

## TEMPERED GLASS .

Glass is tempered by subjecting it to a heating and cooling treatment whereby high compressive stresses are set up at the surfaces with balancing tensile stresses in the center. These balance stresses give tempered glass its increased strength. It can only break under extreme loads, which bend the glass sufficiently to overcome the stresses, or by severe impact with a sharp object, which may penetrate the surface so releasing the stress and fracturing the glass.

Tempered glass is up to five times stronger than ordinary glass of the same thickness, and can meet architectural safety standards for impact resistance anywhere in the world.

Because of its increased strength, tempered glass allows architects and builders for greater scope in their use of glass in buildings.

The benefits of 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.

In areas of particular hazard where standards require the use of a safety glazing material, ALICO EGYPT tempered glass provides an economical and proven solution.

Tempered glass, if ever broken, disintegrates into small, relatively harmless pieces, which are neither large enough nor sharp enough to cause serious injury. This break-safe characteristic is another important aspect of toughened glass safety.

Tempered glass can withstand extremes of heat and cold. At 250 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 allows its extensive use in furniture and domestic appliances.

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

## GENERAL INFORMATION

**Manufacture:** ALICO EGYPT tempered glass is produced by the horizontal "roller hearth" process. Using one of the most modern furnaces in the Emirates, ALICO EGYPT can offer tempered glass in a wide variety of types, sizes, and thickness with maximum flatness and minimum distortion.

**Technical Advice:** Enquiries for technical advice should be submitted to ALICO EGYPT. Technical Services early in the design phase. At this stage full details of the proposed application should be submitted, including tight frame sizes along with details of the proposed glazing system.

**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.

**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.

**Glazing:** 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 current ALICO Egypt's Glazing Recommendations.

**Working of Tempered glass:** Tempered glass must not be cut or worked. Any work on the glass will affect its properties and may result in breakage. Therefore, all work on the glass must be done before tempering.

**Safety & Standards:** ALICO EGYPT tempered glass of an appropriate thickness meets standards for glass impact resistance anywhere in the world at every level of severity. It meets Standards for impact performance requirements for flat safety glazing materials for use in buildings and has successfully been tested according to BS6206, and complies in full respect with Federal Specification DD-G-001403, ASTM 1048-90 and ANSI Z97.1

## PROPERTIES

**Strength:** The degree to which the resistance to applied loading of the glass is increased by tempering can be varied. It is dependent to some extent on the thickness and nature of the glass. In general, the strength can be increased by four to five times.

**Thermal Strength:** Tempered glass offers greatly increased resistance to sudden temperature changes compared with annealed glass. The stress characteristics of tempered glass of normal soda-lime composition are unchanged up to about 300 degrees centigrade and are not affected by sub-zero temperatures. Tempered glass has been tested down to -70 degrees centigrade and can be exposed to a thermal gradient so that one surface of the glass reaches a temperature not exceeding 250 degrees centigrade, while the other is exposed to ambient air temperatures. It will withstand splashing with molten metal and red-hot scale, although the surface of the glass is liable to be plucked by such treatment, which will impair visibility. Plucking will weaken the glass and may eventually cause breakage. Where unusual thermal conditions apply, advice should be obtained.

The thermal expansion of tempered glass is the same as that of ordinary annealed glass.

**Breakage:** When broken, tempered glass fractures into small pieces, which are less likely to inflict cuts as, may be caused by broken annealed glass. For certain applications, glass can be supplied in which the full degree of tempering is not applied, and only in these cases the fractured pieces can be longer.

**Abrasion Resistance:** The thermal tempering process does not increase the resistance of the surface to scratching or abrasion compared with that of annealed glass.

### Availability Table G-TUF @

#### Standard Special Order

Clear: 6,8,10,12,15,19 2100 x 3200 2440 x 4800

Bronze: 6,8,10,12

Grey: 6,8,10

Blue: 6

Blue-Green: 6

PC-Reflective glass types 6mm 2100 x 3300

(Clear, Bronze, Grey, Blue, Blue Green, Green)

## MINIMUM DIMENSIONS

(All types) 250 x 250mm

## TOLERANCES - ON DIMENSIONS

All Glass Types Tolerances (mm) Square ness (mm)\*

4,5,6 Up to 1200mm +/- 1.6 2.5

1200 – 2000mm +/- 1.6 2.5

2000 – 3000mm +/- 2 4.0

Over – 3000mm +/- 2 5.0

8,9,12mm – 600mm +/- 2 2.5

Over – 600mm +/- 3 4.5

15,19mm – 1000mm +/- 3 5.0

Over – 1000mm +/- 3 5.0

\*Square ness to tolerance is quoted as the difference in the measurements of the diagonal dimension.

