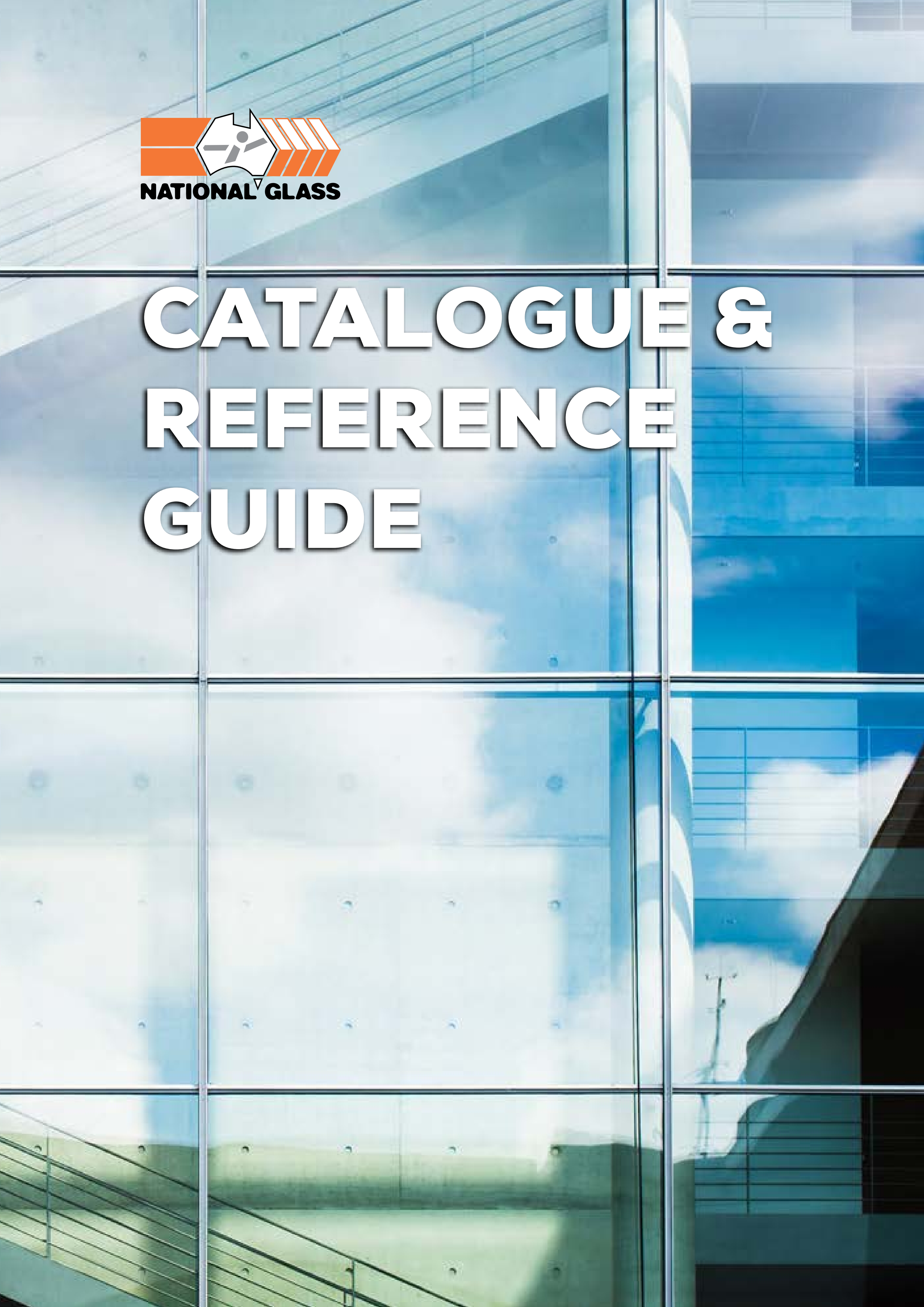


NATIONAL GLASS

CATALOGUE & REFERENCE GUIDE

BRISBANE
166 Granite St, Geebung
QLD 4034
PO Box 4 Virginia
QLD 4014
Email: sales.brisbane@nationalglass.com.au
Phone: 07 3131 3555
Fax: 07 3131 3666

OUTSIDE BRISBANE METRO
Toll free phone: 1800 177 999
Toll free fax: 1800 634 840

SYDNEY
374 Vardys Rd, Kings Park
NSW 2148
Email: sales.sydney@nationalglass.com.au
Phone: 02 8869 9200

