

**ECCELT**  
**GLASSOLUTIONS**  
SAINT-GOBAIN

# TOLERANCES HANDBOOK

*With Guidelines  
for visual evaluation  
of glass used  
for construction*



  
**SAINT-GOBAIN**  
**GLASS**

## INTRODUCTION

## INTRODUCTION

This Handbook regulates tolerances of Basis glasses, machining and the resulting products such as Tempered Safety Glass, Heat-Soak Tested Tempered Safety Glass, Laminated Safety Glass and Insulated Glass.

The Bases of the individual chapters are the current EN as well as ÖNORM- and DIN Standards. They describe any articles in the Standards which are not conclusive and/or applications which are not discussed at all.

In addition to these, the relevant Guidelines for visual evaluation have been integrated.

The Tolerance Handbook, in its current edition, forms the basis of our Terms of supply and sale.

**This Handbook supersedes all previously published tolerances.**

**Standard tolerances:**

Standard tolerances are those tolerances which can be achieved under normal production processes.

**Special tolerances:**

Special tolerances can be achieved with additional measures being taken in production processes.

The increased operations necessary to achieve these tolerances are noted in the particular tolerances and are possible to achieve at extra cost when they are indicated in orders.

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## Basis Glass

# 1. BASIS GLASS

The following Standards are the foundation for the Basis Glass:

ÖNORM EN 572-1 Glass in building - Basic Soda Lime Silicate Glass Products

Part 1: Definitions and General Physical and Mechanical Properties

ÖNORM EN 572-2 Glass in building

Basic Soda Lime Silicate Glass Products Part 2: Float Glass

ÖNORM EN 572-3 Glass in building - Basic Soda Lime Silicate Glass

Products: Part 3: Polished Wired Glass

ÖNORM EN 572-4 Glass in building - Basic Soda Lime Silicate Glass

Products: Part 4: Drawn Sheet Glass

ÖNORM EN 572-5 Glass in building - Basic Soda Lime Silicate Glass

Products: Part 5: Patterned Glass

ÖNORM EN 572-6 Glass in building - Basic Soda Lime Silicate Glass

Products: Part 6: Wired Patterned Glass

The above mentioned Standards specify, classify and define the various glass products and their dimensional and quality requirements.

As excerpt from ÖNORM EN 572 Part 2: Float Glass, the following dimensional tolerances are given.

Nominal thickness (mm)	Dimensional tolerance (mm)
3	± 0,2
4	± 0,2
5	± 0,2
6	± 0,2
8	± 0,3
10	± 0,3
12	± 0,3
15	± 0,5
19	± 1,0
25	± 1,0

Tab. 1: Glass thickness tolerances

For these tolerances there is no differentiation between standard and special tolerances.

## 2. CUTTING TO SIZE

Should tolerances outside those covered in this Chapter occur then the following is applicable: ÖNORM EN 572

General length tolerance  $\pm 0.2$  mm/m edge length

### 2.1 General

It is important to take account of the so-called slope-cut. This is dependent on the thickness of the glass and its characteristics (brittleness etc.)

Glass thickness (mm)	Extreme (mm)
4, 5, 6	$\pm 1$
8, 10	$\pm 2$
12	$\pm 3$
15	+ 5 / - 3
19	+ 6 / - 3

Tab. 2: Slope-cut values

This is to be taken into account when stating required tolerances.  
 i.e. dimensions of glass with arris-ed edges can be double the slope-cut value.  
 Non-right angle units can have the following tolerances (similar to cut-back).  
 The geometry of the element will remain.

#### 2.1.1 Acute corner Float - not definable zone

Angle	x
$\leq 12,5^\circ$	- 30 mm
$\leq 20^\circ$	- 18 mm
$\leq 35^\circ$	- 12 mm
$\leq 45^\circ$	- 8 mm

Tab. 2a: Break-off

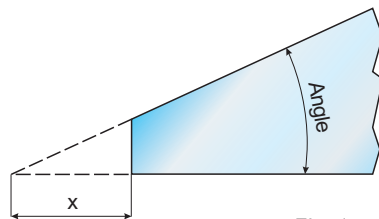


Fig. 1

The area of the possible break-off creates an undefinable zone. It is possible that irregularities occur at the edges (e.g. overbreaks) as well as on the surface, these are no grounds for any claim.

## Cutting

### 2.1.2 Acute corner FT, Laminated, Insulated - not definable zone

For production-technical reasons, we reserve the right to manufacture corner cut-backs in accordance with Table 2b. Should this not be carried out, then the dimensions given in Table 2b will apply as non-definable zone. It is possible that irregularities may occur at the edges (e.g. over-breaks) as well as on the surface. These are no grounds for any claim.

Angle	X
$\leq 12,5^\circ$	- 65 mm
$\leq 20^\circ$	- 33 mm

With angles  $> 20^\circ$  the cut-back and the non-definable zone equals the break-off.

Tab. 2b: Cut-back

Angles  $> 20^\circ$  no cut-back, break-off Point 2.1.1 possible.

The tolerances shown in Point 3.1.2 Table 5 cannot be added to the tolerances in the above Tables 2a. and 2b.

## 2.2 Diagonal tolerance

Method: Measurement of the diagonals  
 Measurement: Tape measure  
 Tolerances: Difference in length of diagonals  $\leq 2\text{mm}$

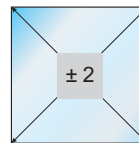


Fig.2

## 2.3 Structure direction in patterned glass

As standard: Direction of structure parallel to the vertical edge.

Exceptions are only allowed when the direction of the structure is shown on a drawing and noted "direction of structure acc. drawing" when ordering.

## Cutting

## SGG ALBARINO S SGG ALBARINO T

			Photovoltaic and solar characteristics	
Nr.	Parameter	Description / Unit	03.ZQPSX46PDB01.A	
1	<b>Aspect defects:</b> max. number of defects. Evaluation acc. to EN 572 Part 5: Viewing distance 1.5 m Viewing perpendicular to the unit which is stood 3 m in front of a matt grey surface	Core defects (inclusions)	visible inclusions are not permissible	
2		Spherical bubbles	Ø up to 2 mm unrestricted amount permissible	
3			Ø > 2 mm not permissible	
4		Elongated bubbles	Width > 0.8 mm not permissible	
5			Length > 10 mm not permissible	
6				
7		Bubbles less than 1mm	Maximum 3 per cm <sup>3</sup>	
8		Defect marking		
9	<b>Dimensions / weight</b>	Available thicknesses	3.2 mm / 4.0 mm	
10		Thickness tolerance	+/- 0.2 mm	
11		Specific weight	Weight calculation (kg) 2.5 x area (m <sup>2</sup> ) x thickness (mm)	
12		Squareness	Diagonal difference 2 mm	
13	<b>Surface</b>	Surface quality	Structure one or both sides	
14		Surface distortion	Max. 0.8mm (measured with feeler gauges on an ideal surface)	
15		General bow	maximum 3 mm per m total width (measured portrait)	
16		Pattern draw (width)	omitted	
17		Pattern draw (height)	omitted	
18		Deformation	Maximum 10% of nominal thickness	
19		Deflection	Maximum 2 mm	

Tab. 3

## Cutting

## sgc ALBARINO P

			Photovoltaic and solar characteristics
Nr.	Parameter	Description / Unit	03.ZQPSX46PDB02.A
1	<b>Aspect defects:</b> maximum number of defects. Evaluation acc. to EN 572 Part 5: Viewing distance 1.5 m. Viewing perpendicular to the unit which is stood 3 m in front of a matt grey surface	Core defects (inclusions)	visible inclusions are not permissible
2		Spherical bubbles	Ø up to 2 mm unrestricted amount permissible
3		Elongated bubbles	Ø > 2 mm not permissible
4			Width > 0.8 mm not permissible
5			Length > 10 mm not permissible
6			
7		Bubbles less than 1mm	Maximum 3 per cm <sup>3</sup>
8		Defect marking	
9	<b>Dimensions / weight</b>	Available thicknesses	4.0 mm
10		Thickness tolerance	+/- 0.3 mm
11		Specific weight	9.0 +/- 0.5 kg/m <sup>2</sup>
12		Squareness	Diagonal difference 2 mm
13	<b>Surface</b>	Surface quality	Structure one or both sides
14		Surface distortion	Maximum 0.8 mm (measured with feeler gauges on an ideal surface)
15		General bow	maximum 3 mm per m total width (measured portrait)
16		Pattern draw (width)	omitted
17	Pattern draw (height)	omitted	
18		Deformation	Maximum 10% of nominal thickness
19		Deflection	Maximum 2 mm

Tab. 4

## Cutting

## sge MASTERGLASS

Nr.	Parameter	Description / Unit	
1	<b>Aspect defects:</b> maximum number of defects. Evaluation acc. to EN 572 Part 5: Viewing distance 1.5 m. Viewing perpendicular to the unit which is stood 3 m in front of a matt grey surface	Core defects (inclusions)	visible inclusions are not permissible
2		Spherical bubbles	Ø up to 2 mm unrestricted amount permissible
3			Ø > 2 mm not permissible
4		Elongated bubbles	Width > 0.8 mm not permissible
5			Length > 10 mm not permissible
6			
7		Bubbles less than 1mm	Maximum 3 per cm <sup>3</sup>
8		Defect marking	
9		<b>Dimensions / weight</b>	Available thicknesses
10	Thickness tolerance		+/- 0.5 mm
11	Specific weight		Weight calculation (kg) 2.5 x area (m <sup>2</sup> ) x thickness (mm)
12	Squareness		Diagonal difference 2 mm
13	Surface quality		Structure one or both sides
14	<b>Surface</b>	Surface distortion	Maximum 0.8 mm (measured with feeler guages on an ideal surface)
15		General bow	maximum 3 mm per m total width (measured portrait)
16		Pattern draw (width)	Maximum 4 mm within one meter
17	Pattern draw (height)	Maximum 2 mm within one meter	
18	Deformation	Maximum 10% of nominal thickness	
19	Deflection	Maximum 2 mm	

Tab. 5

## Cutting

**sgG SR DECORGLASS**

Nr.	Parameter	Description / Unit		
1	<b>Aspect defects:</b> maximum number of defects. Evaluation acc. to EN 572 Part 5: Viewing distance 1.5 m. Viewing perpendicular to the unit which is stood 3 m in front of a matt grey surface	Core defects (inclusions)	visible inclusions are not permissible	
2		Spherical bubbles	Ø up to 2 mm unrestricted amount permissible	
3			Ø > 2 mm not permissible	
4		Elongated bubbles	Width > 2 mm not permissible	
5			Length > 15 mm not permissible	
6				
7		Bubbles less than 1mm	Maximum 10 per cm <sup>3</sup>	
8		Defect marking		
9	<b>Dimensions / weight</b>	Available thicknesses	3.0 / 4.0 / 5.0 / 6.0 / 8.0 / 10 mm	
10		Thickness tolerance	+/- 0.5 mm	
11		Specific weight	Weight calculation (kg) 2.5 x area (m <sup>2</sup> ) x thickness (mm)	
12		Squareness	Diagonal difference 3 mm	
13		Surface quality	Structure one or both sides	
14	<b>Surface</b>	Surface distortion	Maximum 0.8 mm (measured with feeler gauges on an ideal surface)	
15		General bow	maximum 3 mm per m total width (measured portrait)	
16		Pattern draw (width)	Maximum 6 mm within one meter	
17	Pattern draw (height)	Maximum 2 mm within one meter		
18	Deformation	Maximum 10% of nominal thickness		
19	Deflection	Maximum 2 mm		

Tab. 6

## Cutting

## sgg DECORGLASS

Nr.	Parameter	Description / Unit	
1	<b>Aspect defects:</b> maximum number of defects. Evaluation acc. to EN 572 Part 5: Viewing distance 1.5 m. Viewing perpendicular to the unit which is stood 3 m in front of a matt grey surface	Core defects (inclusions)	visible inclusions are not permissible
2		Spherical bubbles	Ø up to 5 mm unrestricted amount permissible
3			Ø > 5 mm not permissible
4		Elongated bubbles	Width > 2 mm not permissible
5			Length > 25 mm not permissible
6			
7		Bubbles less than 1mm	Maximum 10 per cm <sup>3</sup>
8		Defect marking	
9	<b>Dimensions / weight</b>	Available thicknesses	3.0 / 4.0 / 5.0 / 6.0 mm
10		Thickness tolerance	+/- 0.5 mm
11		Specific weight	Weight calculation (kg) 2.5 x area (m <sup>2</sup> ) x thickness (mm)
12		Squareness	Diagonal difference 3 mm
13		Surface quality	Structure one or both sides
14	<b>Surface</b>	Surface distortion	Maximum 0.8 mm (measured with feeler gauges on an ideal surface)
15		General bow	maximum 3 mm per m total width (measured portrait)
16		Pattern draw (width)	Maximum 6 mm within one meter
17	Pattern draw (height)	Maximum 2 mm within one meter	
18	Deformation	Maximum 10% of nominal thickness	
19	Deflection	Maximum 2 mm	

Tab. 7



## 3. MACHINING

Tolerances are dependent on the particular type of edge machining.  
 Should tolerances outside those covered in this Chapter occur then the following is applicable:

- EN 12150 Glass in Building - Thermally toughened glass
- ÖNORM EN 1863 Glass in Building - Heat strengthened glass
- ÖNORM EN 1096-1 Glass in Buildings, Coated glass
- EN 14179-1 Guideline for the evaluation of the visual quality of Glass in Building

### 3.1 Edge machining

#### 3.1.1 Rectangles

##### 3.1.1.1 Standard tolerances

There is differentiation between the edge machining of arressed, ground and polished.

Therefore 2 tolerance classifications are given:

- a) arressed
- b) ground / polished

For arressed edges the tolerances given in "Cutting to size" with slope-cut are valid.

It is therefore possible that the exact dimension when measured to the corner is less than the nominal dimensions. This variance is a result of production conditions and cannot be considered reason for any claim.

For ground/polished edges the following table applies.

Edge length (mm)	$d \leq 12 \text{ mm}$	$d = 15 + 19 \text{ mm}$
$\leq 1000$	$\pm 1,5$	$\pm 2$
$\leq 2000$	$\pm 2,0$	$\pm 2,5$
$\leq 3000$	$+ 2,0 / - 2,5$	$\pm 3$
$\leq 4000$	$+ 2,0 / - 3,0$	$+ 3,0 / - 4,0$
$\leq 5000$	$+ 2,0 / - 4,0$	$+ 3,0 / - 5,0$
$\leq 6000$	$+ 2,0 / - 5,0$	$+ 3,0 / - 5,0$

Tab. 8: Rectangular standard tolerances

The diagonal tolerances results from  $1.42 \times$  rectangular tolerance.  
 e.g. 2300 mm edge length gives  
 $1.42 \times 2.3 = 3.3 \text{ mm} \rightarrow 3 \text{ mm}$  diagonal tolerance)

## Machining

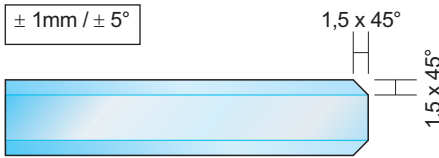


Fig. 3: Edge machining - edge polished

### 3.1.1.2 Special tolerances

The following tolerances can be achieved with increased expense. This special process results in the first sheet of glass being measured exactly. Non-machined sheets must be re-cut.

