of air flows at the glass surface and outdoor and indoor air temperature. Condensation on the outer glass surface inside the room is usually caused by increased humidity, insufficient air ventilation inside the room, for example, due to curtains, blinds, window sills, improperly installed radiators, and the like. The formation of condensate under the above conditions shall not be considered a defect in the glass units.

6.1.6. Cloudiness of Glass Surfaces.

Cloudiness of the glass unit from the outside is normal for glass units with selective glass. Because such glas units have good thermal insulation properties, they do not transmit heat to the outside and their outer glass cools to ambient temperature at night. Then in the morning, when the air warms up, moisture condenses on the cold glass. In glass units with less good thermal properties, the heat leaves the room and heats the outer glass and therefore it does not cloud up. The formation of condensate under the above conditions shall not be considered as a defect in the glass units.

6.1.7. Moisture inside the glass unit.

Most often, the moisture inside the IGU is caused by poor ventilation of the premises. There is always some water vapour in the air of the premises. The concentration of vapours in the premises also increases due to the hermetic of the new window. The windows become misty when the room is very humid and the temperature is low.

6.1.8. Glass Discoloration.

All materials for the production of glass units have their own colour, which depends on the raw materials. Coated glass also has its own characteristic colour. This colour may vary due to optical conditions (light transmission and reflection, direction of view of the glass). Fluctuations in colour intensity are possible due to the amount of iron oxide in the glass, the coating process, the coating itself, the thickness of the glass. When additional orders of coated glass are produced, it is not possible to guarantee that the colour will be completely identical for reasons related to the production technology.

6.2. Glass Cracks.

There are several basic rules that always hold true in the case of untempered glass breaking and must be taken into consideration. The following are three decomposition rules.
1. Cracks always branch out only in the direction of their spread. If these branches are followed back, they come to the centre of the primary crack and decay.
2. A crack can never jump over the already existing crack. The crack ends at the next crack reached. Because of this fact, it is often possible to determine the sequence of their occurrence and the location and cause of the initial crack.

3. The average number of cracks depends on the degree of load during cracking. A denser network of cracks is usually formed when the glass is subjected to a higher breaking load than vice versa. When evaluating fission images, one should always start with the question of thermal causes, so that the first step can be unambiguously to be classified as a group of thermal or mechanical cracks. The figure below shows the mechanical decomposition of the twist.

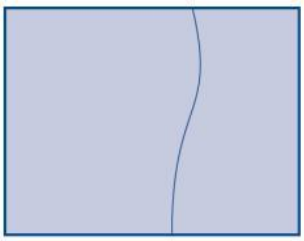


Fig. 29 Twist cracking in a glass unit.

Tempered glass can crack by itself. A Heat Soak Test should be performed to evaluate the destination of the glass unit. The essence of the heat soak test is the detection of the undissolved chemical element nickel sulphide in the glass raw material. The presence of a nickel sulphide impurity in tempered glass can cause the glass to explode spontaneously even after several years of operation. After this test, the probability of spontaneous explosion of glass installed in the object is reduced up to 99.8 percent.

When the tempered glass is tested by the HS test, the glass is placed in an oven at 290 ° C (± 10 ° C). Careful temperature control must be performed to determine the holding time. The holding time at the highest temperature is an important factor in the HS test process. After the HS test, the probability of self-breaking glass is reduced to a minimum.

6.2.1. Thermal Cracks.

The mechanical stresses in the glass caused by the heat (in the case of single glazing or double-glazed glass units) occur when the temperature difference between the two points on the surface of the glass occurs. The reasons influencing the temperature difference are:

- sunlight;
- indoor air conditioning and heating.

Theoretically, solar radiation should not affect the thermal stresses of the glass, if the entire surface of the glass is evenly illuminated by the sun and the temperature is evenly distributed over the entire area of the glass. In practice, however, this is extremely rare because glass units are embedded in the glazing groove of the spacer and are fully / or partially shaded. Only thermally toughened or tempered glass should be used for glazing opaque areas. Heating and ventilation devices are usually installed near windows and therefore, creating hot or cold zones on the glass surface, cause thermal stresses. Fault risk factors are described in Table No. 15.

Table 15. Cracking Risk Factors for Glass Units.

Cause	A source of Stress	Factors affecting thermal cracks	Measures to reduce the risk of thermal cracks
Sunlight	Frame	The increased risk depends on: a. Frame materials 1. Wood or PVC; 2. Dark aluminum with thermal breakdown; 3. Dark heavy metal; 4. light aluminum with thermal breakdown; 5. light aluminum; 6. concrete. b. Frame type 1. fixed bright, without pressure gaskets; 2. attachable, opening vents; 3. horizontal sash;	Insulate the frame from the masonry. Use edge covering at the edges less than or equal to 45 mm.

		4. sliding; 5. fixed or opening frame with pressure gaskets.	
	Shadows of facade elements from the outside	The risk of thermal cracking increases if: 1. vertical projection; 2. horizontal projection; 3. outdoor blinds.	Maintain a distance of at least 20 mm from the blinds over their entire height for natural ventilation. Under no circumstances should there be contact between the blinds and the glass.
	Paint on glass (inside or outside)	The risk of thermal cracking is greatly increases.	Try to avoid.
	Paper or plastic screens (internal or external)	The risk of thermal cracking is greatly increases.	Try to avoid.
	Interior curtains	The risk of thermal cracking is greatly increases if the curtains are NOT transparent and there is no ventilation.	The space between the glass and the curtains inside the building must be ventilated.
	Items are propped against the glass	The risk of thermal cracking is greatly increases.	Try to avoid.

7. Procedure for Accepting Claims Regarding Glass Products.

A claim for the quality of the pane or glass unit must be submitted immediately. The customer may send a written claim to the seller from the date of delivery of the goods no later than:

- within 5 calendar days - for glass units; single glass without coating or with hard coating
- within 1-2 calendar days - for glass with selective or other soft coatings.

Upon receipt of the goods, a visual inspection of the received goods must be performed and any observed cracks or other visually visible defects must be immediately reported to the manufacturer and recorded in the acceptance documents. All other information must be provided in writing (e-mail), indicating the location and circumstances of the damages.

<u>The following must be submitted when submitting a claim:</u>

- a defect report (in xls format) filled in by the manufacturing company in the prescribed form, in which the quality discrepancy is precisely identified and substantiated, as well as the quantity of defective goods, order number, date of receipt of goods, defect detection conditions shall be indicated.
- <u>Photographs (jpg format):</u>

1) a photograph of the visible defect in the product. The location of the defect must be marked on the photo;
2) a photograph of the entire defective product at the time of defect detection. The defective product must be on the pyramid before detection or at another location of the detection;
3) photographs of the product marking label in order to identify the stages of the occurring of the defects in production. In the absence of a product label, a photograph of the full inscription on the spacer shall be provided;
4) clearly visible defects (cracks, breakages) must be identified at the time of acceptance of the products.

The defective glass unit / pane must be returned. If the purchaser is unable to return the defective glass unit, he shall notify the manufacturer, stating the reasons.

The location of the defect must be marked (using a sticker or non-washable marker) on the defective product subject to returning. When returning defective products that are manufactured for payment and for expertise examination, the manufacturer must be notified of the time of the shipment thereof before they are shipped. The defective product must be marked indicating the purpose of dispatch.

If the customer does not plan to use glass units within 7 days (deadline for reporting transport damage), the goods should be unpacked and inspected, and the defects found should be evaluated according to the standard.

Warning. The manufacturer of glass units does not reimburse the costs of reassembling/reinstalling glass units.

8. Warranty Conditions for Glass Units.

8.1. Glass units have a 5-year warranty unter the contract, from the date of invoicing. If without a contract, a 2-year warranty is provided from the date of invoicing.

8.2. A warranty may also be provided for a longer period, it shall be specified in a separate contract, indicating additional exploitation conditions for the glass units.

8.3. If the customer exports glass units, this warranty only applies if it has been approved in writing by the manufacturer.

8.4. No warranty is given:

8.4.1. When glass units, single glass breaks and/or are smashed after delivery to the Buyer;

8.4.2. For the loss of color and/or stains of the decorative elements inside the glass units (Georgian bar, duplexes) exposed to the effects of the atmosphere;

8.4.3. When cracks in glass units occur when the glass units are unpacked and removed from the pyramid;

8.4.4. When blinds are installed inside the glass unit, for the oxidation of the blinds and their failures;

8.4.5. For glass units, when, upon receipt from the manufacturer, the hermetic layer of the glass unit is damaged during their transportation and/or installation;

8.4.6. For glass units, the glass of which is painted and/or films are pasted on it, and/or conditions of aeration are not created;

8.4.7. For glass units, when a pressure valve is installed inside the glass unit, as the glass unit is not secure when the valve is open, so there is a possibility of fogging and/or argon leakage;

8.4.8. For circular shape glass units;

8.4.9. Other shape glass units smaller than 250 x 180 mm;

8.4.10. For glass unit, single glasses, one side of which is 6 times longer than the other (1:6), if the glass unit structure / single glass contains at least one of the following glass thicknesses - 3mm, 4mm, 33.1 mm, 33.2 mm;

8.4.11. For glass units, tempered glasses, one side of which is 10 times longer than the other (1:10);

8.4.12. For glass units which structure has armored glass;

8.4.13. For glass units, tempered glasses, which are operated under special conditions (steam, fire, etc.), except for cases where these conditions are provided for when ordering the product;

8.4.14. For glass units that, at the customer's request, were produced not according to the requirements of the company's standard (other glass was used instead of tempered or laminated glass, etc.);

8.4.15. For the glass breakage (clear glass) when the glass unit structure is with "Tempered-Clear-Tempered" glasses, because the clear glass is affected by the permissible deflections (bends) of the tempered glass;

8.4.16. For glass units, tempered glasses that have been glazed, installed in frames without following the glazing instructions (STR) provided for in the building regulations;

8.4.17. When for the process of insertion of the glass units, tempered glass into the window frames, sticky and sealing materials containing solvents, diluents, acid components were used. Materials that are not provided in the material

compatibility tables Sp, Ss provided by the glass unit manufacturer (Annex No 5 and Annex No 6);

8.4.18. For the glass breakage (clear glass) when the glass unit structure is with "Tempered-Clear-Tempered" glasses, because tempered glass is affected by the permissible deflections (bends) of the tempered glass;

8.4.19. When tempered glass, which is in the glass unit, or single tempered glass breaks/explodes/splits by itself due to the undissolved chemical element nickel sulfide which is in the raw glass material and which expands (see clause 6.2).

