FACTORY STANDARD

wutkowski®
YOUR PARTNER IN GLASS

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§ 1

General provisions

The Factory Standard of "Wutkowski" Spółka z ograniczoną odpowiedzialnością was established based on the following European Standards:

PN-EN 572-2 Glass in building - Basic soda lime silicate glass products. Part 2: Float glass;

PN-EN 1036-1 Glass in building - Mirrors from silver-coated float glass for internal use. Part 1: Definitions, requirements and testing methods.

PN-EN 12150-1 Thermally toughened soda lime silicate safety glass. Part 1: Definition and description;

PN-EN ISO 12543-5 Glass in building - Laminated glass and laminated safety glass - Part 5: Dimensions and edge finishing;

PN-EN ISO 12543-6 Glass in building - Laminated glass and laminated safety glass - Part 6: Appearance.

PN-EN 14179-1 Glass in building - Thermally quenched toughened soda lime silicate safety glass Part 1: Definition and description;

PN-EN 1863-1 Glass in building - Thermally reinforced soda lime silicate glass Part 1: Definition and description;

The Factory Standard sets out the basic parameters of Wutkowski's products and their quality standards and possible deviations.

§ 2

Definitions

safety building glass – a product made of at least one glass pane which minimizes the risk of human injury and cuts if broken
d – nominal thickness of the glass

B, H - side dimensions

Φ – hole diameter

z – glass surface, i.e. the product of multiplication of width B and length H

point defects – non-transparent spots, bubbles and foreign matter

linear defects – foreign matter and small or deep scratches

non-transparent defects – noticeable defects in the glass (inclusions in the glass or in the interlayer)

bubbles – these are usually air bubbles which may appear in the glass or in the interlayer

foreign matter – any undesirable inclusions in the glass caused in the process of production

cracks – sharp cracks or serration running from the edge through the glass

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§ 3

Performance tolerances for glass

THICKNESS

Maximum deviations of Float glass thickness

Limiting thickness deviation of laminated products with foil and Float glass			
thickness (mm)	tolerance	thickness (mm)	tolerance
2	+/- 0.2	10	+/- 0.3
3	+/- 0.2	12	+/- 0.3
4	+/- 0.2	15	+/- 0.5
5	+/- 0.2	19	+/- 1
6	+/- 0.2	25	+/- 1
8	+/- 0.3		

Thickness measurement

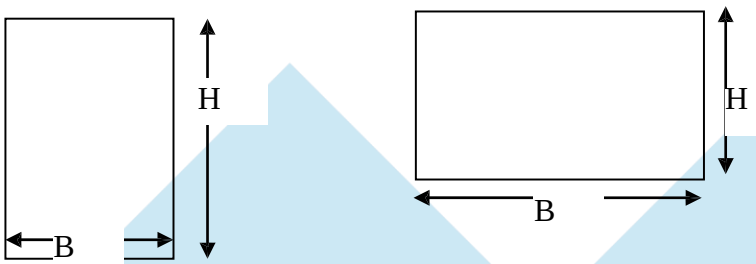
The thickness of the glass should be calculated as the average of the measurements taken at the centres of the four sides. Measurements should be made to the nearest 0.01 mm and their average should be rounded to 0.1 mm.

If individual measurements are rounded to about 0.1 mm, they should also be within the limits of maximum permissible deviations.

DIMENSIONS

Width B and length H

If the dimensions of laminated or toughened glass are given with reference to rectangular plates, the first dimension should be width B and the second dimension should be length H, as shown in the figure:



Dimensions should be given in millimetres. Each dimension should be within the specified maximum permissible deviations.

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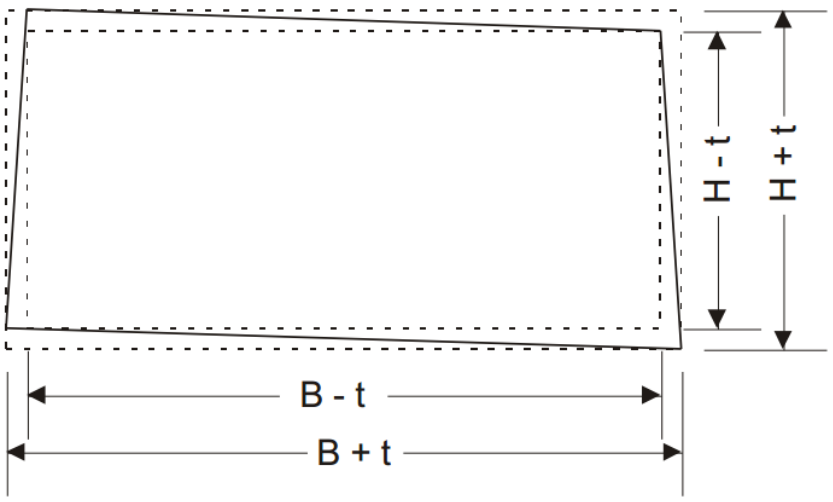
Width tolerance, B, and length tolerance, H

