RT 37946 en

316.4 Talo 2000
417.5 Talo 90
X31 special windows... SfB
F32 Maintenance and service code

JT SAFETY GLASS
Jaakko-Tuote Oy

1. *Library Pedagogen, Gothenburg, glass columns, 2005. Tempered laminated beams 12+12+12 clear 1.52 polished edges.*
2. *Helsinki Railway Station, skylights at train platforms, 2001. Tempered 8 mm clear, polished edges, heat-soak-tested.*
3. *Yläjärvi Library, 2002. triple-glazed insulating glass, outer glass 6 mm Ipasol Natura.*

Selection table for types of safety glass

Use		Page	Laminated	Tempered
1	Aquarium glass	10	***	**
2	Vehicle glass	11	**	***
3	Installation	16		
4	Insulating glass	7	***	***
5	Heat-soaked glass, heat treatment	6		
6	JT-electromacnetic interference protection, Electrically heated glass	9 6	****	**
7	Self-supporting facade structures	15	**	***
8	Spandrel glass	10	**	***
9	Railing and balcony glass	15	***	**
10	Skylights	6	*	****
11	Ship and boat glass	11	***	**
12	Glass and polycarbonate combinations	15	****	*
13	Glass testing equipment	16		
14	Glass edge polishing	6		
15	Floor glass and stair treads	15, 6	****	**
16	Bullet-proof glass	14	****	*
17	Classified safety glass	8, 9	****	*

Selection table for types of safety glass

Use		Page	Laminated	Tempered
18	Door glass and sliding walls	12	***	**
19	Surveillance mirrors	15	****	*
20	Table and interior glass	15	***	**
21	Glass resistant to blast pressure	9	****	*
22	Sauna doors	12	*	****
23	Technical information	2, 3, 5, 6, 13		
24	Testing classifications	9		
25	Safety glass	6	****	***
26	Safety glass quality control	16		
27	Machinery glass	11	***	**
28	Sports hall glass	10	*	****
29	UV protection glass	13	****	*
30	Glass elements for skylit areas	6	***	**
31	Sound insulating glass	12	****	*

***** Tempered & laminated glass
**** Good
*** Average
** Usable
* Suitable for a tempered and laminated combination

TECHNICAL INFORMATION ABOUT GLASS

Bending stress and glass thickness t

To calculate the bending stress σ and glass thickness, we recommend the so-called Timoshenko formula.

$$\sigma = b^2 \times \frac{\beta \times q}{t^2} \qquad t = b\sqrt{\frac{\beta \times q}{\sigma_{allow.}}}$$

Deflection

The deflection in the middle of the sheet can be calculated by using the formula:

$$f = C_k \times \frac{q \times b^4}{E \times t^3}$$

σ = see table "allowable stresses"
t = glass thickness
a = longer side of glass
b = shorter side of glass
β = factors resulting from ratio of sides a and b,
C_k (see adjacent table)
q = uniform load
f = deflection
E = modulus of elasticity 7500 kN/cm²

a/b	β	C_k
1,0	0,287	0,0443
1,1	0,332	0,0530
1,2	0,376	0.0616
1,3	0,416	0,0697
1,4	0,452	0,0770
1,5	0,487	0,0843
1,6	0,517	0,0906
1,7	0,545	0.0964
1,8	0,569	0,1017
1,9	0,591	0,1064
2,0	0,610	0,1106
3,0	0,713	0,1336
4,0	0,741	0,1400
5,0	0,748	0,1416

Experimentally specified deflections for tempered JT safety glass

The Laboratory of Construction Technology at the VTT Technical Research Centre of Finland has experimentally specified the bending stresses for tempered and laminated JT safety glass under a uniform load equally supported on four sides. In the tests, the glass was uniformly loaded with a constantly increasing load until it broke. The measured breaking stress for tempered glass was 507 MPa (5171 kp/cm²) and for laminated glass 234 MPa (2382 kp/cm²). The size of the glass sheets used in the testing was 1000 x 2000 mm.

Experimentally specified values for JT safety glass

Glass structure	Size (mm)	Breaking stress (kN)	(kp)	Deflection (mm)
6 mm temp.	1000 x 1000	56,4	5751	37,4
6 mm temp.	1000 x 2000	63,2	6444	59,5
3 + 3 mm lam.	1000 x 2000	13,6	1387	24,8

Allowable stresses

When using the Timoshenko Method for calculating allowable stress values, the following MPa values of allowable bending stresses ($\sigma_{allow.}$) are recommended.

Safety factor n	1	1,5	2	2,5	3	4	5	8	10
Ordinary and laminated glass	75	50	37,5	30	25	18	15	9	7,5
Tempered glass	175	117	87,5	70	58	44	35	22	17,5

Glass thickness in relation to wind load

The glass thickness in relation to the wind load is calculated with the so-called Marcus method using the formula:

$$t = 10^3 \times \sqrt{\frac{3}{4} \times \frac{p}{\sigma} \times \left(1 - \frac{5}{6} \times \frac{r^2}{1+r^4}\right) \times \frac{r\left(1+vr^2\right)}{1+r^4}}$$

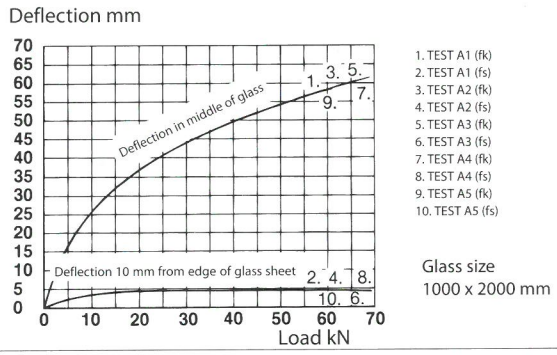
t = calculated glass thickness (mm)
σ= calculated glass bending stress (kN/m²)
p = total wind load (kN) = q x a x b
r = side radius = b/a
a = longer side of glass (m)
b = shorter side of glass (m)
v = Poisson's ratio = 0,25
z = height above ground (m)
q = wind pressure (kN/m²)

Example: $q = 0{,}49\ (z/10)^{0{,}32}$ in suburbs and industrial areas.

Wind pressure specified according to Paragraph 3.4 "Wind load" of Part B1-3 of the Finnish Building Regulations.

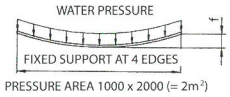
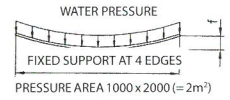
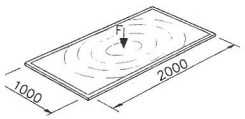
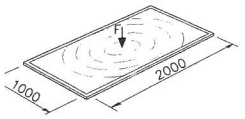
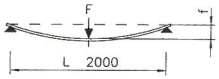
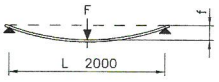
1 kW = 1,36 hv = 102 kpm/s = 1 kNm/s
1 kWh = 860 kcal
1 kcal = 427 kpm
1 Pa = 1 N/m²
1 MPa = 1 N/mm² = 10,19 kp/cm²
1 kP = 9,81 N
1 at = 1 kp/cm² = 98,06 kPa
1 kN = 101,94 kp
1 bar = 100 kPa = 0,1 MPa
1" = 25,4 mm
1 mm H_2O = 9,8 Pa
1 ft = 12" = 304,8 mm
10 m H_2O = 1 kp/cm²

Bending test for tempered glass



Wind speed and pressure			1 knot = 0,514 m/s	
Bofors	***Pressure kp/m²**	**Knots**	**m/s**	**magnitude / effect**
0	0	0	0...0,5	calm: smoke rises straight upwards
1	0,08	1...3	0,51...1,5	weak draught: slight draught is felt
2 3	0,4 1,2	4...6 7...10	2,0...3,0 3,5...5,1	low wind: sways flags and shakes light leaves
4 5	2,5 4,9	11...16 17...21	5,6...8,1 8,6...10,6	moderate wind: straightens flags, shakes leaves and small branches
6 7	8,2 13	22...27 28...33	11,2...13,6 14,2...16,7	stiff wind: shakes fairly large branches
8 9	20 29	34...40 41...47	17,2...20,3 20,8...23,8	severe wind: sways large branches and fairly small trees
10	40	48...55	24,3...27,9	storm: sways trees and bends branches
11	54	56...63	28,4...31,9	severe storm: rips roofs off buildings
12	71	64...71	32,4...35,0	hurricane: cuts trees and pulls them up by the roots

