

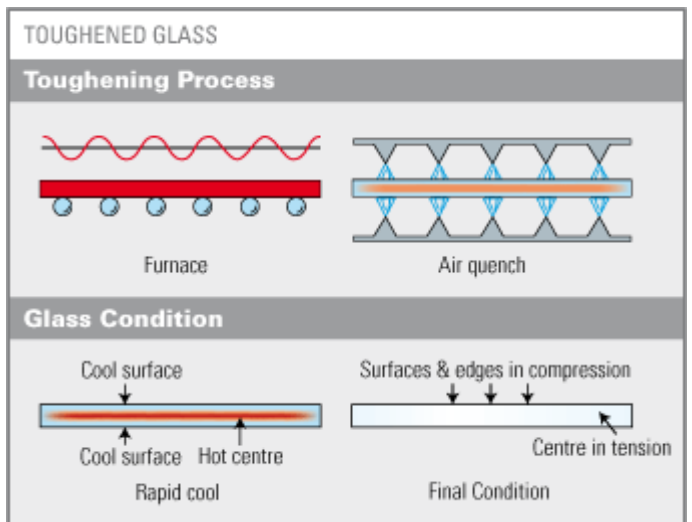
1. HEAT TREATED GLASS (TEMPERED & HEAT STRENGTHENED)

1.1 General Information

Heat Treated Glass is produced by heating the glass to a plastic state at around 650°C, and then by computer control, the glass is moved into the quench area where it is rapidly cooled by a series of high pressure air nozzles.

This rapid cooling or quenching induces high compression stress in the glass surface, while the centre remains in tension.

Although the physical characteristics remain unchanged, the additional stresses created within the glass increases its thermal and mechanical strength.



Heat Strengthened glass is twice as strong as the annealed glass while Tempered glass is up to five times stronger than ordinary annealed glass of the same thickness.

1.2 Technical Information

Due to the internal stresses in the Tempered heat treated glass, several benefits can be achieved such as:

1.2.1 Safety

In the unlikely event of Tempered glass breaking, it fractures into small particles, significantly reducing the risk of injury. This break-safe characteristic is an important aspect of tempered glass.

The benefits of safety glass can therefore be enjoyed, for example, along passage- ways and areas of high pedestrian traffic, in doors and adjacent panels; in shower and bath enclosures; in garden windbreaks; in balconies, balustrades and staircases.





1.2.2 Strength

Tempered glass has high mechanical strength and is 4 to 5 times stronger than annealed glass of the same thickness due to the stresses induced during tempering process.

It also has high thermal strength, when compared to annealed glass, can withstand a temperature differential of 250°C, and is stable in temperatures ranging from -70°C to 300°C.

Tempered glass can withstand extremes of heat and cold. At 300 degrees centigrade it can be sprayed with ice-cold water and remain intact. This resistance to severe temperature differentials means that it can be used where annealed glass could be subject to breakage through thermal stress. For example, windows which for a large part of the day may be partly in shade and partly in direct sunshine.

Heat resistance combined with strength also allow its extensive use in furniture and domestic appliances.

1.2.3 Mechanical Fixing

Tempered glass has high mechanical strength and can therefore be used with mechanical fixings, such as patch, spider, hinge (frameless), point and countersunk fixing.

1.2.4 Security

Tempered glass is much harder to break than annealed float or laminated glass. If broken it will not provide security, however the noise due to breakage is often a deterrent.

Typical Tempered glass applications:

- Doors and Side Panels.
- Internal Partitions.
- Low Level Glazing.
- Spandrel Panels.
- Balustrades and Fences.
- Shower Doors and Screens.
- Frameless Glass Doors and Entries.
- Structural Glass Walls.
- Glass Canopies.
- Furniture.

Wherever the benefits of ordinary glass need to be combined with extra strength, safety or heat resistance, tempered glass can offer a complete and proven solution.



1.3 First Glass (F.G) HEAT TREATED GLASS (FG-T)

1.3.1 Manufacture: **F.G** Tempered glass is produced by the horizontal process. Using the most modern and advanced furnaces in the World, FIRST GLASS can offer tempered glass in a wide variety of types, sizes, and thickness with maximum flatness, minimum distortion and best quality.

1.3.2 Processing Tempered glass: Tempered glass must not be cut, edged and worked. Any work on the glass will affect its properties and may result in breakage. Therefore, all work on the glass must be done prior to tempering.