Nominal dimension of side B or H	tolerance	
	nominal glass thickness d ≤ 8	nominal glass thickness d > 8
≤ 1000	± 1,0	± 1,0
1000 < B or H ≤ 2000	± 2,0	± 2,0
> 2000	± 3,0	± 3,0

Checking dimensions and rectangularity

Nominal dimensions of width B and length H should not be greater than the described rectangle which is a product of the increase of the nominal dimensions by the upper maximum permissible deviation t, or smaller than the described rectangle which is a product of the decrease of the dimensions by the lower maximum permissible deviation t. The sides of the described rectangles are parallel to each other and should have a common central point. The limits of the rectangularity should be the described rectangles.



graniczne odchylenia szerokości B i długości H

[limits of maximum permissible deviations of width B and length H]

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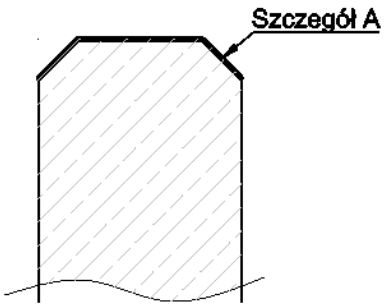
§ 4

Grinding of glass edges

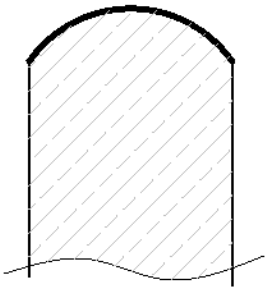
Grinding and polishing of glass edges

[Detail A]



Trapezoidal cut known as the pencil cut (f-edge) – made with the use of diamond discs on multi-head vertical or horizontal grinders, or made with the use of diamond peripheral discs on the numeric centre.

- ground edge - matt cut along the entire edge
- polished edge - shiny edge
- grinding and polishing angle for the pencil cut - detail A $\alpha = 45^{o}$ within the length range of 0.3-1.3mm



Round trapezoidal cut (c-edge) – made with the use of diamond peripheral discs.

- cut edge - matt
- polished edge - shiny edge

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§ 5

Hole drilling

Due to the glass properties and the course of the toughening process, there are some restrictions regarding the location and diameter of the holes in the glass, in relation to its edges, corners and other holes.

Layout of holes

Variables which affect the limitations on the hole layout

d – nominal thickness of the glass

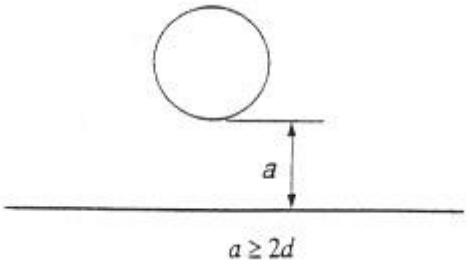
B, H - side dimensions

Φ- hole diameter number

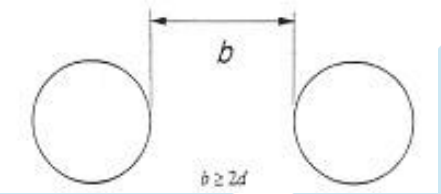
of holes shape of glass

Round (drilled) holes

Distance **a** from the edge of the glass to the edge of the hole should not be less than double the nominal thickness of the glass **2d**



Distance **b** between the edges of the holes should not be less than **2d**.



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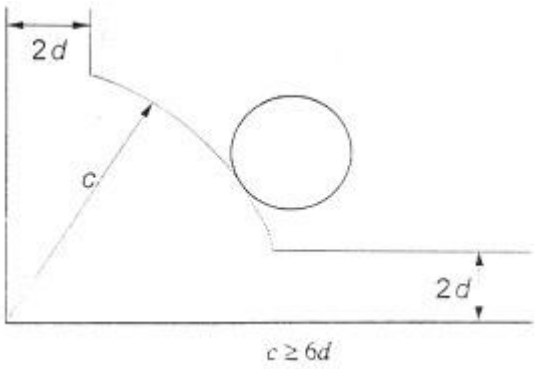
Distance **c** of the edge of the hole from the corner of the glass should not be less than **6d**.



