

Technical conditions „Flat glass and mirror processing“

(Valid from March 6th 2017.)

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Technical conditions compiled with reference to standards:

LST EN 1036-1:2008,

LST EN 1036-2:2008,

LST EN 572-1:2012,

LST EN 572-2:2012,

LST EN ISO 12543-5:2002,

LST EN ISO 12543-6:2002 ,

LST EN 12150-1:2016,

and characteristics of equipment in the production process.

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Part I

Flat glass and mirror processing

1. Permissible dimension tolerance for glass and mirror product cutting and processing:
 - 1.1. For 4; 5; 6 mm glass:
 - For rectilinear edges +/- 1 mm;
 - For curvilinear edges, according to provided electronic drawings +/- 1 mm;
 - For curvilinear edges, according to provided templates +/- 2 mm
 - 1.2. For 8; 10; 12 mm glass:
 - For rectilinear edges +/- 1 mm;
 - For curvilinear edges, according to provided electronic drawings +/- 1,0 mm.
 - For curvilinear edges, according to provided templates +/- 2,5 mm
 - 1.3. For 15; 19 mm glass:
 - For rectilinear edges +/- 1,5 mm
 - For curvilinear edges, according to provided electronic drawings +/- 1,5 mm
 - For curvilinear edges, according to provided templates +/- 3 mm
 - 1.4. For mirrors:
 - For rectilinear edges ≤ 2000 mm +/- 1 mm
 - For curvilinear edges, according to provided electronic drawings > 2000 mm +/- 1,5 mm
 - For curvilinear edges, according to provided templates +/- 2 mm
 - 1.5 Tolerance limit for tempered glass, according to LST EN 12150-1:2016:

Dimensions in millimetres

Width and length nominal dimension of side	Tolerance, t	
	Nominal glass thickness, d \leq 8	Nominal glass thickness, d $>$ 8
≤ 2000	$\pm 2,0$	$\pm 3,0$
2000 - 3000	$\pm 3,0$	$\pm 4,0$
> 3000	$\pm 4,0$	$\pm 5,0$

Dimensions in millimetres

Limit deviation v, on the difference between diagonals		
Nominal dimension (width) or (length)	Nominal glass thickness, d \leq 8	Nominal glass thickness, d $>$ 8
≤ 2000	≤ 4	≤ 6
2000 - 3000	≤ 6	≤ 8
> 3000	≤ 8	≤ 10

1. The total allowable deflection of a sheet of tempered glass cannot exceed 3 mm/m, local deflection cannot exceed 0,3 mm/300 mm.
2. Tolerance for chamfer edge (bevel) processing width +/- 1 mm.
3. Protective film sticking to the mirror:
 - 4.1. The colour of the protective film on the back side of a mirror is non-regulated.
 - 4.2. Connections, but no more than one in 1 m², and air bubbles of the protective film are allowed on the back side of a mirror.
4. Glued glass constructions:
 - 5.1. Tolerances of overall dimensions of glued glass cannot exceed the sum tolerance of glass cutting and processing.
 - 5.2. The permissible overall dimensions of glued glass constructions are those that limit construction capacity up to 0,8 – 1,2 m³, irrespective of its complexity.
 - 5.3. It is not recommended to pour liquids or heavy bulk materials into glued glass constructions. There are special constructions for this purpose, e.g. aquariums etc.

6. Anisotropy (iridescence)

The thermal toughening process produces areas of different stress in the cross section of the glass. These areas of stress produce a bi-refracting effect in the glass, which is visible in polarized light. When thermally toughened soda lime silicate glass is viewed in polarized light, the areas of stress show up as coloured zones, sometimes known as „leopard spots“.

Polarized light occurs in normal daylight. The amount of polarized light depends on the weather and the angle of the sun. The bi-refracting effect is more noticeable either at a glancing angle or through polarized spectacles. Anisotropy is not a defect but a visible effect.