Edge length (mm)	d ≤ 12 mm	d = 15 + 19 mm
≤ 1000	+ 0,5 – 1,5	+ 0,5 – 1,5
≤ 2000	+ 0,5 – 1,5	+ 0,5 – 2,0
≤ 3000	+ 0,5 – 1,5	+ 0,5 – 2,0
≤ 4000	+ 0,5 – 2,0	+ 0,5 – 2,5
≤ 5000	+ 0,5 – 2,5	+ 0,5 – 3,0
≤ 6000	+ 1,0 – 3,0	+ 1,0 – 3,5

Tab. 9: Rectangular special tolerances

### 3.1.2 Shapes

Also here there is differentiation between the qualities of standard and special, whereby the special tolerances are achieved only on the CNC machines.

## Machining

With 15 and 19 mm glass there is an addition of 1 mm in all tolerances.

Edge length $d \leq 12$ mm		
Standard		special (CNC)
$\leq 1000$	$\pm 2,0$	$+ 1 - 1,0$
$\leq 2000$	$\pm 3,0$	$+ 1 - 1,5$
$\leq 3000$	$\pm 4,0$	$+ 1 - 2,0$
$\leq 4000$	$\pm 5,0$	$\leq 3900$ $+ 1 - 2,5$
$\leq 5000$	$- 8 / + 5$	$\leq 5000$ $- 4 / + 2$
$\leq 6000$	$- 10 / + 5$	$\leq 6000$ $- 5 / + 2$

Tab. 10

## 3.2 Machining

The positional tolerance for all processes in Section 3.2 relate to measurement from the dimensioned edge.

### 3.2.1 Corner cut-off arrissed $> 100 \times 100$ mm

#### 3.2.1.1 Standard

Tolerance  $\pm 4$  mm location/size

### 3.2.2 Corner cut-out arrissed

#### 3.2.2.1 Standard

Tolerance  $\pm 4$  mm location/size

## Machining

### 3.2.3 Edge cut-out and cut-outs in the main body of glass arissed

#### 3.2.3.1 Standard tolerances for hand-working

Cut-out length	Tolerance
≤ 500	± 5
≤ 1000	± 6

Tab. 11: Edge cut-out tolerances HW arissed

Tolerance ± 4 mm location

#### 3.2.3.2 Standard tolerances for CNC-(Master Edge and BAZ) working

Note: Minimum of 15 mm for internal radii

Cut-out length	Tolerance
≤ 2000	± 4
≤ 3400	± 4
< 6000	± 5 mm

Tab. 12: Edge cut-out and cut-outs in the main body of glass tolerances CNC arissed

Tolerance ± 3 mm location

### 3.2.4 Corner cut-off ground

#### 3.2.4.1 Standard

Tolerance ± 2 mm

(Corner cut-off < 100 x 100mm otherwise shape)

Tolerance ± 4 mm location

#### 3.2.4.2 Special tolerances

Special tolerance ± 1,5 mm. Machining is carried out on CNC machine which means that CNC pricing is to be taken account of.

Machining

### 3.2.5 Corner cut-off polished - CNC-(Master Edge and BAZ) *machined*

#### 3.2.5.1 Standard

Tolerance  $\pm 2$  mm  
(Corner cut-off  $< 100 \times 100$  mm  
otherwise shape)

#### 3.2.5.2 Special tolerances

$\pm 1,5$  mm

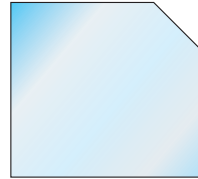


Fig. 4

### 3.2.6 Corner cut-out ground

#### 3.2.6.1 Standard

Note: Minimum of 15 mm for internal radii  
Tolerance  $\pm 2$  mm Size, Location  $\pm 3$  mm

#### 3.2.6.2 Special tolerances

Note: Minimum of 15 mm for internal radii  
Special tolerance  $\pm 1,5$  mm  
Machining is carried out on CNC-(Master Edge and BAZ) machine

### 3.2.7 Corner cut-out polished - CNC-(Master Edge and BAZ) *machined*

Note: Minimum of 15 mm for internal radii

#### 3.2.7.1 Standard

Tolerance  $\pm 2$  mm

#### 3.2.7.2 Special tolerances

Tolerance  $\pm 1,5$  mm

## Machining

### 3.2.8 Edge cut-out and cut-outs in the main body of glass ground or polished - CNC-(Master Edge and BAZ) machined

#### 3.2.8.1 Standard

Note: Minimum of 15 mm for internal radii

Cut-out length	Tolerance
≤ 500	± 2
≤ 1000	± 3
≤ 2000	± 3
≤ 3400	± 4

Tab. 13: Edge cut-out tolerances CNC ground or polished

#### 3.2.8.2 Special tolerances

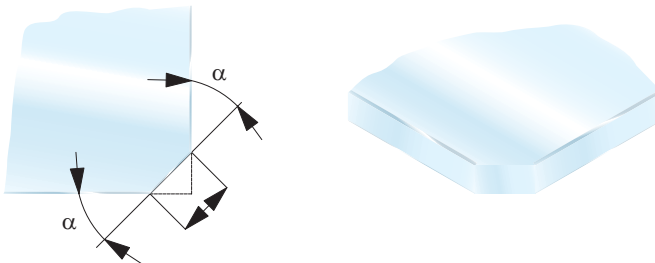
Note: Minimum of 15 mm for internal radii

Special tolerance ± 1,5 mm

### 3.2.9 Seamed corners

is the grinding down of an existing sharp edge at the corner of the glass

$\alpha$  = about equal in angle



Production technology may result in different levels of seamed corners (Master Edge and BAZ: rounded corner polished or fine ground with  $r=2\text{mm}$ ) or lack of seam → this is no round for a claim.

Machining

### 3.3 Hole drilling

Drilled hole location and location tolerances are as per edge-working tolerances.

#### 3.3.1 Drilled hole diameter

Diameter

≤ 30 mm ± 1 mm

> 30 mm ± 2 mm

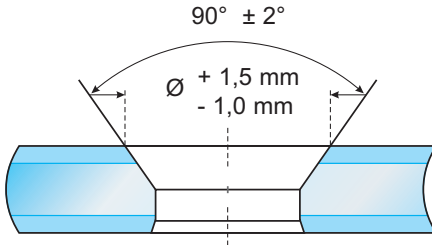


Fig.5: Countersunk hole tolerance

#### Countersunk holes in Laminated safety glass

The cylindrical drilled hole of the rear sheet is manufactured with a diameter 4 mm greater than the core diameter of the countersunk hole.

$$X = (\text{Countersink-}\varnothing - \text{Core-}\varnothing) / 2$$

$$\text{min Glass thickness} = X + 2$$

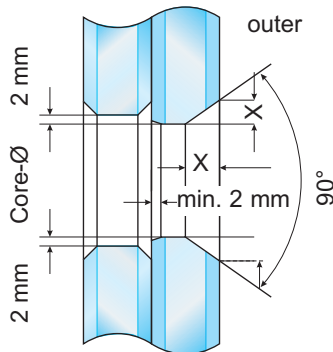


Fig. 6

## Machining

## 3.3.2 Drilled hole locations

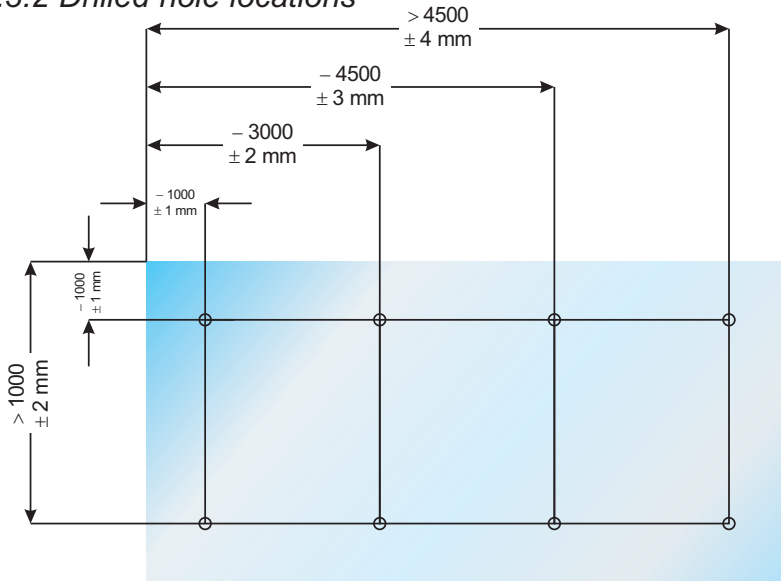


Fig. 7

## 3.3.3 Hole size and location for 4 - 6 mm FT

S = Glass thickness

Edgework	Edges arissed
Minimum diameter	$D \geq S$ - Hole edge beveled
Distance hole edge to glass edge	$\geq 2 S$
Distance hole edge to hole edge	$\geq 2 S$
Offset in corners	See sketch 8

Tab. 14: FT 4 - 6 mm hole size/location

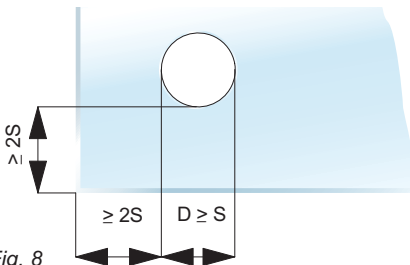


Fig. 8



## Machining

### 3.3.4 Hole size and location for 8 - 12 mm FT

S = Glass thickness

Edgework	Edges arressed
Minimum diameter	$D \geq S$ - Hole edge beveled
Distance hole edge to glass edge	$> 2S$
Distance hole edge to hole edge	$> 2S$
Offset in corners	See sketch 9

Tab. 15: : FT 8 - 12 mm hole size/location

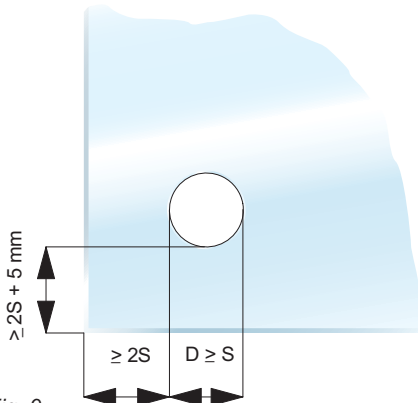


Fig. 9

Drilled holes in corners (up to 50 mm hole centre), must be located asymmetrically (min. 5mm difference between X and Y distance). When this is NOT possible, then the holes must be slotted (due to increased risk of breakage during tempering).

#### 3.3.4.1 Minimum distance from edge of hole to edge of hole

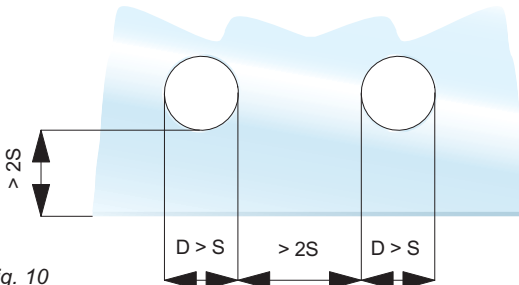


Fig. 10

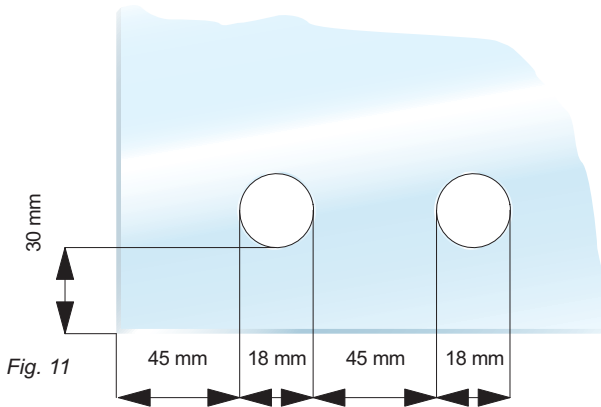
## Machining

### 3.3.5 Hole size and location for 15 mm and 19 mm FT

#### 15 mm Securit FT

Edgework	Edges fine ground
Minimum diameter	18 mm - hole edge beveled
Distance hole edge to glass edge	30 mm
Distance hole edge to hole edge	45 mm
Offset in corners	See sketch 11

Tab. 16: FT 15 mm Hole size/Location



## Machining

### 19 mm Securit FT

Edgework	Edges fine ground
Minimum diameter	25 mm - hole edge beveled
Distance hole edge to glass edge	40 mm
Distance hole edge to hole edge	60 mm
Offset in corners	See sketch 12

Tab. 17: FT 19 mm Hole size/Location

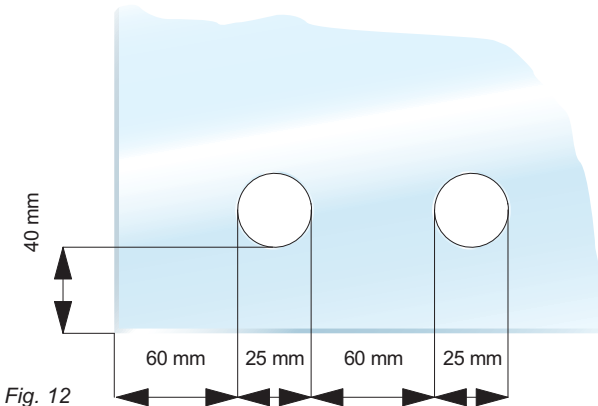


Fig. 12

## 3.4 Edge machining qualities

Basis of edge machining qualities is DIN 1249 Part 11.

Due to production technological reasons Eckelt Glas GmbH reserves the right to polish edges that may be required to be flat ground.

### 3.4.1 Cut edges (KG)

A cut edge is that edge which results from cutting Float glass. The edges are sharp.

Slight wave lines occur perpendicular to the edges.

Generally the cut edge is broken flat, however, it is possible that irregular breaks may occur particularly in thick sheets and non-rectangular shaped sheets.

## Machining

It is also possible that irregularities occur during working of the glass (e.g. through breaking of the glass). Flakes which do not reduce the individual glass thickness by greater than 15 % are permissible. The maximum radius of a flake cannot exceed 3 mm.