## THICKNESS TOLERANCES

Nominal Thickness	Temp.
4mm	3.8 - 4.2
5mm	4.8 - 5.2
6mm	5.7 - 6.3
10mm	9.5 - 10.5
12mm	11.5 - 12.5

## BOW TOLERANCES

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.

## PRODUCTION

ALICO EGYPT tempered glass is manufactured by the horizontal process where one dimension does not exceed 2440 mm.

## DISTORTION

Glass tempered by the horizontal process does not exhibit tong kink 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 250-300mm apart perpendicular to either the long or short axis of the glass. Where one dimension exceeds 2 meters however, the bands will always be perpendicular to the long axis.

With that provision, glass can be tempered so that such distortion occurs in specified direction, out this may incur a cost premium.

Any distortion in tempered glass will be more accentuated in the body tinted reflective glass types.

Please refer to our ALICO EGYPT leaflet ATAD 01 5 regarding acceptance criteria for tempered glass

## SHAPES

The tolerances mentioned earlier do not apply to shapes, and enquiries must be submitted for glass types other than square, rectangles or circles. Templates may be required for the manufacture of approved shapes.

## HOLES

Non-circular. Please submit all enquiries.  
Circular (25mm diameter or less).

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  $-0 + 1$  mm.

The positional tolerance on all holes shall be  $+ 1.5$ mm in all glass thickness.

All drilled holes will have a ground finish with arris. If the total area of all holes exceeds 1/6th 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 times 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.

#### NOTCHES

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 with arris and should normally be 75mm or greater. If less, enquiries must be submitted.

Tolerances on notch dimensions  $-0 + 2$ mm.

Position of notch relative to edge of glass tolerance  $+ 2$ mm.

The edges of all notches will have a ground finish.

#### CIRCLES

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

Nominal thickness	Maximum diameter	Minimum diameter
mm	mm	mm

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 thicknesses should be submitted.

The information contained in this and other ALICO EGYPT-publications, is offered for your assistance in the application of products fabricated by ALICO EGYPT, BUT DOES NOT CONSTITUTE A WARRANTY OF MERCHANTABILITY, NO WARRANTY THAT THE MATERIAL IS FIT FOR ANY PARTICULAR PURPOSE OR USE, NO WARRANTY AGAINST GLASS BREAKAGE OF ANY TYPE, AND NO OTHER WARRANTY, EXPRESS OR IMPLIED. Actual performance may vary in particular applications. Contact ALICO EGYPT-offices, concerning particular applications.

## **ACCEPTANCE CRITERIA FOR ANNEALED AND TEMPERED GLASS**

### **SCOPE**

This leaflet covers the requirements for cut to sizes flat, transparent, clear, tinted and reflective 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

### **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 gray 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.

## **ACCEPTANCE CRITERIA FOR ANNEALED AND TEMPERED GLASS**

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

Wave - imperfections resulting from irregularities of the surfaces of glass, making objects viewed at varying angles appear wavy or bent.

## ACCEPTANCE CRITERIA FOR ANNEALED AND TEMPERED GLASS

Tempered : (Kind FT): fully tempered glass is up to 5 times stronger as annealed glass or the same thickness & configuration. When broken, it breaks in innumerable small fragments of more or less cubical shape. Intended for general glazing and safety glazing such as doors, building entrances, internal partitions or other uses where the superior strength characteristics & safety properties of fully tempered glass are required.

### FABRICATION REQUIREMENTS

Annealed Annealed: - Edges shall be clean cut, arrissed, polished, beveled or mitered as specified.

- Dimensional tolerances - refer to Table 1

- Imperfections - refer to Table 2

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 discoloration or non-uniform tint or color.

- Dimension tolerances: refer to Table 3

- Imperfections: refer to Table 4

- Bow & Warp tolerances: refer to Table 5

## ACCEPTANCE CRITERIA FOR ANNEALED AND TEMPERED GLASS

TABLE 1  
DIMENSIONAL TOLERANCES (RECT.SHAPES) TYPE  
1/ANNEALED

Thickness Thick.Toler. Length & Width +/- mm (max)