8.5. Factors that cannot be influenced by the manufacturer.

The glass manufacturer does not take any responsibility for the defects of the glass units that have occurred after the installation of the glass units, because the factors influencing this process are beyond the control of Bodesa, UAB. Such factors include:

8.5.1. Glass units break because they are installed in the parts of the structure which can be opened;

8.5.2. Careless transportation from the Buyer to the construction site; transport and storage in a horizontal position. The glass must always be transported and stored upright;

8.5.3. Incorrectly installed glass support blocks, failure to assess the allowed by the standard overlap of the panes in the glass unit;

8.5.4. Very airtight frames if the windows consist of several layers;

8.5.5. Uneven heating of the glass caused by shadows falling on the window, which cause large temperature differences. Sudden heating of the room using space heaters during construction;

8.5.6. Gluing a membrane, aluminium foil, glued profile or similar object to the whole pare or any part of the pane’

8.5.7. Abnormal heating of the glass if there are solar or roller blinds behind the glass without leaving enough space for air;

8.5.8. Vibration caused by noise from airplanes, heavy machinery and explosions;

8.5.9. Other factors and their examples which are given in the Annex No. 4 Examples and descriptions of thermal, mechanical fractures;

8.5.10. Other glass unit damage factors are described in Table 15. Cracking Risk Factors for Glass Units;

8.5.11. Unlimited spread of butyl into the glass unit during exploitation.

9. Basic Requirements for the Installation of Glass Units in Frames.

The edge of the glass units after installation in the window frame must be covered by at least 12 mm. The support plates must be (6*25) mm in size and their hardness should not exceed 80-90 Shores. There must be a gap of at least 3 mm along the perimeter between the width and height of the glass unit and the opening of the window frame.

10. Annexes to the Standard:

10.1. Annex No.1 Practical Rules for the Installation of Pressure Valves in Glass Units;
10.2. Annex No. 2 Warranty Conditions for Glass Units with a 10-year Warranty;
10.3. Annex No. 3 Modeling progress of desired glass unit structures and dimensions;
10.4. Annex No. 4 Examples and descriptions of thermal, mechanical fractures;
10.5. Annex No. 5 CompatibilityofweathersealantswithTENAGLASS® IGU secondarysealants;
10.6. Annex No. 6 Dow Corning® Construction Industry System Sealant Compatibility Statement;
10.7. Annex No. 7 The Effect of Atmospheric Pressure and Temperature on Insulating Glass Units and Warranty Obligations;
10.8. Visualisation of the Standard_ (separate document)
https://www.bodesa.lt/useful-tools-company-standard/

Annex No. 1

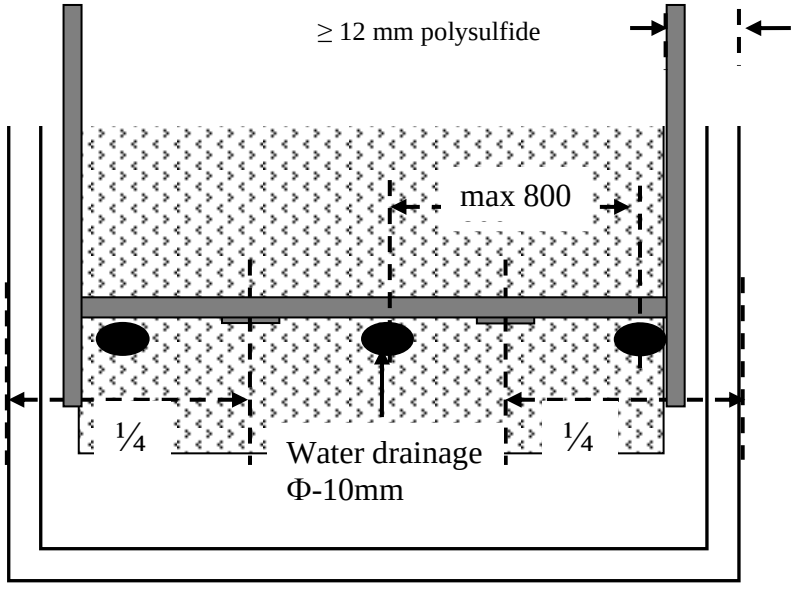
Practical Rules for the Installation of Pressure Valves in Glass Units

1. Pressure valves shall be installed in triple glass units in each chamber.
2. When the area of a glass unit is 4 m^2 and more, 2 pressure valves in one chamber are recommended.
3. Only tempered glass should be used for IGUs with pressure valves.
4. The aspect ratio of glass units must not exceed 1:6.
5. It is recommended to use the outer glass, which thickness is 2 mm greater than the thickness of the inner glass.
6. The width of the spacer of the glass unit should not exceed 18 mm. Otherwise, calculations should be performed to calculate the possible deflection of the pane of the IGU.
7. In the case of double or tripleglass units, all glass panes shall be at least 6 mm thick.
8. The position of the valves installed in the building in the glass units must be vertical (mounted at the top of the vertical edge of the glass unit) and open.
9. Pressure valves operate when the pressure difference between the outside and inside of the IGU is 80 + - 10 mbar.
10. The Swisspacer valve works all the time because it is direct acting, because it does not have an inside valve. Further concentrations of argon / krypton gas after filling in the IGU are not regulated.
11. Pressure valves do not completely equalise the pressure inside the glass unit with the pressure outside it, but only reduce the difference.
12. Approximately (depending on wind and air temperature) the pressure changes by about 10 mbar ascending every 100 m.
13. Valves shall be installed when IGUs are expected to be transported or installed at a height of> 650 m.
14. <u>Transportation Conditions for Glass Units with Pressure Valves:</u>
    - glass units with pressure valves shall not be transported by air.
    - during the transport of glass units to the place of installation, when the pressure in the transport environment changes in the range of more than 80 + -10 mbar, the position of the valve must remain vertical and there must be no sudden pressure fluctuations. The valve pipe must be open during transportation, air must flow through the ventilation ducts of the window frame up to the valve of the glass unit.

Annex No. 2

Warranty Conditions for Glass Units with a 10-year Warranty

1. The warranty conditions given in clauses 8 and 9 apply;
2. Warranty conditions for glass units:
   - required sealing depth of 6 mm (polysulphide) when the area is ≥ 5 m2;
   - required sealing depth of 8 mm (polysulphide) when area ≥ 9 m2;
   - tempered glasses after the HS test;
   - the structure of the glass unit does not contain tempered and clear float glass together;
   - all spacer connections are hermetically sealed with butyl and taped with “Mylar”.
3. Installation requirements:
   - all panes of glass in the glass unit must be based on the base of the window frame over their entire thickness, taking into account the overlaps of the panes in the glass unit.
   - the size of the window frame for the installation of the glass unit must be such as to ensure normal resistance after sealing, as well as the mechanical impact of the building structure during operation shall be taken into account.
   - the sealing materials must be compatible with the basic materials of the glass units (see Annex No. 5 and Annex No. 6).
   - the length of the support blocks must be 25 mm / 1 m^2 for the width of the glass unit;
   - the difference between the edge length of the window frame and the edge length of the glass unit must be minimum 3 mm, 2m for the edge of the glass unit;
   - good water drainage of the window frame must be ensured.



4. The guarantee does not cover the glass units:
   - which are mounted on skylights or the plane of the glass units is inclined in relation to the vertical of the building, if the glass unit structure calculations for these special conditions have not been carried out.