Tolerance for drilled hole diameters

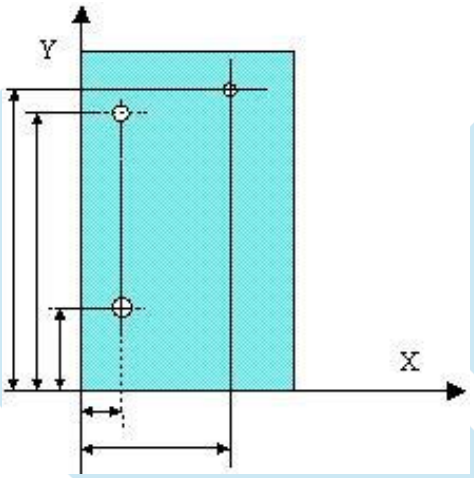
Tolerance for drilled hole diameters	
Nominal diameter of the hole Φ	Hole diameter tolerance
4 mm ≤ Φ ≤ 20 mm	± 1.0 mm
20 mm < Φ ≤ 100 mm	± 2.0 mm
Φ >100 mm	As agreed with the manufacturer

Drilled hole diameter tolerance for laminated glass

Tolerance plus offset for laminated glass

Tolerance of drilled hole layout

Measurements of the locations of placement of the holes are made in two directions, at the right angle (x, y) from the same reference point for all the holes, to the centre of the hole.



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Glass dimension	Tolerance of drilled hole layout	
	Nominal thickness of the glass d ≤ 12 mm	Nominal thickness of the glass d > 12 mm
B or H ≤ 2000 mm	± 2.5 mm	± 3.0 mm
2000 mm <B or H ≤ 3000 mm	± 3.0 mm	± 4.0 mm
B or H > 3000 mm	± 4.0 mm	± 5.0 mm

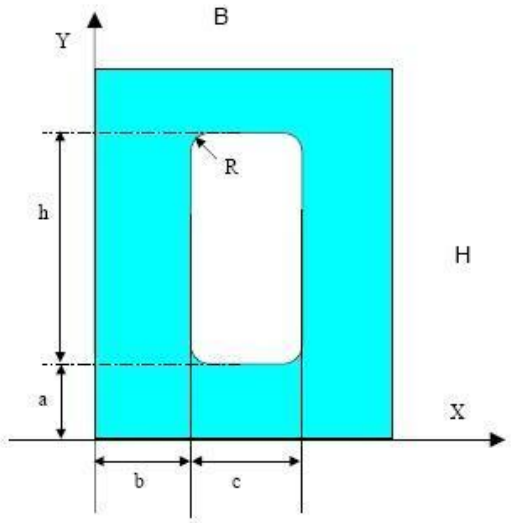
The layout of rectangular holes

The strip (a, b) between the rectangular hole and the edge of the glass must not be smaller than half

of the hole size in a given direction.

$a \geq h / 2\, b$

$b \geq c / 2$



Corners of rectangular holes must be rounded. Minimum rounding radius R = 9 mm

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Rectangular holes tolerance

Hole side dimension	Tolerance (h, c)
h or c	± 3.0 mm

Rectangular holes layout tolerance

The layout of rectangular holes is measured in two directions, at the right angles, to the X and Y axes which are axes (points) of reference to the nearest edge of the rectangular hole.

Glass dimension	Rectangular holes layout tolerance (a, b)	
	Nominal thickness of the glass d ≤ 12 mm	Nominal thickness of the glass d > 12 mm
B or H ≤ 2000 mm	± 2.5 mm	± 3.0 mm
2000 mm <B or H ≤ 3000 mm	± 3.0 mm	± 4.0 mm
B or H > 3000 mm	± 4.0 mm	± 5.0 mm

§ 6

Cuts on edges and in corners

It is possible to make multiple cut and cut configurations. The following are general layout and tolerance rules.

The size of cuts on the edges

The size of cuts on the edge may not be greater than a third of, respectively, the width and height of the glass piece.

$c \leq B / 3$

$h \leq H / 3$

The layout of cuts on the edges

Distance between the two cuts on the edge (k) must be greater than or equal to half the width of the larger of them. The width of the cut on the edge is considered to be the dimension measured parallel to the edge on which the cut is made.

$k \geq h/2$

Distance between the cut on the edge and the edge of the glass pane (j) must be greater than or equal to half the cut width and not less than 100 mm.

$j \geq h/2$

Internal corners of the cuts must be rounded. Minimum rounding radius R ≥ 9mm.