1.3.3 Handling: As with all glass, the edge of tempered glass is vulnerable, and care is necessary both in handling and installation, since an edge damaged in handling may result in subsequent breakage.

1.3.4 Storage: Tempered glass should be stored in a near vertical position, set on edge on strips of wood, felt or other relatively soft material. It should not be stacked horizontally and should be kept dry.

1.3.5 Cleaning: For all types of glass, it is necessary to take precautions and protective measures to avoid damage or scratches. Glass panels that have been in position for several weeks should first be washed down with clean water before being cleaned with a soft sponge and leather. Particular attention should be paid to the removal of dried abrasive dust particles.

1.3.6 Installation: In glazing, edge clearance must always be allowed, and insulation or cushioning should be used to prevent contact with hard materials. The glazing and fixing techniques should be generally in accordance with International Standards and is the responsibility of the installer; FIRST GLASS as glass supplier can provide recommendations but bears no responsibility or liability for proper installation.

1.3.7 Safety & Standards: **F.G** Tempered glass meets standards for glass impact resistance test. It meets Standards for impact performance requirements for flat safety glazing materials for use in buildings and has successfully been tested according to several international standards. BS6206, ASTM 1048 and ANSI Z97.1





1.3.8 DIMENSIONS

Maximum	2400mm x 4800mm	<i>max. (2440mm x 5100mm)</i>
Minimum	100mm x 250mm	

1.3.8.1 DIMENSIONS TOLERANCES

<u>Glass Types</u>	<u>Tolerance (mm)</u>
4mm	± 1.6
5mm	± 1.6
6mm	± 1.6
8mm	± 2.0
10mm	± 2.4
12mm	± 3.2
15mm	± 4.0
19mm	± 4.8

1.3.8.2 THICKNESS TOLERANCE

<u>Nominal Thickness</u>	<u>Actual Thickness</u>
4mm	3.78 - 4.19
5mm	4.57 - 5.05
6mm	5.56 - 6.2
8mm	7.42 - 8.43
10mm	9.02 - 10.31
12mm	11.91 - 12.49
19mm	18.26 - 19.84

1.3.9 BOW TOLERANCE

By nature of the tempering process it is not possible to produce consistently, glass as flat as annealed glass. The deviation of bow may vary dependent upon the thickness, size, aspect ratio and other factors. Bow is measured with the glass in their vertical plane and supported at quarter points. The maximum deviation from a straight edge is measured on the concave surface.

The maximum bow for horizontally tempered glass is 1mm per meter up to 1 meter dimension and up to 2mm per meter for dimensions greater than 1 meter.

1.3.10 DISTORTION

Glass tempered by the horizontal process does not exhibit tong marks distortion, nor the degree of bow associated with the vertically hung process. Under particular lighting conditions and viewing angles, the pattern of stresses in tempered glass can sometimes be seen. This strain pattern is usually noticed in strong sunlight. It is an inherent characteristic of tempered glass.

Some slight distortion can occur in horizontally tempered glass due to the directional nature of the process. This is in the form of distortion bands 1900mm apart perpendicular to either the long or short axis of the glass. However, with the new technology that FIRST GLASS is the distortion is minimized to a very low level.

Any distortion in tempered glass will be more accentuated in the body tinted and/or high reflective glass types.

1.3.11 SHAPES

The tolerance mentioned earlier does not apply to shapes, and enquiries must be submitted for glass types other than square, rectangular or circles. Templates or digital drawings may be required for the manufacture of some shapes.

1.3.12 HOLES

DRAWING 1

Figure 4
Maximum hole diameter to be less than 33% of narrowest height/width of glass for holes over 30mm.
Dog and cat doors special rules.