TOWNSVILLE
Cnr Kelli & Taryn St, Mt St John
QLD 4818
PO Box 8011 Garbutt BC
QLD 4814
Email: sales.townsville@nationalglass.com.au
Phone: 07 4755 3100
Fax: 07 4755 3130

ROCKHAMPTON
16 Power St, North Rockhampton
QLD 4701
Email: sales.rockhampton@nationalglass.com.au
Phone: 07 4924 1650
Fax: 07 4924 1651

CONTENTS

01 ABOUT NATIONAL GLASS

ABOUT NATIONAL GLASS

National Glass is Australia's leading glass manufacturer and processor using state of the art advanced automation and machinery to deliver high quality products and service. National Glass specialise in custom laminating, insulated glass units, digital printing, tempered and high end processed glass providing solutions for energy efficiency, noise reduction, structural and strength demands and decorative applications. Products are marketed under the following trade names:

- Acousta™ Noise Reduction Glass
- Duo Plus™ IGU's
- Duo Ultra™ High Performance IGU's
- ImageTek™ Digital Printed Glass
- SOL-R™ Low-E Coated Glass
- SOL-XT™ High Performance Low-E Coated Glass
- Stormsafe Cyclone Resistant Glass Systems

A large range of glass stock types are available including Clear, Tinted. Low-Iron, Low-E, Laminated, Acid Etched, Silvered and Patterned glass. National Glass has 4 manufacturing and sales centres located in Brisbane, Sydney, Townsville and Rockhampton including 4 toughening furnaces, multiple CNC processing centres, IGU, Laminating and Dip-Tech Digital printing lines.

PRODUCTS AND CAPABILITIES

LAMINATING

Using the latest nip roller and autoclave technology to build custom laminated glass panels with standard PVB, Acoustic, Vanceva, solar control and structural interlayers. Max size 5000mm x 2600mm.

INSULATED GLASS UNITS

Fully automated production line manufacturing warm edge super spacer IGU's. Max size 4500mm x 2700mm.

DIGITAL PRINTING

Diptech technology glass printing centre producing high quality images and graphic designs under our trade name ImageTek™. Max size 5000mm x 2700mm.

TEMPERED GLASS

Producing toughened, heat strengthened and heat soaked toughened from 4mm to 19mm thicknesses in many different substrates to AS2208 and AS2080 standards. Max size 5050mm x 2800mm.

PROCESSING

Multiple CNC centres enable accurate processing of glass to customer specifications.

SHOWROOM

Available to our trade customers is the National Glass showroom displaying a range of products.




02 INTRODUCTION TO GLASS

INTRODUCTION TO GLASS

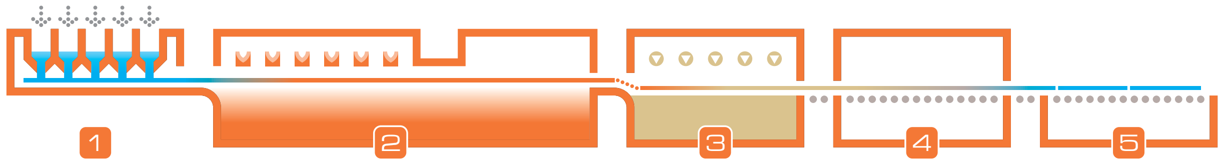
HISTORY

The use of glassware dates back over 7000 years. But it was the Romans around 2000 years ago that made use of it in buildings. The glass produced was only translucent, but its purpose was to protect from wind and rain and to let light through.

Over the course of history up until the early 1900's, the technology to make glass was largely restricted to casting or blowing glass cylinders. Casting involved directing the molten glass mixture into a mould. The cylinder process involved mouth blowing molten glass into a cylinder shape and then 'unwrapping' the hot glass and forming it into flat sheets. The early 1900's produced a mechanical means of making blown cylinders and the process of drawn glass was also developed which involved lifting the glass out of a molten glass vat.

Though glass could now be made on a larger industrial scale, the improvements still produced glass with slightly uneven or distorted surfaces. In order to improve the optical qualities, both surfaces of the glass were sometimes required to be ground and polished to achieve the desired optics. This made the process slow and inefficient. Then in 1952, Pilkington Glass started developing the "Float glass process" which revolutionised glass manufacture. It ensured higher optical quality, flatness and no distortion.