Annex No. 3

Modeling progress of desired glass unit structures and dimensions

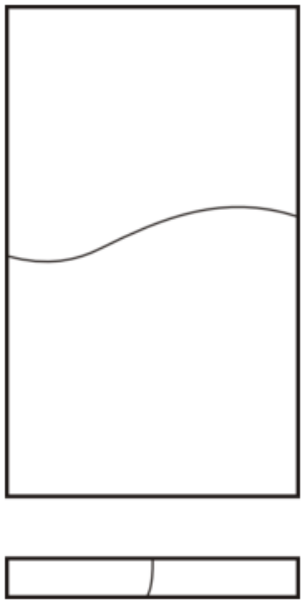
1. The desired glass unit structure is created by selecting the glass and spacers.
2. The smallest spacers and glasses in the structure are taken.
3. The permissible length of the edge of the glass is taken from Table 1. “Approximate maximum area of glass units” for selected glass and spacers.
4. Knowing the area of the glass unit and the maximum allowable length of the edge, the maximum allowable length of the other edge is calculated.
5. After calculating the length of the other side, it is calculated whether the allowed aspect ratio is maintained.
6. If the side lengths or the area of the glass unit exceeds the recommended ones, calculations must be made.
7. If the selected glass unit structure is satisfactory and is proposed for use, calculations must be made using the Mepla system or similar.
8. When modeling the glass unit structures, please follow the statement:
   “When different thicknesses of glass panes are used in a single glass unit, the area limitation will always be influenced by the glass of lower thickness”.
9. The capacity of Bodesa for cutting laminated glass is 4600x2800 mm.

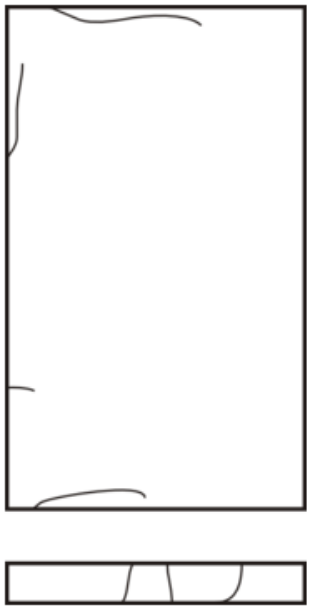
Annex No. 4

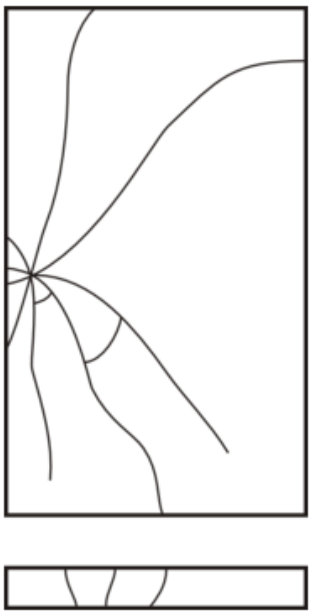
Examples and descriptions of thermal, mechanical fractures

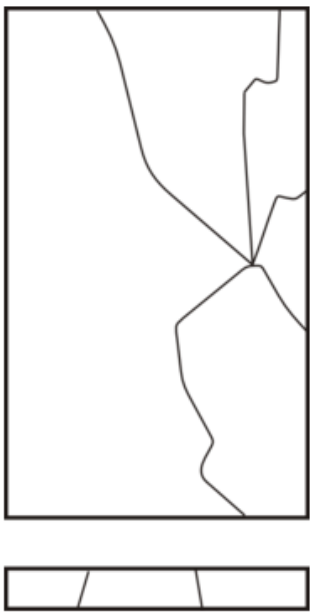
The presentation of fracture images will be limited to the essence of the fracture image. The unequivocal identification of the causes of glass breakage requires considerable expertise and should be determined by specialists.

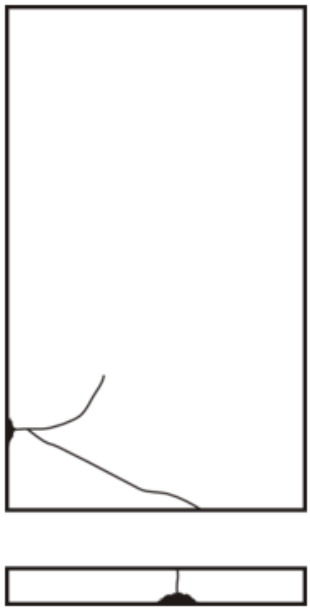
Mechanical breaks, cracks

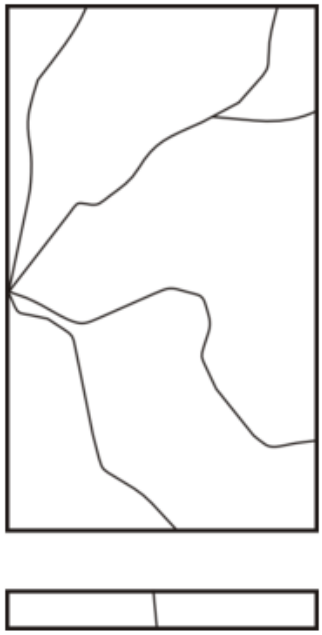
Type of glass	**Glass twist breakage**
Polished, rolled sheet, laminated, patterned/ornamental glass 	Load: mechanical, evenly distributed - short-term - dynamic **Cause of splitting** Insufficient glass thickness (usually in the case of double fixing); Compression of the glazing unit; Deflection of the window frame. **Characteristics of the defect** Edge crack angle in all directions; Transition angle is not right; Visible starting point in the edge zone and possible curvilinear cracks in the centre of the split. Lines always run from the edge; Straight cleavage lines; Cracks are short; Often back lines go to the edge with long cracks. Straight lines at the end. Frequent intersection of fracture edge surfaces; Possible curvilinear cracks in the middle area; No centre of the damage.

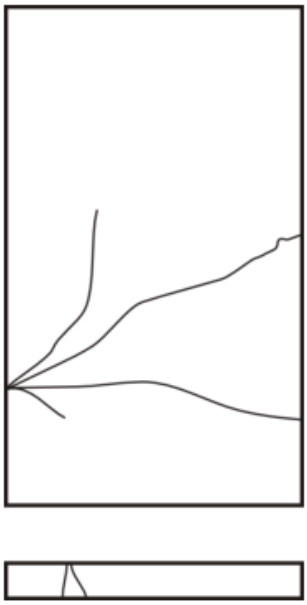
Type of glass	**Pinching breakage**
Polished, rolled sheet, laminated, patterned/ornamental glass 	Load: mechanical point or uniformly distributed short term dynamic - long term static **Cause of splitting** Too small or inadequate support pads in the presence of high glass weight; Incorrect installation of the glazing bar and not taking into account the change of glass/frame length. **Characteristics of the defect** The angle of crack of the edge in all directions is not right; The angle of transition is not right; Visible exit point in the edge zone; Possible curvilinear cracks in the centre of the split. Lines always run from the edge; fracture lines are straight; cracks are short; Often back lines go to the edge with long cracks. Lines straight at the end No curvilinear cracks in the middle area

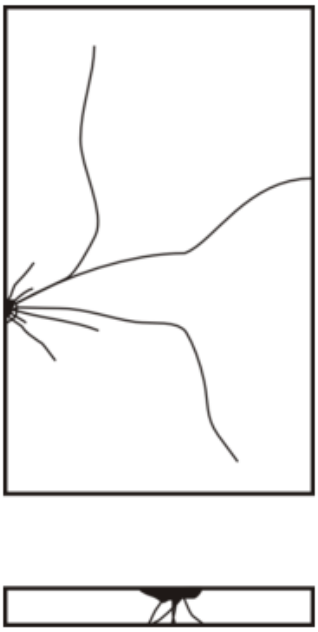
Type of glass	Fracture of a flat glass edge
Polished, rolled sheet, laminated, patterned/ornamental glass 	Load: mechanical point - short term - low / medium intensity **Cause of splitting** Pebbles between the panes; Impact with a tool; Impact of a hammer on the glazing bar; Other impacts or collisions. **Characteristics of the defect** Angle of edge crack in all directions, not right; Angle of transition not right; Visible exit point in the edge zone; Possible curvilinear cracks in the centre of the fracture. **Course of the lines** Radial shapes from the edge; Straight to angular fracture lines; Usually does not extend to the adjacent edge, rarely to other edges. Straight lines at the end; In the middle of the glass or extending to the edge of the glass Curvilinear cracks may occur at the adjacent edge.

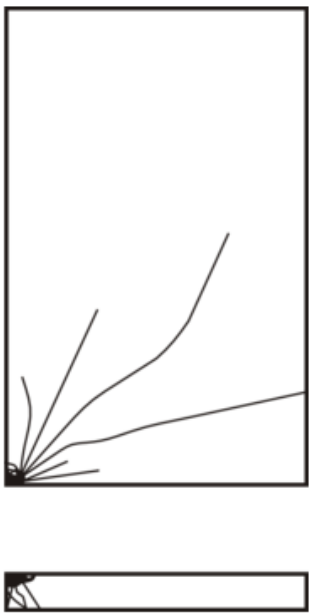
Type of glass	Fracture of a heat strengthened glass edge
Only partially toughened glass in accordance with DIN EN 1863 	Load: mechanical point - short-term - low/medium intensity **Cause of splitting** Pebbles between the panes; Impact with a tool; Impact of a hammer on the glazing bar; Other impacts or collisions. **Characteristics of the defect** Angle of edge crack in all directions, not right; Angle of transition not right; Visible exit point in the edge zone; Possible curvilinear cracks in the centre of the split. **Course of the lines** Radial shapes from the edge; Straight to wavy fracture lines; Goes to the edge. End Going to the edge. Curvilinear cracks often occur at the adjacent edge; No islands of cleavage, the crack always extends to the glass

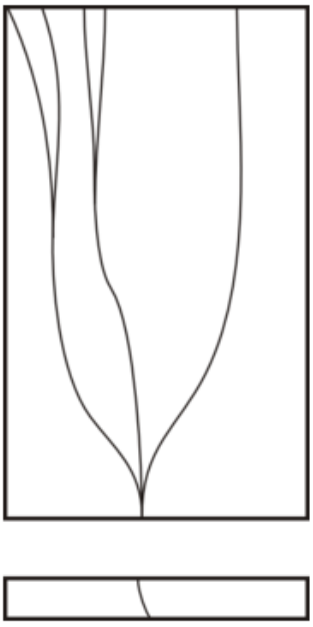
Type of glass	Pressure fracture of the glass edge
Polished, rolled sheet, laminated, patterned/ornamental glass 	Mechanical point load: stress - short or long term - low/medium intensity **Cause of splitting** Primary damage when placed on stone or metal; Primary damage, incorrect installation of the glazing bar; Pebbles or metal between the edge of the glass and the support pad. **Characteristics of the defect** Angle of edge crack in all directions, not right; Angle of transition not right; Curvilinear cracks in the edge are initially of different sizes; Clear centre at the edge. **Course of the lines** Radial shapes from the edge; Straight to angular cleavage lines; Usually does not go to the edge; No curvilinear fractures in the middle. End Straight lines; In the middle of the glass or passing to the edge of the glass. **Other features** Small or large curvilinear cracks at the beginning of the split.