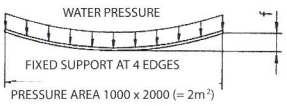
* evenly against sheet, cw = 1.1

JT GLASS STRENGTH TESTS		TEST NO.	DATE	GLASS GRADE	BREAKING LOAD	DEFLECTION
FIGURE 1: **TEMPERED GLASS** EVENLY DISTRIBUTED LOAD FIXED SUPPORT AT 4 EDGES WATER PRESSURE TEST		28	22.01.08	TEMP. 4 MM	2500 kp	36 mm
		27	22.01.08	TEMP. 5 MM	3900 kp	38 mm
		* 1	11.10.07	TEMP. 6 MM	8400 kp	53 mm
		* 2	11.10.07	TEMP. LAM. 4+4 0,76	8400 kp	49 mm
		26	21.01.08	TEMP. LAM. 5+5 0,76	14800 kp	53 mm
FIGURE 2: **LAMINATED GLASS** EVENLY DISTRIBUTED LOAD FIXED SUPPORT AT 4 EDGES WATER PRESSURE TEST		23	21.01.08	LAM. 3 + 3 0,76	900 kp	14 mm
		* 3	11.10.07	LAM. 4 + 4 0,76	1400 kp	14 mm
		24	21.01.08	LAM. 5 + 5 0,76	2200 kp	13 mm
		25	21.01.08	LAM. 6 + 6 0,76	2800 kp	12 mm
FIGURE 3: **TEMPERED GLASS** POINT LOAD FREELY SUPPORTED AT 4 EDGES		21	01.11.07	TEMP. 4 MM	350 kg	32 mm
		20	01.11.07	TEMP. 5 MM	463 kg	30 mm
		19	01.11.07	TEMP. 6 MM	890 kg	35 mm
		22	01.11.07	TEMP. 8 MM	1560 kg	34 mm
		18	01.11.07	TEMP. LAM. 4+4 0,76	1000 kg	33 mm
		31	22.01.08	TEMP. LAM. 5+5 0,76	1225 kg	29 mm
FIGURE 4: **LAMINATED GLASS** POINT LOAD FREELY SUPPORTED AT 4 EDGES		29	22.01.08	LAM. 3 + 3 0,76	175 kg	15 mm
		40	18.03.08	LAM. 4 + 4 0,76	175 kg	12 mm
		30	22.01.08	LAM. 5 + 5 0,76	200 kg	7 mm
		36	22.01.08	LAM. 6 + 6 0,76	350 kg	9 mm
		43	18.03.08	LAM. 8 + 8 0,76	775 kg	11 mm
		39	30.01.08	LAM. 10 + 10 0,76	725 kg	6 mm
		44	18.03.08	LAM. 12 + 12 0,76	1800 kg	10 mm
FIGURE 5: **TEMPERED GLASS** POINT LOAD FREELY SUPPORTED AT 2 EDGES		17	01.11.07	TEMP. 5 MM	95 kg	286 mm
		14	01.11.07	TEMP. 6 MM	180 kg	278 mm
		16	01.11.07	TEMP. 8 MM	325 kg	188 mm
		* 5	12.10.07	TEMP. LAM. 4+4 0,76	350 kg	202 mm
		35	22.01.08	TEMP. LAM. 6+6 0,76	575 kg	112 mm
FIGURE 6: **LAMINATED GLASS** POINT LOAD FREELY SUPPORTED AT 2 EDGES		* 4	12.10.07	LAM. 4 + 4 0,76	135 kg	83 mm
		32	22.01.08	LAM. 5 + 5 0,76	175 kg	36 mm
		34	22.01.08	LAM. 6 + 6 0,76	225 kg	46 mm
		37	30.01.08	LAM. 8 + 8 0,76	325 kg	30 mm
		38	30.01.08	LAM. 10 + 10 0,76	525 kg	25 mm

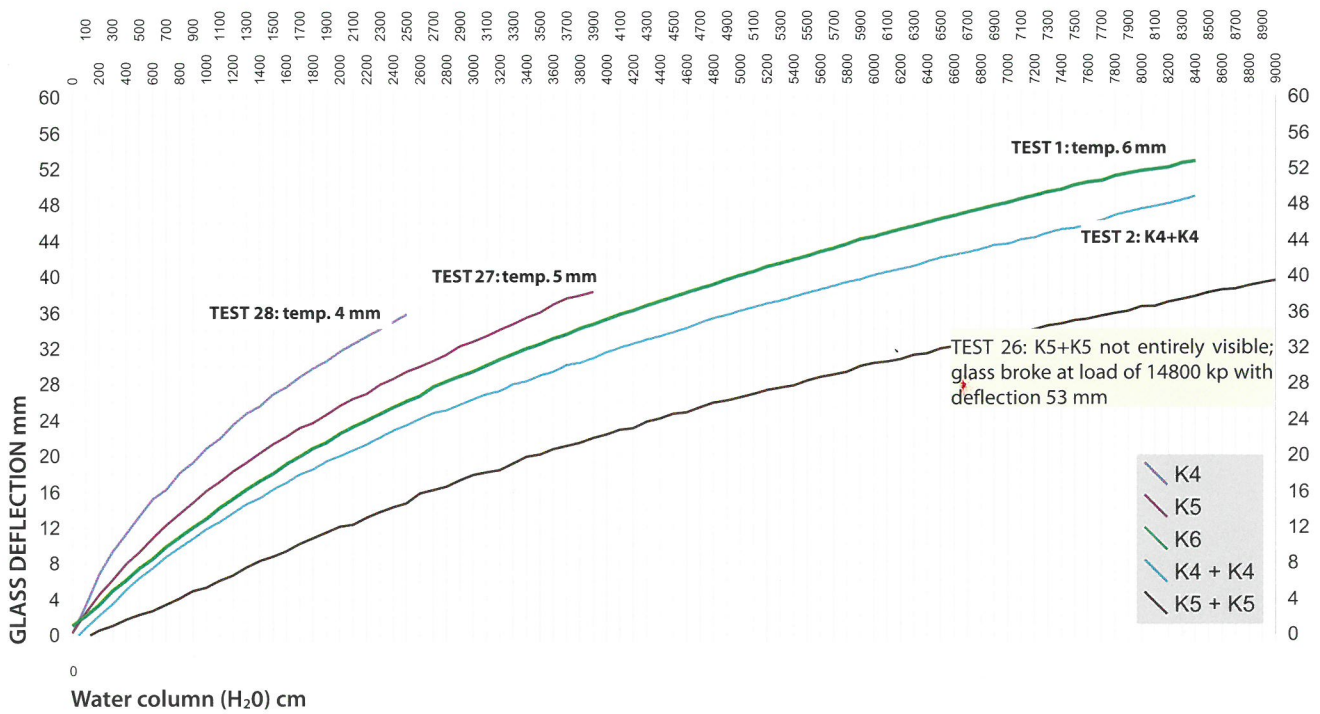
Test glass sheet size: 2070 mm x 1070 mm.
All 50 tests were conducted at Panelia on Jaakko-Tuote Oy's premises.

* = VTT's supervisor Research Engineer Kai Mannersola, present (11-12 October 2007, tests nos. 1-11).

Test glass sheet size: 2070 x 1070 mm TEMPERED AND TEMPERED LAMINATED GLASS
Loading area: 1000 x 2000 mm (= 2m²)



LOADING ON GLASS kp



GENERAL INFORMATION ABOUT SAFETY GLASS

Laminated JT safety glass

Laminated glass is manufactured by bonding two or more sheets of glass with a strong and flexible PVB interlayer. After preheating, a permanent bond is achieved in autoclaves under high pressure at a temperature of approximately 150°C.
Increasing the number of glass sheets and interlayers enhances the protective characteristics of the glass. Strength can be increased by using tempered glass in the lamination layers.
Laminated JT safety glass complies with international standards such as DIN and EN. Laminated safety glass also available in curved shapes. Curved safety glass is used in, for example, display windows, glass railings and spandrel glass.
The maximum size of a flat laminated glass sheet is 3210 x 6000. The maximum size of a curved glass sheet is approximately 3100 x 4300.

Characteristics of safety glass	Laminated	Tempered
Resistance to chemicals	Same as glass	Same as glass
Operating temperatures – allowable continuous max. – allowable temporary max. – allowable min.	 + 100 °C + 120 °C no restrictions	 + 300 °C + 300 °C no restrictions
Softening temperatures – glass – lamination interlayer	 + 600 °C * + 100 °C	 + 600 °C -
Tensile strength of PVB interlayers	21 N/mm²	-
* characteristics do not return. The manufacturing processes for safety glass do not alter chemical properties.		

Raw materials

Based on many years of experience, JT safety glass is manufactured from carefully selected high quality glass. To ensure prompt deliveries, Jaakko-Tuote Oy stocks all the glass types and interlayers shown on the accompanying list. Glass types and interlayers not belonging to the standard selection can also be procured by special order. The size of the raw material in the groups is generally 3210 x 6000 mm, except for pattern glass and mirrors.

PVB interlayers

Either the JT number (recommendation) or the factory's interlayer should be specified in the order.