DIAGRAM 2.0: FLOAT GLASS MANUFACTURING LINE



FLOAT GLASS

The glass industry often makes reference to the terms 'float' or 'annealed float glass'. The float glass process is the most common method of manufacturing flat glass today. Essentially a molten glass mixture floats on a bed of molten tin and then into annealing ovens where the glass is cooled. Annealing refers to the process of slowly cooling hot glass to reduce its brittleness, to enable the glass to be cut and/or toughened.

Float glass manufacturing is a 24 hour continuous all year process and one consequence is that the process can't be stopped without the molten materials solidifying and damaging the furnace and bath chambers. The process can be slowed down so that 'warm repairs' are undertaken with glass continually being made but dumped. Every 10 to 15 years a float line requires a complete production stoppage for rebuilding, called 'cold repairs'. Depending on size, a typical float line can produce between 500-1000 tonnes of glass per day.

FLOAT GLASS MANUFACTURING

(See Diagram 2.0)

1. Raw materials mixed through the batch house (recycled glass, silica sand, limestone, soda ash) and fed into melting furnace.
2. Heated to 1700°C, the molten glass mixture flows into a bath filled with molten tin.
3. The molten glass floats on top of the tin, temperature decreasing to around 1100°C, the hardening glass floats out of the bath into the annealing chamber.
4. The temperature now drops to around 700°C.
5. Glass continues its path from annealing chamber to be cut to required sheet sizes.

COMMON GLASS TYPES

CLEAR FLOAT

As the name suggests, clear float glass is colourless and highly transparent when viewed face on with a slight green tinge when viewed on edge. If offers a very high level of natural daylight or visible light transmittance to pass through it and little resistance to the sun's direct solar energy. Thicknesses produced range from 2mm to 25mm.

TONED/TINTED

Produced by adding small quantities of metal oxide colourant during a clear float production run. The colour created is embedded in the glass and cannot be removed. Most common colours are grey, green, blue and bronze. Tinted glass is primarily designed to provide a greater degree of solar control for buildings.

COATED GLASS

Coated glass is designed to provide a higher level of energy efficiency and control over climate. Non coated or standard ordinary glass provide only a solar control function as a single glazed glass (but can provide thermal control when double glazed). Low-E coated glass provides both solar and thermal control in both single and double glazing. Coated glass is made by applying a thin layer of metal compounds during or after float glass manufacture.

The industry provides a wide range of coatings with differing levels of performance and colours. When glazed some of these coatings are almost unnoticeable whereas others are highly reflective.

INSULATED GLASS UNITS

Also called IGU's or Double Glazing, consist of two or more panels of glass separated by a spacer bonded together with the void filled with air or Argon gas. IGU's are a significantly more energy efficient glazing system than ordinary single glass.

TOUGHENED SAFETY GLASS

Ordinary float glass is heated to approx. 620oC in a toughening furnace and then automatically conveyed to a quench chamber where it is snap cooled to produce glass which 4 to 5 times stronger than ordinary float glass. If broken, the whole panel of glass shatters into smaller pieces of relatively blunt granules.

LAMINATED SAFETY GLASS

A safety glass made by laminating two or more sheets of glass with a flexible plastic based interlayer or PVB. The glass and PVB are bonded together by heat and pressure in an autoclave.

Different interlayer and glass combinations can provide safety, noise reduction, security and climate control benefits over ordinary single float glass. In the event of breakage, depending on the severity of the impact, glass will not splinter into jagged dangerous pieces and will remain intact in the opening.

TOUGHENED LAMINATED GLASS

A safety glass where the glass panels are toughened before being laminated. This provides added strength and security features over single toughened or laminated glass.

MIRROR

Produced by coating clear or tinted float glass with silver and then layering protective coats of paint to prevent corrosion. Available as a safety glass with a thin vinyl sheeting that is bonded to the glass.

PATTERNED GLASS

Along with decorative applications, pattern glass provides a degree of privacy by diffusing the object rather than obscuring.

ACID ETCHED GLASS

Applying an acid wash to one surface of the glass produces a frosted type finish.

PRINTED GLASS

A ceramic based paint is applied to the glass which is then fused together during the toughening process. Ceramic based paints are permanent, durable and non-porous. Printed glass can be supplied in full panel colours or with digital image applications.