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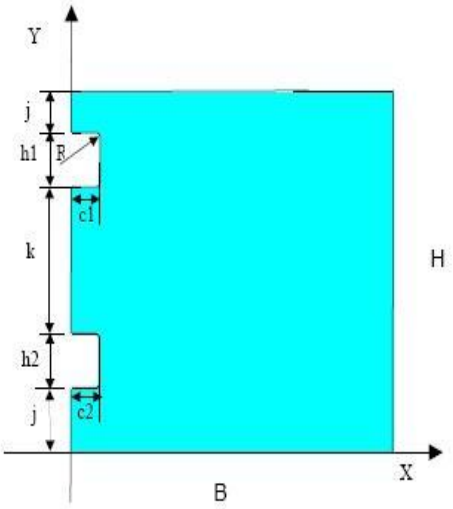

The tolerance of the layout of cuts on the edges

The measurements of the locations of the cuts on the edge are made in two directions, at the right angle, to the X and Y axes which are the axes (points) of reference to the nearest edge of the cut.

The tolerance of the layout of cuts on the edges is shown in the table and figure below

Glass dimension	Tolerance of placement of the cuts on the edge (a_1, a_2, a_3, a_4, b_1, b_2, b_3, b_4)	
	Nominal thickness of the glass d ≤ 12 mm	Nominal thickness of the glass d > 12 mm
B or H ≤ 2000 mm	± 2.5 mm	± 3.0 mm
2000 mm <B or H ≤ 3000 mm	± 3.0 mm	± 4.0 mm
B or H > 3000 mm	± 4.0 mm	± 5.0 mm

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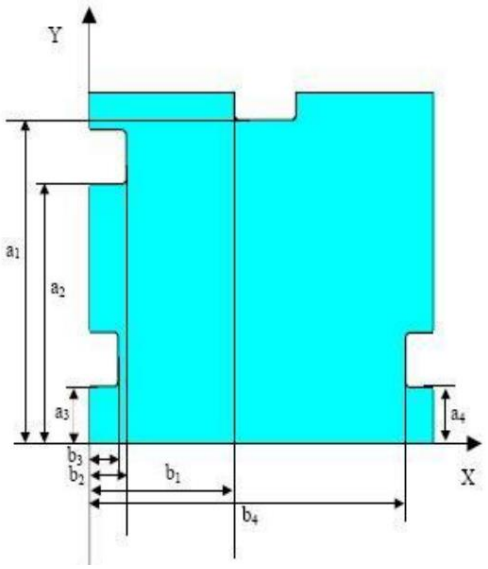

Size of cuts in the corner

The size of cuts in the corner may not be greater than a third of, respectively, the width and height of the glass piece $c \leq B / 3$

$h \leq H / 3$

Internal corners of the cuts must be rounded. Minimum rounding radius $R \geq 9$mm.

Tolerance of the cuts in the corner

Side of the cut in mm	Tolerance (h, c)
h or c	± 3.0 mm

Tolerance of the layout of cuts in the corner

The measurements of the locations of the cuts in the corner are made in two directions, at the right angle, to the X and Y axes which are the axes (points) of reference to the nearest edge of the cut.

Glass dimension	Tolerance of the placement of cuts on the edge (a, b)	
	Nominal thickness of the glass d ≤ 12 mm	Nominal thickness of the glass d > 12 mm
B or H ≤ 2000 mm	± 2.5 mm	± 3.0 mm
2000 mm <B or H ≤ 3000 mm	± 3.0 mm	± 4.0 mm
B or H > 3000 mm	± 4.0 mm	± 5.0 mm

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§ 7

Permissible defects

Conditions for observation and assessment of defects

The glass should be viewed by placing it vertically and parallel to a matt screen, in diffused daylight or equivalent. The observer should be at a distance of 2 m from the glass, looking at it perpendicularly (the matt screen should be on the other side of the glass) with the naked eye.