### 3.4.2 Arrissed edges (KGS)

An arrissed edge is a cut edge which has had its edges smoothed. Due to production technological reasons Eckelt Glas GmbH reserves the right to grind or polish edges - the quality is at least arrissed.

#### 3.4.2.1 Edge fine internal

The glass sheet is brought to the desired dimension by grinding the surface of the edge. Blank areas and flakes are permissible.

#### 3.4.2.2 Edge polished internal

The glass sheet is brought to the desired dimension by grinding the surface of the edge. Blank areas and flakes are permissible.

The polished edge is an over-polished ground edge. Polishing marks are permissible.

### 3.4.3 Edges ground to size, adjusted, (KMG) in cut-outs

The glass sheet is brought to the desired dimension by grinding the surface of the edge. Blank areas and flakes are permissible.

### 3.4.4 Flat Ground edges (fine adjusted, KGN)

The surface of the glass edge is completely machined. The ground edge has a matt/frosty appearance. Blank areas and flakes are not permissible.

An edge treated with waterjet is classified as a ground edge.

### 3.4.5 Polished edges (KPO)

A polished edge is an over-polished refined ground edge.

Matt areas are not permissible.

Polishing marks that can be seen and felt are permissible.

Due to production technology, it is possible that glass may be processed on different edge working machines. This may result in differences in the visual appearance of the ground or polished edge. This is no basis for ant claim.

## 4. sGGSECURIT – Monolithic safety glass, FT-HST Heat-Strengthened Glass

In addition applicable:

EN 12150-1/-2, DIN 1249 Part 12, ÖNORM EN 1096-1

Guideline for the evaluation of visual quality of glass in building according to Hadamar.

Should tolerances outside those covered in this Chapter occur then the following is applicable:

### **FT**

Additionally applicable: ÖNORM EN 12150, ÖNORM EN 1096 - 1

### **FT-HST:**

Additionally applicable: ÖNORM EN 14179; ÖNORM EN 1096 - 1

### **Heat-Strengthened Glass**

Additionally applicable: ÖNORM EN 1863, ÖNORM EN 1096 - 1

### 4.1 General distortion

Standard 0.3 % the measured length

(the edges and diagonals are to be checked, whereby none of the measured values may be greater than 0.3 % of the measured length).

Units that are square with an aspect ratio between 1:1 and 1:1.3 and thin sheets  $\leq 6$  mm will deviate from flatness greater than small rectangular sheets.

### 4.2 Local distortion (roller waves)

Standard 0.3 mm over 300 mm measured length

The measurement is to be taken at least 25 mm from the glass edge.

### 4.3 Guideline for visual evaluation of Tempered Safety Glass

#### **Introduction**

This guideline applies to flat, thermally toughened safety glass (FT) for applications in the building industry. Thermally toughened glass in terms of this guideline is glass that has been heated during the production process and cooled down afterwards using air.

This has the effect that FT glass is largely resistant to impact, distortion and temperature change. In case of FT glass being damaged the typical fracture structure with many small fragments is created.

## SGGSECURIT - Tempered Safety Glass

### 4.3.1 Area of application

Using this guideline the visual quality assessment of toughened safety glass made from float glass and cast glass each clear in mass for the building industry. The assessment is carried out in accordance with the evaluation principles described in the following, using the subsequent tables and specifications.

The visible glass area remaining when installed is to be assessed.

### 4.3.2 Evaluation

As a rule the vision through the glass and not the surface view of the glass is crucial when checking. The defects detected during the test are checked for their permissibility in accordance with the tables.

- Defect size  $\leq 0.5$  mm for clear float glass will not be taken into account
- Defect size  $\leq 1.0$  mm for cast glass either clear or body-tinted glass will not be taken into account
- Impairments, which are not always avoidable due to the manufacturing process, such as areas of distortion in the form of defects, must not, as a rule, be larger than 3 mm including their halo.

The evaluation is carried out in accordance with the following standards: DIN 1249, Edition 1973 (has in the meantime been superseded)

The test is carried out in such a way that:

- The evaluators eye is at a distance of 1 m for clear and body-tinted glass
- for cast glass, either clear or body-tinted, at a distance of 1.5 m and at mid-height of the unit.

The assessment of the vision should be effected from a viewing angle, which conforms to generally acceptable room utilization. As a rule a perpendicular viewing angle is to be assumed.

The evaluation is performed during lighting conditions that are the same as diffuse daylight.

## SGGSECURIT - Tempered Safety Glass

### 4.3.3 Deviations from markings

In addition to the regulations in Standards for the marking of safety glass, we reserve the right to mark, amend or change the location of the marking, even when glass has been ordered without any marking. We advise that such changes give no reason for any claim and will not be accepted as grounds for replacement.

Glass outside of our dimensional tables:

Glass with dimensions which lie outside of our dimensional tables can be produced. These units, however, do not necessarily comply with the tolerances set out in Clauses. 4.1 and 4.2 - greater tolerances are allowable. It is possible that an edge bow occurs along the long edge of the glass (the glass is no longer flat rather "Banana-shaped").

The following Table 18 lists the deviation possibilities together with their check for permissibility.

Area of application: Float glass, clear and body-tinted glass

- Hairline scratches  
(surface damage that cannot be felt using finger nails)
- Closed seeds
- Crystalline defects (non-fused glass splinters)
- Outer area and edge damage of arrissed edges
- Slight shelling of arrissed edges, which does not affect the strength of the glass.

## sGGSECURIT - Tempered Safety Glass

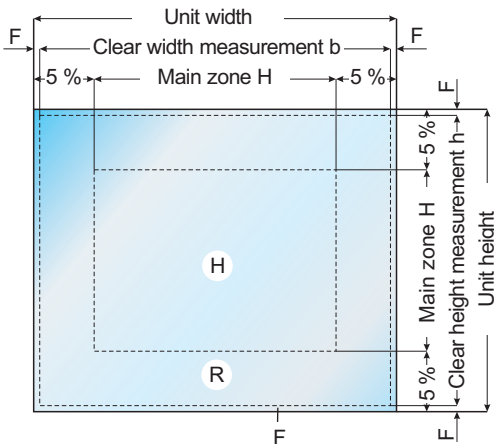
Permissibility per unit - Float glass, clear and body-tinted glass					
Zone	Hairline scratches not perceptible	Seeds closed	Flaws crystalline	Flat edge damage* seamy edge	Slight shelling** seamy edge
F	permissible	permissible	permissible	permissible	permissible
R	permissible but not bunched together	permissible size ≤ 0,5 mm permissible halo ≤ 3 mm	permissible size ≤ 0,5 mm	not permissible permissible, if F = R	not permissible permissible, if F = R
H	permissible but not bunched together and in their sum not more than a length of 150 mm	not permissible	not permissible	-	-

Due to the thermal tempering process a chemical and mechanical change of the surface texture, such as spot formation and roller imprints, with regard to the respective glass type cannot be avoided. Due to production technology, it is possible that corner points may be ground down prior to tempering

\*= not deeper than 15 % of sheet thickness

Tab. 18:

**F = Rebate Zone**      Glass rebated in frames  
**R = Edge Zone**        Area 5 % of the visible width and height  
**H = Main Zone**



F = Rebate Zone applies only to glazing with circumferential frame construction. For constructions and door systems with freestanding edges only the assessments according to Zone R and H apply.

Fig. 13



## sGGSECURIT - Tempered Safety Glass

The following Table 19 lists the deviation possibilities together with their check for permissibility.

Area of application: Cast glass, clear and body-tinted glass

- Hairline scratches  
(surface damage that cannot be felt using finger nails)
- Closed seeds
- Crystalline defects (non-fused glass splinters)
- Outer area and edge damage of arressed edges
- Slight shelling of arressed edges, which does not affect the strength of the glass
- Closed bubbles

Permissibility per unit

- Float and Cast glass
- Clear and body-tinted glass

Unit/m <sup>2</sup>	Hairline scratches not perceptible	Seeds closed	Bubbles closed	Defects crystalline	Flat edge damage* seamy edges	Slight shelling** seamy edges
per m <sup>2</sup> of glass surface	permissible on entire surface	L ≤ 20 mm B ≤ 1 mm permissible 1 piece	≤ 3 mm up to 5 mm 1 piece	≤ 3 mm bis up to 5 mm	permissible	permissible
		L ≤ 10 mm B ≤ 1 mm  permissible on entire surface, but not bunched together	< 3 mm  permissible on entire surface, but not bunched together	permissible on entire surface, but not bunched together		

As cast glass is subject to an individual manufacturing process spherical or line-shaped defects and blistering represent the characteristic quality condition. Pattern deviations as a result of roller change and pattern mismatch cannot always be ruled out and can thus not be the subject of claims.

\* Not deeper than 15 % of the pane thickness in the glass volume.

Tab. 19

## 5 . sGGSERALIT/sGGEMALIT-H SCREEN-PRINT AND ENAMEL

Should tolerances outside those covered in this Chapter occur then the following is applicable:

- EN 12 150 for Toughened safety glass
- EN 1863 for Heat-strengthened glass
- EN 14179 for HST-TSG
- ÖNORM EN 1096 - 1
- Deviations from marking see 4.3.3

### 5.1 Guideline for the visual quality assessment of enameled and screen-printed glass

#### 5.1.1 Area of application

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

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

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

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

## 5.1.2 Explanations/Notes/Terms

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

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

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

The enameled side is normally the side that is opposite to any weathering exposure.

Depending on the production process and colour of an enameled glass, it shows a higher or lower intensity of light transmission and is thus not opaque. Light colours always give a higher transmission than dark colours.

In the case of major differences of the luminance or high luminous intensities (daylight) between the normal viewing side and the rear side, optical light- dark shadows become apparent in the glass when viewing from the rear side.

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

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

Screen print:

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

Continuous rolling:

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

**Exception:** manual rolling, see Point 5.1.2.1.1.1

Continuous pouring:

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

**Should the glass be seen from both sides we recommend a 1:1 sample**

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

**5.1.2.1.1 Continuous rolling**

The flat glass sheet passes under a grooved rubber roller, which transfers the enamel paint to the glass surface without the addition of any solvents and thus in an environmentally friendly method. Consequently a homogenous colour distribution is ensured (an absolutely flat surface is a prerequisite for this, i.e. cast glass cannot be rolled as a rule), which is however only adjustable to a limited degree with respect to colour application (colour thickness, covering capacity). Typically the grooved structure of the roller can be seen (coated side). However, normally one can hardly notice these "grooves" from the front (viewed through the glass - for viewing procedure see Point 5.1.3).

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

**5.1.2.1.1.1 Manual rolling**

Production techniques may require manual application of enamel using a lambswool roller (Designation: LM). This type of order is mainly used for glass with enamel borders. Clouding, hazing and shadows in paint coverage as well as an inhomogeneous appearance in transmission cannot be avoided.

**5.1.2.1.2 Continuous pouring**

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

### 5.1.2.1.3 Screen printing

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

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

The location of the screen-print is to be agreed for the particular sheet size and shape (reference point & clear edge).

Up to 3mm of unprinted edge may occur due to tolerances with respect to glass and screens.

Coating over-run on the edge is process-related.

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

### 5.1.2.2 Edge quality

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

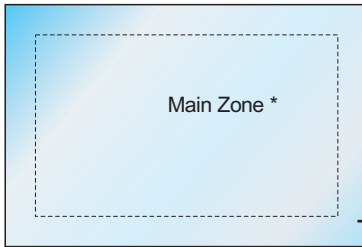
## 5.1.3 Visual evaluation

The assessment of the visual quality of enameled and screen-printed glass is carried out from a distance of at least 3 m using and perpendicular or at a maximum of 30° to perpendicular, in normal daylight without direct sunlight or backlight from the front or rear side in front of an opaque background.

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

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

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



\* If visible edges are requested when the order is placed, the edge zone is omitted and the main zone extends to the glass edge. The visual quality requirements are specified in the following Tables 20 and 21.

Rebate zone circumferential 15 mm

Fig. 14

### 5.1.4 Special Note

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

Type of defect	Main zone	Edge zone
Defects in enamel point-wise and/or linear	Quantity: max. 3 number, of those none $\geq 25 \text{ mm}^2$ Sum of all defects: max. $25 \text{ mm}^2$	Width: max. 3 mm, sporadically 5 mm Length: no restriction
Hairline scratches (only visible in changing light conditions)	Allowable up to 10 mm length	Allowable / no restrictions
Clouding / Misty areas / Shading	Not permitted ***	Permitted / no restriction
Water stains	Not permitted	Permitted / no restriction
Coating over-run at edges	Not applicable	* Permitted
Dimensional tolerance for edge enameling and partial enameling **, see Fig. 13 Enamel width:	Depending on width of enamel: Tolerance:	
$\leq 100 \text{ mm}$	$\pm 1,5 \text{ mm}$	
$\leq 500 \text{ mm}$	$\pm 2,0 \text{ mm}$	
$\leq 1000 \text{ mm}$	$\pm 2,5 \text{ mm}$	
$\leq 2000 \text{ mm}$	$\pm 3,0 \text{ mm}$	
$\leq 3000 \text{ mm}$	$\pm 4,0 \text{ mm}$	
$\leq 4000 \text{ mm}$	$\pm 5,0 \text{ mm}$	
$\leq 5000 \text{ mm}$	$\pm 6,0 \text{ mm}$	
Positional tolerance of enamel ** (only for partial enameling)	Print size: $\leq 200 \text{ cm}$ : $\pm 2 \text{ mm}$ Print size: $> 200 \text{ cm}$ : $\pm 4 \text{ mm}$	
Colour deviations	See Point 5.1.5	

Tab. 20: Type of defects / tolerances for full surface or partial surface enameled glass

## sGGSERALIT / sGGEMALIT-H

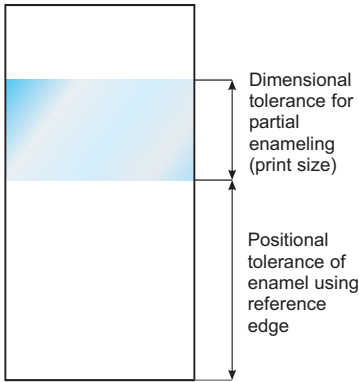


Fig. 15 for Tab. 20: Type of defects / tolerances for full surface or partial surface enameled glass

- \* Defects  $\leq 0.5$  mm ("Pinholes" = minute defects in the enamel) are permitted and are generally not taken into account.  
Repairing defects using enamel paint prior to the tempering process or using organic after the tempering process is permitted, however, organic lacquers must not be used, if the glass is further processed to insulating glass and the defect is located in the edge seal of the insulating glass. The repaired defects must not be visible from a distance of 3 meters.
- \*\* The positional tolerance of the enamel is measured from the reference point.
- \*\*\* Orders which require manual rolling of enamel may have an inhomogeneous appearance in transmission.