BASIC INDUSTRY TERMS

Glass is generally sold as cut-to-size panels cut from larger sheets of glass or as original sized 'loose' sheets and bulk sheet quantities. Bulk sheets are sold as blocks or packs, timber cased or end capped glass.

For sizing descriptions, the industry norm is to always state height first and then width.

Glass is sold and calculated as square metres (height x width).

BASIC INDUSTRY TERMS (CONTINUED)

FOR EXAMPLE: 1200mm H x 1500mm W

Convert to m (metres) first = 1.2m x 1.5m

= 1.8 sqm² of glass

Processing refers to work done on panels of glass (by machinery or manually), such as edge polishing, holes, cutouts & shapes. Glass perimeter edgework such as Flat Polishing is charged per lineal metre (height + width x 2, for a full 4 sided perimeter polish).

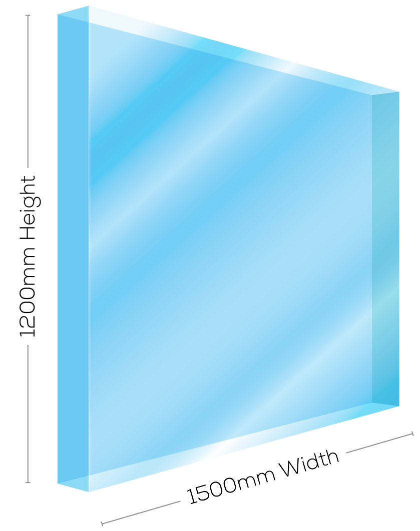
FOR EXAMPLE: 1200mm H x 1500mm W

Convert to lm (lineal metres) first = (1.2 lm + 1.5 lm) x 2

= 5.4 lm of flat polishing

Other processes e.g. holes, cutouts generally charged as per or eaches.

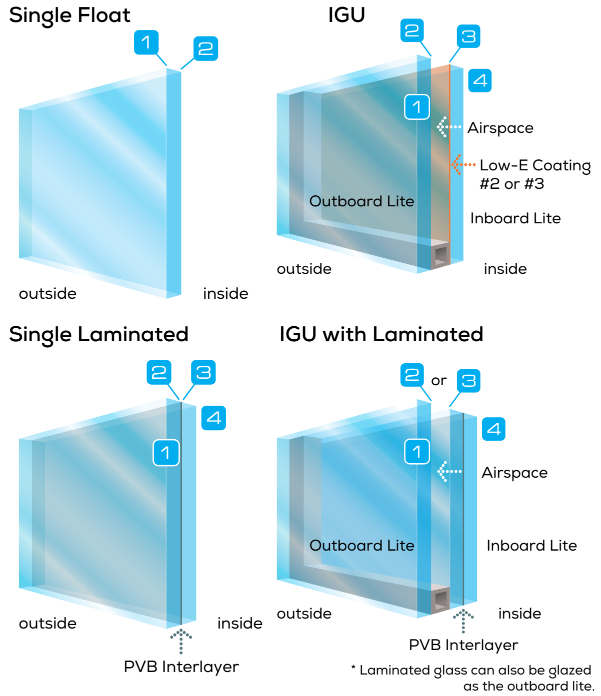
DIAGRAM 2.1: SIZING DESCRIPTIONS



GLASS SURFACE POSITIONS

The sides of a sheet of glass or surface position are identified by a simple numbering method. #1 is the outside view and #2 is inside. This is helpful when the glass has to be glazed a certain way, such as coated glass and/or is cut as a shape.