JT no	Factory interlayer no.			Light transmission factor %
0	clear			89
2	S4055 (S234)	light smoke		55
4	S6028 (S434)	medium dark smoke, brown		28
4	362800	medium dark smoke, brown		28
5	360900	dark smoke, brown		09
6	216500	opal		68
7	803000	black		0
8	220700	white		8
9	OY-2	moss green	non-transparent	0
10	OR-1	wine red	non-transparent	0
11	OYR-1	yellow	non-transparent	0
12	377300	green		73
15	7021	bluish-grey, violet		55
16	082800	grey hound		28
18	654400	grey		44
20	377800	vehicle green 0.76		80
21	547800	Japanese blue 0.76		78
22	367700	vehicle bronze 0.76		77
23	218000	matte interlayer		

Vanceva interlayers

0001 Coral Rose
0002 Aquamarine
0003 Smoke Grey
0004 Sahara Sun
0005 Ruby Red
0006 Sapphire
0007 Evening Shadow
0008 Golden Light
0009 Arctic Snow
000A Cool White
000C Deep Red
000D True Blue
000E Tangerine

Tempered JT safety glass

The glass is heated to a temperature of approximately 630 °C, after which it is air-cooled rapidly and symmetrically on both sides of the glass sheet.
At that point a prestressed condition is formed in the glass, with the compression stress on the surface and the tensile stress in the centre. Tempered glass can be as much as 5 times stronger than ordinary glass. Upon breaking, tempered glass crumbles into small blunt chips that could cause minor injuries. The glass can also be laminated, in which case the fragments will remain attached to the interlayer. All JT tempered glass, flat and curved, is also of laminated quality and complies with the DIN and EN standards.

Tempered glass thicknesses and manufactured sizes (mm):

Thickness (mm)	Flat	Curved
3,15		1000 x 2000
4,0	1750 x 3000	1500 x 2400
5...6	2440 x 4980	1500 x 2400
8, 10 ja 12	2440 x 4980	
15 and 19	max approx. 300 kg	

Glass qualities

Glass group	Glass type	Glass thickness (mm)										
		2,1	2,5	3	4	5	6	8	10	12	15	19
I	Clear float	o	o	x	x	x	x	x	x	x	x	x
II	Bronze			x	x	x	x	x	x	x		
	Grey			x	x	x	x	x	x	x		
	Green		o	x	x	x	x	x	x			
	Arctic blue				x		x					
	Azur blue						x					
III	Stopsol clear				x		x					
	Stopsol grey						x					
IV	K glass, hard coating			x	x		x					
	G glass, hard coating				x		x					
	TopN Soft coating				x*		x*					
V	Ipasol Natura						x*	x*				
	Ipasol Neutral						x*	x*				
	Sunergy				x		x	x	x			
VI	Crepi				x		x					
	Chinchilla clear				x			x				
	Chinchilla bronze				x			x				
	Cotswold				x							
VII	Mirror			o	o							
	Bronze Mirror				o							
	Polished wired glass						o					
	Etched glass				x		x	x	x			
VIII	Activ glass				x		x	x				
IX	Optiwhite glass			x	x		x	x	x	x		

o = glass suitable for laminating
x = glass suitable for tempering and laminating
x* = coating towards airspace

Glass groups:

I clear float
II coloured float
III reflecting glass
IV low emissivity glass
V solar protection and low emissivity glass
VI pattern glass
VII special glass
VIII self-cleaning glass
IX Optiwhite glass

Dimensional tolerances of glass

Basic dimension (mm)	Dimensional differences			Work related	
	Cut	Laminated Tempered without polishing		Polished edges RH	Location of holes and outcuts
< 1000	± 1,5	± 2	± 1,5	+ 0 - 2	± 1
< 1500	± 1,5	± 2	± 1,5	+ 0 - 2	± 1
< 2000	± 1,5	± 2	± 1,5	+ 0 - 2	± 1,5
< 2500	± 1,5	± 2	± 1,5	+ 0 - 2	± 1,5
< 3000	± 2	± 2,5	± 2	+ 0 - 2	± 1,5
< 3500	± 2	± 2,5	± 2	+ 0 - 2	± 2
< 4000	± 2	± 2,5	± 2	+ 1 - 2	± 2
< 4500	+ 3 - 2	± 3	+ 3 - 2	+ 1 - 2	± 2,5
< 5000	+ 3 - 2	± 3		± 2	± 2,5
< 6000	+ 3 - 2	± 3		± 2	± 3

The tolerances in the above table are for glass up to ≤ 6 mm thick. When the glass thickness 8...12 mm, ± 1 must be added to the values in the table. When the glass thickness exceeds 12 mm, ± 2 must be added to the values in the table.

Thickness tolerances of float glass

Glass thickness	Thickness tolerance
3, 4, 5, 6 mm	± 0,2 mm
8, 10, 12 mm	± 0,3 mm
15 mm	± 0,5 mm
19 mm	± 1,0 mm

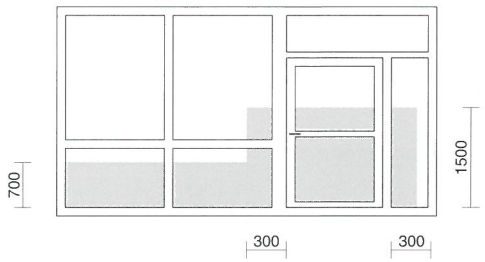
Length temperature coefficient (α) and specific heat (C)		
Material	α = 1 : °C	C = kcal : kg°C
Aluminium	0,000024	0,220
Concrete	0,000014	0,210
Copper	0,000017	0,094
Glass, ordinary	0,000008	0,200
Lead	0,000029	0,031
Brass	0,000019	0,092
Wood	0,000004	0,600
Steel	0,000012	0,114
Zinc	0,000030	0,094

Dimensional change of object: $\Delta l = \alpha \times l \times \Delta t$ — l = length of object (mm), Δt = temperature change (°C)

Amount of heat: $Q = C \times m \times \Delta t$ — Q = amount of heat (kcal), m = mass of object (kg)

Transfer of large glass sheet to vertical polishing machine.

Critical impact areas



Enhancing the security of public buildings is now considered essential. Window glazing plays a key role in increasing security. Glass must always be dimensioned to withstand the same horizontal loads as railing glass.

Safety glass must always be selected when glass is placed in doors or in windows near doors 0-1.5 m above the floor. Elsewhere safety glass must be used 0-700 mm above the floor. Ordinary glass can be used for glazing less than 250 mm wide.

Properties of untreated sheet glass

Chemical composition	
Silicon acid SiO_2	71...75 %
Aluminium oxide Al_2O_3	0,5...1,5 %
Iron oxide Fe_2O_3	0,05...0,15 %
Calcium oxide CaO	5...10 %
Magnesium oxide MgO	2...5 %
Sodium oxide Na_2O	13...16 %
Potassium oxide K_2O	0...1 %
Sulphur trioxide SO_3	0...0,5 %

Physical properties			
Density	2,5 kg/dm³	Index of refraction	1,5
Compressive strength	90 kN/cm²	Emissivity	0,85
Tensile strength	2,9...9,8 kN/cm²	Light transmission (6 mm glass)	0,87
Bending strength	2,9...9,8 kN/cm²	Reflection (6 mm glass)	0,07
Modulus of elasticity	7500 kN/cm²	Absorption (6 mm glass)	0,15
Poisson's ratio	0,25	Direct transmission (6 mm glass)	0,83
Specific heat	0,84 kJ/kgK	Total transmission (6 mm glass)	0,90
Coefficient of thermal expansion	0,000008/°C	Sound insulation (6 mm glass)	28 dB
Thermal conductivity	0,81 W/mK	U-value (6 mm glass)	5,6 W/m²K

Electrically heated glass

If the application of the glass requires that it must be partially or entirely heated, electrical heating is a proven solution, and it can be implemented using all laminated glass sizes or sub-areas. The effective values are approximately 2-7 W/dm2, depending on the functional application.

Skylights

JT skylights made from double-glazed or triple-glazed insulating glass can be flat or curved. The outermost glass is generally 6 mm tempered glass, the innermost glass tempered laminated, and the middle glass tempered. This configuration facilitates the safe use of many types of low-emissivity glass and achieves an excellent low U-value.

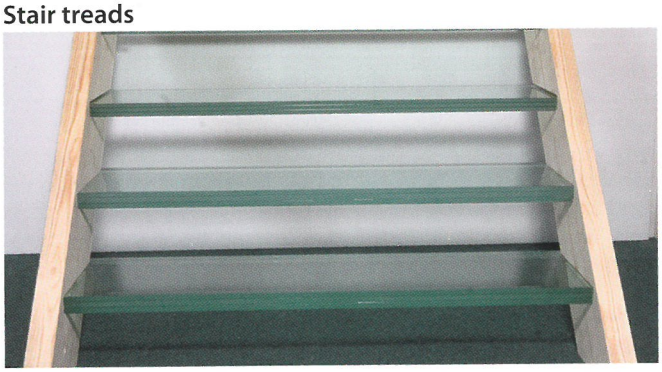
Glass elements for skylit areas

Glass elements for skylit areas can be clear, coloured, or low-emissivity glass, and must be designed to withstand snow and wind loads. For example, 4+4 0.76 MRH tempered laminated glass, whose breaking stress exceeds 4000 kp/m2 (40 kN), is a safe and reliable solution.

Glass edge polishing

Glass edge polishing (RH) enhances the glass's durability, dimensional accuracy, and is often necessary as a result of further processing. The most common edge polishings for JT safety glass are:
TSH = sharp bevel grinding, extensive use area, easiest and cheapest, often sufficient for the manufacturing of tempered and laminated glass. Does not improve dimensional accuracy.
RH = ground edges, where the edges are ground completely smooth and the glass is dimensionally accurate. The most generally used.
KRH = RH's edges polished, used for example in certain glass for furniture. The polished edge option is slightly more expensive than RH.
Edge polishing can also form the shape of the edge, the most common of which are the so-called trapezoid and C-forms.
The trapezoid edge is straight with bevels at the edges. The C-form is part of a circular arc that is used, for example, in vehicle glass.