## sGGSERALIT / sGEMALIT-H

Type of defect	Main Zone	Edge Zone
Defects in screen print point-wise* or/and linear	Quantity: max. 3 number of those none $\geq 25 \text{ mm}^2$ Sum of all defects: max. $25 \text{ mm}^2$	Width: max. 3 mm, sporadically 5 mm Length: no restriction
Hairline scratches (only visible in changing light conditions)	Allowable up to 10 mm length	Allowable / no restrictions
Clouding / Patching / Shading	Permitted	Permitted / no restriction
Water stains	Not permitted	Permitted / no restriction
Coating over-run at edges	Not applicable	*Permitted
Tolerance of design (b) see Fig. 14 Print area $\leq 100 \text{ mm}$ $\leq 500 \text{ mm}$ $\leq 1000 \text{ mm}$ $\leq 2000 \text{ mm}$ $\leq 3000 \text{ mm}$ $\leq 4000 \text{ mm}$ $\leq 5000 \text{ mm}$ $\leq 6000 \text{ mm}$	Depending on size of print area: $\pm 1,0 \text{ mm}$ $\pm 1,5 \text{ mm}$ $\pm 2,0 \text{ mm}$ $\pm 2,5 \text{ mm}$ $\pm 3,0 \text{ mm}$ $\pm 4,0 \text{ mm}$ $\pm 5,0 \text{ mm}$ $\pm 6,0 \text{ mm}$	No restrictions
Defect per figure ***	See Fig. 16 and Fig. 17	
Positional tolerance of screen print (a) **, see Fig. 14	Print size: $\leq 200 \text{ cm}$ : $\pm 2 \text{ mm}$ Print size: $> 200 \text{ cm}$ : $\pm 4 \text{ mm}$	
Resolution precision (c and d)**** see Fig. 14 $\leq 30 \text{ mm}$ $\leq 100 \text{ mm}$ $> 100 \text{ mm}$	Depending on size of print area: $\pm 0,8 \text{ mm}$ $\pm 1,2 \text{ mm}$ $\pm 2,0 \text{ mm}$	
Colour deviations	see Point 5.1.5	

Tab. 21: Defects / tolerances for screen-printed glass

\* Defects  $\leq 0,5 \text{ mm}$  ("Pinholes" = minute defects in the screen print) are permitted and are generally not taken into account.

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

\*\*\* Defects must not be located closer than 250 mm to each other. Serial defects are not permitted (recurrence at the same location on sheet after sheet).

\*\*\*\* The toleranced can accumulate



sGGSERALIT / sGGEMALIT-H

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

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

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

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

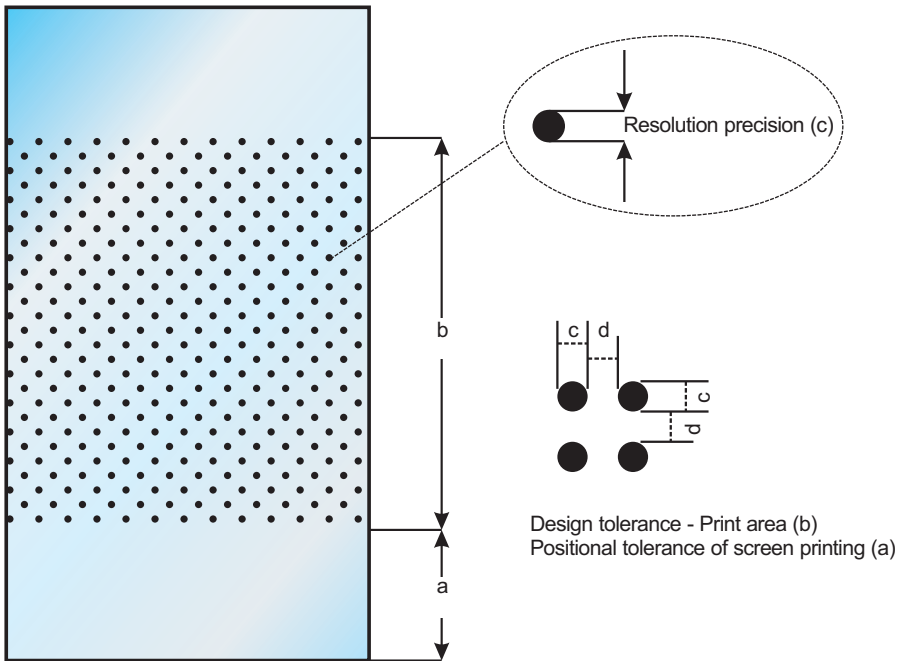


Fig. 16 to Tab. 21: Types of defects / tolerances for screen-printed glass

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Tab. 21 can principally also be used for the assessment of "misprints".

Geometry of the pattern (resolution precision)

Assessment **defects per figure**

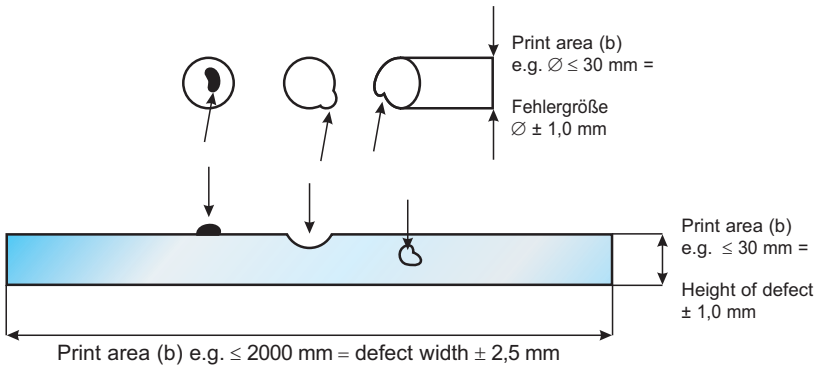


Fig. 17 for Tab. 21: Geometry of the figure (resolution precision) - Assessment: Defects per figure

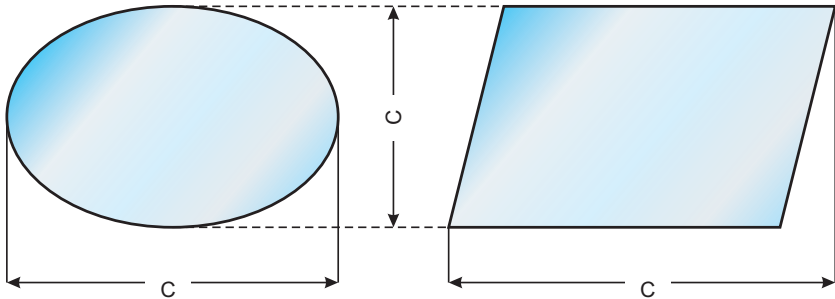


Fig. 18 for Tab. 21: Geometries

Applies accordingly also to oval and other geometries (Assessment = Width x Height).

### 5.1.5 Assessment of the perceived colour

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

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

Generally the base glass is float glass, i.e. the surface is flat and high light reflection occurs.

In addition, this glass may have a variety of coatings such as solar control layers (increasing the light reflection of the surface), coatings which reduce reflection, or it can also be slightly embossed such as for example in the case of structured glass.

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

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

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

Paints are "adjusted" such that they "melt into" the surface within 2 - 4 minutes at a glass surface temperature of approx. 600 - 620 °C. This "temperature window" is very narrow and cannot always be constantly maintained particularly for glass sheets that have different sizes. Furthermore the type of application is also critical for the perceived colour. Due to the thin coating, screen printing provides less paint covering capacity than a product manufactured using continuous rolling with thicker and therefore denser paint application.

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

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

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

The human eye reacts very differently to various colours. While a very small colour difference becomes drastically noticeable in the case of blue tints, colour differences with green tints will be less obvious. Additional variable influences include the viewing angles, size of the object and particularly also how close two objects to be compared are positioned to each other.

An objective visual estimation and assessment of colour differences is not possible due to the aforementioned reasons. The introduction of an objective assessment standard therefore requires the measurement of the colour difference under previously precisely defined conditions (glass type, colour, illuminant.)

In cases, in which the customer demands an objective assessment standard for the defined colour, the procedure must be coordinated with the supplier beforehand.

The basic process is defined in the following:

- Sampling of one or more colours
- Selection of one or more colours
- Predefinition of tolerances per colour by the customer e.g. permitted colour deviation:  
 $\Delta L^* \leq \dots \Delta a^* \leq \dots \Delta b^* \leq \dots$  in the CIELAB Colour system measured for illuminant D 65 (daylight) using d/8° sphere geometry, 10° standard colorimetric observer, gloss included.
- Checking for feasibility on the part of the supplier with respect to adherence to the default tolerance (order size, availability of raw materials etc.).
- Producing a 1:1 production sample and approval by the customer
- Manufacturing the order within the defined tolerances. If no particular assessment standard has been agreed upon,  $\Delta E^* \leq 2,90$  applies as measured using the measuring procedure described above. When PLANILUX DIAMANT is used as the substrate a  $\Delta E^* \leq 2,00$  is applicable.  
 Exceptions are all red colours (BF3xx, BFCxxx) and Blue colours (BF5xx, BFExx)

### 5.1.6 Application Notes

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

sGGSERALIT / sGEMALIT-H

- Enameled glass as HST Toughened safety glass can be heat soak tested. The respective necessity of the FT heat soak test must be checked by the user and the manufacturer must be informed. The structural performance values of enameled glass must not be equated with an unprinted or non-enameled glass.

## 5.2 Metallic colours

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

## 5.3 Print on weathered side of glass - Surface 1

This new colour system has been specially developed for decoration of float glass on surface 1. The colours have an increased resistance to chemical and weathering. Generally, the guideline for evaluation of screenprinted glass is applicable.

Exceptions:

The inspection is to take place from the screen-printed side or from both sides if the glass is ordered for visions areas.

A colour difference of  $\Delta E^* \leq 2,90$  applies only at the time of delivery.

The weathering will cause change in the appearance of the colour and will depend on the colour. Therefore, the following additional colour tolerances are allowable after installation - they are divided into 3 colour groups:

- Light colours: AU2WS (white)  
Proportion of white base colour at least. 88% (e.g. AU2WS)  
Colour difference  $\leq \Delta E 3,0$  allowable
- Mid-tones: AU550WS (blue), AU150WS (yellow), AU640WS (green), AU300WS (red), AUM1WS (etch colour)  
Colour difference  $\leq \Delta E 5,0$  allowable (e.g. AUM1WS)
- Dark colours: AU752WS (grey), AU1WS (black)  
Proportion of dark base colour at least. 12 % (e.g. AU1WS)  
Colour difference  $\leq \Delta E 10,0$  allowable

Claims will generally not be acknowledged, when in addition to our general recommendations for cleaning the following particular conditions for "printed on weathered glass side - surface 1" are not complied with.

The facade must be cleaned at least twice per year. Should the façade be subject to soiling to a level greater than normal environmental conditions (e.g. major city centre or an industrial area), then the printed glass surface is to be cleaned twice per year

## sGGSERALIT / sGEMALIT-H

using an abrasive glass cleaner (e.g. Radora Brillant).  
The use of acidic cleansers is not permissible.

- Custom colour: AU500 WS has visually a very transparent appearance. In addition, AU500 WS may have a non-uniform coverage due to differing levels of fusion during tempering. Both are characteristics of this colour and are not grounds for any claim.

## 6. sGGSTADIP - LAMINATED SAFETY GLASS

### 6.1 Dimensional tolerances

(with reference to Saint-Gobain product specification for laminated safety glass)  
Should tolerances outside those covered in this Chapter occur then the following is applicable:

The tolerances are generally in accordance with EN ISO 12543

ÖNORM EN 1096 - 1

The relative dimensional tolerances of the basis products used in the laminated safety glass are applicable as well as the allowable shift tolerances as shown in Table 22 and 23.

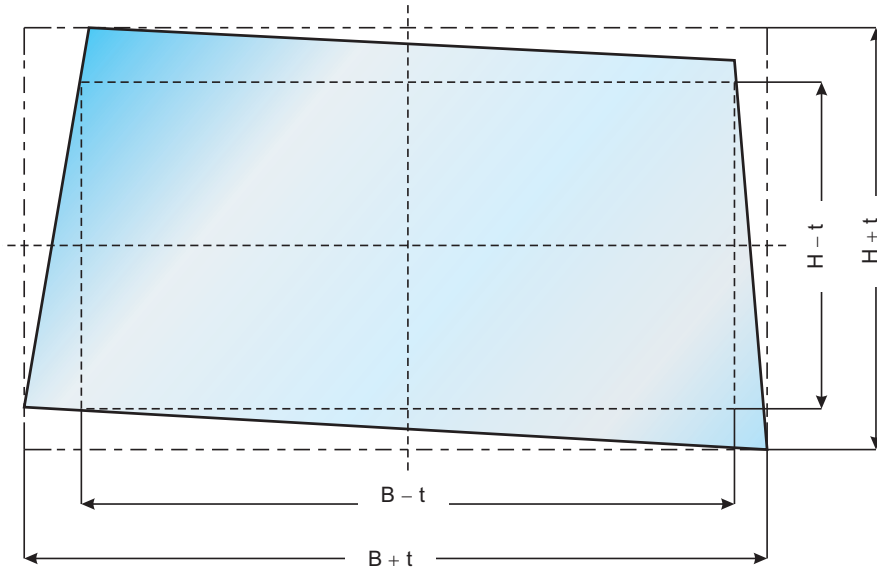


Fig. 19: Extreme dimensions for sizes in rectangular units

Example:

Laminated safety glass of 6 mm Tempered / 0.76 mm PVB / 6 mm Heat-strengthened  
Edges polished

Dimensional tolerances of individual sheets:  $\pm 1,5$  mm

Additional shift tolerance:  $\pm 2$  mm

Equals a total of allowable tolerance =  $\pm 3,5$  mm

## sGGSTADIP - LAMINATED SAFETY GLASS

## 6.2 Shift tolerance (edge step)

The individual sheets may, as a result of production techniques, shift against each other during the laminating process.

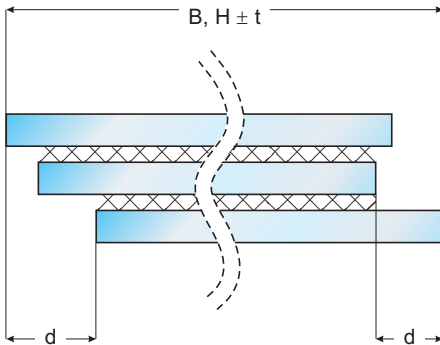


Fig. 20 - Shift

It is standard to process each individual sheet of a laminated safety glass of two or more sheets. The longest edge of the element is referred to in Tables 22 and 23.