DIAGRAM 2.2: GLASS SURFACE POSITIONS

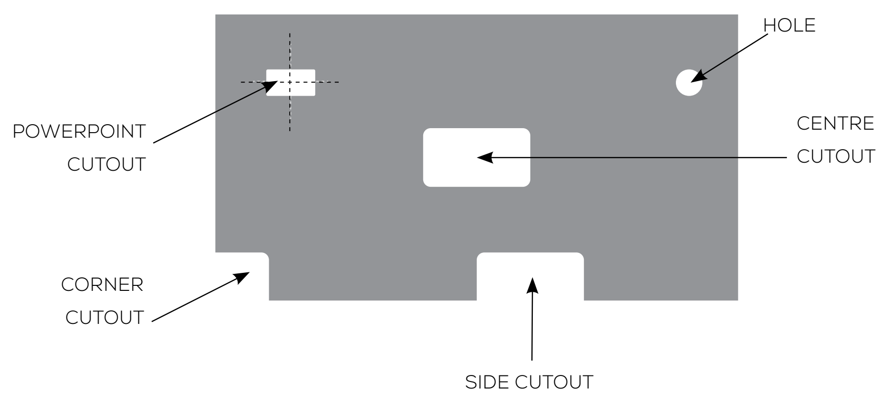


EDGEWORK AND PROCESSING

Glass is used in many applications where edgework or surface processing of cut-to-size glass panels are performed. Precision cutting and drilling through CNC stations help to achieve the standards required. This includes high quality flat polished perimeter edges, internal cutouts and holes. Though templates are sometimes required, the preference is to accept from customers CAD type based files which ensures precision outcomes.

DIAGRAM 2.3: TYPICAL HOLE & CUTOUT DIAGRAM

(For more information go to Section 13 edgework & processing)



03 ENERGY

SOL-R™ Neutral laminated with 6mm Lacobel®T Deep Black spandrel glass

CLIMATE & ENERGY

Glass in buildings provide many benefits and features including protection from the elements, allowing us to be part of the outside world, providing natural daylight and the ability to passively heat the home on colder days. However, when used as a clear single panel of window glass, it is less effective in controlling the indoor climate and promoting energy efficiency. In response the glass industry have developed solar control glass (tinted, low-E, reflective glass) and thermal control glass (low-E glass and IGU's).

The Australian government is also focused on the objective of reducing greenhouse gas emissions through the efficient use of energy in residential housing and commercial buildings. This has been proven by introduction and implementation of various codes and legislation. Energy efficient building measures have been in place for many years in North America and Europe.

This section shows how glass is used to mitigate the harsh effects of climate in which we live. It will however in most cases limit the discussion to glass only. Performance values shown are for glass only. Energy efficient window compliance should in most cases make reference to the total glazing system, meaning glass and window frame. Window fabricators should have accredited testing to prove the performance of their glazing systems to meet compliance requirements. Any information used from this publication should be referenced against tested product and building codes that are in existence.

ENERGY EFFICIENCY

The National Construction Code (NCC) for buildings has provisions that require the use of energy efficient windows and doors. This requires window fabricators to have their products tested and rated under WERS or the Windows Energy Rating Scheme which is compliant with the NCC.

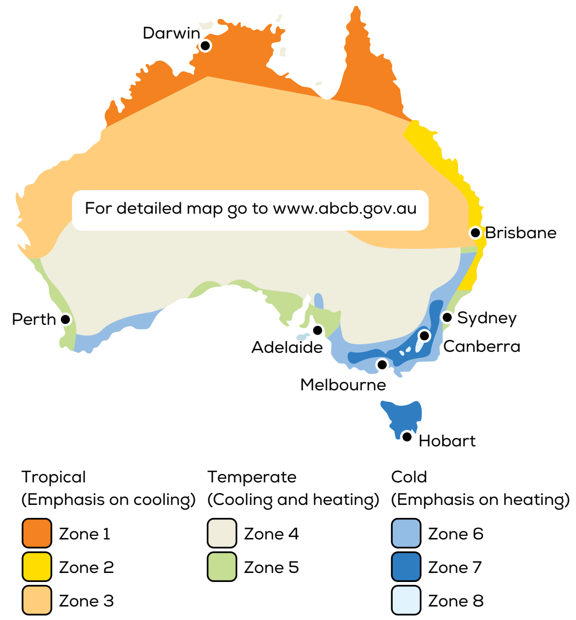
ENERGY EFFICIENT WINDOWS

The type of climate has a major influence on window performance. To enable the correct selection of higher performing windows in different areas of Australia, WERS has split the country into three main zones, tropical, temperate and cold. See Diagram 3.0.

For actual area/locality details on climate zones, refer to BCA.

- Cooling climate (tropical, subtropical and hot arid areas) – warmer climates where most of the energy used year round is to cool the building;

DIAGRAM 3.0: CLIMATE ZONES



- Mixed climate (temperate) – in these areas heating and cooling represent approximately a 50/50 split of energy use;
- Heating climate (alpine and cool temperate) – colder climates where most of the energy used year round is in heating the building.

MEASURING WINDOW & GLASS PERFORMANCE

Performance is most commonly measured through the; SHGC (Solar Heat Gain Co-efficient) and U-Value factor.