Figure 3
Distance between holes to be at least 4x thickness of glass

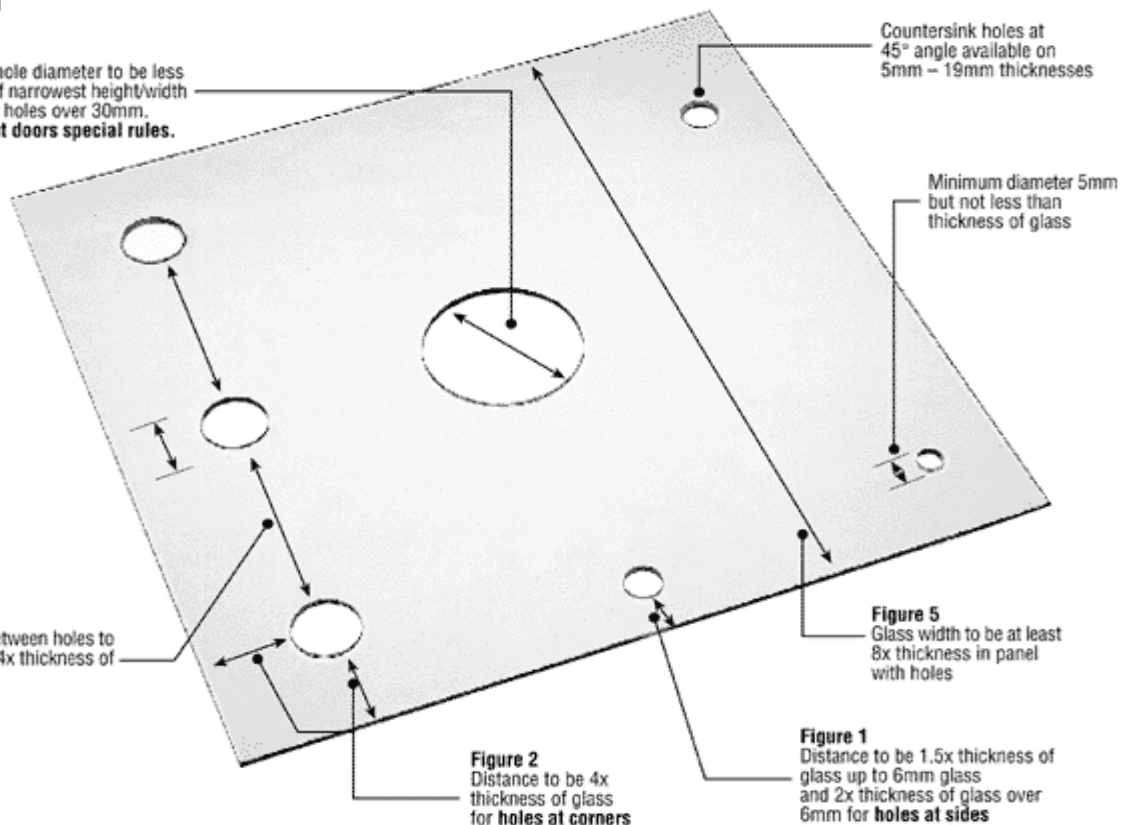
Figure 2
Distance to be 4x thickness of glass for holes at corners

Figure 1
Distance to be 1.5x thickness of glass up to 6mm glass and 2x thickness of glass over 6mm for holes at sides

Countersink holes at 45° angle available on 5mm – 19mm thicknesses

Minimum diameter 5mm but not less than thickness of glass

Figure 5
Glass width to be at least 8x thickness in panel with holes



The diameter of holes should not be less than the thickness of the glass. In cases where smaller holes are required, enquiries must be submitted.

Tolerance on drilled hole diameters of 25mm and under is ± 1 mm.

The positional tolerance on all holes will be ± 1 mm in all glass thickness.

All drilled holes will have a ground finish with arise. If the total area of all holes exceeds $1/6^{\text{th}}$ of the plate area, or there are more than four holes, the enquiry must be submitted.

The distance from the edge of the plate to the edge of the hole must never be less than 1-1/2 time the glass thickness.

The edge of the hole adjacent to a corner must not be nearer to the corner (extended in the case of a rounded corner) than 4 times the thickness of the glass.

For holes exceeding 30mm diameter the distance from the edge of the plate to the edge of the hole must at least be $1/3$ of the width of the plate.

1.3.13 NOTCHES

DRAWING 2

Figure 2
Height/width of cut-out to be no more than 33% of height/width of glass

Minimum 19mm radius at semi-circle of cut-out

Figure 4
Interior width and height of cut-out not to be less than the thickness of the glass

Figure 1
Distance between cut-out and edge of glass to be at least 50% of hole/cut-out width or height in the direction in question.
Minimum of 75mm 4-6mm glass
Minimum of 100mm 8-19mm glass

Minimum radius equals glass thickness at end of cutout

DRAWING 3

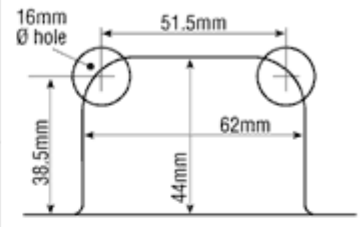


Figure 5
Centre Notches
Notches with holes in the corner of notch must be to special dimensions as noted in Drawing 3

Figure 6
External corners must be rounded

Figure 3
Rectangular cut-outs to have a hole radius, have radius corners or semicircular ends not less than the glass thickness

Corners Rounded



- Many configurations of notches can be supplied but enquiries must be submitted.
- Re-entrant corners of notches cannot be sharp. They must have a radius R at least equal to the thickness of the glass.
- Edges will have a ground finish and should normally be 75mm or greater. If less, enquiries must be submitted.
- Tolerances on notch dimensions ± 2 mm.
- Position of notch relative to edge of glass tolerance + 2mm.
- The edges of all notches will have a ground finish.