For rectangles:

Sheet up to	Allowable maximum shift for nominal thickness of laminated safety glass		
	≤ 8 mm	≤ 20 mm	> 20 mm
≤ 2000	1,0	2,0	3,0
>2000-4000	2,0	2,5	3,5
> 4000	3,0	3,0	4,0

Tab. 22

For shapes:

Sheet up to	Allowable maximum shift for nominal thickness of laminated safety glass		
	≤ 8 mm	≤ 20 mm	> 20 mm
≤ 2000	1,5	3,0	4,5
>2000-4000	3,0	4,0	5,5
> 4000	4,5	5,0	6,0

Tab. 23

Laminated glass of Fully Tempered glass with a width less than 20 cm and a length greater than 150 cm may have excessive deformation along the long edge, (the glass is no longer flat rather "Banana-shaped"). Edge shift is not in accordance with Point 6.2. These are a result of production technology and cannot be accepted as grounds for a claim.

## 6.3 Thickness tolerance

The thickness of the laminate must not exceed the sum of the individual sheets as given in the Standard for basis glass (EN 572).

The extreme dimension of the interlayer must not be considered if the thickness of the interlayer is < 2 mm. For interlayers ≥ 2 mm a thickness a tolerance of ≥ 2 mm is to be accommodated.



## SGGSTADIP - LAMINATED SAFETY GLASS

### Example:

Laminated glass made of 2 x Float glass with a nominal thickness of 3 mm and an interlayer of 0.5 mm. According to EN 572-2 the float glass thickness of 3 mm has a tolerance of  $\pm 0.2$  mm. Therefore, the nominal thickness is 6.5 mm an extreme thickness  $\pm 0.4$  mm.

## 6.4 Machining

Laminated glass of two or more sheets will have the individual sheets machined with edges KG, KGS, KMG, KGN or KPO.

Fully Tempered or Heat-Strengthened glass may not have a post-treatment equalization of the edges.

Combinations without either tempered glass may be post-machined.

## 6.5 Distortion tolerance/Flatness deviation

Deviations in surface flatness: 3 mm/m edge length

For laminated glass, the tolerances for local distortion remain in effect.

### *6.5.1 Area of Application*

This standard determines defects in the glass sheet, the interlayer and evaluation methods with reference to visual quality. Of particular note are the acceptance criteria in the vision area. These criteria are used on the product at time of delivery.

### *6.5.2 Standards reference*

This European Norm contains dated and un-dated references from other publications. These Standard references are noted in the text and the publications are subsequently stated. Fixed references may have later changes or revisions which must be incorporated. Where references are undated, the latest edition of the referenced publication is to be used.

DIN EN ISO 12543-1

Glass in Building - Laminated glass and laminated safety glass - Part 1: Definitions and description of component parts.

DIN EN ISO 12543-5

Glass in Building - Laminated glass and laminated safety glass - Part 5: Dimensions and edge finishing.

## sGGSTADIP - LAMINATED SAFETY GLASS

### 6.5.3 Definition

For the use of this standard the definitions in EN ISO 12543-1 as well as the following apply:

#### 6.5.3.1 Point-formed defects

This type of defect includes opaque spots, bubbles and foreign matter

#### 6.5.3.2 Linear defects

This type of defect includes scratches, grinding traces inclusions

#### 6.5.3.3 Other defects

Defects such as chips, and defects in the interlayer such as folds, shrinkage and stripes

#### 6.5.3.4 Opaque spots

Visible defects in laminated glass e.g. tin spots, inclusions in glass or the interlayer

#### 6.5.3.5 Bubbles

Generally air-bubbles found in the glass or interlayer

#### 6.5.3.6 Foreign matter

Any undesired matter which has found its way into the product during manufacture

#### 6.5.3.7 Scratches or grinding marks

Linear damage of the surface of the glass

#### 6.5.3.8 Chips

Sharp pointed cracks or splits which run from the edge into the body of the glass

#### 6.5.3.9 Folds

Disturbances which occur as a result of folding of the interlayer and which are visible after manufacture

## sGGSTADIP - LAMINATED SAFETY GLASS

### 6.5.3.10 Stripes due to heterogeneity in the interlayer

Optical disturbances in the interlayer caused by defects in the manufacture of the interlayer and are which become visible after lamination.

## 6.5.4 Surface defects

### 6.5.4.1 Point-formed defects in the visible area

Evaluation in accordance with the method of checking in Section 5.1.3 the permissibility of point-formed defects will depend upon the following:

- Size of the defect
- Frequency of the defect
- Size of the glass unit
- Number of sheets used in the laminated glass

These are shown in Table 24.

Defects smaller than 0.5 mm are not considered.

Defects larger than 3 mm are not permitted.

**NOTE:** The permissibility of point-formed defects in laminated glass is dependent on the thickness of the individual sheets.

**NOTE:** Bunching of defects is when 4 or more defects occur within a distance < 200 mm from each other. This distance reduces to 180 mm in three-sheet laminated glass, to 150 mm in four-sheet laminated glass and to 100 mm in five (or more)-sheet laminated glass.

The number of allowable defects in Table 24 is increased by 1 for an individual interlayer which is thicker than 2 mm.

Defect size d in mm		0,5 < d ≤ 1,0	1,0 < d ≤ 3,0			
			A ≤ 1	1 < A ≤ 2	2 < A ≤ 8	A > 8
Sheet size A in m <sup>2</sup>		for all sizes				
Number of allowable defects	2 sheets	no limit	1	2	1/m <sup>2</sup>	1,2/m <sup>2</sup>
	3 sheets	but not	2	3	1,5/m <sup>2</sup>	1,8/m <sup>2</sup>
	4 sheets	bunched	3	4	2/m <sup>2</sup>	2,4/m <sup>2</sup>
	≥ 5 sheets	defects	4	5	2,5/m <sup>2</sup>	3/m <sup>2</sup>

Tab. 24: Allowable point-formed defects in the visible area

## sGGSTADIP - LAMINATED SAFETY GLASS

### 6.5.4.2 Linear defects in the visible area

Evaluation in accordance with the method of checking in Section 6.5.9, the permissibility of linear defects is as given in Table 25.

Sheet size	Number of allowable defects with length $\geq 30\text{mm}$
$\leq 5 \text{ m}^2$	Not allowed
5 bis $8 \text{ m}^2$	1
$> 8 \text{ m}^2$	2

Tab. 25: Allowable linear defects in the visible area

Linear defects of less than 30 mm length are allowed.

### 6.5.5 Defects in the edge area of framed edges

In evaluating according to Section 6.5.9, defects which are not greater than 5 mm in diameter are allowable in the edge area. In units with an area  $\leq 5 \text{ m}^2$  the edge area is 15 mm. The edge area becomes 20 mm in units with an area  $> 5 \text{ m}^2$ . If bubbles are present the area with the bubbles must not exceed 5 % of the edge area.

### 6.5.6 Chips

Chips are not allowed

### 6.5.7 Folds and stripes

Folds and stripes in the visible area are not allowed

### 6.5.8 Defects in unframed edges

Laminated glass is typically installed in frames. Should it not be framed, then only the following types of edge finishing are possible:

- Ground edge
- Polished edge
- Mitred edge

To DIN EN ISO 12543-5

## SGGSTADIP - LAMINATED SAFETY GLASS

Under these conditions, shells, bubbles, defects in the interlayer and pull-in of the interlayer are allowable when they are not visible when checked to Point 6.5.9

Visible edges must be highlighted when ordering in order to achieve the best possible edge quality. The edge on which the glass stands in production remains noticeable.

Should the visible edge not be highlighted then interlayer-residue at the edge is allowed.

### 6.5.9 Evaluation methods

The laminated glass to be evaluated is to be viewed in front of and parallel to a grey background and in diffuse daylight (or equivalent lighting conditions.) The viewer is to stand at a distance of 2 m from the glass and look at the glass at an angle of 90° (whereby the matt background is on the other side of the glass).

Defects which are deemed as disturbing in this way of viewing must be marked. Subsequent evaluation is according to specification.

External glazing with free weathering of the glass edges may result in the hygroscopic nature of the PVB interlayer causing colour changes in the 15 mm edge zone - depending upon environmental conditions. This is product-specific and is permissible.

In laminated glass – with more than 4 layers (glass thickness 10 mm – single sheet) with SentryGlas interlayer, it is possible that the phenomenon of „Haze“ (milky clouding between the sheets) may occur. This is an effect of production which cannot be avoided and is therefore not considered as grounds for any claim.

In laminates and LITE-FLOOR with SentryGlas® interlayers, it is possible that under particular viewing conditions, anisotropy-like (see Point 7.4.4.2.3) dark spots, stripes and rings may be visible. These are a result of production methods and cannot be considered as defects or reasons for a claim.

### 6.5.10 Coloured interlayers

Loss of colour intensity may occur to coloured or matt interlayers over a period of time due to weather influences (e.g. UV-radiation). Therefore, supplies of glass subsequent to those of a similar type already installed may appear to have a slightly noticeable colour-difference. This is no grounds for any claim.

SGGSTADIP - LAMINATED SAFETY GLASS

### 6.5.11 Laminated safety glass with stepped edges

Generally, all laminated glass with stepped edges will have the interlayer-residue removed. In two-sheet laminates this is typically possible.

In laminates with three or more sheets and where the middle sheet(s) is/are recessed to the outer sheets, interlayer residue will be removed if the step depth and width is equal to the thickness of the middle sheet(s). All other step sizes will require specific approval of the production manager.

Interlayer residue, as long as it can be removed as described above, cannot be completely removed and can be no grounds for any claim. All other steps which are not described above may have interlayer residue which cannot be removed and which is also no grounds for any claim.

For applications where insertions into the laminate step is envisaged, the customer should provide a sample (or at least extreme dimensions) of the insertion.

As a result of lamination there may be some interlayer residue which may, when stored on supporting blocks, become deformed. This is no grounds for any claim.

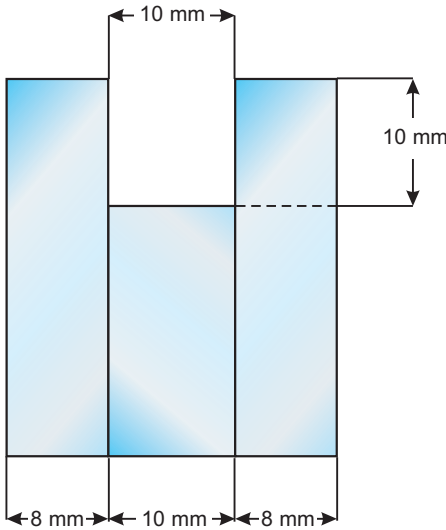


Fig. 21

## sGGSTADIP - LAMINATED SAFETY GLASS

### 6.5.12 Stadip Arte

Evaluation of the interlayer as well as the completed laminate.

The evaluation takes place from inside in diffuse daylight at a distance of 1.5 m.

View the interlayer perpendicular to the glass and for a period of 30 seconds. Folds in the interlayer which may be visible depending on light incidence and viewing angle are permissible - they are product-specific and could be a result of handling or transportation.

Allowable defects:

	Point-form defects	Linear defects
Maximum size of defect	2 mm	25 mm
Maximum amount per m <sup>2</sup>	6	-
Total defects per m <sup>2</sup>	-	100 mm
Maximum defects in a square 500 x 500 mm	4	80 mm

Tab. 26

## sGGCLIMAPLUS - INSULATED GLASS

## 7. sGGCLIMAPLUS - INSULATED GLASS

Should tolerances outside those covered in this Chapter occur then the following is applicable: DIN 1286-1/-2

ÖNORM EN 1096-1

ÖNORM B 3738

EN ISO 1279

Guideline for the evaluation of the visual quality of Insulated Glass according to Hadamar.

Guideline for the evaluation of the visual quality of Glass in Building published by BIV and BF - June 2004 Edition

Guideline for the application and processing of sGGSTADIP Silence®.

### 7.1 Edge seal

The completion of the edge seal is in accordance with the system specification for sGGCLIMALIT.

The tolerance for spacer bar location relative to the glass edge is +/- 2.5 mm

The seal or adhesive compound of the element may not encroach more than 2 mm more than the edge seal into the cavity and onto the glass.

In corners and spacer-connecting locations as well as with the use of special glass (e.g. cast glass) it is unavoidable that either seal or adhesive compound may intrude into the cavity or onto the inner glass surface. This is technically conditional and can be no grounds for a claim for defectiveness.

### 7.2 Thickness tolerance at edge seal

Composition	Thickness tolerance
Two sheets	± 1,0 mm
Three sheets	± 2,0 mm
sGGSECURIT FT glass	± 1,5 mm
sGGSTADIP laminated	± 1,5 mm
with curved sheets	+ 3,0 mm / - 1,5 mm

Tab. 27

### 7.3 Dimensional tolerance / shift tolerance

#### 7.3.1 Dimensional tolerances

In accordance with the basis products plus shift (see 7.3.2)



## sGGCLIMAPLUS - INSULATED GLASS

## 7.3.2 Shift

### 7.3.2.1 Rectangles

≤ 2000 mm edge length	2,0 mm
2001 - 3500 mm edge length	2,5 mm
> 3500 mm edge length	3,0 mm

Tab. 28

### 7.3.2.2 Shapes

≤ 2000 mm edge length	2,0 mm
2001 - 3500 mm edge length	3,0 mm
> 3500 mm edge length	4,0 mm

Tab. 29

## 7.4 Edge deletion

Dependent on the type of coating, the coating will be deleted from the edge of the unit - normally by grinding. There may be residue from grinding which will cause this are to appear different from the non-coated area. This also applies to stepped edges of insulated glass.

### 7.4.1 Tempered safety glass with cut sized coating

For double glazed units with combinations of toughened glass and coatings, it cannot be guaranteed that the coating can be removed completely from the outer pane. This remaining coating is technically not avoidable by our sub-suppliers and according the state of the art. These areas corrode and wheather automatically after some time.

## 7.5 Spacer bar

Applications of bent and joined spacer bars are used which, depending on the method of production and type of material used, will appear different. Dependent on the process used, gas-filling plugs may be visible in the spacer bar.

The colour of the spacer bar will influence the behaviour of reflections at the edge of the unit.

Regulations state that the spacer bar must show identification of the insulated unit. The size, colour and type of identification may vary according to the process used.

The tolerance for spacer bar location relative to the glass edge is +/- 2.5 mm.