Stair treads



Point loading on stair treads, freely supported on two edges, width 280 mm, span 1000 mm

load (kg)	10+10 lam. temp. thickness 20.9 mm deflection (mm)	12+12 lam. temp. thickness 25.1 mm deflection (mm)	10+10+10 lam. temp. thickness 31.8 mm deflection (mm)	12+12+12 lam. temp. thickness 37.9 mm deflection (mm)
50	1,1	0,8	0,8	0,3
75	2,2	1,3	1,4	0,7
100	3,3	1,8	2,1	0,7
125	4,0	2,4	2,4	1,2
150	4,7	2,9	2,9	1,4
200	6,9	3,8	3,9	2,5
250	8,0	4,8	5,1	2,8
300	9,6	6,0	6,1	3,8
350	11,6	6,9	6,9	4,2
400	12,9	8,1	8,0	4,8

The glass is not loaded to the breaking point. Tests demonstrated that the deflections for tempered and non-tempered glass are similar when the loading is 50-400 kg.

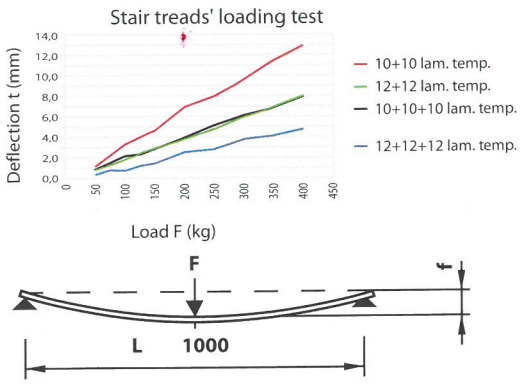
Safety glass

Safety glass is manufactured by laminating, tempering, heat strengthening glass, or a combination of these methods.
Safety glass is used where ordinary glass cannot provide sufficient protection against mechanical stresses, burglary, vandalism, and weather conditions. During the manufacturing process, many special characteristics can be added to the glass. These include sound insulation, UV protection, solar radiation protection, or an alarm system. The security and quality of buildings can be enhanced by using safety glass and combining its protective characteristics.
In this RT product sheet, the areas treating laminated glass are headlined in blue and the areas treating tempered glass are in red.

Heat-soak treatment

Heat-soak testing is glass heat treatment according to DIN 18516. The purpose of the heat-soak treatment, undertaken after the glass has been tempered, is to find the sheets of glass containing NiS impurities; these will expand and break as the temperature rises during the testing period. The treatment reduces tempering stresses by a few percentage points by slightly increasing the fragment size of the glass.
During Jaakko-Tuote Oy's approximately twenty years of practical experience with the heat-soak treatment, less than 1% of glass has broken. For that reason Jaakko-Tuote Oy recommends testing only load-carrying glass structures that, upon breaking, would create a substantial risk of damage.

Stockmann Oy Helsinki, 2009. Artwork "Iiris" on restaurant's ceiling. Tempered and laminated, heat-soak tested glass 6+6 Optiwhite glass with various coloured interlayers, polished edges.



JT insulating glass

Technical properties of JT insulating glass

Property	Insulating glass, metal profile (Al)	Insulating glass, TPS profile
Manufacturing size, maximum	3200 x 5000 mm	2700 x 3500 mm
Manufacturing size, minimum	190 x 350 mm	190 x 350 mm
Width of airspace	6...24 mm	6...20 mm
Sealing depth (polysulfide or silicon)	2...18 mm	2...18 mm
Stair element stepping (maximum 4 edges)	Lower edge 0...50 mm other edges 0...250 mm	Lower edge 0...50 mm other edges 0...250 mm
Non-rectangular shapes	Many different geometric forms	Many different geometric forms

JT insulating glass complies with the EN 1279 standard, and the production is certified by the VTT Technical Research Centre of Finland.

Examples of technical properties of insulating glass types (complying with EN 673 and EN 410)

Glass type	Element structure	Thickness mm ±2	Weight kg/m²	U-value W/m²K	Total light transmission %	Total solar energy transmission %
FLOAT GLASS	2k 4-12-4	20	20	2,9	81	76
	2k 4-12Ar-4	20	20	2,7	81	76
Ar = Argon 90%	3k 4-12-4-12Ar-4	36	30	1,8	74	68
LOW EMISSIVITY GLASS	2k 4-15Ar-N4	23	20	1,1	78	61
	2k 4-15Ar-K4	23	20	1,5	75	72
	2k 4SN-15Ar-4	23	20	1,2	79	58
	3k 4-12-4-12Ar-K4	36	30	1,3	68	64
K = K-glass, hard coating	3k 4K-12Ar-4-12Ar-K4	36	30	1,0	63	58
N = TopN, soft coating	3k 4SN-12Ar-4-12Ar-SN4	36	30	0,7	71	50
SN = Optitherm SN, soft coating	3k 6K(h)-15Ar-6(h)-((4(h)+0.76+4(h))	51	52	1,1	64	57
SOLAR PROTECTION-LOW EMISSIVITY GLASS	2k 6I-15Ar-4	25	25	1,1	73	42
	3k 6I-15Ar-4-9Ar-4	38	35	0,9	67	39
	2k 6Su-15Ar-6	27	30	1,8	61	52
I = Ipasol Neutral 73/39	2k 6Su-15Ar-N6	27	30	1,1	59	44
Su = Sunergy clear	3k 6Su-15-6-15Ar-(N4+0.38+4)	51	31	0,8	52	40
BODY-TINTED (absorptive) SOLAR PROTECTION GLASS	2k 4gy-12Ar-4	20	20	2,7	51	56
	2k 6gy-12Ar-6	24	30	2,7	39	46
gy = grey	2k 6gy-12Ar-N4	24	30	1,3	38	35
REFLECTIVE SOLAR PROTECTION GLASS	2k St6-12Ar-6	24	30	2,7	58	59
	2k St6-12Ar-N6	24	30	1,3	55	45
St = Stopsol super silver clear	2k Stgy6-12Ar-N6	24	30	1,3	25	25
Stgy = Stopsol super silver grey						
SELF-CLEANING + SELECTIVE GLASS	3k A6(h)-15Ar-K6(h)-15-((4h)+JT22+4(h))	51	52	1,1	49	58
	3k A6(h)-15Ar-K6(h)-15-(4(h)+0.76+4(h))	51	52	1,1	61	59
A = Activ						
(h) = all tempered						

Security and other additional properties for insulating glass

- tempering and laminating
- UV protection (p. 13) and sound insulation (p. 12)
- JT bullet protection (p. 15) and JT burglary protection (p. 8)
- JT electromagnetic interference protection (p. 9)
- JT resistance to blast pressure (p. 9)
- self-cleaning (Activ glass)
- silkscreen printing and sandblasting

Examples of implemented locations:

- Arcada and Practicum Vocational College, Helsinki 2003...2004
- Parliament House, extension, Helsinki, 2004
- Shopping Centre Entresse, Espoo, 2008
- Hermia, Tampere, 2001
- Tietotekniikkatalo, Tampere, 2005
- Rauma Library 2002 and Lohja Library 2005
- ICT-building, Turku, 2005
- Sturegallerian, Stockholm, 2008
- Studentskrapan, Stockholm, 2007
- Kv. Rådhuset, Helsingborg, 2008
- Kv. Oxen, Stockholm, 2009

Biolan Oy, Eura, 2010. Triple-glazed insulating glass, 3 K A6(h)-15 Ar-K6(h)-15-(4(h)+JT22+4(h)), all tempered. Balcony ceilings: tempered laminated A6(h)+6(h)JT22. Railing glass: tempered laminated 6(h)+6(h) and 8(h)+8(h).