SHGC – SOLAR HEAT GAIN CO-EFFICIENT

Refers to the total amount of solar energy transmittance entering a building through the glazing as heat gain. This measure equates to the Sun's direct transmittance energy (T) plus the part of this energy absorbed by the glass and re-radiated inside (E) (See diagram 3.1). The lower the number the better. It's most commonly used in relation to the cooling of the building (SHGC can also be calculated as 86% of the Shading Co-efficient). 3mm clear float has a SHGC of 0.86.

THE SHGC CAN ALSO BE STATED IN THE FOLLOWING WAYS:

- 3mm clear lets in 86% of the Sun's total direct heat or;
- 3mm clear keeps out only 14% of the Sun's total direct heat.

Another way to describe how the SHGC is used is in terms of energy consumption in watts/m2.

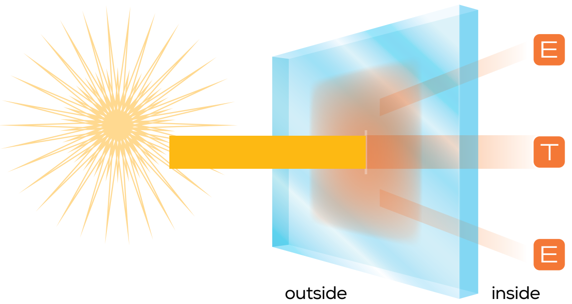
For example the sun's direct energy typically radiates on a hot day 785 watts and 6mm Sunergy® Green has a SHGC of 0.41. If you multiply 785 watts x 0.41 (SHGC) you get 322 watts per m2 radiated into the building. In this example the Sunergy® glass is reducing the sun's direct energy into the building by 59%.

DIAGRAM 3.1: SHGC FORMULA

SHGC = Sun's direct transmission energy (T)

\+ Re-radiated heat (E)

= SHGC



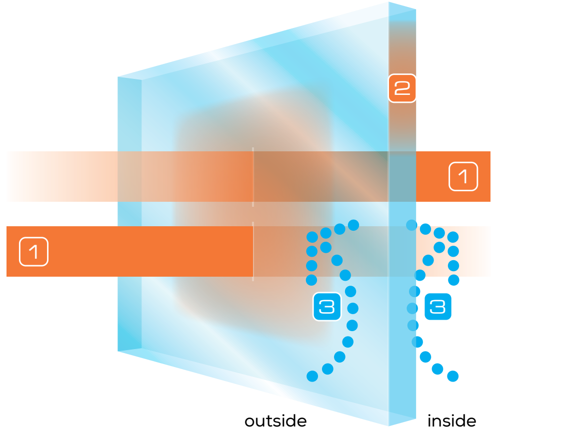
U -VALUE

Measures heat transfer by method of **re-radiation conduction** and **convection** (See diagram 3.2). The Sun's direct energy transmission through the glass is not the only way in which heat is transferred through the glazing. Heat also flows naturally from warm air/bodies to cold air/bodies. This heat flow is in the form of long wave (infrared) energy. On warm days the Sun's direct heat on an object (called short wave infrared – what we feel as sunlight heat on our bodies) causes it to absorb and re-radiate this heat in the form of a low-energy heat (long wave infrared radiation). U-value is used to measure this type of non-solar heat transfer. On cold winter days/night time, U-value is measuring the amount of heat loss from inside the home generated, for example, from a heater. It is not to be confused with measuring the Sun's direct energy transmission on the glass as measured by SHGC. U-value and SHGC are both important when considering energy costs and comfort. However, each measure may have more weight in different climates.

U-value is measured in watts per square metre per degree Celsius (Wm2K) difference. The amount of heat energy transferred as measured by the U-value can be calculated by taking for example 4mm clear float with a U-value of 5.9w/m2oC and multiplying the difference between outdoor and indoor temperature (32oC outside and 24oC inside = 8oC) › 5.9 x 8oC = 47watts per m2 heat transferred between the outside and inside. The lower the U-value the better the thermal insulation properties of the glazing system. The U-value is progressively reduced by adding; more than one pane of glass (IGU's) which reduces the effect of conduction and convection and; a low-E coating which reduces the effect of re-radiation.

DIAGRAM 3.2: U-VALUE

- U-value (summer and winter conditions);
- Measures thermal or non-solar heat flow occurring through conduction, convection and re-radiation.