## sGGCLIMAPLUS - INSULATED GLASS

## 7.6 Guideline for the visual evaluation of quality

### Guideline for the evaluation of visual quality of glass in building

National Association of Glass producers, Hadamar

National Association of Glaziers and Window-makers, Hadamar

National Association of Float Glass wholesalers, Insulated glass manufacture, processing, Troisdorf

National Association of Glass Industry and Mineral fibre industry, Düsseldorf

This guideline has been produced by the Technical Department of the Institute for Glazing technology and window makers, Hadamar and the technical committee of the Association of Float Glass wholesalers, Insulated glass manufacture, processing, Troisdorf. Status: June 2004

#### 7.6.1 AREA OF APPLICATION

This guideline applies to the visual quality assessment of insulating glass for the building industry. The assessment is carried out in accordance with the evaluation principles described below using the allowances specified in the table 30 to Section Point 7.6.3.

The visible glass area, which remains when it has been installed, is to be assessed. Insulated glass units with coated, body-tinted, laminated glass or tempered glass (FT or HS) can also be evaluated with the help of the table 30 to Section Point 7.6.3.

The guideline applies only to a limited extent to insulating glass in special applications such as insulating glass with profiles in the cavity (muntin bars), insulating glass with elements built into the cavity (reflectors etc.), insulating glass using cast glass, anti-bandit glass and fire-resisting glass. These glass products must be assessed subject to the materials used, the production processes and the respective manufacturer's instructions.

The evaluation of the visual quality of edges of processed glass is not part of this guideline. For units that are not completely framed, the evaluation criteria of edge zone is omitted. The intended use is to be given at time of order.

For the evaluation of the external appearance of glass in facades it is necessary to specify particular requirements.

## sGGCLIMAPLUS - INSULATED GLASS

### 7.6.2 Evaluation

Generally when checking for defects the vision through the glass, i.e. looking at the background and not the surface view is crucial. For this, the defects must not be specially marked.

The evaluation of the glazing units in accordance with the table 30 following Section Point 7.6.3. must be carried out at a distance of approx. 1 m from inside to outside and from a viewing angle which is the typical room utilization.

The inspection is performed during diffuse daylight (e.g. overcast) without direct sunlight or artificial lighting.

Interior glazing should be inspected in diffuse and typical for that application lighting, viewing perpendicular to the glazing.

The glazing is to be evaluated from outside (outside view) at the same standard distance.

Evaluation methods and viewing distances may vary according to specific product for particular glazing applications which are not covered herein. It is often that the given checking methods cannot be achieved on a project.

### 7.6.3 Allowances for the visual quality of glass in building

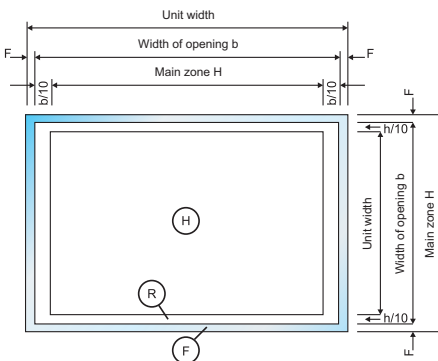


Fig. 22

- F = rebate zone: width 18 mm (with the exception of mechanical edge damage, no restrictions)
- R = edge zone: area 10 % of the opening width and height (less stringent evaluation)
- H = main zone (most stringent evaluation)

## SGGCLIMAPLUS - INSULATED GLASS

Table compiled for Float glass, tempered, heat-strengthened, laminated, laminated safety glass either coated or uncoated.

Zone	Permissible per unit are:
F	Outer area and edge damage or shells, which do not affect the strength of the glass and do not exceed the edge seal depth.
	Inner-lying shells without loose shards, which have been filled using sealants.
	Pointed and flat residues, as well as scratches are unlimited.
R	<b>Inclusions, bubbles, spots, stains etc.:</b>
	Sheet area $\leq 1 \text{ m}^2$ : max. 4 number $\dot{a}$ $< 3 \text{ mm } \emptyset$
	$1 \text{ m}^2 < \text{glass area} \leq 3 \text{ m}^2$ : max. 5 number $\dot{a}$ $< 3 \text{ mm } \emptyset$
	$3 \text{ m}^2 < \text{glass area} < 5 \text{ m}^2$ : max. 6 number $\dot{a}$ $< 4 \text{ mm } \emptyset$
	Glass area $> 5 \text{ m}^2$ : max. 8 number $\dot{a}$ $< 5 \text{ mm } \emptyset$
	<b>Residues (pointed) in the cavity :</b>
	Sheet area $\leq 1 \text{ m}^2$ : max. 4 number $\dot{a}$ $< 3 \text{ mm } \emptyset$
	$1 \text{ m}^2 < \text{glass area} \leq 3 \text{ m}^2$ : max. 5 number $\dot{a}$ $< 3 \text{ mm } \emptyset$
	$3 \text{ m}^2 < \text{glass area} < 5 \text{ m}^2$ : max. 6 number $\dot{a}$ $< 4 \text{ mm } \emptyset$
	glass area $> 5 \text{ m}^2$ : max. 8 number $\dot{a}$ $< 5 \text{ mm } \emptyset$
	<b>Residues (flat) in cavity:</b> whitish grey or transparent
	glass area $\leq 1 \text{ m}^2$ : max. 1 number $\leq 4 \text{ cm}^2$
	$1 \text{ m}^2 < \text{glass area} \leq 3 \text{ m}^2$ : max. 2 number $\leq 4 \text{ cm}^2$
$3 \text{ m}^2 < \text{glass area} \leq 5 \text{ m}^2$ : max. 3 number $\leq 4 \text{ cm}^2$	
glass area $> 5 \text{ m}^2$ : max. 5 number $\leq 4 \text{ cm}^2$	
<b>Scratches:</b>	
Glass area $\leq 1 \text{ m}^2$ : Sum of individual lengths: max. 60 mm - Individual length max: 30 mm	
$1 \text{ m}^2 < \text{Glass area} \leq 3 \text{ m}^2$ : Sum of individual lengths: max. 90 mm - Individual length max: 40 mm	
$3 \text{ m}^2 < \text{Glass area} \leq 5 \text{ m}^2$ : Sum of individual lengths: max. 120 mm - Individual length max: 40 mm	
Glass area $> 5 \text{ m}^2$ : Sum of individual lengths: max. 160 mm - Individual length max: 60 mm	
<b>Hairline scratches:</b> not allowed bunched together	
H	<b>Inclusions, bubbles, spots, stains etc.:</b>
	Sheet area $\leq 1 \text{ m}^2$ : max. 3 number $\dot{a}$ $< 2 \text{ mm } \emptyset$
	$1 \text{ m}^2 < \text{Glass area} ? 3 \text{ m}^2$ : max. 4 number $\dot{a}$ $< 3 \text{ mm } \emptyset$
	$3 \text{ m}^2 < \text{Glass area} < 5 \text{ m}^2$ : max. 6 number $\dot{a}$ $< 3 \text{ mm } \emptyset$
	Glass area $> 5 \text{ m}^2$ : max. 8 number $\dot{a}$ $< 4 \text{ mm } \emptyset$
	<b>Residue (flat) in cavity:</b> whitish grey or transparent
	Glass area $\leq 1 \text{ m}^2$ : max. 1 number $\leq 3 \text{ cm}^2$
	$1 \text{ m}^2 < \text{Glass area} \leq 3 \text{ m}^2$ : max. 2 number $\leq 3 \text{ cm}^2$
$3 \text{ m}^2 < \text{Glass area} \leq 5 \text{ m}^2$ : max. 3 number $\leq 3 \text{ cm}^2$	
Glass area $> 5 \text{ m}^2$ : max. 5 number $\leq 3 \text{ cm}^2$	

## sGGCLIMAPLUS - INSULATED GLASS

Zone	Permissible per unit are:
H	<b>Scratches:</b>
	Glass area $\leq 1 \text{ m}^2$ : Sum of individual lengths: max. 40 mm - Individual length max: 20 mm
	$1 \text{ m}^2 < \text{Glass area} \leq 3 \text{ m}^2$ : Sum of individual lengths: max. 60 mm - Individual length max: 30 mm
	$3 \text{ m}^2 < \text{Glass area} \leq 5 \text{ m}^2$ : Sum of individual lengths: max. 90 mm - Individual length max: 30 mm
	Glass area $> 5 \text{ m}^2$ : Sum of individual lengths: max. 20 mm - Individual length max: 30 mm
	<b>Hairline scratches:</b> not allowed bunched together
R + H	Maximum quantity of allowances as for Zone R
	Inclusions, bubbles, spots and stains etc from 0.5 to $< 1.0 \text{ mm}$ are permitted without any area restriction, except for bunched occurrences.
	A bunched occurrence exists, if at least 4 inclusions, bubbles, spots and stains etc. are present within a circular area of diameter $\leq 20$ .

Tab. 30

**NOTES:**

- Defects  $\leq 0,5 \text{ mm}$  will not be considered. Areas of distortion occurring must not be larger than 3 mm.
- In addition to the allowances in the above table, SKN or Xtreme coatings is allowed to have 2 additional inclusions, bubbles, spots etc. with a maximum diameter of 3 mm within Zone H.

**Laminated and laminated safety glass:**

- The allowances of Zone R and H increase in frequency per layer of glass by 50 %.
- In resin poured sheets, production related waving can occur.

**Tempered safety glass, heat-strengthened glass as well as laminated glass and laminated safety glass of tempered or heat-strengthened glass:**

- The local distortion on the glass surface - except tempered or heat-strengthened cast glass - is not allowed to exceed 0.3 mm over a 300 mm measuring length.
- The bow over the complete edge length except tempered or heat-strengthened cast glass - is not allowed to exceed 3 mm per 1000 mm of edge length. Other lower requirements must be specifically agreed. Units that are square with an aspect ratio between 1:1.5 and thin sheets  $< 6 \text{ mm}$  will have greater deviation from flatness.

## sGGCLIMAPLUS - INSULATED GLASS

### 7.6.4 General information

The guideline represents an assessment standard for the visual quality of insulating glass in building. When assessing an installed glass product it must be assumed that apart from the visual quality also the characteristics of the glass product with regard to performing its functions must be considered.

Characteristics of glass products such as acoustic value, energy and light transmittance, relate to tested units in accordance with the respective standard. Other sizes, combinations as well as application and external influences may cause the given values to change or the visual appearance to change.

The multitude of the various glass products does not allow that the table 30 following Section Point 7.6.3 can be applied without restrictions. A product-related assessment may be required. In such cases, e.g. for anti-bandit glazing the particular requirement characteristics must be assessed as a function of the utilization and installation situation. When assessing certain characteristics the specific properties must be considered.

#### 7.6.4.1 Properties of glass products

##### 7.6.4.1.1 Inherent colour

All materials used for glass products possess raw material-related inherent colours, which can become more obvious with increasing thickness. In order to meet legal requirements with regard to energy saving, coated glass is used.

Coated glass also has an inherent colour. This inherent colour can be variably noticeable when looking through the glass and/or when surface viewing. Fluctuations of the perceived colour are possible due to the iron oxide content of the glass, the coating process as well as due to changes to glass thicknesses and unit composition, and cannot be avoided.

##### 7.6.4.1.2 Colour differences of coatings

An objective evaluation of colour difference in transparent and non-transparent coatings requires measurement and checking of the colour difference under exactly defined conditions (glass type, colour, light condition). Such an evaluation cannot be part of this guideline. Colour differences in coating types – both temperable and non-temperable – cannot be excluded and are not grounds for any claim

##### 7.6.4.1.3 Insulating Glass with inner profiles (muntin bars)

Due to environmental influences (e.g. climatic conditions) as well as vibrations or manually initiated oscillations, vibration noises from the profiles can temporarily occur.

## sGGCLIMAPLUS - INSULATED GLASS

Visible saw-cuts and minor paint separations in the cutting area are production-related. Deviations from the squareness within the field divisions must be assessed generally subject to the manufacturing and installation tolerances.

Effects of temperature related length changes on cavity profiles are typically unavoidable.

#### *7.6.4.1.4 Assessment of the visible area of edge seals*

In the visible area of edge seals and therefore outside the visible glass area production-related characteristics can be noticeable on the glass itself and the spacer bar of insulating glass (e.g. Litewall ISO, Vario, Insulated glass with UV-resistant edge seals)

Particularly with different coloured sealants (e.g. grey butyl and grey silicone) it is possible that processing techniques may cause unusual characteristics.

In particular the following product characteristics may be visibly noticeable:

Insulated glass with selective solar and thermal control coatings show maximum transmission in the range of visible light (380-700 nm) and high reflection in the range of infra-red light (> 780 nm).

In the transition range of long-wave light from 650 - 780 nm, the reflection is seen by the human eye, depending on viewing angle, as a reddish, bluish or greenish colour.

Because the coating is backed by the primary and secondary seal at the edge of the unit, this visual recognition of colour is increased. As a result of spacer bar location and seal depth tolerances as well as tolerances in edge-stripping of the coating, the width of the colour band may differ.

Where extra-wide edge-stripping (stepped units) special bonding and/or with Silicone-smear surfaces techniques are required, it is possible that a heterogeneous appearance occurs at the edge seal.

Depending on the glazing system, it is also possible that this may occur on the sides of the glass or where mechanical restraints are placed.

Impurities in the cavity

In the main zone and in the edge zones, no visible impurities shall be allowed.

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

## sGGCLIMAPLUS - INSULATED GLASS

#### 7.6.4.1.5 Outer surface damage

The cause of any mechanical or chemical damage to outer surfaces, which is found after installation, must be determined. Such defects can also be assessed according to Section Point 7.6.3.

Moreover, the following standards and guidelines with others are applicable:

- Technical Guidelines of the Glazing Industry
- VOB DIN 18361 "Glazing work"
- DIN EN 572 "Glass in building"
- Product standards for the viewed products
- Notes on cleaning which have been established by the national glass association and the respective specifications and installation instructions of the manufacturers.

#### 7.6.4.1.6 Physical Features

The following unavoidable physical phenomena which may be visible in the glass are exempt from assessment of the visual quality:

- Interference phenomena
- Brewster's fringes
- Anisotropy
- Condensation on outer glass surfaces (dew formation)
- Moisture-adhesion on glass surfaces

#### 7.6.4.2 Explanation of Terms

##### 7.6.4.2.1 Interference phenomena

With insulating glass made from float glass it is possible that interference in the form of spectral colours can occur. Optical interference is interference fringes of two or more light waves which intersect at one point.

They appear in the form of more or less intensely coloured zones, which change when pressure is applied to the sheet. This physical effect is intensified by the plane-parallel configuration of the glass surfaces. This plane-parallel configuration provides a distortion-free vision area. Interference phenomena occur accidentally and cannot be influenced.