1.3.14 CIRCLES

The diameters generally available in the various thicknesses are given below:

<u>Nominal thickness</u> <u>mm</u>	<u>Maximum diameter</u> <u>mm</u>	<u>Minimum diameter</u> <u>mm</u>
5	600	50
6	750	50
10	1000	75
12	850	100
15	upon request	upon request
19	upon request	upon request

Enquiries for other sizes or thickness should be submitted.

1.4 ACCEPTANCE CRITERIA FOR ANNEALED AND HEAT TREATED GLASS

1.4.1 SCOPE

This part covers the requirements for cut to sizes flat, transparent, clear, tinted and coated glass types. To be used primarily for building construction, general architectural uses or to control the transmission of light, heat, normal radiation or combination thereof.

The guidelines for criteria followed are:

- ASTM 1036 : Annealed Glass
- ASTM 1048 : Heat Treated Glass



1.4.2 TERMINOLOGY

- Vision interference angle - the acute angle included between the plane of the glass and the vertical plane perpendicular to the wall.

- Imperfections in flat glass:

Crush - a lightly pitted area resulting in a dull grey or white appearance over the region.

Dig - deep, short scratches.

Dirt - a small particle of foreign matter imbedded in the glass surface.

Gaseous inclusions - round or elongated bubbles in the glass.

Knot - a transparent area of incompletely assimilated glass

Lines - fine cords or strings, usually on the surface of sheet glass.

Open gaseous inclusions - bubbles at the surface of glass that are open, leaving a cavity in the surface.

Process surface imperfections - slight surface imperfections that originated in the process that can be small particles of foreign materials on either surface or surface irregularities.

Ream - inclusions within the glass or layers or strings of glass that are not homogeneous with the main body of the glass.

Rub - abrasion of the glass surfaces producing a frosted appearance. A rub differs from a scratch in having appreciated width.

Scratch - any marking or tearing of the surface produced in manufacturing or handling, appearing as though it were done by a sharp or rough instrument.

Smoke - streaked areas appearing as slight discoloration.

Stone - any crystalline inclusion imbedded in the glass

String - transparent line appearing as though a thread of glass had been incorporated into the sheet

1.4.3 CLASSIFICATIONS (F.G STOCK RANGE)

Annealed	:	Clear:	Type 1, Class 1,	Quality 3
		Tinted:	Type 1, Class 2,	Quality 3
		Reflective:	Type 1, Class 3,	Quality 3
		Patterned:	Type 2, Class 1/2,	Form 3, Quality p8, Finish f1 of f2, Pattern p1/2/3/4
		Wired:	Type 2, Class 1,	Form 1, Quality p8, Mesh m1/2/3
Tempered	:	Clear:	Kind FT, condition A Type 2,	Class 1, Quality q3
		Tinted:	Kind FT, Condition A, Type 1,	Class 2, Quality q3



Reflective: Kind FT, Condition A, Type 1,
Class 3, Quality q3.
Patterned: Kind FT, Condition A, Class 1 / 2,
Form 3, Quality q8, Finish f1/2

(Quality Q3) *intended for architectural fenestration or other applications where distant objects are viewed through the glass by the observer.*

Tempered glass is also known as Toughened glass

1.4.4 FABRICATION REQUIREMENTS

Annealed: Edges shall be clean cut, polished, bevelled or mitred as specified.
Dimensional tolerances – refer to Table 1 below
Imperfections – refer to Table 2 below

Tempered All fabrication such as cutting, edgework, drilling holes, notching, grinding etching, sandblasting shall be performed prior to the tempering. After tempering it cannot be modified.
Tempered glass produced through the Horizontal Tempering Process may contain surface waves caused by contact with rollers. This waviness is detectable when viewing reflected images from a distance.
Strain pattern: in fully tempered glass a strain pattern, which is not normally visible, may become visible under certain light conditions. It is an inherent characteristic and should not be mistaken as discolouration or non-uniform tint or colour.