JT burglary protection glass and safety glass classified as building glass

Safety glass classified as building glass

(impact by heavy object)

JT TYPE	STRUCTURE	THICKNESS mm ± 1	WEIGHT kg/m²	LIGHT TRANSMISSION %	CLASSIFICATION	
					EN 12600	BS 6206
JT 1(C)2 / F1	Tempered	4	10	90	*	o
JT 2(B)2 / F1	3 + 3 0,38	6	15	89	*	o
JT F2	Tempered	5	12,5	90		o
JT 1(B)1 / F2	3 + 3 0,76	6	15	89	*	o
JT 1(C)1 / F3	Tempered	6	15	89	*	o
JT F3	4 + 4 1,14	9	21	89		o
JT 1(B)1	4 + 4 0,38	8	20	88	*	
JT 1(B)1	4 + 4 0,76	9	21	88	*	
JT 1(B)1	5 + 5 0,38	10	26	88	*	
JT 1(B)1	5 + 5 0,76	11	27	88	*	
JT 1(B)1	4 + 4 0,76 Temp.	9	20	88	*	
JT display window	3 + 3 + 3 1,52	12	25	88		o

Safety glass against vandalism

(impact by hard object)

JT TYPE	STRUCTURE	THICKNESS mm ± 1	WEIGHT kg/m²	LIGHT TRANSMISSION %	CLASSIFICATION	
					EN 356	DIN 52290
JT P1A	Laminated	8	20	88	*	
JT P2A	Laminated	9	21	88	*	
JT P3A	Laminated	9	22	88	*	
JT P4A	Laminated	10	23	87	*	
JT P5A	Laminated	11	24	87	*	
JT A0	Laminated	8	20	88		o
JT A1	Laminated	9	21	88		*
JT A2	Laminated	9	21	88		*
JT A3 / EHO1	Laminated	10	23	87		*
JT DH4 / EHO2	Laminated	12	24	87		*

Safety glass against burglary

(impact by sharp object)

JT TYPE	STRUCTURE	THICKNESS mm +2 -1	WEIGHT kg/m²	LIGHT TRANSMISSION %	CLASSIFICATION	
					EN 356	DIN 52290
** JT P6B / B1	Laminated	14	31	87	*	*
JT P6B / B1	Laminated	17	40	86	*	*
JT P7B / B2	Laminated	28	65	85	*	*
JT P8B / B3	Laminated	31	68	85	*	*
JT-SAFETY 9	Temp. lam.	9	20	88		o
JT-SAFETY 10	Temp. lam.	11	26	88		o
JT-SAFETY 20	Temp. lam.	12	27	88		o
JT-SAFETY 30	Temp. lam.	13	28	88		o
JT-SAFETY 40	Temp. lam.	15	29	87		o
JT-SAFETY 50	Laminated	38	85	77		o

Ship-classified safety glass

JT TYPE	STRUCTURE	THICKNESS mm	WEIGHT kg/m²	LIGHT TRANSMISSION %	CLASSIFICATION
					ISO 614
JT-ISO	Tempered	6...19	15...47,5	89...86	o

* = official certificates
o = tested at factory or by customer

** = Recommended glass size ≤ 2 m²

Testing methods for burglar protection glass and safety glass classified as building glass

EN 12600			BS 6206 SFS 5314			EN 356			DIN 52290/4 SFS 5311			EN 356		DIN 52290/3 SFS 5312	
Class	Drop height mm	Energy J	Class	Drop height mm	Energy J	Class	Drop height mm x quantity	Energy J	Class	Drop height mm x quantity	Energy J	Class	Class Impact quanti-ty	Class	Class Impact quanti-ty
3 2 1	190 450 1200	93 221 589	F1 F2 F3	305 457 1219	135 202 538	P1A P2A P3A P4A P5A	1500 x 3 3000 x 3 6000 x 3 9000 x 3 9000 x 9	60 121 241 362 362	A1 A2 A3 EH02/ DH4	3500 x 3 6500 x 3 9500 x 3 12500 x 9	141 262 383 504	P6B P7B P8B	30...50 51...70 over 70	B1 B2 B3	30...50 51...70 over 70
Impact of heavy object, tyre iron, 50 kg			Impact of heavy object, leather sack, 45 kg buckshot			Impact of hard object, metal ball 4.1 kg ∅ 100 mm			Impact of hard object, metal ball 4.1 kg ∅ 100 mm			Impact of sharp object, axe 2 kg, 11 m/s, 300 J		Impact of sharp object, axe 2 kg, 11 m/s, 300 J	
Test glass 876 x 1938 mm			Test glass 865 x 1930 mm			Test glass 1100 x 900 mm			Test glass 1100 x 900 mm			Test glass 1100 x 900 mm		Test glass 1100 x 900 mm	

EN 12600 safety-classified building glass:
The classification code's first number indicates the higher drop height, Classes 3-1, from where, when dropping, the glass is not broken, or breaks safely.The letter in parenthesis in the middle indicates the way in which the glass breaks::
A= glass breaks like ordinary glass
B= glass breaks like laminated glass
C= glass breaks like tempered glass.
The last number indicates the drop height, Classes 3-1, from where, when dropping, the glass is not broken, or breaks like laminated glass.

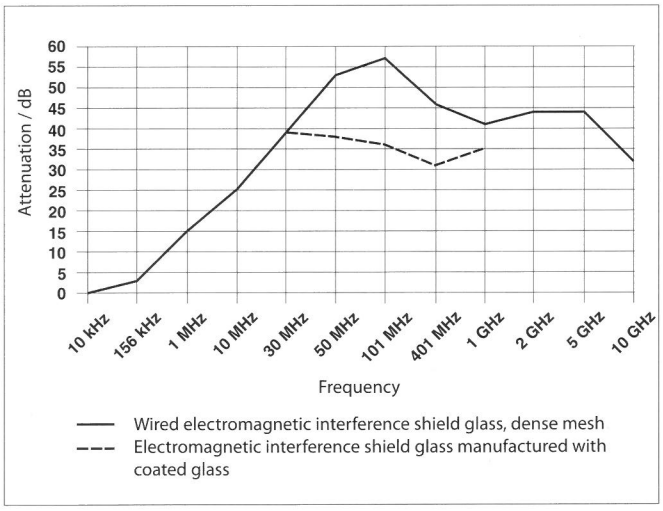
JT electromagnetic interference shield safety glass

FREQUENCY	ATTENUATION / dB	
	Wired electromagnetic interference shield glass, dense mesh	Electromagnetic interference shield glass manufactured with coated glass
10 kHz	0	
156 kHz	3	
1 MHz	15	
10 MHz	25	
30 MHz	39	39
50 MHz	53	38
101 MHz	57	36
401 MHz	46	31
1 GHz	41	35
2 GHz	44	
5 GHz	44	
10 GHz	32	

Magnetic field 10 kHz...10 Mhz,
Plane waves and microwaves 30 MHz...10 GHz

JT electromagnetic interference shield safety glass

Electromagnetic interference shield glass is used to reduce the environment's electromagnetic radiation. Electromagnetic interference protection can also be combined with tempered and laminated JT safety glass.



Graphical presentation of electromagnetic interference protection attenuation

Glass resistant to blast pressure

JT number	Classification code	Pressure (bar)	Thickness (mm)	Weight (kg/m²)
JT10/E1	ER1, D1	0,5	11, temp.lam.	26
JT11/E1	ER1, D1	0,5	31, double-glazed insulating glass	42
JT20/E2	ER2, D2	1,0	21, temp.lam.	52
JT21/E2	ER2, D2	1,0	39, double-glazed insulating glass	62
JT30/E3	ER4, D3	2,0	39, temp.lam.	92
JT31/E3	ER4, D3	2,0	55, double-glazed insulating glass	104

JT safety glass, resistant to rapid pressure impacts and impulse stresses caused by negative pressures, has been tested at German research institute according to the EN 13541 and DIN 52290 (Part 5) standards.

All JT blast-protected glass is tempered and laminated; if the glass breaks, the chips will not scatter but will remain attached to the interlayer. When installing glass resistant to blast pressure, attention must also be paid to the durability of the frame construction. This type of glass is used in, for example, administration buildings, the chemical industry, laboratories, banks and other locations possibly susceptible to explosions.

Sports hall glass

Tempered glass is generally used in sports halls; 12 mm tempered glass is recommended for the walls of squash courts. Laminated glass can also be used in certain structures. Ice hockey rink glass is usually 12 mm tempered glass, with 15 mm glass at certain locations.

Aquarium glass

Aquarium glass in public facilities generally consists of multilayered tempered and laminated glass whose edges are MRH ground. When calculating the strength of the glass, it should be taken into account that the loading is continuous, and that the maximum water level is the uppermost edge of the tank. For example a water depth pf 5 m yields a 0.5 kp/cm2 pressure on the glass. One of the strongest types of aquarium glass manufactured by Jaakko-Tuote Oy has been 4 x 12 mm tempered laminated glass, size 3845 x 1756 mm.

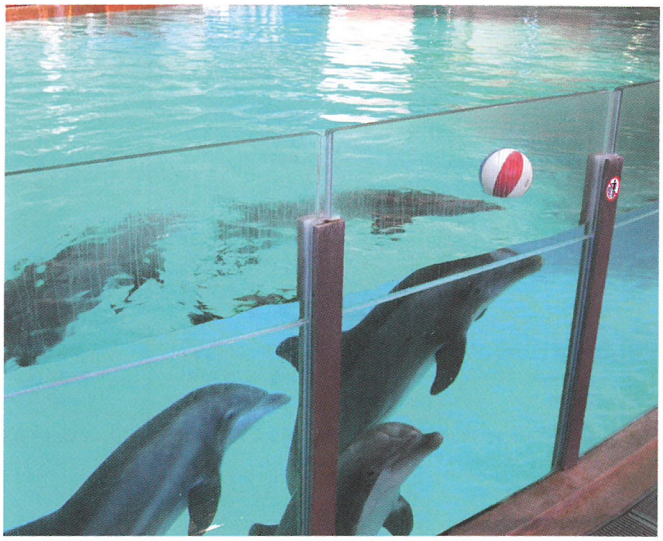
Depending on their size, small aquariums for the home can be also constructed with 2-layer glass.

Laminated JT spandrel glass

Laminated JT spandrel glass is flat or curved edge ground glass; the thickness is 3+3 mm. In terms of its use it has proven extremely effective with respect to durability, safety and the ability to retain its colour. For decades without complaints, Jaakko-Tuote Oy has supplied laminated spandrel glass for large-scale and demanding locations whose wall areas have covered hundreds of square metres, and where the walls have been exposed to varying compass directions and shadowing from adjacent buildings.