1 Re-radiation.

2 Conduction.

3 Convection.

Table 3A shows insulation comparisons between glass and other building materials. The lower the number the better the insulation. The U-value is the reciprocal of the "R" value and either can be calculated from the other e.g. U = 1/R or R = 1/U.

U and R values are variable and dependent upon climatic conditions. That means that the transmittance of heat through a glazing system changes. Therefore glass transmits heat at varying rates depending upon the prevailing climatic condition. When comparing glazing systems based upon U-value, it is important that the climatic conditions used to model all the systems are the same.

WHICH MEASUREMENT IS MORE RELEVANT?

Conduction, convection and re-radiation are measured by the U-value whilst direct transmittance energy from the Sun is measured by the SHGC. Why use both measures? Are one of these measures more relevant than the other in different climates?

In general terms where homes are artificially cooled or heated in any climate, glass with a lower U-value will reduce energy costs. However, for warm climates when we combine the SHGC and U-value into one total heat gain number (relative heat gain – RHG see also page 120), it is the control of the Sun's direct intensity on an unshaded glazing as measured by the SHGC which becomes more relevant. The Sun's direct heat (measured by SHGC) controls a much larger percentage of the total heat gain when compared to other heat flows (as measured by U-value). For warm climate unshaded windows, control of the Sun's direct energy with a glass that has a lower SHGC is the first important step in design. As previously mentioned, a lower U-value will further assist in heat gain reduction and lower energy costs.

TABLE 3A: INSULATION COMPARISONS U-VALUE W/M²K	
Single glazing	5.60–6.20
Single low-E coating	3.60–4.20
Standard IGU	2.40–2.70
Low-E IGU	1.90–2.10
Low-E/argon gas IGU	1.30–2.00
Low-E/triple/argon gas IGU	0.80
Wall insulated*	0.50–1.00
Ceiling/roof insulated*	0.25–0.33

* Average recommended insulation levels (converted from R-value) for Australian homes.

IMPROVING WINDOW ENERGY EFFICIENCY

LOW-E COATED GLASS

Consists of a microscopically thin, virtually invisible coating applied to the glass which provides additional solar and thermal control over ordinary non coated glass. Though primarily designed for IGU's, LowE glass is used in single glazed windows.

IGU'S

Insulated glass units (IGU's) are a significantly more energy efficient glazing system than single glazed windows. The still air and additional glass pane in the IGU reduce the effects of heat transfer through conduction, convection and radiation. However a degree of solar control is still required and in many circumstances in Australia where windows are exposed to direct solar energy, a tinted and/or low-E glass should be used in combination to reduce this heat gain.

WINDOW LOCATION/BUILDING ORIENTATION

For windows positioned on easterly and westerly elevations, controlling overheating is most important. A combination of low-E and IGU's with lower SHGC's are most effective. For heating and mixed climates, windows positioned on northern elevations allow for the Sun's direct energy to passively or naturally heat the interior. In combination with low-E coated and/or IGU's, the heat generated can be trapped or re-radiated back into the room which in turn reduces heating costs.

SHADING DEVICES

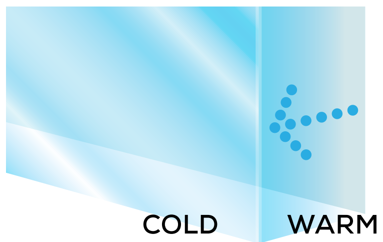
Eaves and external shading devices can also be used in reducing the adverse effects of direct heat gain particularly on east and west facing facades. External devices should be adjustable to allow for different climate conditions. Internal blinds or curtains are less effective as the heat has already penetrated the room. A thermal assessment should be carried out on the glazing to determine risk of thermal breakage when using these devices.

BASIC PRINCIPLES OF HEAT TRANSFER THROUGH GLASS

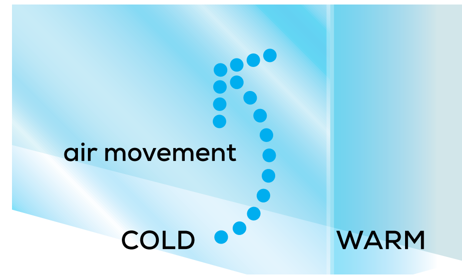
The basic principle of heat transfer is that heat will always move through the glazing to the colder side. Summer heat will migrate towards the colder interior and winter warmth will migrate to the colder outside environment.