##### 7.6.4.2.2 Double-sheet effect/Brewster's fringes

Insulating glass possesses an air/gas volume enclosed by the edge seal, the condition of which is determined in essence by the barometric air pressure, the altitude of the production plant above sea level as well as the current air temperature at the production plant site.



## sGGCLIMAPLUS - INSULATED GLASS

If insulating glass is installed at other altitudes, if temperature changes and fluctuations of the barometric air pressure (high and low pressure) occur, concave or convex deflections of the individual sheets and thus optical distortions are the result.

Multiple reflections can also occur in various intensities on surfaces of insulating glass.

These reflections are more recognisable, if for example the background of the glazing is dark or if the glass has been coated.

This phenomenon is a physical principle for all insulating glass units.

#### 7.6.4.2.3 Anisotropy

Anisotropy represents a physical effect for tempered glass resulting from the internal stress distribution. The perception of dark coloured rings or stripes, resulting from the viewing angle is possible during polarized light and/or viewing through polarized glasses. Polarized light is present in normal daylight. The magnitude of the polarization is dependent on the weather and solar altitude. The double refraction becomes more noticeable using a flat viewing angle or also with glass facades facing at right angles.

#### 7.6.4.2.4 Condensation on outer pane surfaces (dew formation)

Condensation can form on outer glass surfaces, if the glass surface has a lower temperature than the ambient air (e.g. fogged-up car windows).

Condensation formation on the inner glass surface of the insulating glass pane is caused by lack of air circulation e.g. by deep recesses, curtains, flowerpots, flower boxes, Venetian blinds as well as by disadvantageous installation of heating elements.

For insulating glass with good thermal insulation, condensation can form temporarily on the glass surface exposed to weathering, if the external humidity (relative humidity outside) is high and the air temperature is higher than the temperature of the glass surface.

#### 7.6.4.2.5 Moisture-retention on insulating glass

Moisture-retention on glass surfaces on the outside of the insulating glass can vary e.g. due to imprints from rollers, fingers, labels, paper textures, suction pads, sealant residues, smoothing agents, parting agents or environmental influences.

Varying degrees of moisture-retention can become apparent on moist glass surfaces as a result of condensation, rain or cleaning water.

## INTERIOR

## 8. INTERIOR - Product tolerances for interior applications

ECKELT manufactures products which can also be used for interior applications - such as recessed doors in all-glass constructions - which have been conceived only for this application.

Experience shows that glass used for furniture (or similar) is expected to be of a higher standard of optical quality.

To simplify the management of orders we have determined the following Interior tolerances for machining and products:

- A) All-glass doors and door assemblies:  
Should glass be ordered in accordance with All-glass terms, the Interior tolerances as described below are applied
- B) Other products:  
Should glass be ordered as "Interior quality" then the glass will be billed with a 5 % surcharge added.

During production the Interior tolerances as described below are then applied.

### 8.1 Basis glass

See Chapter 1

### 8.2 Cutting to size

See Chapter 2

### 8.3 Machining

See Chapter 3. Deviations and limitation on special tolerances (Point 3.1.1.2) are listed below. No edge damage is permissible.

#### 8.3.1 Dimensional tolerances

For rectangles in all glass thicknesses

≤ 1000 mm edge length	+ 1,0 mm / - 1,5 mm
1001 - 3000 mm edge length	+ 1,0 mm / - 2,0 mm

Fig. 31

## INTERIOR

## 8.4 HST-FT, Heat-Strengthened glass

See Chapter 4. Deviations and limitation on special tolerances (Points 4.1, 4.2 and 4.3.2) are listed below.

### *8.4.1 General distortion*

0.15 % of the measured length

### *8.4.2 Local distortion*

0.18 mm over 300 mm measured length

The measurement is to be taken at least 25 mm from the glass edge

### *8.4.3 Guideline for the visual evaluation of Tempered*

#### *Safety Glass, HST-FT, HS*

The guideline under Point 4.3 is applicable, deviations as follows:

Evaluation as under 4.3.2, however, defects  $\leq 0.5$  mm in bunches are not permissible.

## INTERIOR

## 8.5 Screenprint and Enamel

See Chapter 5, from which the following deviations and limited particular tolerances are listed as follows.

Point and/or linear defects in Enamel:

Number: max. 3,

from which none > 9 mm<sup>2</sup> (equates to 3x3 mm)

applicable up to glass of area up to 2 m<sup>2</sup>, each additional 2m<sup>2</sup> results in double the amount of allowable defects

Point and/or linear defects in Screenprint:

Number: max. 3,

from which none > 9 mm<sup>2</sup> (equates to 3x3 mm)

applicable up to glass of area up to 2 m<sup>2</sup>, each additional 2m<sup>2</sup> results in double the amount of allowable defects

## 8.6 Laminated Safety Glass

See Chapter 6, from which the following deviations and limited particular tolerances with regards to Point 6.2 are listed as follows

### 8.6.1 Shift tolerance

Applicable for rectangles with two sheets for all glass thicknesses.

≤ 1000 mm edge length	+1,5 mm / -2,0 mm
1001 - 3000 mm edge length	+1,5 mm / -2,5 mm

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## SSG BONDING TOLERANCES AND TOLERANCES FOR INTEGRATION OF FITTINGS

# 9. SSG Bonding tolerances and tolerances for integration of fittings

## 9.1 Thickness tolerance

Thickness tolerances for basis products as applicable, see also:

Monolithic glass - Chapter 1 - Table 1

Laminated glass - Chapter 6 - Point 6.3

Insulated glass - Chapter 7 - Point 7.2

Additionally +/- 2 mm bonding tolerance

## 9.2 Dimensions of bonding tolerance

### 9.2.1 SSG Bonding with monolithic glass

Pre-requisite is always a fine ground or polished edge

Rectangles:

≤ 2000 mm edge length	± 2,0 mm
2001 - 4000 mm edge length	± 3,5 mm
> 4000 mm edge length	± 5,0 mm

Tab. 33

Shapes and bent glass:

≤ 2000 mm edge length	± 4,0 mm
2001 - 4000 mm edge length	± 5,5 mm
> 4000 mm edge length	± 7,0 mm

Tab. 34

## SSG BONDING TOLERANCES AND TOLERANCES FOR INTEGRATION OF FITTINGS

### 9.2.2 SSG Bonding with laminated glass

Pre-requisite is always a fine ground or polished edge

Rectangles:

≤ 2000 mm edge length	± 3,0 mm
2001 - 4000 mm edge length	± 4,5 mm
> 4000 mm edge length	± 6,0 mm

Tab. 35

Shapes and bent glass:

≤ 2000 mm edge length	± 5,0 mm
2001 - 4000 mm edge length	± 6,5 mm
> 4000 mm edge length	± 8,0 mm

Tab. 36

### 9.2.3 SSG Bonding with insulated glass

Pre-requisite is always that the outer sheet has a fine ground or polished edge

Rectangles:

≤ 2000 mm edge length	± 2,0 mm
2001 - 4000 mm edge length	± 3,5 mm
> 4000 mm edge length	± 5,0 mm

Tab. 37

Shapes and bent glass:

≤ 2000 mm edge length	± 4,0 mm
2001 - 4000 mm edge length	± 5,5 mm
> 4000 mm edge length	± 7,0 mm

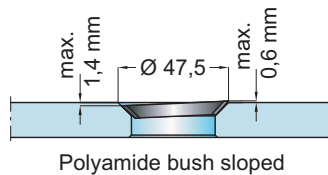
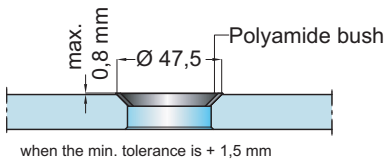
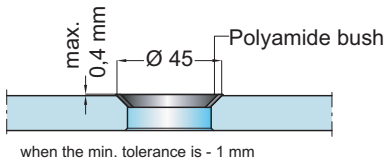
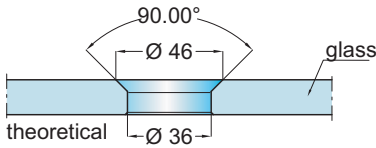
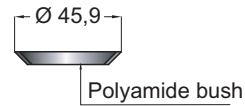
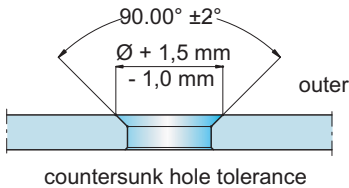
Tab. 38

## SSG BONDING TOLERANCES AND TOLERANCES FOR INTEGRATION OF FITTINGS

### 9.3 Application of Fittings / ironmongery

For ironmongery and fittings that are to be fixed into countersunk holes, tolerances from Chapter 3 - Point 3.3.1 are applicable.

Possible installation locations of fittings  
e.g. **MULTIPOINT**



countersink with 90 °

Fig. 23

## SSG BONDING TOLERANCES AND TOLERANCES FOR INTEGRATION OF FITTINGS

Possible installation locations or fittings  
e.g. **LITEWALL MONO**

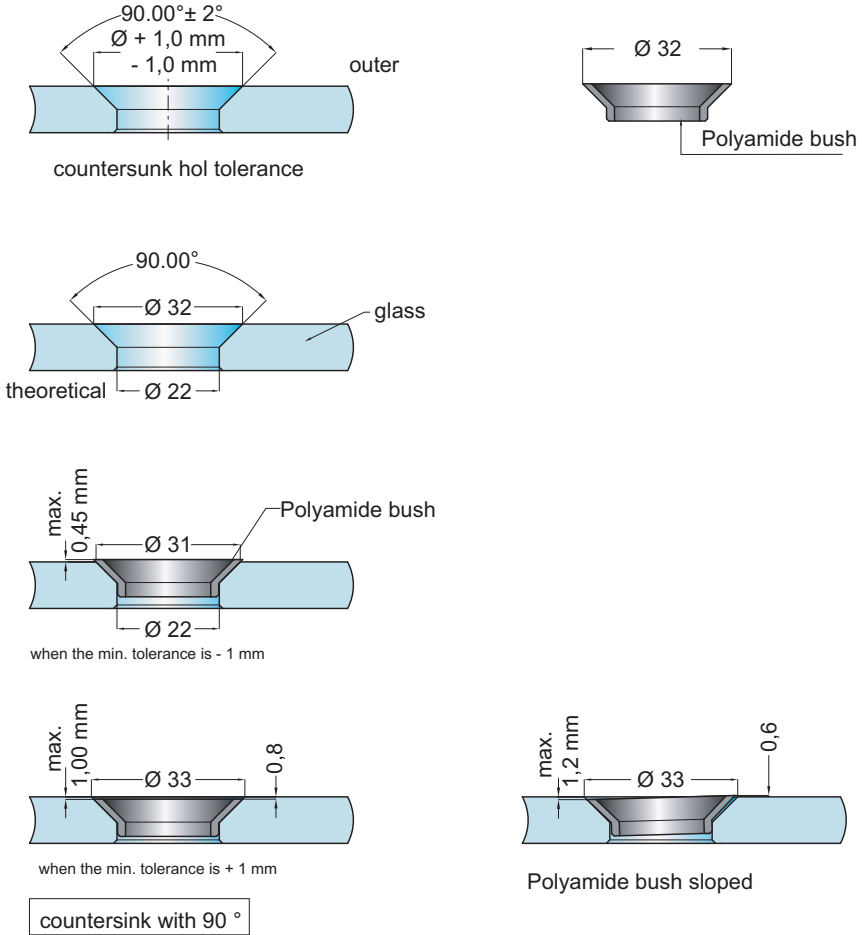


Fig. 24



## 10. sGGBIOCLEAN

### 10.1 Tolerances and visual evaluation

#### 10.1.1 *Visual evaluation*

A visual evaluation of the glass can only be carried out when the glass surface is dry.

Scratches, coating defects and surface defects are evaluated on the dry glass in accordance with EN 1096. When the glass is coated with water/wet, scratches, coating defects, surface defects, transport roller residue, sticker residue, finger-prints etc. may be obvious as a result of the defective coating performance (the film of water is broken by the scratches). These are no reasons for any claim.

Residue from transport rollers disappear from experience generally after a number of activations through sunlight and do not have any detrimental effects on the performance of the coating. The smallest surface defects caused by the coating being transported on furnace rollers may result in irreparable performance breakdown in the coating function.

All the above mentioned situations are normally only obvious when the glass is covered in water as no film of water will form on these areas. Improvement is possible if cleaned with acetone.

#### 10.1.2 *Tolerances*

Colour rendition measurements in accordance with CIELAB have been carried out between annealed and tempered glass showing deviances of up to 3.3 DE (coating side). Colour rendition deviances of this value between annealed and tempered sGGBIOCLEAN glass give no grounds for any claim.

## 11. sGGSATINOVO

The visual evaluation of the etched surface is to be carried out in diffuse daylight without direct sunlight or artificial lighting, at a distance of at least 2 m and at a viewing angle which represents the typical use of the room. Should tolerances outside those covered in this Chapter occur then the following is applicable: EN 572-2 and Guideline for the evaluation optical quality of glass in buildings.

TYPE	DEFINITION	TOLERANCES	
SHADOW EFFECTS	Tone difference in the acid etching in parts of the glass	not allowed	
STRIPES	Some waves of differing horizontal or vertical tone in the acid etching in parts of the glass.	not allowed	
TRANSPARENT AND TRANSLUCENT AREAS	Areas without acid etching and translucent which cause aesthetic blemishes in the glass.	Diameter of pinhole	Number
		≤ 1 mm	Unrestricted
		> 1 mm bis ≤ 3 mm	0,6/m <sup>2</sup> , max. 12/sheet
		> 3 mm bis ≤ 5 mm	0,25/m <sup>2</sup> , max. 5/sheet
ROLLER TRACES	A small translucent line which forms a boundary between two areas of the same tone of acid etching	not allowed	
WHITE SPOTS ON THE ETCHED SURFACE	a limited area with a diameter less than 3 mm with differing etch character.	allowed up to a maximum allowed up to a maximum d < 3 mm and they are not bunched in an area of < 1 m <sup>2</sup>	
ACID ETCHED SPOTS ON UN-ETCHED SIDE	acid etching on the non-etched surface	allowed when the patch is < 3 cm from glass edge	
SCRATCHES	Scratches on the etched surface	See Guideline for the evaluation of visual quality of glass in building.	

Tab. 39

## 12. sGGVISION-LITE

### 12.1 Surface quality and Visual evaluation

#### **DURABILITY:**

The coating sGGVISION-LITE fulfills the durability criteria Class A to the European Standard EN 1096-2.

The official tests were carried out at Institut National du Verre (INV, National Glass Institute) in Belgium: Test Report INV Nr. 02/BE.213 and Nr. 02/Be.214 from 24. July 2002.