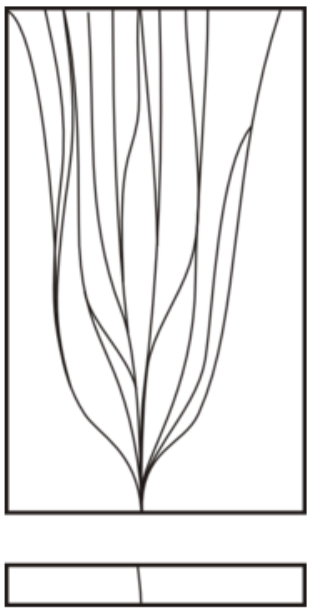
Type of glass	Pressure fracture of a thermally strengthened glass edge
Only thermally strengthened glass according to DIN EN 1863 	Mechanical point load: short or long term - low/medium intensity **Cause of splitting** Excessive clamping pressure; Excessive pressure when fixing wooden glazing bar without gasket **Characteristics of the defect** Edge crack angle in all directions, not right; Transition angle not right; No or very little curvilinear cracking at the start of the edge; Clear centre at the edge. **Course of the lines** Radial shapes from the edge; Curvilinear to angular cleavage lines, rarely straight lines; Always going to the edge. End Straight lines; In the middle of the glass or passing to the edge of the glass. **Other features** No islands of cleavage and the crack always extends to the edge of the glass (according to DIN EN 1863) and depends on the size and thickness of the glass.

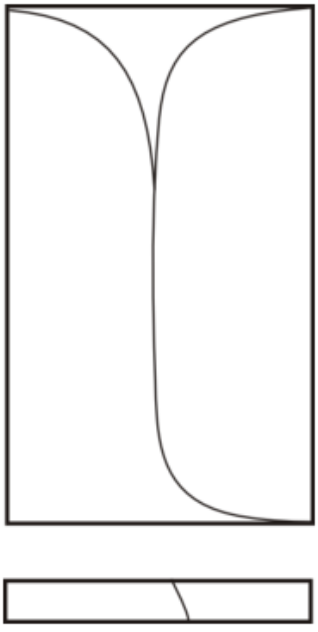
Type of glass	Pressure cracking of the glass edge
Polished, rolled sheet, laminated, patterned/ornamental glass 	Mechanical point load: short or long term - low/medium intensity **Cause of splitting** Too small support pads with high glass weight; Excessive clamping pressure; Excessive pressure when turning a wooden glazing bar without gasket. **Characteristics of the defect** Angle of edge crack in all directions, not right; Angle of transition not right; No or very little curvilinear cracking at the start of the edge; Clear centre at the edge. **Course of the lines** Radial shapes from the edge; Straight to angular cleavage lines; Usually does not extend to the edge. End Straight lines; In the middle of the glass or going to the edge of the glass

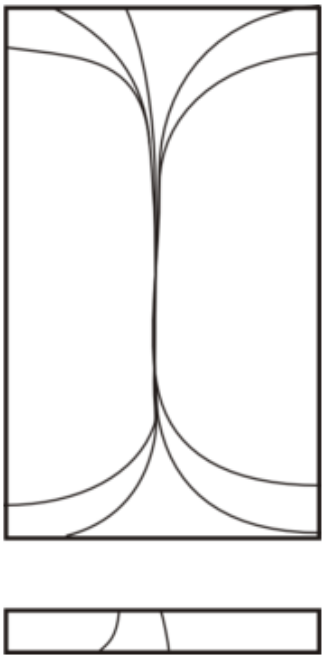
Type of glass	Glass edge breakage under point load
Polished, rolled sheet, laminated, patterned/ornamental glass 	Mechanical point load: short term - low/medium intensity **Cause of splitting** Placing on stone or metal; Impact on edge with metal part; Incorrect use of clamping straps on transport structures. **Characteristics of the defect** Angle of crack of edge in all directions, not right; Angle of transition not right; The curvilinear cracks in the edge are initially of different sizes depending on the impact force; Clear centre at the edge **Course of the lines** Radial shapes from the centre; Straight to angular cleavage lines; Usually does not go to the edge. End Straight lines; In the centre of the glass or going to the edge of the glass. **Other features** Clear curvilinear cracks.

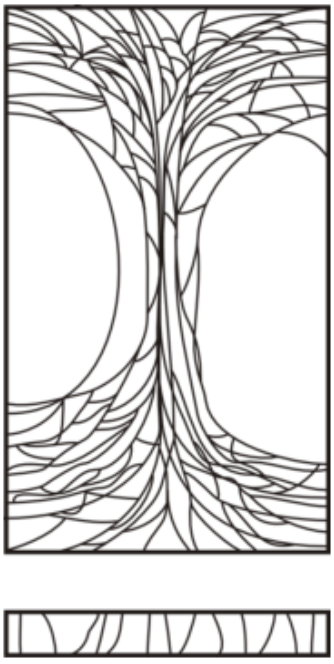
Type of glass	Impact breakage of the glass corner
Polished, rolled sheet, laminated, patterned/ornamental glass 	Mechanical point load: short term - low/medium intensity **Cause of splitting** Placement on stone or metal; Impact on corner by metal part; Glass twist/roll through corner. **Characteristics of the defect** Angle of edge crack in all directions, not right; Angle of transition not right; Edge curvature cracks are initially of varying size depending on the impact force; Clear centre corner. **Course of the lines** Radial shapes from the corner; Straight to angular cleavage lines; Usually does not go to the edge. End Straight lines; In the middle of the glass or going to the edge of the glass. **Other features** Clear curvilinear cracks at the beginning of the cleavage

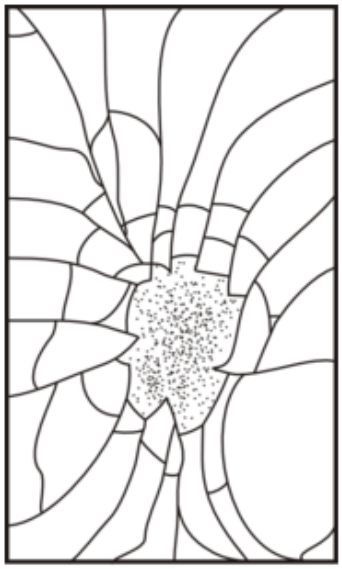
Type of glass	Delta breakage I
Polished, rolled sheet, laminated, patterned/ornamental glass, reinforced glass 	Mechanical surface load: long term - static/dynamic - double sided fixing **Cause of splitting** Long-term heavy snow load in the case of double or triple sided fixing. **Characteristics of the defect** Edge crack angle not right; Transition angle not right; No curvilinear cracks at the edge of the glass; Centre of split at the edge. **Course of the lines** Relatively parallel to the longer edge over the entire surface; Straight, not angular, slightly curved lines; Delta or cup-shaped. Straight lines at the end; Partly to the edge of the glass. **Other features** Possible curvilinear cracks in the surface on the load side; Increasing number of cracks with increasing load.

Type of glass	Delta breakage II
Polished, rolled sheet, laminated, patterned/ornamental glass, reinforced glass 	Mechanical surface load: long term - static/dynamic - double sided fixing **Cause of splitting** Long-term heavy snow load in the case of double or triple sided fixing. Heavy overload on double-sided shelves. **Characteristics of the defect** Edge crack angle not right; Transition angle not right; No curvilinear cracks at the edge of the glass; Centre of split at the edge. **Course of the lines** Relatively parallel to the longer edge over the entire surface; Straight, not angular, slightly curved lines; Delta or cup-shaped with large branching. Straight lines at the end; Partly to the edge of the glass. **Other features** Possible curvilinear cracks in the surface on the load side; Increasing number of cracks with increasing load.