When designing spandrel façade construction, sufficient airflow and allowances for thermal expansion must be provided behind the glass.

A wide range of colours is available; besides approximately 20 interlayer colours, there are also coloured glass and reflecting glass alternatives. Upon request, Jaakko-Tuote Oy will supply colour samples.



Särkänniemi Delfinarium, Tampere, 2006. Tempered tank glass 12+12+12 clear 1.52. Laminated tempered aquarium glass 12+12+12+12 Optiwhite glass, clear 1.52, largest sheet 3845 x 1756 mm.

Tempered JT spandrel glass

Tempered JT spandrel glass can be flat or curved; the thickness is generally 6 mm with ground edges (MRH), and the glass is painted with the silkscreen method on the air side. The glass is installed with the painted side facing the wall. The colour of the wall should always be uniform to prevent the possible formation of shadows on the glass. There are several colour alternatives; upon request, Jaakko-Tuote Oy will supply colour samples.

The airflow behind the façade glass is also important. For a natural airflow in the wall's vertical direction, a normal 20 mm board thickness is sufficient, for example, 20 x 100 boards spaced c/c at 600 mm intervals, with the lower and upper ends open for airflow.

For particularly demanding locations, heat-soak testing can be carried out for the tempered glass if required. The rejection rate in the conducted tests has been less than 1%.

Joensuu Lyseo Primary School, 2006. Tempered silkscreen printed glass, tempered clear glass.

Vehicle glass

Vehicle glass manufactured by Jaakko-Tuote Oy is made in installation-ready sections that comply with the ECE, SFS and AS standards. JT vehicle glass is marked with the manufacturer's permanent markings. Besides the factory's own quality control, quality is monitored by the VTT Technical Research Centre of Finland, the Finnish Vehicle Administration (AKE), and others.

JT windscreens are installation-ready parts manufactured to shape according to the specific make and model of vehicle. JT windscreens are always manufactured from laminated glass.

JT side glass is flat or curved and manufactured to shape from tempered glass. It can also be manufactured from insulating glass, as normally used in the side glass of buses and trams.

JT safety glass can also be used in bus and railway carriage partitions, as well as in railings and other interior features.

Machinery glass

JT safety glass for machinery cabs is either laminated, tempered, or a combination of both. It can also be manufactured as insulating glass to provide excellent thermal insulation and protection from outside noise.

Compared to tempered glass, laminated glass provides better protection for machine operators.

Tempered glass is suited best for operable glass and emergency exit hatches, as well as places subject to torsional stresses.

Ship and boat glass

JT safety glass for ships and boats is manufactured according to the customer's drawings and specifications. The glass can be laminated, tempered or a combination of both. Reflective glass is also used; 6-19 mm tempered glass complies with the quality requirements of the ISO 614 standard.

Buses' windscreens and side glass.

Matias Chapel, Virrat, 2009. Double-glazed insulating glass, laminated glass sheets.

Sound insulating glass

Sound waves falling on glass create onward frequency oscillations. At the frequency of coincidence, the progression of sound waves is identical to the wave speed of the bending oscillations in the glass. At high frequencies, this weakens the sound insulation capacity of normal window glass. Examples of high frequency sounds include jet engines and exhaust air from pressure cylinders.

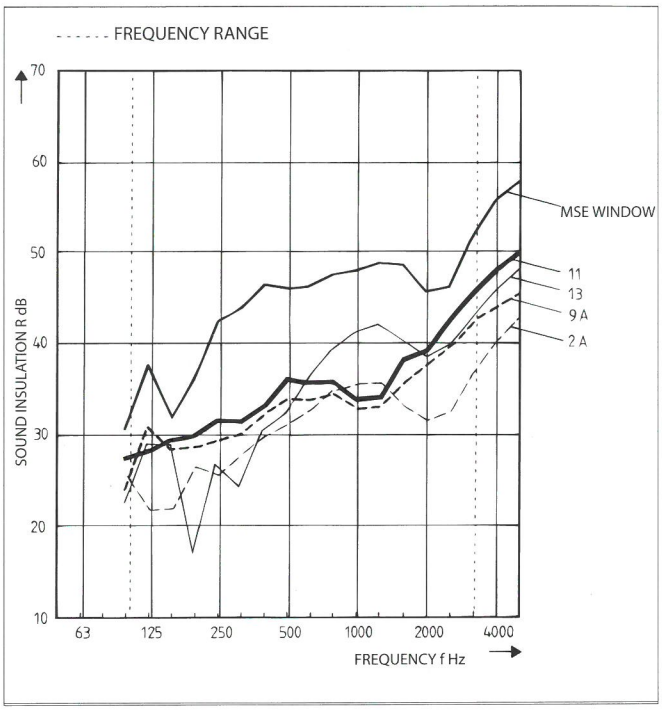
By laminating two sheets of glass together with flexible interlayers that increase friction, the progression of sound waves is effectively prevented, especially at high frequencies. At lower frequencies, sound insulation can be improved by using thicker glass. JT sound insulating glass does not alter the optical or light transmission characteristics of the glass. Sound insulation can be added to all window types.

Sound insulating glass according to the ISO 140-3:1995 (1) and ISO/DIS 717-1.2:1996 (2) standards.

R_w is the sound reduction index. The size of the tested glass was 1200 x 1200 mm.

Glass no.	Glass (mm)	Lamination (mm)	R_w (dB)	$R_w + C$ (dB) jet aircraft noise	R_w+C_{tr} (dB) city noise
1	MSE window*	0,76	47	46	44
2A	3+3	0,76	33	32	31
3A	3+3	2,28	34	34	32
4A	4+4	0,76	34	33	32
5A	4+4	1,14	34	34	32
6A	4+4	2,28	34	34	32
7	4+4 resin	2,0**	33	32	31
8A	3+3+3+3	0,76	36	35	34
9A	3+3+3	1,52	35	35	33
10A	5+5	1,52	35	34	33
11	6+6	1,52	37	36	34
12A	8+8	1,52	37	36	34
13	2k(3+3)-12	0,76	36	34	30
14	2K 4-8	tempered	31	30	28

*MSE window, all glass laminated 3+3 mm, 0.76 glass.
Inner frame 2k(3+3) - 12 insulating glass and outer frame 3+3 mm, 0.76 laminated glass.
** Glass No. 7 resin laminated.



Glass doors and sliding walls

Safety glass should always be used in doors, especially in schools, day care centres, sports halls, hospitals, restaurants, and other public buildings.
Laminated glass is generally used for JT door glass, but for certain applications such as sauna doors, tempered glass is recommended. Solid glass doors are generally made from 8 mm tempered glass with ground edges. Regarding the working required for hinges and door pulls, see the instructions on page 13. Sliding walls are generally made from 10 mm or 12 mm tempered glass. In demanding locations, the walls are made using 5+5 tempered laminated glass.

JT glass door 4+4 tempered/ laminated, colour interlayers, office's glass wall. Door has three hinges, lockable handle, door pull and aluminium frame.

Sauna doors

JT sauna doors are generally delivered as installation-ready packages that include hinges, a door pull, as well as a wood or aluminium frame; a door closer is an optional accessory. The glass is generally 8 mm tempered and coloured glass. Laminated/tempered glass is recommended for public buildings. Doors have their own RT product data sheet: RT X32/422.3-37941.

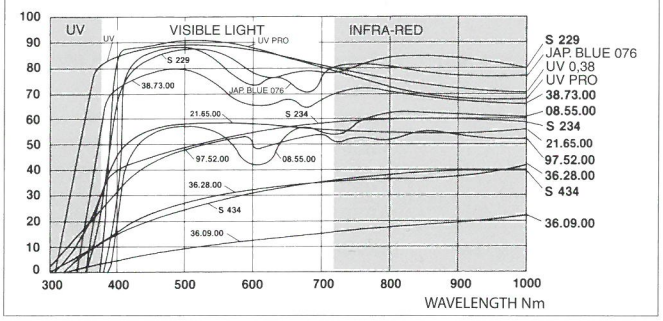
JT sauna door with door closer, tempered 8 mm grey 8 x 21. Door closer is optional accessory.

UV protection glass

The first part of the sun's thermal radiation spectrum consists primarily of ultraviolet radiation having a wavelength of 320-380 nm that is invisible to the human eye. Organic colour pigments react easily to UV radiation, and as a result, colours may change and fade. The UV protection for all laminated glass with PVB interlayers is excellent, approximately 99%. The equivalent value for ordinary glass is 40 %.