7. Roller wave

Roller waves create an optical distortion which is generally noticed in reflection. Glass which is thicker than 8 mm can show of small imprints in the surface (roller pick-up).

8. Spontaneous glass breakage

When using thermally toughened glass, a risk of spontaneous breakage due to the presence of nickel sulfide particles is possible. And it is not possible to eliminate nickel sulfide in glass composition, in terms of characteristics of raw material of glass and current technology. But this problem can be minimized using tempered glass with „heat soak“ treatment.

Under this condition JSC „Gravera“ assumes no responsibility for spontaneous breakage and strongly recommend applying „heat soak“ treatment for tempered glass.

9. Visual glass revision

When revising the defects, the most important thing is an overall view through the glass, i.e. looking at the background and behind, not at reflections. Possible inadequacies are not specially described.

Glass revision must be performed in approximately 2 meters (approx. 1 meter for mirrors) away from the revised surface in a specific observation angle, which complies with generally accepted use of premises. The revision is performed in the dispersed daylight, without direct sunlight or direct artificial lighting.

According to LST EN 1036-1:2008, permissible defects in mirrors:

Area of finished sizes with cut or cut and ground edges	Spot faults				Surface faults	
	Centre zone		Border zone ^{a b}		Brush marks	Scratches
	$\geq 0,2$ mm ^c $\leq 0,3$ mm	$> 0,3$ mm $\leq 0,5$ mm	$\geq 0,2$ mm $\leq 0,5$ mm	$\geq 0,5$ mm $\leq 1,0$ mm	< 50 mm	
$\leq 0,3$ m ²	2	1	2	0	2	0
0,31 to 1,0 m ²	2	1	2	0	2	0
1,01 to 1,5 m ²	3	2	3	1	3	0
$> 1,51$ m ²	4	2	4	2	4	0

^a The size of the border zone is determined as 15 % of the edge length and width, mm

^b Defects greater than 0,5 mm (in centre zone) and 1,0 mm (border zone) are not accepted.

^c Defects smaller than 0,2 mm are accepted providing they do not form a cluster.

Part II

Enamelled glass surface quality check

1. Enamelled glass surface quality is checked visually, looking at the glass surface from a non-enamelled glass side from 1 m away. Observation angle with the glass surface must be of 90° .
2. The check must be performed in a light surrounding, in dispersed daylight.
3. Possible unevenness of enamelled glass surface:
 - 3.1. Stains, spots, bumps etc. (that are caused by dust or other particles on an enamelled surface):
 - > 1 mm diameter – completely impermissible;
 - ≤ 1 mm diameter – permissible within no more than 60 mm distance from the nearest glass edge;
 - $\leq 0,5$ mm diameter – permissible.
 - 3.2. Small slots, pinholes in the surface of enamelled glass:
 - > 1 mm diameter – completely impermissible;
 - ≤ 1 mm diameter – permissible within no more than 60 mm distance from the nearest glass edge;
 - $\leq 0,7$ mm diameter – permissible.
 - 3.3. Pigmental unevenness (when the colour of a part of enamelled glass surface differs from colour of the whole glass):
 - > 30 mm^2 - impermissible.
4. One batch of enamelled glass may slightly differ in shade with another batch, therefore it is recommended to enamel glass, which is in one sightline, at the same time (to order all enamelled glass in corresponding area in single order).
5. Enamelling does not ensure a complete opacity of the glass; therefore, if the glass is intended to be completely opaque, the enamelled glass must be installed on a dark, opaque base. If this requirement is disregarded, uneven opacity of separate areas may cause a visual effect of different colours, even if the corresponding glass areas were enamelled in identic colours (it is especially relevant when using glass enamelled in light colours).
6. After glass tempering, the enamel must be completely and evenly melted on all covering surface and tested by isopropanol test – after stroking any covered tempered enamel area with a marker, its marks must come off easily using diluent and leave no marks at all.