#### **DEFECTS:**

The coating sGGVISION-LITE fulfills the criteria of Standard EN 1096-1: Acceptance criteria for defects in coated glass (Dots, Pinholes, punctiform defects, scratches).

- Notes: Pinholes look "shiny", because the reflection of the glass is higher in these areas because of missing coating. Punctiform defects are, when of similar quality, less visible than in sGGCOOL-LITE, because the light transmission seldom changes. Inclusions in laminates are however more obvious than in conventional laminates because of the better vision through the glass (much less light reflection and higher transmission).

Dirt, finger prints (which are difficult to remove), Hairline scratches, punctiform defects, etc. , are therefore more obvious and are no grounds for a claim.

The same applies when the glass is wet - in addition deposits from stickers, cork spacers and suction cups are visible. These are also no grounds for a claim.

#### **Reflection characteristics:**

- The colour of the remaining light reflection is slightly pink/pale violet, this reflection is only obvious in certain lighting conditions and brightness differences between inside and outside and dependent on the surroundings.
- The reflection of SGG VISION-LITE in monolithic glazing is less than 1%. This reflection is actually normally less. In all cases it is extremely weak, and the difference in the values is not obvious with the naked eye.  
(Note: This value is measured perpendicular to vertical glazing).

## sggVISION-LITE PLUS

- The reflection of a sggVISION-LITE glass is, independent from angle of vision, less than that of uncoated glass; the effect is greatest when one views the glass at right angles. This effect reduces with the angle of viewing and becomes almost zero when viewed from a flat angle.

## 12.2 Installation and cleaning

### Protection from soiling

The glazing must be protected on the construction site from soiling and material splatters such as concrete, plaster and render.

Should soiling to the glass occur, it should be rinsed thoroughly with clean water and wiped dry using a clean cloth or clean, unused squeegee.

### Regular cleaning

In order to maintain the reflection-protection, it is necessary to carry out regular cleaning, depending on the level of soiling. Cleaning is to be carried out using a lot of water and a neutral cleaning agent. Sponges, leather cloths, cloths or clean unused rubber squeegees can be used; these tools should be regularly cleaned during the cleaning process in order to ensure that dirt does not scratch the coating. For the same reason, the water should be changed more often than usual.

## 13. DLS ECKLITE

### Guideline for assessment of the visual quality of DLS ECKLITE elements

#### 13.1 Area of validity

These guidelines cover the evaluation of visual quality of the DLS ECKLITE SC louver elements within the insulated glass cavity. Evaluation will be of the louvre blind with all associated and visible parts. Evaluation of the insulated unit is to be carried out using the relevant chapter.

Evaluation is carried out on the following basis with assistance of subsequent tables and information. The remaining visual room-side and external surface of the louvre blind will be evaluated.

#### 13.2 Control

##### *13.2.1. Basis of evaluation*

Decisive in the evaluation is the surface of the louvres, the surface and coating of the blind box, the location of the louvres in pulled-up as well as lowered positions, the room-side and external surface of the protection profile as well as the surface of the end-profile.

##### *13.2.1.1 Evaluation angle*

The initial check is carried out with the blinds closed, whereby no direct sunlight is allowed to play on the louvers. Following this the louvers are to be checked in their opened position (approx. 45°). Viewing is to be carried out at a distance of one meter at a viewing angle which represents the normal use of the room.

DLS ECKLITE

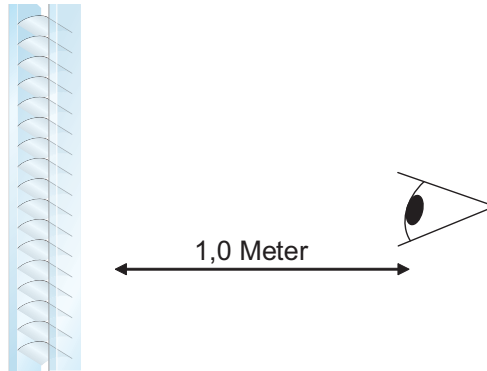


Fig. 25

13.2.1.2 Evaluation area

The surfaces to be viewed are to be divided into perimeter and main zones. The perimeter zone is 1/10 of the height and upper width. The main zone is the remaining visible area minus the perimeter zone. The defects are divided into linear and punctiform defects.

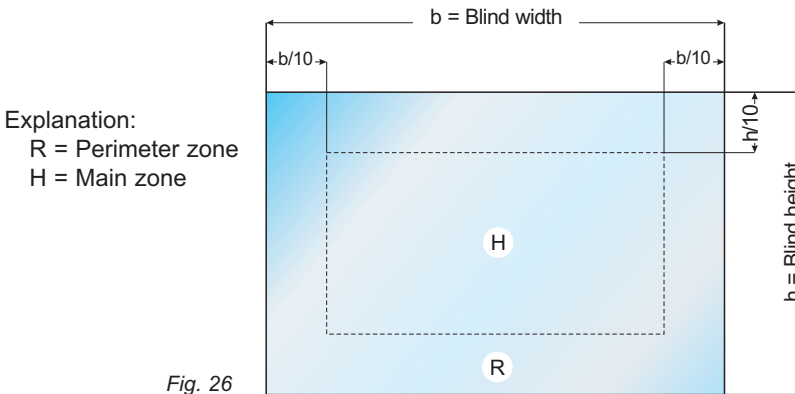


Fig. 26

## DLS ECKLITE

### *Allowable defects in the perimeter zone:*

Only defects visible from one meter distance will be evaluated.

- Linear defects  $\leq 20$  mm, max. width 0,3 mm are permissible however, they are not allowed to be bunched
- Sum of the individual lengths must not exceed 40 mm
- Punctiform defects (inclusions, bubbles, spots, coating defects, debris etc.) up to 1,0 mm in the main zone and 3 defects up to 1,5 mm per running meter in the perimeter zone are permissible however, they are not allowed to be bunched

### *Allowable defects in the main zone:*

Only defects of in the following criteria and visible from one meter distance will be evaluated.

- Linear defects  $\leq 10$  mm , max. width 0,3 mm are permissible however, they are not allowed to be bunched.
- Sum of the individual lengths must not exceed 20 mm
- Punctiform defects (inclusions, bubbles, spots, coating defects, debris etc.) up to 0,5 mm in the main zone and 2 defects up to 1,0 mm per square meter in the perimeter zone are permissible however, they are not allowed to be bunched

### *Dimensional accuracy of the blind and blind box:*

Length tolerance head profile +/- 1 mm

Length tolerance Louvre and End plate

Width B [m]	Tolerance [mm]
$B \leq 2,0$	+/- 2
$2 < B \leq 4$	+/- 4

Tab. 40

Length tolerance Packet height (pulled up)

Glass height H [m]	Tolerance [mm]
$H \leq 2$	+/- 5
$2 < H \leq 4$	+/- 8

Tab. 41

## DLS ECKLITE

## 13.2.1.3 Squareness

When the blind is still, there is an additional deviance from the vertical or horizontal at each point between the fully closed and opened position.

Aspect ratio from B to H 1 : < 2,5 max. 10 mm

B to H 1 : > 2,5 max. 15 mm

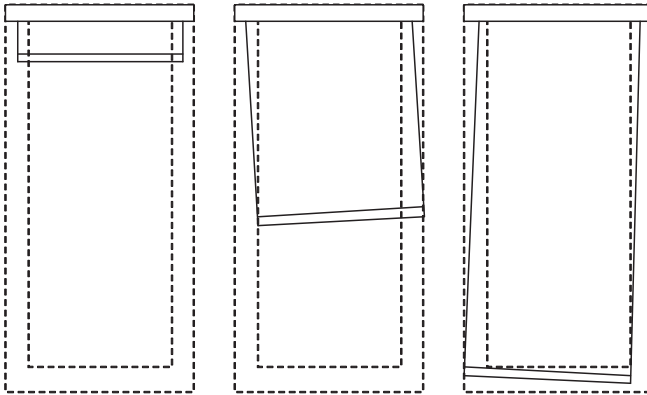


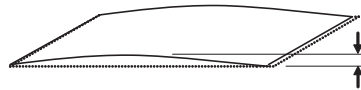
Fig. 27

## 13.2.1.4 Shape tolerances - Louvres

a) Warping



b) Bending



c) Twisting

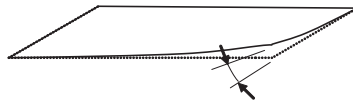


Fig. 28

Type of deformation		Tolerances	
Warping	C [mm] L [m]	a	$C = 0,5 \cdot L^2$
Bending	opened	b	max. 15 mm
	closed		$L \leq 1,5m$ b = 5 mm $1,5 < L \leq 2,5m$ b = 10 mm
Twisting		c	$5^\circ/m$

Tab. 42



## DLS ECKLITE

### 13.2.1.5 *Uniform movement*

If there are several DLS ECKLITE elements glazed next to each other, it is possible, as a result of running-time differences, the end switch point will be reached differently, as well as intermediate positions having slightly different locations.

DLS ECKLITE SC xx-ENC and DLS ECKLITE EVOLUTION has the ability to regulate this situation depending on the system.

## 13.2.2. *Particulars*

### 13.2.2.1 *Raising and lowering*

During raising and lowering it is possible that the guiding cords get caught between louvres. This may cause a distorted image of the louvre blind.

When lowering the louvres it is possible that the lower portion has individual blades that do not sit cleanly in the guide, resulting in increased light intrusion. The louvres will sit cleanly in the same direction only upon automatic reversal when they reach the end strike.

It is possible during movement and in all intermediate positions, that the blind does not hang perfectly horizontal.

This characteristic is a condition of the system and is not a defect.

### 13.2.2.2 *Patina*

A patina occurs on the ends of the louvres through their movement and over time. A patina also occurs on the spacer bars and the side spacer bar faces at the edge of the glass. This is not a defect.

### 13.2.2.3 *Colour deviances*

All materials used have self-colours and can deviate from the sampled colours. Because this cannot be influenced it is not a defect.

Replacement or later supplies may have slightly differing colours to the originals supplied - this is not a defect.

## DLS ECKLITE

### *13.2.2.4 Unheated buildings - Winter conditions*

Commissioning is not to be carried out on units during construction phase or in unheated buildings with low temperatures - that means below 0 degrees Celsius.

### *13.2.2.5. Inward and outward bowing*

DLS ECKLITE is a hermetically sealed insulated glass unit. Changes in barometric pressure, temperatures and elevation differences between production and installation location may result in inward or outward bowing and visual distortion of the insulated unit. This so-called "double-sheet effect" is conditional upon physics and is not possible to influence. This gives no grounds for a claim as long as the performance of the unit is not affected.

## 14. SSG VARIO®

SSG VARIO® is an insulating glass designed for the transom-mullion system FW50 SG from Schüco, without cover plates.

There are the following types:

### SSG VARIO® DZ

This type is manufactured with VARIO® connectors and mechanical restraints on all four sides.

### SSG VARIO® S-FOR

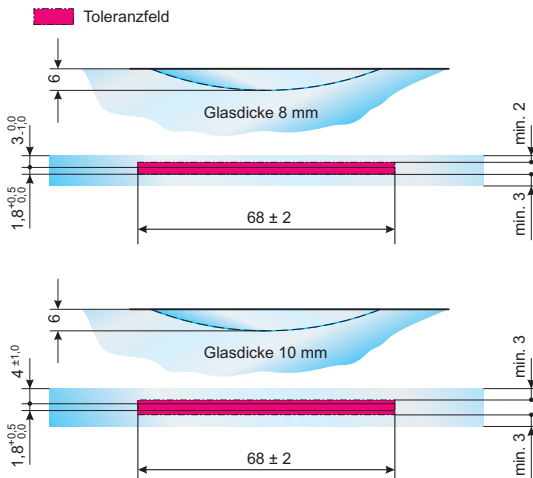
This type is manufactured with 4 number VARIO® connectors and mechanical restraints. All other VARIO® connectors are without mechanical restraints.

### SSG VARIO® Custom

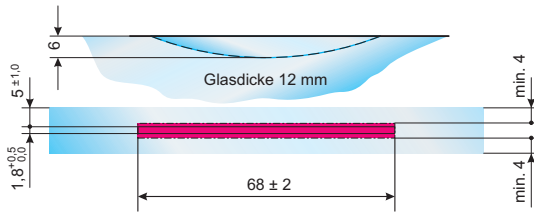
This type is manufactured with VARIO® connectors without mechanical restraints. When mechanical restraints are omitted, the responsibility for approval lies with the customer.

## 14.1 Tolerances

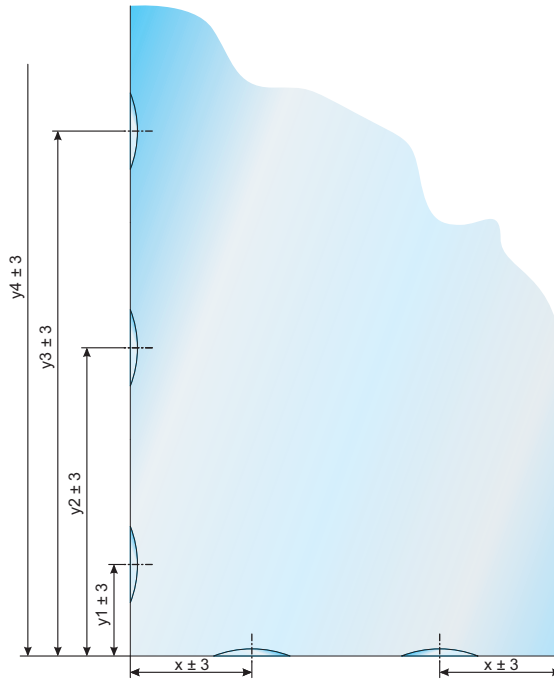
### 14.1.1. Tolerances: Edge kerf



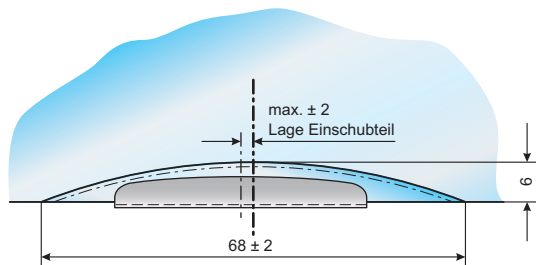
SSG VARIO®



14.1.2. Location tolerance edge kerf:  $\pm 3$  mm



14.1.3. Tolerances: Location of mechanical restraint:  $\pm 2$  mm



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SGG ALBARINO, SGG CLIMALIT, SGG CLIMAPLUS, SGG DECORGLASS, SGG EMALIT,  
SGG MASTERGLASS, SGG PLANIDUR, SGG SECURIT, SGG SERALIT und SGG STADIP  
sind eingetragene Warenzeichen von SAINT-GOBAIN GLASS.