PERMISSIBLE DEFECTS IN TOUGHENED GLASS

No.	Type of defect	Glass surface (z)		
		$z \leq 1.0\ m^2$	$1.0\ m^2 < z \leq 2.0\ m^2$	$z > 2.0\ m^2$
1	Point defects in the form of inclusions of foreign	non-permissible	non-permissible	non-permissible
2	Open (bursting) bubbles	non-permissible	non-permissible	non-permissible
3	Closed bubbles	Permissible 2 bubbles within max dimensions of 2mm	Permissible 3 bubbles within max dimensions of 2mm	Permissible 5 bubbles within max dimensions of 2mm
4	Linear defects in the form of cracks	Permissible if their total length is 40 mm and max thickness up to 0.1 mm and max length of the individual crack is up to 15mm In the marginal strip, single scratches of up to 20 mm in length are permissible	Permissible if their total length is 45 mm and max thickness up to 0.1 mm and max length of the individual crack is up to 15mm In the marginal strip, single scratches of up to 20 mm in length are permissible	Permissible if their total length is 50mm and max thickness up to 0.1 mm and max length of the individual crack is up to 15mm In the marginal strip, single scratches of up to 20 mm in length are permissible
5	Defects of the edge	Dulled edge - slight chips are allowed on the edge, provided they are dulled Ground edge (matt) - chipping, grinding defects (shiny spots) - not allowed Polished (shiny) edge - matt spots, chips - not allowed		
6	Stains, smudges	Permissible if they are not visible in daylight from the distance specified by the standard applicable to the type of glass		
7	Enamel colour	Enamel colour is determined on the basis of a baked enamel sample on a specific type of glass (glass thickness, glass manufacturer) confirmed by the client.		

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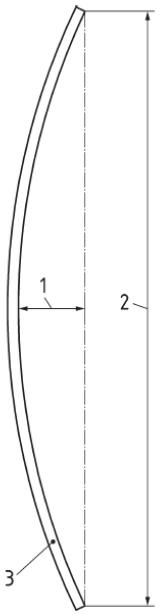
TOUGHENED GLASS DEFORMATION

Overall convexity and deformation in the form of undulation from the rolls:
Maximum allowable values of total convexity and undulation from rolls for horizontally toughened glass:

Type of glass	Maximum allowable deformation	
	Overall convexity in mm/m	Undulation from rolls in mm
Non-coated float glass according to EN-572-1 and EN 572-2	1.5	0.3
Other	4.0	0.5



Objaśnienia
1 odkształcenie do obliczenia całkowitej wypukłości
2 *B* lub *H*, lub długość przekątnej
3 termicznie hartowane szkło

Total convexity

Objaśnienia	Explanations
1 odkształcenie do obliczenia całkowitej wypukłości	1 deformation for the calculation of total convexity
2 *B* lub *H*, lub długość przekątnej	2 *B* or *H*, or the length of the diagonal
3 termicznie hartowane szkło	3 thermally toughened glass

Objaśnienia
1 termicznie hartowane szkło

Deformation in the form of undulation from the rolls

Objaśnienia	Explanations
1 termicznie hartowane szkło	1 thermally toughened glass

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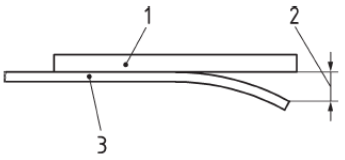
Raised edge:

Maximum allowable values of the raised edge for horizontal toughening:

Type of glass	Glass thickness in mm	Maximum allowable values in mm
Uncoated float glass according to EN 572-1 and EN 572-2	3	0.5
	4 to 5	0.4
	6 to 25	0.3
Other	3 to 19	0.5



Objaśnienia
1 liniał
2 podniesienie obrzeża
3 termicznie hartowane szkło

Raised edge

Objaśnienia	Explanations
1 liniał	1 straight edge
2 podniesienie obrzeża	2 rising of the edge
3 termicznie hartowane szkło	3 thermally toughened glass

§ 8

Marking of toughened glass

According to the PN-EN 12150-1 standard, toughened glass should be marked in a legible and permanent manner.

The label should specify:

- the name or trade mark of the manufacturer
- PN-EN 12150-1 standard number

Missing glass marking is acceptable only if this results from the information contained in the order or previous arrangements with the client!

Standard marking at the Wutkowski plant is “PN-EN 12150 + company logo”.

§ 9

Other physical properties of toughened glass

Anisotropy (opalescence):

During the thermal toughening process, areas of different stresses are produced in the cross-section of the glass. The areas of stress produce a birefringence effect in the glass, visible under polarised light. When glass is observed under the conditions described above, the areas of stress appear as coloured zones, sometimes called “leopard spots”.

Polarisation of light occurs in normal daylight. The degree of polarisation depends on the weather and the angle of incidence of the sun's rays, hence the effect may be visible to a greater or lesser degree.

Anisotropy is not a defect in the glass or the process, but it is a visible effect of the thermal treatment process.

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Heat Soak Test (HST):

Nickel sulphide inclusions are a rare but naturally occurring contaminant present in glass which, under certain conditions, can lead to spontaneous breakage of thermally toughened glass during use.
Because of this risk, it is recommended that an additional thermal treatment known as the heat soak process – the HST test (in accordance with EN 14179 standard) – be performed on the glass. This test reduces the risk of spontaneous breakage of the glass by up to 99% but does not exclude the total risk of glass breakage due to the presence of nickel sulphide (NiS).
Breakage of toughened glass due to the presence of nickel sulphide (NiS) shall not be subject to claims (even if the HST test has been performed).
Toughened glass panes which have been subjected to the HST test are marked legibly and durably with the company mark and the number of EN 14179-1 standard + the company mark.