6 - 0.4 / + 0.2 max 2

8 - 0.6 / + 0.4 2

10 - 0.9 / + 0.3 3

12 - 0.2 / + 0.5 3

15 - 0.9 / + 0.6 4

19 - 0.8 / + 0.8 5

**TABLE 3  
DIMENSIONAL TOLERANCES (RECT.SHAPES) TYPE  
1/TEMPERED**

**Area Tolerances (for 6mm) Strips**

Neither dimension over + 1.6 / - 3.2 mm -  
1930mm

With one or more dims.  
from 1930 to 2438mm + 1.6 / - 3.2 mm + 3.2/-3.2 mm  
and not over 3.7 m2 area

Either dim. over  
2438mm or over 3.7m2 area + 2.6 4.8 mm + 4.8/-4.8 mm

Above dimens. tolerances do not include for strips, which are determined as follows:

- Up to 1829mm - Up to 1829mm: When the width is equal or less than the length divided by 8.
  - Over 1829 to - Over 1829 to: When the width is equal to or less than the 2438mm length divided by 7.
  - Over 2438 to - Over 2438 to: When the width is equal to or less than the 3353mm length divided by 5.
- Tolerances for thick nesses over 6mm or shaped cutting may exceed this tolerances proportionally.

**ACCEPTANCE CRITERIA FOR ANNEALED AND TEMPERED GLASS (SURFACE CONTROL) - QUALITY Q3 - 6MM THICKNESS**

**TABLE2**

Imperfections Up to 2.5m2 2.5 to 7.0 m2 Over 7m2  
Central Outer Central Outer Central Outer

Gaseous inclusions 1.6mm 2.4mm 3.2mm 4.8mm 6.4mm 6.4mm  
(max. size)

Open gaseous 1.2mm 1.6mm 1.2mm 1.6mm 3.2mm 3.2mm  
inclusions

Knots, diets, stones 0.4mm 0.8mm 1.6mm 1.6mm 3.2mm 3.2mm

Scratches & rubs medium medium medium heavy heavy heavy  
(intensity)

Digs (max.length) 1.6mm 2.4mm 3.2mm 4.8mm 6.4mm 6.4mm

Process surface medium medium medium heavy heavy heavy  
(intensity) (visible as a (visible as a  
slight greyish haze) cloudy surface)

**REMARKS:**

- Glass thickness over 6mm may contain proportionally more & larger imperfections.
- Central area is considered to form an oval or circle centered on the pane whose axes or diameter do not exceed 80% of the dimensions. The remaining axes is considered the outer area.
- Intensity (scratches, rubs, crush): when looking through the 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

**ACCEPTANCE CRITERIA FOR ANNEALED & TEMPERED GLASS**

**TABLE 4**

**OVERALL BOW & WARP TOLERANCES TEMPERED GLASS**

460 460-910 910-1220 1220-1520 1520-1830 1830-2130 2130-2440 2440-2740 2740-3050 3050-3350

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 13 16

**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. When the above procedure is impractical for larger sizes of 3mm thickness, place the glass on a flat surface, concave side down, and use a dial indicator, reading 0.02mm increments, to determine bow & warp tolerances shown in parentheses in Table 2 shall apply when the alternate procedure is used (see 8.5 and Table 1).

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

**ACCEPTANCE CRITERIA FOR ANNEALED AND TEMPERED GLASS**

**TEST METHODS**

- Bow & Warp: see Table 4

- Wave, reams, strings & lines: Place sample in a vertical position at a distance of approximately 1 m from a brick wall or a similar background showing essentially straight lines. 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. Determine strength characteristics for Kind FT glass in accordance with nondestructive testing.

- 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.

**ACCEPTANCE CRITERIA FOR ANNEALED AND TEMPERED GLASS**

**Product marking:** The identification marking when required, shall include the manufacturers name, trademark, and the designation of fully tempered, 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 shall be 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.

The information contained in this and other ALICO EGYPT-publications, is offered for your assistance in the application of products fabricated by ALICO EGYPT, BUT DOES NOT CONSTITUTE A WARRANTY OF MERCHANTABILITY, NO WARRANTY THAT THE MATERIAL IS FIT FOR ANY PARTICULAR PURPOSE OR USE, NO WARRANTY AGAINST GLASS BREAKAGE OF ANY TYPE, AND NO OTHER WARRANTY, EXPRESS OR IMPLIED. Actual performance may vary in particular applications. Contact ALICO EGYPT-offices, concerning particular product applications.

## LAMINATED GLASS

### Introduction

Laminated glass consists of a tough plastic interlayer made of a cleric resin bonded together between two panes of glass. Once sealed together, the glass sandwich" behaves as a single unit and looks like normal glass. Annealed, heat strengthened or tempered glass can be used to produce laminated glass. Similar to the glass in car windshields, laminated glass may crack upon impact, but the glass fragments tend to adhere to the plastic interlayer rather than failing free and potentially causing injury.