Type of glass	Surface pressure breakage I
Polished, rolled sheet, laminated, patterned/ornamental glass also glazing unit 	Mechanical surface load: long term - dynamic/static **Cause of splitting** Excessive loading due to differences in temperature, air pressure, and/or height between the manufacturing and installation site of the glazing unit; Aquarium glass of too small dimensions to be fixed on 4 sides. **Characteristics of the defect** Angle of edge crack in all directions, not right; Centre of fracture not identified; Angle of transition not right; No curvilinear cracks near the edge of the glass. **Course of the lines** Corner to corner, S or arc-shaped; Parallel to the longer edge, often with branches; Straight, curved but not angular cleavage lines. In the end always from the centre of the glass to the corner or near the corner of the glass. Surface curvilinear cracks; External curvilinear cracks in convex glass (usually subatmospheric pressure in the gap), in convex glass (overpressure in the gap) on the side of the gap, so as to distinguish whether the fracture is due to overpressure or to subatmospheric pressure; In single glazing, curvilinear cracks on the load side; The number of splits increases with increasing load.

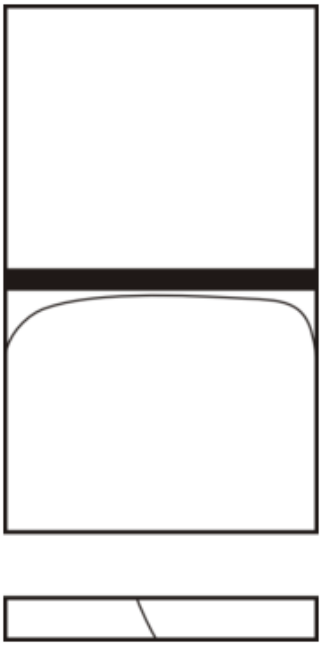
Type of glass	Surface pressure breakage II
Polished, rolled sheet, laminated, patterned/ornamental glass also glazing unit 	Mechanical surface load: long term - dynamic/static **Cause of splitting** Excessive loading due to differences in temperature, air pressure, and/or height between the manufacturing and installation site of the glazing unit; Aquarium glass of too small dimensions to be fixed on 4 sides. **Characteristics of the defect** Angle of edge crack in all directions, not right; Centre of fracture not identified; Angle of transition not right; No curvilinear cracks near the edge of the glass. **Course of the lines** Corner to corner, S or arc-shaped; Parallel to the longer edge, often with branches; Straight, curved but not angular cleavage lines. In the end always from the centre of the glass to the corner or near the corner of the glass. **Other features** Surface curvilinear cracks; External curvilinear cracks in convex glass (usually subatmospheric pressure in the gap), in convex glass (overpressure in the gap) on the side of the gap, so as to distinguish whether the fracture is due to overpressure or to subatmospheric pressure; The number of splits increases with increasing load.

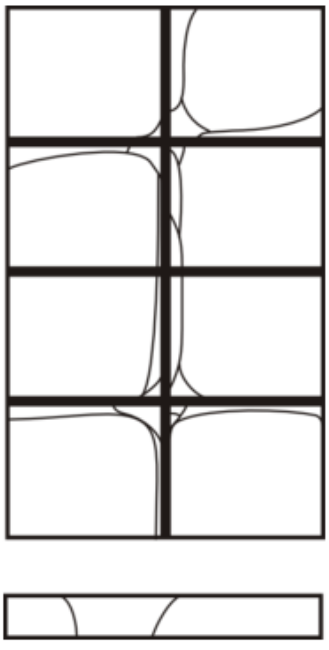
Type of glass	Surface pressure breakage III
Polished, rolled sheet, laminated, patterned/ornamental glass, very often glazing unit 	Mechanical surface load: short term - dynamic/static – high intensity **Cause of splitting** Excessive loading due to differences in temperature, air pressure, and/or height between the manufacturing and installation site of the glazing unit; Snow avalanches from the roof; Filling the glass unit with too cold gas. **Characteristics of the defect** Angle of edge crack in all directions, not right; Centre of fracture not identified; Angle of transition not right; No curvilinear cracks near the edge of the glass. **Course of the lines** Corner to corner, arc-shaped, with many branches; Crack lines relatively parallel to the longer edge, with large aspect ratio; Straight, curved but not angular cleavage lines. In the end always from the centre of the glass to the corner or near the corner of the glass. **Other features** Surface curvilinear cracks; External curvilinear cracks in convex glass (usually subatmospheric pressure in the gap), in convex glass (overpressure in the gap) on the side of the gap, so as to distinguish whether the fracture is due to overpressure or to subatmospheric pressure; Curved cracks on the load side of the single pane. The number of splits increases with increasing load.

Type of glass	Surface pressure breakage IV
Polished, rolled sheet, laminated, patterned/ornamental glass, also glazing unit  	Mechanical surface loading - short lifetime - dynamic - very high intensity **Cause of splitting** Very high load due to temperature, air pressure and/or height differences between the manufacturing and installation site of the glazing unit; Too cold gas filling and large gap in the glass unit; Explosion. **Characteristics of the defect** Angle of edge crack in all directions, not right; Unidentified centre of fracture; Transition angle not right; No curvilinear stresses near the glass edge. **Course of the lines** Corner to corner, arc-shaped; Fracture pattern with transverse cracks increasing towards the aperture in the middle of the glass; Straight, usually circular cleavage lines. At the end, always from the middle of the glass to the corner or near the corner of the glass. **Other features** Surface curvilinear cracks: external curvilinear cracks in convex glass (usually subatmospheric pressure in the gap), in convex glass (overpressure in the gap) on the side of the gap, so that it can be known whether the crack is due to overpressure or subatmospheric pressure; The number of cracks increases with increasing load; In single glazing, curvilinear cracks on the load side; In the case of explosion, curvilinear cracks on the load side.

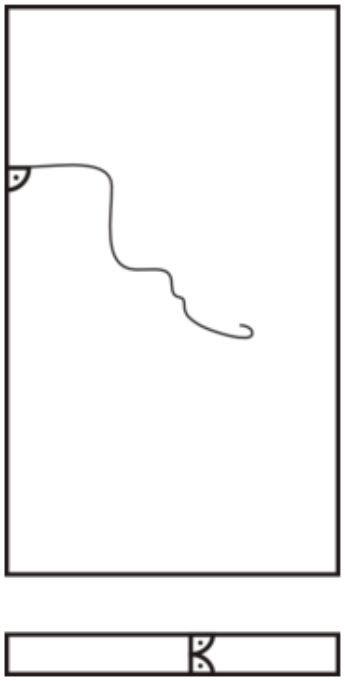
Type of glass	Surface pressure breakage V
Laminated glass, also glazing unit  	Mechanical surface loading - short lifetime - dynamic - very high intensity **Cause of splitting** Very high load due to temperature, air pressure and/or height differences between the manufacturing and installation site of the glazing unit; Too cold gas filling and large gap in the glass unit; Explosion. **Characteristics of the defect** Angle of edge crack in all directions, not right; Unidentified centre of fracture; Transition angle not right; No curvilinear stresses near the glass edge. **Course of the lines** From centre, arc-shaped; Ho hole; Fracture pattern with transverse cracks increasing towards the middle of the glass; Straight, usually circular cleavage lines. At the end, always from the middle of the glass to the corner or near the corner of the glass. **Other features** Surface curvilinear cracks: external curvilinear cracks in convex glass (usually subatmospheric pressure in the gap), in convex glass (overpressure in the gap) on the side of the gap, so that it can be known whether the crack is due to overpressure or subatmospheric pressure; The number of cracks increases with increasing load; In single glazing, curvilinear cracks on the load side; In the case of explosion, curvilinear cracks on the load side.

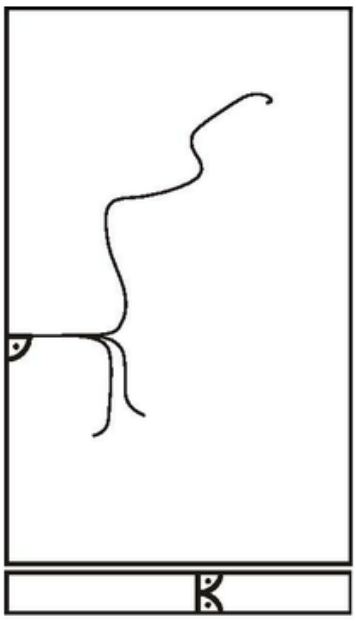
Splits in the presence of a decorative frame

Type of glass	Splits at the decorative frame I
Only glazing unit from polished, rolled sheet, laminated, patterned/ornamental glass 	Mechanical uniformly distributed load: medium dynamics + long term - weak dynamics + short term **Cause of splitting** Insufficient spacing between the panes when internal decorative frames are used; Large differences in air pressure, temperature and/or altitude between the manufacturing and installation site of the glazing unit. **Characteristics of the defect** Angle of the edge crack in all directions, not right; Transition angle not right; Usually impossible to attribute unambiguously. **Course of the lines** Always runs from edge to edge; Straight cleavage lines, often turning away from the decorative strip in the edge zone; Cleavage parallel to the decorative frame; Frequent transfer of cleavage edges. At the end it is usually impossible to attribute unequivocally; Straight cleavage lines running to the edge. **Other features** Small curvilinear cracks in the middle area; Mostly into the gap of glasses; Can be avoided by using single safety glass or by manufacturing with a larger gap between the panes.