§ 10

Marking of thermally reinforced glass

In accordance with EN 1863-1, thermally reinforced glass panes should be marked in a legible and permanent manner.
The marking should include:
- name or company mark of the manufacturer
- PN-EN 1863-1 standard number

The absence of marking on the glass must result from the information contained in the order or from previous agreements with the customer!

Wutkowski's standard marking is “PN-EN 1863 + company mark”.

§ 11

Glass bending

Maximum glass dimension: 1,000 x 2,440 mm
Maximum glass dimension: 200 x 500 mm
Glass thickness: 5– 12 mm
Maximum external bending radius: 7,000 mm
Edge bending up to 1,000 mm

Thickness [mm]	Minimum dimension [mm]	Maximum dimension [mm]	External minimum radius [mm]
5 - 6	200 x 500	1000 x 2440	450
4.8 - 10			1000
12			1200

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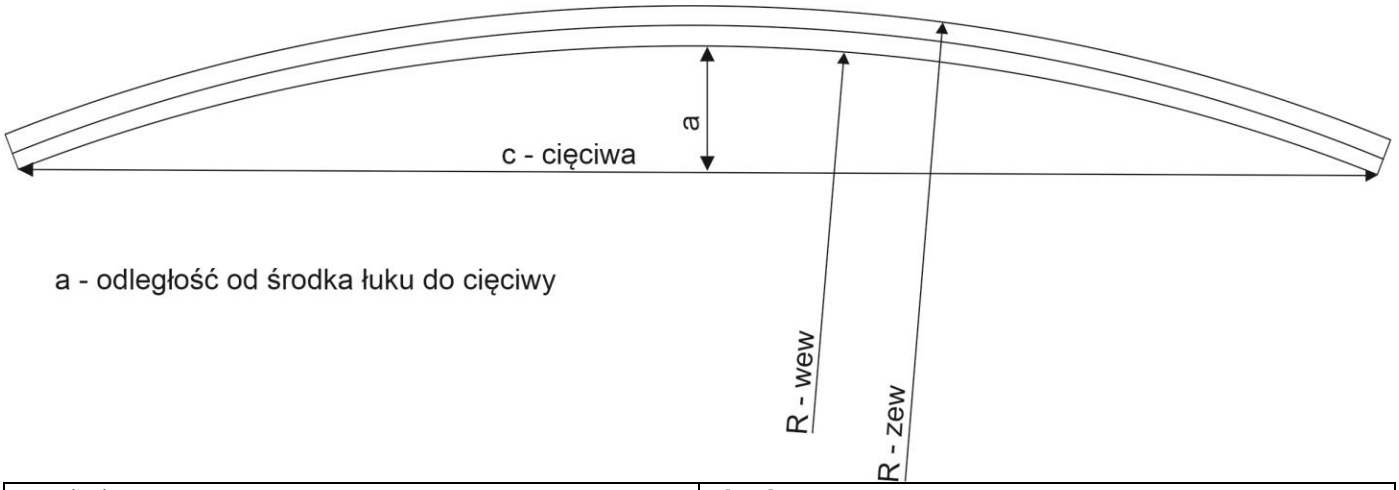


C - cięciwa	chord
A - Odległość od środka łuku do cięciwy	Distance from the centre of the arc to the chord
R wew.	R ext.
R zew.	R int.

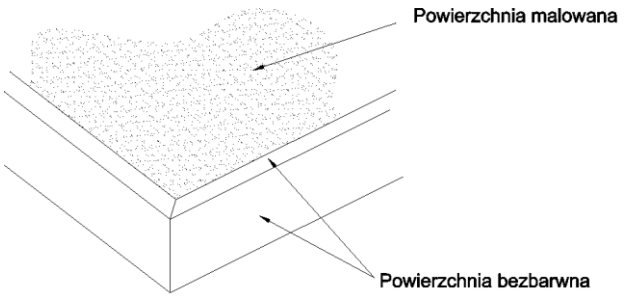
R ext. - external radius
R int. - internal radius

Tolerances:
c ± 3 mm
a ± 2 mm

§ 12

PAINTING OF TOUGHENED GLASS

[Painted surface]



[Colourless surface]

Permissible defects of glass painted in one of the RAL colours

The colour of the coatings applied to the glass surface depends on the thickness of the glass, the process of its manufacture, and the composition of the mixture of glass raw materials. Depending on the angle at which the glass is viewed, the colour may be noticeably variable. Glass manufacturers try to ensure the best possible repeatability of process parameters, and thus the colour and shade of the glass. Nevertheless, each of these processes has certain tolerance limits of repeatability, within which there may be slight differences in the observed shade and colour.