Part III

Technical properties of curved tempered glass

- **Maximum dimensions:** 3600 mm (straight edge) * $\widehat{\quad}$ 2400 mm (curved edge, depending on the curving radius)

2. Maximum length:

6mm		2250mm (5.7mm \leq 1850mm)
8mm		3050mm
10mm		3320mm
12mm		3600mm
15mm ~ 19mm		3600mm

- **Minimum dimensions:** 450 mm (straight edge) * $\widehat{\quad}$ 800 mm (curved edge)
- **Glass thickness:** 6 mm^{-0.3} ~ 19 mm
- **Information on curving:**

Glass thickness	6mm	8mm	8mm	10mm	10mm
Maximum dimension of a curved edge	2400	1800	2400	1400	2400
Minimum radius (mm)	1200	1200	2000	1200	2000
Max arch height (mm)	570	570	570	570	470

Glass thickness	12mm	12mm	15mm	19mm
Maximum dimension of a curved edge	1400	2400	2400	2400
Minimum radius (mm)	1200	2000	4000	4000
Max arch height (mm)	360	570	570	570

Visual quality standards (clear float (polished) glass):

Shaft marks: there can be no visible shaft marks when looking from a 45° angle; checking distance \geq 800 mm;

Radius deviation between two glasses: \leq 3.8% of a curved side length;

Arch deviation: \leq 2.5%;

Diagonal/oblique glass torsion: \leq 6% of involute length;

Size of broken glass particles: 3 ~ 5 times, compared to particles of the same thickness flat tempered glass.

Part IV

Laminated glass technical conditions Dimensions and limit deviations according ISO 12543-5:2011 Limit deviation on thickness

The limit deviations on thickness of laminated glass shall not exceed the sum of the limit deviations of the constituent glass panes specified in the basic products standards. (ISO 12543-1:2011 Annex A)

If the total interlayer thickness is less than or equal to 2 mm, an additional limit deviation of $\pm 0,1$ mm applies. If the total interlayer thickness is greater than 2 mm, an additional limit deviation of $\pm 0,2$ mm shall apply.

Measurement of thickness

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

The individual measurements, when rounded to the nearest 0,1 mm, shall also be within the limit deviations.

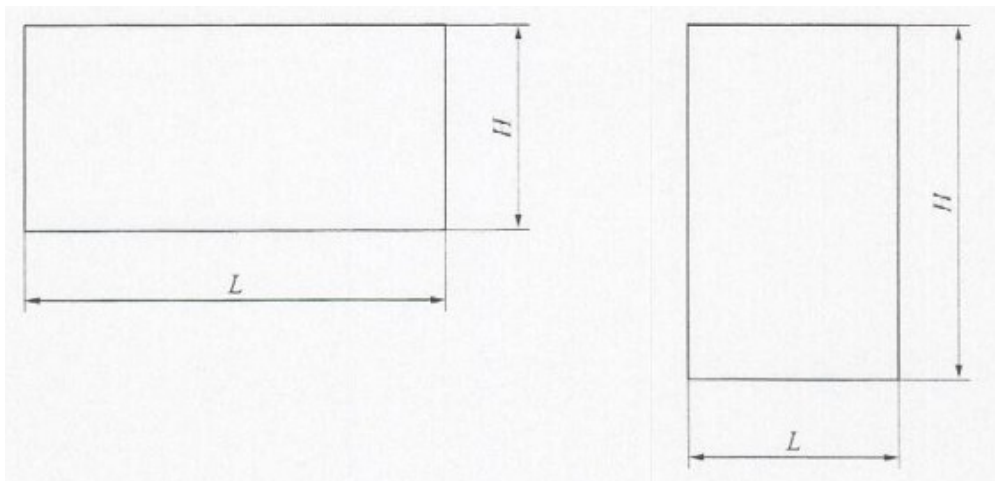
For laminated glass incorporating patterned glass, the measurement shall be made by means of an instrument of the plate gauge type with diameter $55 \text{ mm} \pm 5\text{mm}$.