DIMENSIONAL TOLERANCES (RECT. SHAPES)

<i>TABLE 1</i>		
Thickness	Thick. Toler.	Length & Width ± mm (max)
6	-0.44 / + 0.2	max 1.6
8	-0.58 / + 0.43	2.0
10	-0.98 / + 0.31	2.4
12	-0.18 / + 0.49	3.2
19	-0.74 / + 0.84	4.8

TABLE 2

Imperfections	Up to 2.5m ²		2.5 to 7.0 m ²		Over 7m ²	
	Central	Outer	Central	Outer	Central	Outer
Gaseous inclusions (max. size)	1.6mm	2.4mm	3.2mm	4.8mm	6.4mm	6.4mm
Open gaseous inclusions	1.2mm	1.6mm	1.2mm	1.6mm	3.2mm	3.2mm
Knots, dirt, stones	0.4mm	0.8mm	1.6mm	1.6mm	3.2mm	3.2mm
Scratches & rubs (intensity)	medium	medium	medium	heavy	heavy	Heavy
Digs (max. length)	1.6mm	2.4mm	3.2mm	4.8mm	6.4mm	6.4mm
Process surface (intensity)	medium	medium	medium	heavy	heavy	Heavy
	(visible as a slight greyish haze)			(visible as a cloudy surface)		

REMARKS:

- Glass thickness over 6mm may contain proportionally more & larger imperfections.
- Central area is considered to form an oval or circle centred on the pane whose axes or diameter does not exceed 80% of the dimensions. The remaining area is considered the outer area.
- Intensity (scratches, rubs, and crush): when looking through glass and perpendicular to it using daylight (without direct sunlight) the imperfection shall not be detected at
Medium: 3.3mm
Heavy: over 3.3mm
- Digs: separated at least 305mm



Bow & Warp Test

Test Method: Place sample glass in a free-standing vertical position, resting on blocks at the quarter points. With the glass in this position, place a straight edge across the concave surface, parallel to and within 25.4mm of the edge, and measure the maximum deviation with a taper or feeler gage. A dial indicator may be used.

OVERALL BOW & WARP TOLERANCES / TEMPERED GLASS

TABLE 3

	460	460-910	910-1220	1220-1520	1520-1830	1830-2130	2130-2440	2440-2740	2740-3050	3050-3350
Glass Thickness										
4	3	5	7	9.5	13	16	19	22	25	
6	1.6	3	5	7	12	12	16	19	22	25
8	1.6	2	4	6	7	9	11	14	17	21
10	1.6	2	3	5	6	8	10	12	16	19
12-19	1.6	1.6	2	3	5	6	7	9.5	12	16

Localized warp: for rectangular glass not exceed 1.6mm over any 300mm span (for strips 2.4mm).

Wave, reams strings & lines

Place sample in a vertical position at a distance of approximately 1m from a brick wall or a similar background showing essentially straight line. Look through the sample at a distance of approximately 2m from the sample using daylight without direct sunlight or with background light suitable for observing each type of imperfection. View the sample at an angle to the surface of not less than the vision interference angle in the table for the applicable glass in Specification C 1036. The angle of vision shall be perpendicular to the wall. Determine acceptability in accordance with the applicable table of blemishes in specification C 1036.



Scratches, rubs, stones & gaseous inclusions

Place sample in a vertical position approximately 1m from the viewer's position. Look through the sample using daylight without direct sunlight or with background light suitable for observing each type of blemish. Determine acceptability in accordance with the applicable blemishes in Specification C 1036.

Strength characteristics

Determine strength characteristics of kind HS glass in accordance with surface and edge compression. Determining strength characteristics for Heat Treated glass is done by Non-destructive Photo-elastic Measurement of Surface Stresses testing according with ASTM C1279.

- Surface & edge compression: Examine specimens by the light polarization method for surface or edge compression. When the range of the apparatus permits examination for edge compression only, obtain the averaged value for all midpoints.

1.5 Product marking

The identification marking, includes the manufacturer's name (First Glass), trademark and the designation of fully tempered (**F.G-T**) or Heat Strengthened (**F.G-HS**), as applicable. The identification marking shall be either permanent or temporary, as specified. Heat treated glass intended for use in vision areas (such as door and windows) shall be permanently marked. Permanent identification marking is accomplished by sandblasting, etching, or fired - on ceramic decal or silk-screened imprint methods that do not introduce stresses. The marking shall be located at the corner of the glass where it shall be fully visible and legible when the glass is installed.