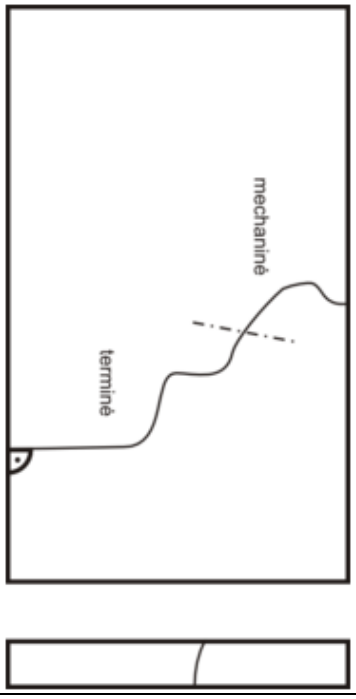
Type of glass	Splits at the decorative frame II
Only glazing unit from polished, rolled sheet, laminated, patterned/ornamental glass 	Mechanical point or uniformly distributed load: medium dynamics + long term or short term **Cause of splitting** Insufficient spacing between the panes when internal decorative frames are used; Decorative frames with solid distance points at the centre of the frame crossing; Large differences in air pressure, temperature and/or altitude between the manufacturing and installation site of the glazing unit. **Characteristics of the defect** Angle of the edge crack in all directions, not right; Transition angle not right; Usually impossible to attribute unambiguously. **Course of the lines** Always runs from edge to edge; Straight cleavage lines; Cleavage usually parallel to the frame; Frequent transfer of cleavage edges. At the end it is usually impossible to attribute unequivocally; Straight cleavage lines running to the edge. **Other features** Small curvilinear cracks in the middle area; Mostly into the gap of glasses; Can be avoided by using single safety glass or by manufacturing with a larger gap between the panes.

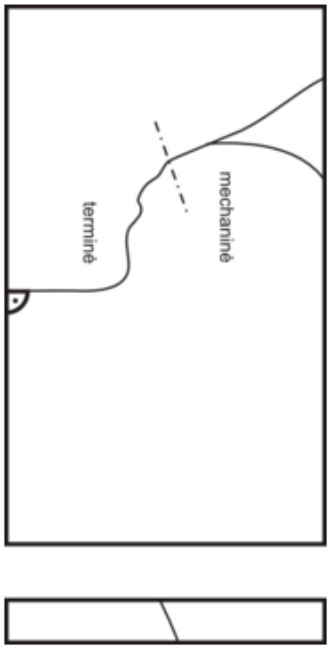
Thermal cracks

Type of glass	Normal thermal crack
Only glazing unit from polished, rolled sheet, laminated, patterned/ornamental glass 	Mechanical point or uniformly distributed load: medium dynamics + long term or short term **Cause of splitting** Insufficient spacing between the panes when internal decorative frames are used; Decorative frames with solid distance points at the centre of the frame crossing; Large differences in air pressure, temperature and/or altitude between the manufacturing and installation site of the glazing unit. **Characteristics of the defect** Angle of the edge crack in all directions, not right; Transition angle not right; Usually impossible to attribute unambiguously. **Course of the lines** Always runs from edge to edge; Straight cleavage lines; Cleavage usually parallel to the frame; Frequent transfer of cleavage edges. At the end it is usually impossible to attribute unequivocally; Straight cleavage lines running to the edge. **Other features** Small curvilinear cracks in the middle area; Mostly into the gap of glasses; Can be avoided by using single safety glass or by manufacturing with a larger gap between the panes.

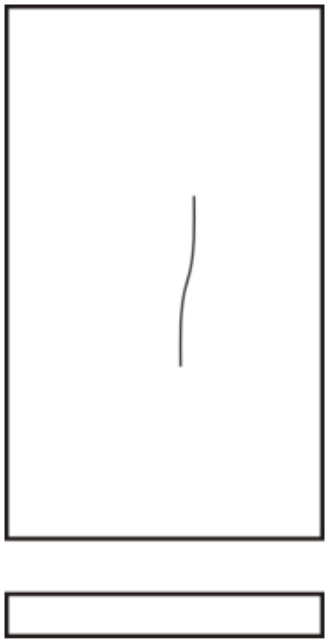
Type of glass	Large thermal crack
Polished, rolled sheet, laminated, patterned/ornamental glass. In the case of reinforced glass, deviations due to the mesh are possible. 	Evenly distributed thermal load: high intensity **Cause of splitting** Welding torch near the glass; Hot air fan near the glass; Asphalt moulding with uneven protective coating on the glass; Internal partial covering of the glass in strong sunlight. **Characteristics of the defect** Edge crack angle is right; Transition angle is right; No curvilinear cracks at start. **Course of the lines** Straight edge crack line; Change of direction near the cold/heat zone with frequent splitting into several cracks, then the line is curved. Straight line at the end; Rarely with hook. **Other features** Curvilinear cracking is possible, especially in the first change of direction zone. Wavy lines occur, especially in the first change of direction zone.

Hybrid crack

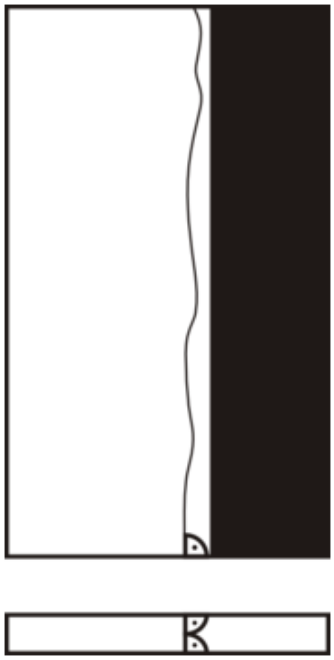
Type of glass	Hybrid crack I
Polished, rolled sheet, laminated, patterned/ornamental glass 	Thermal/mechanical load **Cause of splitting** Multiple effects through surface loading (suction, wind) on already thermally loaded glass. **Characteristics of the defect** The angle of the edge crack is not right; Transition angle not right; Curvilinear cracks at the edge of the glass; Centre of fracture not recognisable. **Course of the lines** Thermal crack initiation with change of direction near the cold/heat zone, then curvilinear and continuing as a mechanical crack from straight to angular lines. Straight lines at the end; without hooks. **Other features** Possible curvilinear surface cracks

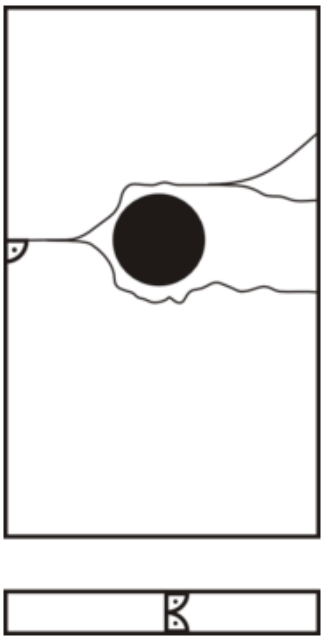
Type of glass	Hybrid crack II
Polished, rolled sheet, laminated, patterned/ornamental glass 	Thermal/mechanical load **Cause of splitting** Multiple effects through surface loading on already thermally loaded glass of too small dimensions. **Characteristics of the defect** The angle of the edge crack is not right; Transition angle not right; No curvilinear cracks at the edge of the glass; Centre of fracture not recognisable. **Course of the lines** Thermal crack initiation with change of direction near the cold/heat zone, then curvilinear and continuing as a mechanical crack from straight to angular lines. Straight lines at the end; without hooks. **Other features** Possible curvilinear surface cracks

Type of glass	Hybrid crack III
Polished, rolled sheet, laminated, patterned/ornamental glass 	Thermal/mechanical load **Cause of splitting** Multiple effects through thermal (partial shading) and mechanical loading (wind pressure) on already mechanically loaded glass (cracking). **Characteristics of the defect** Edge crack angle not right, transition angle not right; Edge curvilinear cracks present; Identifiable cleavage centre on the free edge. **Course of the lines** Mechanical crack starting with a change of direction through thermal loading near the cold/heat zone, then curvilinear and continuing as a mechanical crack from straight to angular lines, also with branching. Straight lines at the end; without hooks; can go to the edge. **Other features** Possible curvilinear surface cracks.

Type of glass	Short central thermal cracks
Polished, rolled sheet, laminated glass, thick resin-laminated glass 	Thermal point load: very high intensity (Only for very large and thick glasses) **Cause of splitting** Welding torch close to the glass; Hot air fan close to the glass; Severe spot heating in a very large area of the display case or similar glass. **Characteristics of the defect** In the centre of glass area; Start not at the edge of the glass; Cannot distinguish between start and end. **Course of the lines** Snake or worm shape in the centre of the glass with no significant change of direction. At the end in the middle of the glass area; Start not at the edge of the glass; Cannot distinguish between start and end. **Other features** Slight edge deviation possible; Wavy lines possible; Often not visible from any angle.