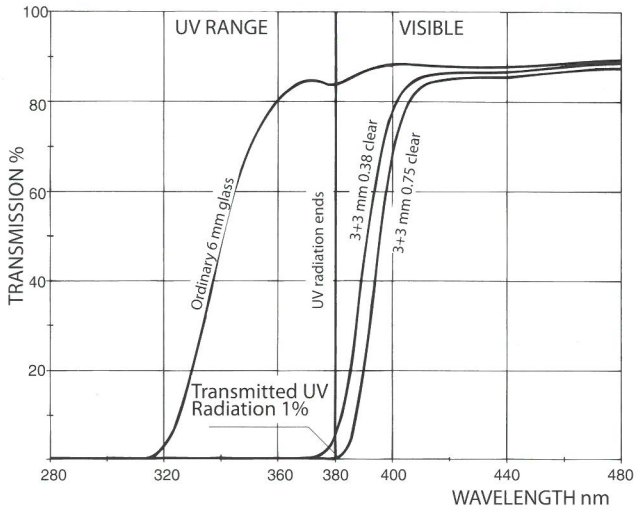
Using JT safety glass achieves the same above-mentioned 99 % UV protection.

Total transmission (%) PVB interlayers, 3+3 laminated glass

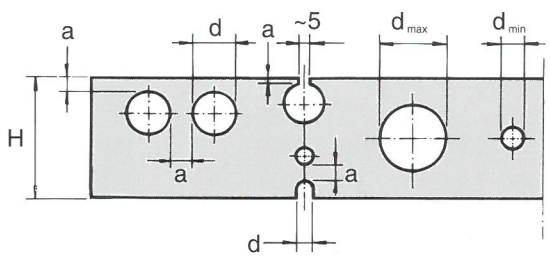


Commercial premises, Stockholm, 2007.
Laminated glass 10+10 clear 1.52, ground edges, size 3125 x 5827 mm.

Total transmission (%)
3+3 laminated glass and ordinary 6 mm glass



Working instructions and recommended dimensioning of glass that will be tempered

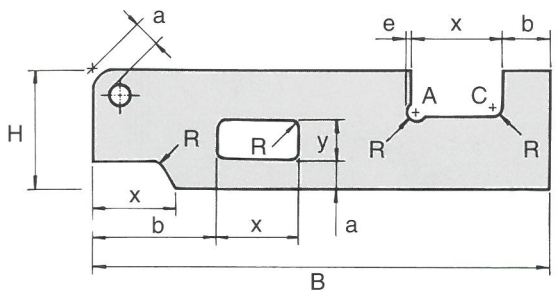


Hole diameters and locations

The minimum diameter of holes must be 5 mm, or if the glass is thicker, equal to the thickness of the glass t. The diameter of the hole must not be larger than one-third of the width of the glass sheet at its narrowest point.

Glass thickness t (mm)	a	d_{min}	d_{max}
3...6	≥ 1,5 x t	≥ 5 mm	≤ H : 3
8...19	≥ 2 x t	≥ t	≤ H : 3

Each hole must be surrounded by glass by at least half the diameter of the hole's stem, a = d/2.
If the hole is at the corner of the glass, a = 4 x t (lower diagram)
If a < 1.5 x t, the hole must be open (glass thickness 3-6 mm)
If a < 2 x t, the hole must be open (glass thickness 8-19 mm)



a = 4 x t (holes in corners) y = H : 3
b = x : 2 x = B : 3

Rectangular openings

Dimensions of rectangular openings and distances to glass edges:

b ≥ x : 2 a ≥ y : 2
x ≤ B : 3 y ≤ H : 3

Roundings

The corners of openings must always be rounded, Rmin = t. There are two types of roundings, A and C. An angular fitting piece requires A-type roundings. To prevent the rounding from being visible, the covering plate must extend beyond the dimension e.

$$e = R - \frac{R}{\sqrt{2}}, \text{ for example } R = 20.: e = 6$$

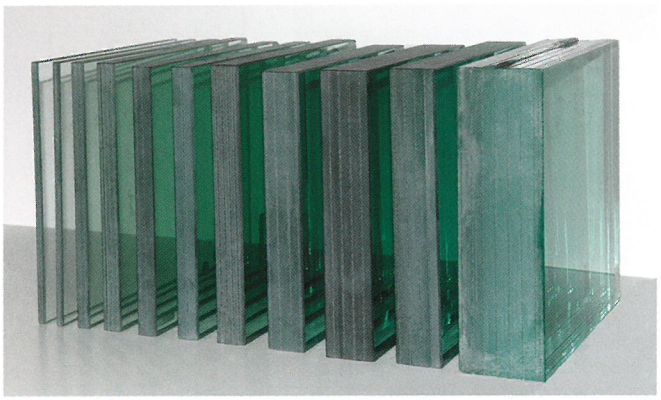
JT bullet-proof glass according to DIN 52290 / part 2

JT no. (order no.)	Protection class	Firearm	Thickness (mm ±0,5)	Weight (kg/m²)	Energy J
JT-121	C1SA	9 mm x 19	20	47	520
JT-123	C1SA	9 mm x 19	21	51	520
JT-128	C1SF	9 mm x 19	30	68	520
JT-129	C1SF	9 mm x 19	39	92	520
JT-130	C2SA	.357 Magnum	26	61	930
JT-131	C2SA	.357 Magnum	24	57	930
JT-137	C2SF	.357 Magnum	41	101	910
JT-138	C2SF	.357 Magnum	40	97	910
JT-140	C3SA	.44 Magnum	32	76	1540
JT-147	C3SF	.44 Magnum	59	145	1520
JT-148	C3SF	.44 Magnum	57	140	1520
JT-160	C4SA	7,62 x 51	48	114	3000
JT-161	C4SA	7,62 x 51	45	107	2940
JT-169	C4SF	7,62 x 51	82	200	2960
JT-171	C5SA	7,62 x 51	75	185	3190
JT-179	C5SF	7,62 x 51	92	229	3160
JT-136	Kalashnikov SA	7,62 x 39 VM, Sp, Fe-core	42	98	2070
JT-168	Kalashnikov SF	7,62 x 39 VM, Sp, HK	67	163	2080

SA = fragments may break off from the rearmost glass, but the bullet cannot penetrate the glass
SF = fragments may not break off from the rearmost glass
Recommended maximum glass size: weight < 700 kg.

Protection class	Calibre	Bullet type	Bullet weight,g	Bullet speed m/s	Distance m
C1	9 mm x 15	VM, RK, WK	8	355...365	3
C2	.357 Magnum	VM, KSp, WK	10, 25	415...425	3
C3	.44 Magnum	VM, FK, WK	15, 55	435...445	3
C4	7,62 x 51	VM, Sp, WK	9, 45	785...795	10
C5	7,62 x 51	VM, Sp, HK	9, 75	800...810	25

VM = full jacket
KSp = conical nose
HK = hardened core
RK = round nose
FK = flat nose
WK = lead core
Sp = pointed nose



JT bullet-proof glass has been tested in Germany according to the DIN standard.

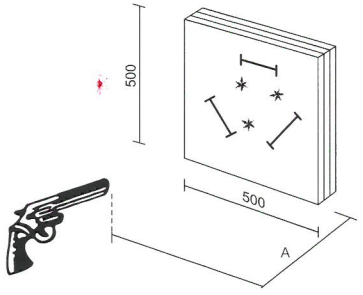
JT bullet-proof glass DIN EN 1063

JT no. (order no.)	Protection class	Firearm	Glass type	Thickness (mm ±0,5)	Weight (kg/m²)	Energy J
JT-110	BR1 S	Small-bore rifle	Lam.	12	30	169
JT-111	BR1 S	Small-bore rifle	2k e-glass	30	40	169
JT-118	BR1 NS	Small-bore rifle	Lam.	19	46	169
JT-119	BR1 NS	Small-bore rifle	2k e-glass	34	44	169
JT-122	BR2 S	9 x 19	Lam.	23	53	640
JT-124	BR2 S	9 x 19	Lam.	27	63	640
JT-125	BR2 S	9 x 19	3k e-glass	60	70	640
JT-127	BR2 NS	9 x 19	3k e-glass	65	85	640
*JT-130	BR3 S	.357 Magnum	Lam.	26	63	943
JT-124	BR3 S	.357 Magnum	Lam.	27	63	943
JT-132	BR3 S	.357 Magnum	3k e-glass	62	75	943
JT-139	BR3 NS	.357 Magnum	3k e-glass	72	100	943
*JT-129	BR4 S	.44 Magnum	Lam.	39	95	1510
JT-139	BR4 S	.44 Magnum	3k e-glass	72	100	1510
JT-149	BR4 NS	.44 Magnum	3k e-glass	78	115	1510
JT-139	BR5 S	5,56 x 45	3k e-glass	72	100	1805
JT-149	BR5 NS	5,56 x 4 5	3k e-glass	78	115	1805
JT-162	BR6 S	7,62 x 51	3k e-glass	88	140	3272
JT-167	BR6 NS	7,62 x 51	3k e-glass	93	150	3272
JT-178	BR7 NS	7,62 x 51	3k e-glass	110	195	3295
JT-199	SG2 S	Shotgun 12/70	Lam.	52	124	2734
JT-188	SG2 S	Shotgun 12/70	3k e-glass	80	125	2734

* = tested also according to DIN 52290, Part 2.
S = fragments may break off from the rearmost glass, but the bullet cannot penetrate the glass
NS = fragments may not break off from the rearmost glass
JT bullet-proof glass, as well as insulating glass, is laminated with ground edges.
The airspace is 15 mm. Recommended maximum glass size: weight < 700 kg.