Width L and length H

General

When laminated glass sizes are quoted for rectangular panes, the first dimension shall be the width L , and the second dimension the length H , as show in Figure 1.

Width and length relative to pane shape **Figure 1.**



The pane of glass shall not be larger than the nominal dimensions, either increased by the upper limit deviation t_1 or smaller than the nominal dimensions decreased by the lower limit deviation t_2 .

Limit deviations on width L , and length H

Limit deviations on width L and length H are given in table 3 for finished sizes and stock sizes. Any displacement shall be included in these limit deviations.

If one component of the laminated glass is a toughened or heat-strengthened glass an additional tolerance of ± 3 mm shall be taken into account..

Limit deviations t_1 and t_2 on width L and length H for finished and stock sizes. Table 3

Nominal dimension L or H	Nominal thickness of laminated glass ≤ 8 mm	Nominal thickness of laminated glass > 8 mm	
		Each glass pane < 10 mm nominal thickness	At least one glass pane ≥ 10 mm nominal thickness
$\leq 2\ 000$	+ 3,0 - 2,0	+ 3,5 - 2,0	+ 5,0 - 3,5
$\leq 3\ 000$	+ 4,5 - 2,5	+ 5,0 - 3,0	+ 6,0 - 4,0
$> 3\ 000$	+ 5,0 - 3,0	+ 6,0 - 4,0	+ 7,0 - 5,0

Displacement

Misalignment at any one edge of the constituent glass panes or plastic glazing sheet material making up the laminated glass.

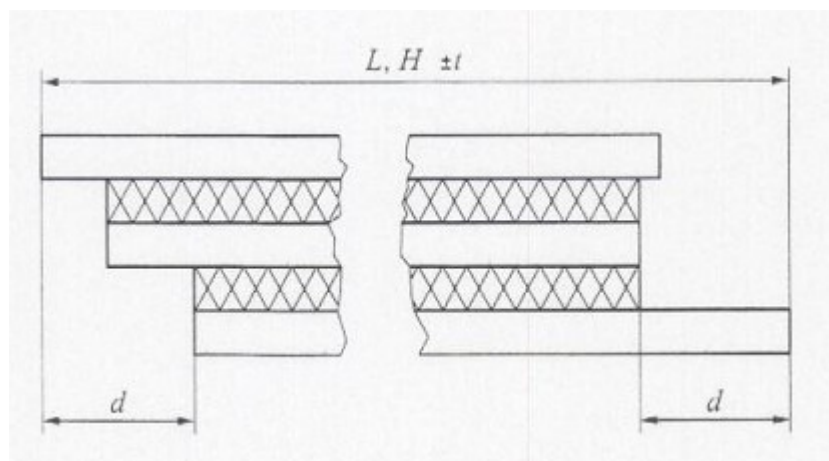


Figure . 2: Displacement

The maximum displacement d , shall be as specified in tabale 2. Width L and length H considered seperately.

Table 2: Maximum displacement.

Nominal dimension L ar H , mm	Maximum permissible displacement d mm
$L, H \leq 1000$	2,0
$1000 < L, H \leq 2000$	3,0
$2000 < L, H \leq 4000$	4,0
$L, H > 4000$	6,0

Appearance of laminated glass according ISO 12543-6:2011

Defects in the vision area

Spot defects in the vision area

When inspected according to the test method, the admissibility of spot defects depends on the following:

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

The number of permissible defects in a pane shall be in accordance with Table 3.

Defects less than 0,5 mm shall not be considered. Defects greater than 3 mm shall not be permitted.

Note: admissibility of spot in laminated glass is independent of the individual glass thickness.

Table 3: Permissible spot defects in the vision area

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

Note: An accumulation of defects occurs if four or more defects are at a distance of < 200 mm from each other. The 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.