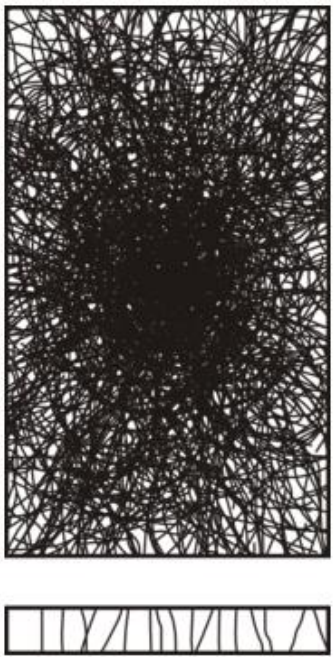
Smooth thermal cracks

Type of glass	1. Smooth thermal crack
Polished, rolled sheet, laminated, patterned/ornamental glass. In the case of reinforced glass, deviations due to the mesh are possible. 	Evenly distributed thermal load: from low to high intensity **Cause of splitting** Partial obscuration by internal blinds close to the glass; Partial obscuration by internal decoration close to the glass; Shadow from roof; Dark spots on the glass (stickers, advertisements, etc.). **Characteristics of the defect** Edge crack angle is right; Transition angle is right; No curved cracks at the start. **Course of the lines** Along frost/heat zone; Slightly wavy thereafter. Straight line at the end; no hook; Mostly gradual (depending on partial coverage). **Other features** Possible deviation of cleavage edges; Rarely curvilinear cracks; Possible wavy lines

Type of glass	2. Smooth thermal crack
Polished, rolled sheet, laminated, patterned/ornamental glass. In the case of reinforced glass, deviations due to the mesh are possible. 	Evenly distributed thermal load: from low to high intensity **Cause of splitting** Partial obscuration with internal decoration right next to the glass; Dark spots on the glass (stickers, advertisements, etc.); Large plant leaf or something similar inside right on the glass. **Characteristics of the defect** Edge crack angle is right; Transition angle is right; No curved cracks at the start. **Course of the lines** Straight edge crack line, change of direction at frost/heat zone, Possible fragmentation near the cold/heat zone. Straight line at the end; Without hook, usually crack transition. **Other features** Curvilinear cracks are common; Possible offset of cleavage edges; Wavy lines occur, especially in the first directional change zone.

Fractures in toughened glass

Type of glass	"Spontaneous decomposition" of nickel sulphide in toughened glass
Only in the case of toughened glass 	Point load: short term - dynamic - high intensity. **Cause of splitting** All types of toughened glass are subject to spontaneous fracture in service, due to impurities of nickel sulphide. This fracture is random and independent of the glass units or the glass manufacturer and cannot be considered as a defect in the glass. It can be avoided by HST (Heat soak test) - hot state test (>95%). **Characteristics of the defect** Clear butterfly-shaped structure in the centre of the fracture (approximately 1-4 cm); Small nickel sulphate inclusion (<0.2 mm) as a black dot at the centre line of the butterfly inside the glass. **Course of the lines** Grid shape, starting from the centre; Typical view of a single shatter of safety glass; Small shards; cracks over the whole area, innumerable, on all edges, always to the edge **Other features** Shattering pattern over the whole area; No curvilinear cracks in the centre; Not visible in single glazing as the glass disintegrates in the event of a crack.

Type of glass	Toughened glass breakage
Only in the case of toughened glass 	Point load short-term dynamic - medium/high intensity. **Cause of splitting** Hammer impact with pointed end; shot; stone impact; in the case of point fixing. **Characteristics of the defect** Visible centre of cleavage, point-shaped with curvilinear cracks. **Course of the lines** Grid shape, starting from the centre; Typical view of a single safety glass shatter; no shards. Cracks over the whole area. Throughout the whole area, uncountable, on all edges, always to the edge **Other features** Shattering pattern over the whole area; Curvilinear cracks in the centre; Not visible in single glazing as the glass disintegrates in the event of a crack.

References:

- „ Guardian techninis vadovas“
- http://www.flachglas-service.de/en/practical_example_cases_of_damage
- http://skpstiklas.lt/Stiklo-paketas/Duziai/Mechaniniai-duziai

Annex No. 5.

Compatibility of weather sealants with TENAGLASS® IGU secondary sealants

Compatibility of weather sealants with TENAGLASS® IGU secondary sealants

Weather sealant	Chemical base	Manufacturer of the weather sealant	Primary sealant	Manufacturer of the primary sealant	TENAGLASS®-PU FR		TENAGLASS®-PU EN		TENAGLASS®-MPU EN		TENAGLASS®-PS EN		TENAGLASS®-MPS EN	
					Testing period	Compatibility[1]	Testing period	Compatibility	Testing period	Compatibility	Testing period	Compatibility	Testing period	Compatibility
Silirub 2	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
			PIB 996	GLASSCHEM	2016 2nd quarter	✔	2016 2nd quarter	✔	2016 2nd quarter	✔	2016 2nd quarter	✔	2016 3rd quarter	✔
			Butylver	FENZI	NT		NT		2017 1st quarter	✔	2017 1st quarter	✔	NT	
Silirub 2/S	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Silirub Pro N	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
			Butylver	FENZI	NT		NT		2017 1st quarter	✔	2017 1st quarter	✔	NT	
Silirub WS	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Swilirub WS+	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Silirub WSE	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Silirub MA	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Silirub+ S8000	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Silirub+ S8100	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Silirub+ S8800	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Silirub PV	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Silirub PC	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Silirub Tradition	1C silicone	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Glaskit TS	1C MS polymer	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	
Soudaseal tradition	1C MS polymer	SOUDAL	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	NT	

✔ - compatible; ✖ - incompatible; NT – not tested.

Compatibility of weather sealants with TENAGLASS® IGU secondary sealants

Weather sealant	Chemical base	Manufacturer of the weather sealant	Primary sealant	Manufacturer of the primary sealant	TENAGLASS®-PU FR		TENAGLASS®-PU EN		TENAGLASS®-MPU EN		TENAGLASS®-PS EN		TENAGLASS®-MPS EN	
					Testing period	Compatibility[1]	Testing period	Compatibility	Testing period	Compatibility	Testing period	Compatibility	Testing period	Compatibility
OTTOSEAL S 110	1C silicone	OTTO CHEMIE	TENAGLASS®-3	TENACHEM	NT		NT		NT		2017 3rd quarter	✔	NT	
			GD115	KÖMMERLING	2017 3rd quarter	✔	2017 3rd quarter	✔	2016 3rd quarter	✔	25.08.2016	✔	NT	
OTTOSEAL S 120	1C silicone	OTTO CHEMIE	GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔
PERENNATOR FA 101	1C silicone	TREMCO ILLBRUCK	GD115	KÖMMERLING	NT		NT		2016 2nd quarter	✔	2016 2nd quarter	✔	NT	
FS500	1C silicone	TREMCO ILLBRUCK	TENAGLASS®-3	TENACHEM	2017 4th quarter	✔	2017 4th quarter	✔	NT		2017 4th quarter	✔	NT	
130 ALKOXY	1C silicone	RAMSAUER	TENAGLASS®-3	TENACHEM	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔
			GD115	KÖMMERLING	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔	2016 4th quarter	✔
120 Neutral	1C silicone	RAMSAUER	TENAGLASS®-3	TENACHEM	2017 4th quarter	✔	2017 4th quarter	✔	NT		2017 3rd quarter	✔	NT	
350 Fassade	1C silicone	RAMSAUER	TENAGLASS®-3	TENACHEM	2017 3rd quarter	✔	2017 3rd quarter	✔	NT		2017 3rd quarter	✔	NT	
490 Glasleistenfüller	1C silicone	RAMSAUER	TENAGLASS®-3	TENACHEM	2017 3rd quarter	✔	2017 3rd quarter	✔	NT		2017 3rd quarter	✔	NT	
Kodisil N	1C silicone	KÖMMERLING	GD115	KÖMMERLING	2016 4th quarter	✔	NT		2016 4th quarter	✔	2016 4th quarter	✔	NT	
Modesil NO11	1C silicone	LAKMA	TENAGLASS®-3	TENACHEM	2017 4th quarter	✔	2017 4th quarter	✔	NT		2017 4th quarter	✔	NT	
Silikon Budowlany	1C silicone	LAKMA	BOSTIK 2000	BOSTIK	2017 4th quarter	✖	2017 4th quarter	✖	NT		2017 4th quarter	✖	NT	

✔ - compatible; ✖ - incompatible; NT – not tested.

Secondary sealant, primary sealant, and weather sealant combinations were tested according to IFT-Guideline DI-01/1 «Three-compound test" P1 "Testing of materials in contact with the edge sealing of insulating glass".

Legal notes

This statement is solely based on the testing procedure mentioned above. Other constituents of the insulating glass unit including glass quality and window profile materials and the design can influence the compatibility with inner and outer sealants. Additionally, other factors such as window production techniques and specific exposure conditions during the service life can influence the performance of the glazed structure. Therefore the performance of the glazed structure is the sole responsibility of its manufacturer.
It is highly recommended for the manufacturer of the glazed structure to perform system testes for specific assembly of the glazed structure before it is put on the market.

Test results are valid for the tested product combination as long as the manufacturers of all products do not change the respective product formulation or production technology considerably. Depending on the application additional tests on compatibility might be necessary. This document remains valid only as long as the products are stored, handled and applied in accordance with respective manufacturer's recommendations.

This document is issued only for informative purposes and cannot be used as a warranty. All general and project specific warranties are given in respective commercial documentation approved by SIA "TENACHEM" and/or Soudal NV.

Annex No. 6.