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For this reason, it is recommended to order glass for the entire room at the same time. The most commonly used glass is Float, but you should take into account its own colour (slightly greenish) which becomes more intense as the thickness of the glass increases, and it changes the shade of the applied paint.

Due to the above deviations, we recommend assessing the colour based on a sample of the same thickness as the ordered glass. Enamel colour is determined on the basis of a baked enamel sample on a specific type of glass (glass thickness, glass manufacturer) confirmed by the client.

Permissible defects of glass painted in one of the RAL colours		
Type of defect	Edge zone (a 15 mm wide strip along the perimeter of the glass)	The main zone (the remaining part of the glass)
Point defects less or equal to 0.5 mm *	Permissible	Permissible
Point defects greater than 0.5 mm.	Permissible with max width of 3mm and any length	Max 3 defects with a surface area of no more than 25 mm^2
Paint residues on the edges	Permissible for panes intended for frames or glass units, not permissible if the edge of the finished product is visible.	Not applicable

* defects ≤ 0.5 mm (starry sky, spot holes in the enamel) are acceptable and are generally not considered as defects

Places where defects have been corrected are acceptable. Repaired defects may not be seen from a distance of more than 3m.

§ 13

Laminated glass

Dimensions and deviation limits

Permissible deviations of dimensions of single laminated glazed panes (according to EN ISO 12543-5) Nominal width and length dimensions should not be greater than or smaller than the limiting deviation (t) for the exact dimensions B and H (mm).

Tolerance of the dimensions of laminated glass, depending on the thickness of the glass pane

Nominal dimensions L and H (mm)	Nominal thickness ≤ 8 mm	Nominal thickness of laminated glass > 8 mm	
		Each glass pane with nominal thickness of <10 mm	At least one glass pane with nominal thickness of ≥ 10 mm
≤ 2000	+3.0 -2.0	+3.5 -2.0	+5.0 -3.5
≤ 3000	+4.5 -2.5	+5.0 -3.0	+6.0 -4.0
> 3000	+5.0 -3.0	+6.0 -4.0	+7.0 -5.0

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Thickness deviation limits for film laminated products

The limits of deviation of laminated glass thickness should not exceed the total of the limits of deviation of the constituent glass panes specified in the basic standards.

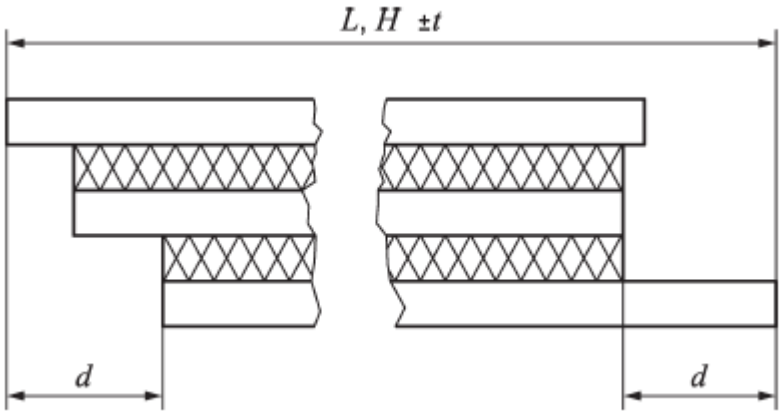
Interlayer thickness	Deviation limit
≤ 2	± 0.1
>2	± 0.2

Maximum permissible deviations of the difference between diagonals

Dimensions in millimetres

Nominal dimension L or H	Nominal thickness of laminated glass ≤ 8 mm	Nominal thickness of laminated glass > 8 At least one glass pane	
		Each glass pane of nominal thickness of < 10	At least one glass pane of nominal thickness of ≥ 10 mm
< 2000	6	7	9
< 3000	8	9	11
< 3000	10	11	13

Displacement



Maximum displacement, d , should be as specified in the following table. Width, L, and length, H, should be considered separately.