Linear defects in the vision area

When inspected according to the test method, linear defects are allowed as given in Table 4.

Table 4: Number of permissible defects in the vision area

Area of pane m ²	Number of permissible defects > 30 mm in length ^a
≤ 5	Not allowed
5 to 8	1
> 8	2
^a linear defects less than 30 mm in length are allowed	

Defects in the edge area for framed edges

When inspected according to the test method, defects which do not exceed 5 mm in diameter or 5 % to the edge area are permitted.

Vents

Vents are not permitted.

Creases and streaks

These are not allowed in the visual area.

Defects in the edge area for unframed edges

Laminated glass is usually installed in frames. However, if laminated glass is unframed, its edges may be as follows: ground edges, polished edges, bevelled edges. When inspected according to the test method, shells and bubbles are permissible if they do not become obvious. Interlayer defects, i.e. extrusions and retractions are permissible.

Test method

The laminated glass is put in a vertical position in front of and parallel to a matt grey screen, and is lit by diffuse daylight or equivalent. The laminated glass is visually inspected perpendicularly at distance of 2 m from the glass, with the matt screen on the other side of the glass. Any visible defects that are disturbing shall be marked.

Client

Contractor

s.p.

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Part V

Recommendations for mirror installation

1. General recommendations

Correct installation allows guarantee for:

- safety for the end user, protecting from breaking,
- mirror quality, protecting polish from breaching,
- undistorted image from mirror reflection.

In order to avoid mirror quality deterioration caused by breaches in metal layer and protective polish layer or distortion of reflected image, the following directions must be followed:

- mirror must be installed on a clean, dry surface. Mirror cannot be in contact with damp surface.
- rough surface, that the mirror is installed on, must be primed.
- non-metal seals must be used in order to ensure vertical air circulation between the back of the mirror and installation surface. It is especially recommended, when mirrors are installed in damp premises, such as bathrooms etc.
- the supporting surface for mirror installation must be perfectly flat, in order to avoid mirror and reflected image distortions.
- if installation surface is not flat, it must be flattened, or non-metal seals should be used to compensate surface unevenness.
- the layer of the back side of the mirror cannot be breached, as it may cause oxidation (black or brown spots are visible on the reflective side)

2. Mirror installation

There are two ways to install a mirror:

- chemical: glue, silicone, or double-sided duct tape.
- mechanical: screws or frame.

2.1 Chemical installation

a. general remarks

- when using glue, silicone, or double-sided duct tape, you must make sure that these gluing products are compatible with the protective coat of the back side of the mirror.
- use supports to support the mirror from below, until the glue is completely dry. Make sure that you put the necessary amount of glue, which is provided in the instruction of the glue manufacturer.

b. special commentaries

- glue and silicone must be applied in vertical stripes, so the air could circulate between the back side of the mirror and installation surface. Evenly press the whole surface of the mirror.

The applied amount of glue or silicone depends on the type of the glue or silicone and weight of the mirror. The table below shows, what a square meter mirror weight is, depending on its thickness:

Mirror thickness	Mirror weight/m ²
3 mm	7.5 kg
4 mm	10 kg
5 mm	12.5 kg
6 mm	15 kg
8 mm	20 kg

Glue or silicone manufacturer must provide recommendations on the amount of glue, necessary to glue the mirror of a certain weight. It is recommended to select the glue and silicones, which are recommended by the mirror manufacturers, on the Internet.

- on the double-sided duct tape, you should advise the manufacturer.

Informative remarks: it is advised to use 10 pieces of tape of 10 mm x 100 mm per kilogram of a mirror. It is also advised to use several small pieces of tape, rather than one big piece.

When installing mirrors mechanically, the main rule is not to allow the mirror be in direct contact with metal (screws, frame etc.). Using gaskets is a must.

Client

s.p.

(name, surname, post, signatures)

Contractor

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