Protection class	Calibre	Bullet type	Bullet weight, g	Bullet speed m/s±10	Distance m
BR1	.22	Blei, RK	2,6	360	10
BR2	9 x 19	VM, RK, WK	8,0	400	5
BR3	.357 M	VM, Ksp, WK	10,2	430	5
BR4	.44 M	VM, FK, WK	15,6	440	5
BR5	5,56 x 45	VM, Sp, WKP1	4,0	950	10
BR6	7,62 x 51	VM, Sp, WK	9,5	830	10
BR7	7,62 x 51	VM, Sp, HK	9,8	820	10
SG2	12/70	Blei, FLG	31,0	420±20	10

VM = full jacket
KSp = conical nose
Sp = pointed nose
RK = round nose
FK = flat nose
HK = hardened core
WK = lead core
WKP1 = lead/steel core
Blei = lead
Blei, FLG = lead-filled



JT bullet-proof glass has been tested in Germany according to the DIN standard EN 1063. Three shots are fired at the glass, the hits forming the triangle, as shown, the length of whose sides is 120 mm, except 125 mm in the SG2 protection class.

Railing and balcony glass

JT safety glass for railings and balconies is manufactured from either laminated or tempered glass, or from a combination of both. The glass can be flat or curved, for example 4+4 tempered laminated glass is already sufficient from the standpoint of strength; the durability is according to Part B1-3 of the Finnish Building Regulations.
There are several installation methods. If the glass is attached through holes it must be tempered or tempered/laminated. Without holes, laminated glass is sufficient. If there is a danger of falling, the glass should be at the least laminated. The glass attachment is carried out so that the glass is kept separate from concrete or metal by using plastic or rubber.

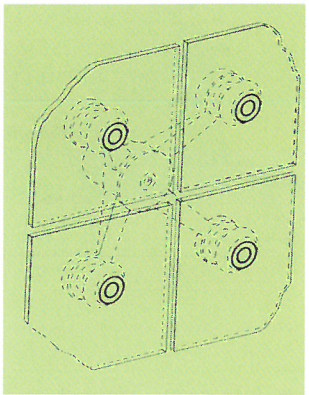
Hotel Rica, Älvsjö, Stockholm, 2006.
Railing glass tempered laminated 4+4 opal, polished edges.

Table and interior glass

JT table and interior glass is manufactured from either laminated or tempered glass, or from a combination of both. A wide range of colour alternatives is available. The glass may also be sandblasted or feature silkscreen printed patterns. CNC machines grind the edges of special glass shapes that can be freely chosen.
JT table and interior glass is used in, for example, restaurants, discos, department stores, traffic terminals, as well as in sports and multi-purpose halls.

Self-supporting facade structures

The picture illustrates the point attachment of spandrel glass to a building's frame construction. The glass is attached at the corners as well as at intermediate intervals of approximately 1000-1500 mm. The glass thickness is 10-15 mm tempered or tempered/laminated polished glass; the holes' drillings and counterborings are selected according to the utilised attachment elements. The glass can be made from single sheets or insulating glass. The joint between the glass sheets is approximately 10 mm.



Example of point attachment principle in a spandrel structure.

Glass-polycarbonate

Using a special method of lamination that combines glass with a polycarbonate sheet and a special interlayer achieves certain features that would require a slightly thicker construction if carried out with glass alone.
To prevent scratches, the polycarbonate is laminated between two equally thick sheets of glass.
Note! The substantial difference between the expansion rates of glass and polycarbonate must be taken into account when making the selection. The laminating is also manufactured with resin, but the optics are weaker compared to the use of interlayers.

Surveillance mirrors

Laminated JT surveillance mirrors have been developed for inconspicuous observation. The characteristics of surveillance mirrors are based on strongly reflecting glass whose light transmission capacity is low, and on different room illumination levels. It is possible to see into a lighter room from a darker one, but not vice versa. In the brighter room, the surveillance window acts as a mirror. Surveillance mirrors can be combined with normal window structures.

Floor glass

Floor glass elements are generally laminated glass sheets supported at four points. The deflection of the glass must be so minor that it cannot be felt by a person walking on it. Besides aiming at an extremely small deflection, the glass's own weight must be added to the load when calculating the thickness of the glass. The stress value generally remains extremely low. The glass edges are polished; the best method is to grind the glass separately before lamination. The edges' support width is 30-50 mm depending on the size and strength.
The size of the largest floor glass element supplied by Jaakko-Tuote Oy has been 3150 x 3150 mm, thickness 52 mm, weight 1250 kg.

Parliament House extension, corridors' laminated floor glass 12+12+12, sandblasted.

Safety glass quality control

The viewing distance is 2 m, normal diffused lighting (cloudy sky) without background lights, viewing perpendicular, glass in use position.
Allowed in the middle part of the glass are scratches whose maximum length is 30 mm and width 1 mm. At edge areas, the maximum allowable length of scratches is 50 mm. No limitations in rabbet areas.
Point defects ø 1 mm and insubstantial hairline cracks are allowed over the entire area. Clusters of scratches and point defects are not allowed.
In tempered/ laminated glass, a few bubbles in the interlayer are allowed in an area approximately 25 mm from the edge of the sheet.

Dimensional tolerances are shown on page 5.

Jaakko-Tuote Oy glass testing equipment

Vehicle and building glass testing

1. Ballistics tests 3-25 m indoors	
2. Heat-soak oven, L = 5 m	DIN 18516
3. Train insulating glass, tightness testing equipment	UIC 566
4. Interlayer moisture measurement equipment MM55	
5. Tempered glass, optical stress meter StrainOptic	EN 12150
6. Tempered glass, compression stress measurement	ISO614
7. Artificial head dropping equipment	ECE43R
8. Laminated glass, kitchen test equipment EN 14449	ECE43R
9. Laminated glass, moisture test	EN 14449
10. Bullet speed measuring equipment OEHLER	
11. Optical distortion testing equipment	ECE43R
12. Coating and tin side sensors	
13. Point load measurement with electronic scale, freely supported on 4-2 sides	
14. Heavy object testing equipment, 45 kg leather sack	BS 6206
15. Bending strength measurement with water pressure, fixed support on 4 sides	
16. Secondary image testing, windscreen optics	ECE43R
17. Trotex laser BP20 thermometer, -35°...+800°	
18. UV radiation meter, Crawford 760	
19. Light transmission measuring equipment VTT	ECE43R

Metal ball dropping equipment:

20. 0.227 kg metal ball 2...7 m	ECE43R
21. 1.03 kg metal ball 4 m	EN 14449
22. 2.26 kg metal ball 4 m	ECE43R
23. 4.1 kg metal ball 1,5...12,5 m DIN 52290	EN 356

JAAKKO-TUOTE OY

Operations began	1971
Premises heated	3 ha
unheated	0,6 ha
12 transformers	16 MW
Power connection	7 MW
Production	laminated and tempered glass profile sheets
Personnel	160

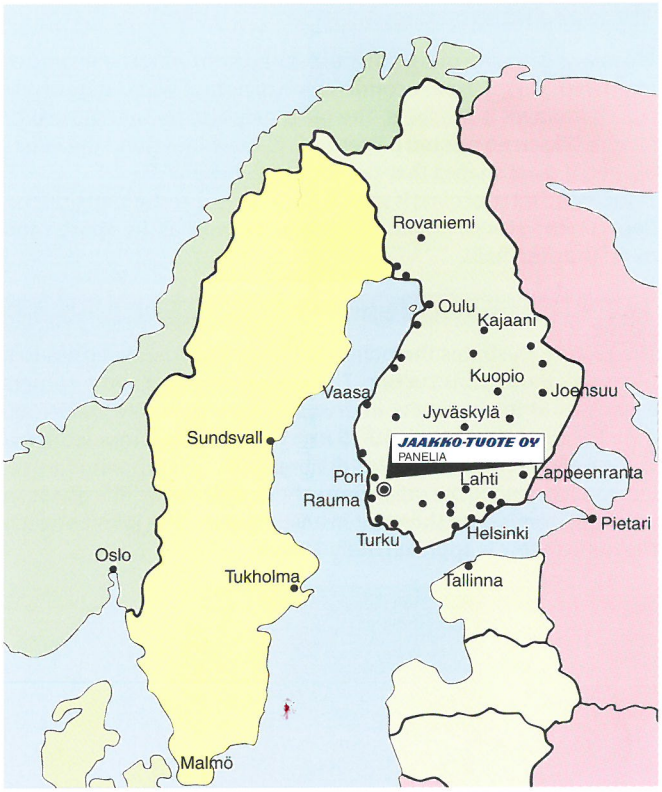
Installation

Installation instructions generally in use apply to JT safety glass. Safety glass must be installed carefully by following the appropriate installation method.

Storage and maintenance

JT safety glass is packed partially between paper spacers (not over the entire area). Safety glass must be stored in dry locations. If the packaging becomes wet, it is opened and the glass is dried to prevent glass mould. Safety glass is washed with water and liquid window washing detergent. The use of abrasive and scratch producing substances and equipment is prohibited.

Offices of Jaakko-Tuote Oy. Upper section laminated spandrel glass 3+3, lower section tundra-patterned brick. JT Siruglass at entrance and railing.



MANUFACTURING AND INFORMATION

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