Laminated glass is the only glass to provide durability, high-performance and multi-functional benefits while at the same time preserving the aesthetic appearance of the glass. Laminated glass furnishes solutions to many architectural design problems and offers increased protection from the effects of disasters such as hurricane, earthquake and bomb blast. Benefits of laminated glass include:

### Vertical Safety Glazing Applications

The Consumer Product Safety Commission (CPSC) and the architectural glazing safety sections of the major model building codes (Basic National Building Code; Standard Building Code; Uniform Building Code) all set uniform requirements for the performance of glazing materials used in applications which present a potential hazard to the public. These applications include entrance doors, storm doors, patio-type sliding doors, shower and bath enclosures, sidelights and fixed glazed panels. Performance requirements are determined by the application and the size of the glazing area. Laminated glass with resin meets all of these established building codes.

### Sloped and Overhead Glazing Applications

The use of glass in sloped and overhead glazing presents a design and safety challenge. If the glass should break for any reason, the glazing system specified needs to be able to provide protection from glass fallout. With adhesion of the glass to the plastic interlayer and its ability to remain integral if broken, laminated glass with resin has passed the requirements set of all the major model building codes in the United States and the Glazing Industry Code Committee for sloped and overhead glazing.

### Burglaries

Burglaries are frequently directed towards targets of easy opportunity and low perceived risk by the burglar. A simple deterrent, security glazing, may be enough to send the intruder to the next easier target. Glazing materials which meet these test requirements are generally strong enough to deter a "smash and grab" burglary, and is often specified for residences, shop fronts and display cases in stores, museums and libraries.

## LAMINATED GLASS - continued

### Ballistic Protection

Security glazing with laminated glass of appropriate thickness and configuration can reduce death and injury from bullets in high-risk locations, while still providing the aesthetic and visions benefits of glass. Bullet-resistant glass is made by bonding alternate layers of glass with resin to form a single, multiple-ply laminate. Laminated glass between 1" and 2" inches thick can generally resist bullets from weapons ranging from a .38 super automatic to a high power.30-06 rifle.

### Bomb Blast Resistance

Unfortunately, bomb attacks and threats are on the rise all over the world. The fear generated by a bomb's instant holocaust of property damage, injury, flame and noise can be more powerful than conventional armed attacks. Bomb blasts propagate

blast energy in all directions, making buildings nearby the intended target candidates for destruction as well. Experts report that approximately 75 percent of all damage and injury from bomb blasts can be attributed to flying and failing glass following the explosion.

Laminated glass can substantially reduce injury resulting from explosions, and even reduce the cost to repair a bombed facility by reducing the extent of damage and opportunity for looting.

#### UV Protection

With time, sunlight can cause considerable damage to buildings furnishings, carpets, artwork, photographs, plants and other valuables. These items need special protection from the damaging effects of the sun's ultraviolet (UV) rays. Laminated glass made with resin can be effective in screening out the harmful UV rays, controlling glare and decreasing solar energy transmittance.

Glazing solar control is accomplished in laminated glass by the interlayer ability to reflect and/or absorb and re-radiate much of the solar UV radiation. Laminated glass made with resin screens out more than 99% of damaging UV light.

While protecting buildings from harmful and damaging solar UV radiation, laminated glass made with resin has no adverse affect on the health of indoor plants. In fact, laminated glass is commonly used in greenhouses and atriums to help protect flower color and reproductive development from the damaging effects of UV radiation. Photoreceptors in plants are still able to absorb sunlight the resin interlayer allows to be transmitted.

#### LAMINATED GLASS - continued

##### Sound Control

In homes, laminated glass is the sound solution to keeping unwanted noise where it belongs - outside. Low-flying airplanes, highway traffic, railways, lawnmowers, or the occasional noisy neighbor, can make relaxing at home difficult. Ordinary windows are the weakest link for allowing unwanted sound to invade the home. Laminated glass offers exceptional sound control because of the sound-dampening characteristics of the plastic interlayer, regardless of the source of the sound.

##### Hurricane protection

Hurricanes are unpredictable forces within Mother Nature's arsenal of destruction. A hurricane's turbulent winds and strong gusts of air often carry wind-borne debris which can slam into glass windows and doors. Once the window panes are broken, the protective exterior "envelope" of a building is compromised, allowing strong winds to rush into a building creating internal pressurization within the structure. The trapped wind forces then push upward on the roof, outward on the exterior walls and can eventually cause complete destruction of the building.

##### Earthquake protection