Dow Corning® Construction Industry System Sealant Compatibility Statement

High Performance Building Solutions

Dow Construction Industry System Sealant Compatibility Statement

Date: 8th January 2020
To : Whom it concerns

Subject: Compatibility

Based on and within the limits of the test results from ASTM C-1087 test procedure or test method ETAG 002 Paragraph 5.1.4.2.5 (long term compatibility through qualitative adhesion test), we confirm that

Dow Sil™ 993 Structural Glazing Sealant,
DowSil™ 994 Ultra Fast Windows Bonding Sealant,
Dow Sil™ 895 Structural Glazing Sealant,
Dow Sil™ 3362 Insulating Glass Sealant,
Dow Sil™ 3362HD Insulating Glass Sealant,
Dow Sil™ 3363 Insulating Glass Sealant,
Dow Sil™ 3793 Insulated Glass Sealant,
Dow Sil™ 983 Structural Glazing Sealant
DOWSIL™ 3545 Insulating Glass Sealant
DOWSIL™ 3364 Warm Edge IG Sealant
Dow Sil™ 791 Silicone Weatherproofing Sealant,
Dow Sil™ 796 PVC-U, Aluminium & Wood Silicone,
DowSil™ 817 Mirror Adhesive
DowSil™ 896 PanelFix
DowSil™ 756 SMS Building Sealant
DowSil™ 776 InstantFix WB
DowSil™ 813C Construction & Concrete Silicone Sealant
DowSil™ 791T Weatherproof Silicone Sealant
DowSil™ 3-0117 Silicone Insulating Glass Sealant
DowSil™ 3540 Fast Cure IG Silicone Sealant
DowSil™ 799 EU Glaze & Go Sealant
DowSil™ 795 Silicone Building Sealant
DowSil™Firestop 700
DowSil™ 335 Butyl Sealant

are compatible together.

High Performance Building Solutions

For more information and assistance in product selection, please contact your Dow Construction Sales Application Engineer or your Dow Technical Service Engineer.

Best regards,

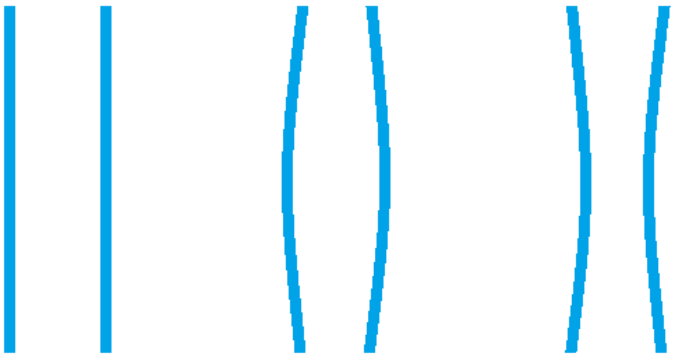
Sébastien Dath
Façade Engineering & Architectural Design Manager - EMEAI
High Performance Building

Annex No. 7

The Effect of Atmospheric Pressure and Temperature on Insulating Glass Units and Warranty Obligations

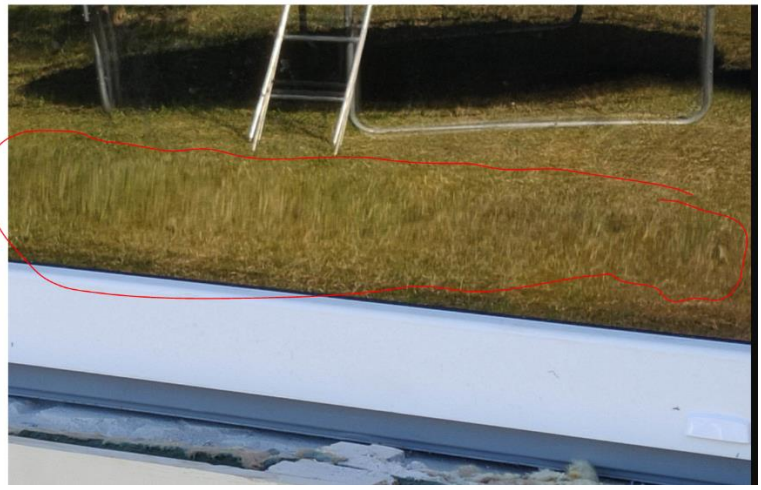
1. Essential information and conditions on pressure regulation inside insulating glass units (hereinafter **IGU**).
   1.1. During the production of IGU, certain conditions are created in the production premises: atmospheric pressure and temperature (hereinafter **original production conditions**), as a result of which the particular pressure is created inside the IGU (hereinafter **IGU production pressure**).
   1.2. IGU can be installed in locations of their final use (installation, storage, operation, etc.) (hereinafter **IGU installation site**) where the atmospheric pressure and temperature (hereinafter **IGU installation pressure**) differ from the original production conditions, which may result in IGU deformation, i.e. to cause cracks and/or fractures of the glass (hereinafter **IGU deformation**).
   1.3. IGU can be transported along a route (places) where atmospheric pressure and temperature (hereinafter **IGU transportation pressure**) also differ (may differ) from the original production conditions, which can also cause IGU deformation. The transportation route of IGU (hereinafter **IGU transportation route**) includes the route from the production premises to (including) the IGU installation site. The IGU transportation route is chosen by the customer (buyer).
   1.4. In order to prevent IGU deformation at IGU installation site and/or on IGU transportation route, on the day of manufacture, an insulating glass unit shall be sealed (adjusted) at the particular pressure (hereinafter **IGU sealed pressure**) that would correspond to the pressure at IGU installation site and /or on IGU transportation route. A special device altimeter (hereinafter **altimeter**) is used for this purpose.
   1.5. IGU sealed pressure is determined (adjusted) during production according to the following criteria/conditions/data: **height** (the highest point of the IGU transportation route (m), if IGU are transported not by air, but by road, sea or rail, i.e. if IGU are transported under the environmental (natural) conditions of IGU transportation route, e.g. by a tented vehicle), **temperature** (average annual temperature (°C) of IGU installation site) (hereinafter **final conditions** and/or **data of IGU use/transportation**), and **pressure** (IGU sealed pressure).
   1.6. The final conditions of IGU use/transportation shall be specified by a customer (buyer) at the time of ordering. The customer (buyer) shall be responsible for the correctness (accuracy) of the data provided and for IGU deformation due to the incorrectness (inaccuracy) of the data provided. The seller shall not be responsible for the incorrectness (inaccuracy) of the data provided by the buyer. The customer (buyer) shall provide the following data:
      – Planned IGU transportation route (https://www.google.com/maps or similar program);
      – The highest point of the IGU transportation route above sea level (m);
      – The IGU installation site altitude above sea-level (m);
      – Average annual temperature (°C) of the IGU installation site;
      *Calculated static and dynamic parameters, where the suitability of IGU structure for the installation site would be assessed;
   1.7. When the altitude of IGU transportation route (highest point) and the altitude of IGU installation site differ by more than 1000 m, it is recommended to manufacture IGU with two-way pressure valves. In this case the pressure adjustment with altimeter shall not be performed.
   1.8. If the buyer does not know/does not specify or specifies incorrect (inaccurate) data of IGU use/transportation, IGU sealed pressure will not be set (adjusted) at all or will be set in accordance with the pressure and temperature of the **original production conditions** on the day of manufacture. In this case, it is considered the buyer's responsibility and the seller shall not be responsible for **IGU deformation**.

2. Other essential information related to the internal cavity pressure of IGUs
   2.1. Due to differences (variations) in pressure, IGU may become non-straight, convex or concave (Picture 1). The IGU bowing either inward and/or outward is a normal physical phenomenon influenced by temperature and/or pressure, as they are continuously changing and are not constant, and IGU installation pressure is determined in accordance with the fixed conditions of IGU end-use/transportation. IGU convexity and/or concavity is not regulated, i.e. the rates thereof are not regulated (in centimeters or other units of measurement).
   Picture 1.



Straight Convex Concave

   2.2. Due convexity/concaveness IGU reflections viewed in the glass will become distorted (hereinafter **distortion**).
   Picture 2.



   Picture 3.

2.3. IGU are filled with argon gas. During the pressure regulation, the amount of argon inside the IGU decreases, which can lead to a decrease in the thermal properties of IGU. Therefore, the exact final conditions of IGU use/transportation specified by the customer are of fundamental importance for the use of IGU and its properties (thermal properties and/or deformation (distortions)).

3. Possible risks and cases when IGU warranty is not provided in the event of the following conditions:
   3.1. Deformation of the IGU may occur and/or IGU may become either non-straight, convex, concave (Figure 1) or even crack (fracture) if (when, because) after sealing IGU at the IGU sealed pressure using altimeter, the units are operated, installed (IGU are installed at a height different from the height specified in the order), or transported not under the conditions (IGU are transported by a route different from the route specified at the time of the order) according to which the seller determined (adjusted) IGU production pressure, or which were incorrectly (inaccurately) specified by the customer (buyer) to the seller, or if IGU will be exposed to end-use/transportation conditions other than the specified ones.
   3.2. Before ordering the glass units, the static and dynamic parameters thereof shall be calculated in order to assess the suitability of the structure of the glass units for their installation site. For this the programs MEPLA or "GLASSGLOBAL" or other programs designed to calculate the static and dynamic parameters of the insulating glass units can be used. If the buyer does not have this option, he must contact a representative of our company to have these calculations done.
4. In cases of IGU distortion and/or deformation after the moment of IGU transfer to the buyer due to the improper setting (adjustment) of IGU pressure by the seller, the seller (manufacturer) shall bear only the costs of IGU remaking. All other costs, losses and/or expenses incurred and/or lost revenue, including but not limited to installation, transportation, storage, taxes, etc. shall not be compensable, reimbursable.