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Nominal dimension L or H	**Maximum permissible displacement** d
L, H ≤ 1000	2.0
1000 < L, H ≤ 2000	3.0
2000 < L, H ≤ 4000	4.0
L,H > 4000	6.0

Point defects within the visible area

Defect dimension d mm		0.5 < d ≤ 1.0	1.0 < d ≤ 3.0			
Glass pane dimension		For each measurement	A ≤ 1	1 < A ≤ 2	2 < A ≤ 8	A > 8
Number or density of permissible defects	2 panes 3 panes 4 panes ≥ 5 panes	No limit; But without accumulation of defects	1 2 3 4	2 3 4 5	1/m2 1.5/m2 2/m2 2.5/m2	1.2/m2 1.8/m2 2.4/m2 3/m2
NOTE Accumulation of defects occurs when at least four defects are < 200 mm apart. This distance is reduced to 180 mm for laminated glass consisting of three panes, to 150 mm for laminated glass consisting of four panes and to 100 mm for laminated glass consisting of five or more panes.						

The number of acceptable defects according to the Table should be increased by one for each individual interlayer thicker than 2 mm.

Linear defects within the visible area

Linear defects within the visible area for unframed edges

Pane surface m2	**Number of acceptable defects with the length of > 30 mm ***
≤ 5	Impermissible
5 to 8	1
> 8	2
*Linear defects with the length of less than 30 mm are permissible	

Layered glass is usually fitted in frames. However, if laminated glass is not framed, its edges may be as specified below, according to ISO 12543-5

- cut edges

- polished edges

- oblique edges

Chips and bubbles, checked according to the test method specified in this chapter, are acceptable if they are not obvious. Defects in the interlayer, i.e. extrusion and recess, are acceptable.

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Spalling and bubble formation, checked in accordance with the test method given in this chapter, are acceptable if they are inconspicuous. Defects in the interlayers, i.e. extrusion and retractions, are acceptable.

Marking of laminated glass

According to EN 14449, permanent marking of laminated glass and laminated safety glass products is not required.

Durability of laminated glass

The quality of glass exposed to: sealing, as well as impact of chemical or physical factors may deteriorate (e.g. discolouration, loss of adhesion, delamination). All materials used in direct contact with laminated glass must be compatible with its components. In addition, vapour condensation or direct exposure to water on the edges of laminated glass adversely affects its properties. Special attention should be paid to the presence of moisture in direct contact with the edges of the laminated glass. Adequate protection against these factors should be ensured.
Laminated glass with a frosted or coloured interlayer exposed to weather factors may change colour over time.

Tint of laminated glass

The colour and tint of glass depends on the thickness of the glass panes, the manufacturing process of the batch, the composition of the glazing raw material mix, the type and thickness. The colour, depending on the viewing angle, can be noticeably variable. Each manufacturing process has certain repeatability tolerances, within which there may be slight unavoidable differences in observable tint and colour. Therefore, there may be slight differences in tint between the panes of the same type from different production batches.
Each interlayer in laminated glass is characterised by a degree of haze. If the number of interlayers is increased, the degree of haze may be more pronounced.

§ 14

Storage and transport of glass

Packing

Glass should be packed in boxes, cages or it should be placed on racks. Boxes and cages should be made of sawn timber, while the racks should be made of metal. All metal parts of the rack which are in direct contact with the glass should be lined with rubber or other cushioning material, each glass pane should be separated with flexible spacers. Windows placed on racks should be secured against sliding. A different packing method is allowed if it protects the glass to the same extent as the above method.

Storage

Glass should be stored in roofed, dry, well-ventilated rooms and protected against atmospheric precipitation, in the temperature not exceeding 40°C, each glass pane should be separated with a flexible spacer. Glass must be protected against contact with silicones, oils and oily or greasy substances. Avoid leaving the stained or wet glass for a long time. During assembly and operation, the glass should not come into contact with chemicals which aggressively affect the glass or film used for lamination, such as: silicones, greases, oily chemicals, alcohols, solvents, etc.

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Transport

It is recommended to transport the glass in a specialized vehicle. When unloading the glass from the supplier's car is carried out by the client, the client is responsible for the correct unloading and any caused damage. If the client collects the glass from the production plant, this takes place at the risk of the client.

Cleaning of the surface and the glass

Chemically-treated glass (Satin) and sandblasted glass - dirt should be removed only with water, no chemicals should be used.

The manufacturer is not responsible for the use of chemicals or tools which cause damage to the surface of the glass, sandblasting coating, adhesive decorations or Teflon coating on the mirror.

§ 15

Change description

1. A paragraph has been added: Glass bending
2. A paragraph has been added: Other physical properties of toughened glass
3. A paragraph has been added: Marking of thermally reinforced glass
4. Paragraph update: Laminated glass
5. Paragraph update: Hole drilling

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