Heat is transferred through the glazing by three methods:

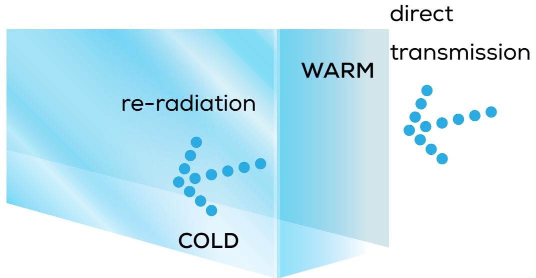
Conduction Is the process where heat travels through a solid material or like a frying pan heating up.



Convection is the transfer of heat by the movement of air across a surface or similar to hot air from a hair dryer.



Radiation heat transfer makes reference to both direct transmission and re-radiation. Direct transmission is the heat we feel on our bodies when we are next to a sunny window. Re-radiation occurs when the glass absorbs this short wave radiation and re-radiates it to the interior or exterior.



VENTILATION

The use of windows in a room that create a breezeway or air draft can reduce the effects of heat gain. This is of particular use where the room or building is not air-conditioned.

AIR-CONDITIONING VENTS

Air from these vents should be directed away from the window. Air blowing on or close to the glass surface will create a greater convection of hot air into the room.

INTERNAL CURTAINS/DRAPES

These can be of benefit during cold night time conditions. Tight fitting heavy drapes and pelmets around the window can assist in keeping the warmth in.

GLARE REDUCTION

Reducing annoying glare can be achieved through controlling the amount of daylight that passes through the glass. Though it should also be noted that glare is subject to individual perception. Some situations may require other methods to control glare such as external barriers, blinds, ceramic fritted patterns or matrixes on the glass itself or removing the cause of the glare.

To assist in reducing glare, the glazing industry looks at the Visible Light Transmittance % (VLT) measurement. The higher this number the brighter the interior will be and possibly the greater level of glare. Typically 3mm clear has a high VLT of 90% which means that it lets through 90% of daylight. An adverse effect of restricting the level of interior light in a room is increased artificial lighting. This results in increased costs and less of the benefits of natural daylighting. As a general guide, glass products with a VLT of around 70% or lower will aid in the reduction of glare.

CONDENSATION

Water from condensation build up and resultant water run-off can damage window frame/sills and seep into walls and adjoining areas. Condensation will form when the moisture in the air condenses out on surfaces that are cooler than the 'dew' point. Insulated walls, ceilings and floors provide better thermal barriers than windows. Window surfaces being colder than other surfaces in a room are more prone to condensation build up. Condensation can also occur on the outside of windows in hot humid climates where the inside room temperature (through air-conditioning) is lower than the outside temperature. If the area is subject to condensation, IGU's are the best method to help reduce the likelihood of it occurring. IGU's provide a thermal barrier between the inside and the outside. The lower the U-value of the unit the better.

UV AND FADING PROTECTION

There is no guarantee that furnishings or objects can be completely protected from fading. Though ultraviolet light is a significant contributor to fading, it can also be visible light and infrared radiation (heat) that cause fading and damage. Choosing glass products restricting UV transmission, visible light and infrared radiation will assist in the reduction of fading. For example, the Polyvinyl Butyral (PVB) interlayer in laminated glass can screen out up to 99% of all UV light. Adding either a tinted interlayer, a body tinted or low-E coated glass will lessen the damage from visible and infrared components.

TINTED GLASS

Produced by adding a colourant during the manufacture of clear float glass, tinted glass provides a greater degree of solar control for buildings when compared to single clear glass. Most common colours are grey, green and blue tones.

Tinted glass works by absorbing the sun's direct heat energy (like a dark coloured shirt on a warm day) with re-radiation and convection through air movement drawing away the heat build up in the glass.

FEATURES AND APPLICATIONS

- Solar control – reduction of the sun's direct heat energy through the glass;
- Reducing the sun's direct heat energy by 30-50% over ordinary clear glass;
- Permanent colour – Also called a body tinted glass as the tint is an integral part of the glass. The colour cannot be removed;
- Reducing cooling energy costs;
- Reducing glare;
- Low external reflectance;
- Improving privacy during daytime.

DESIGN AND GLAZING NOTES

Thermal Breakage - The thicker the tinted glass, the darker the appearance and colour becomes.

As the thickness increases, the glass absorbs more heat and therefore maybe more prone to thermal breakage if glazed in annealed form. Toughening or heat strengthening will prevent these breakages.

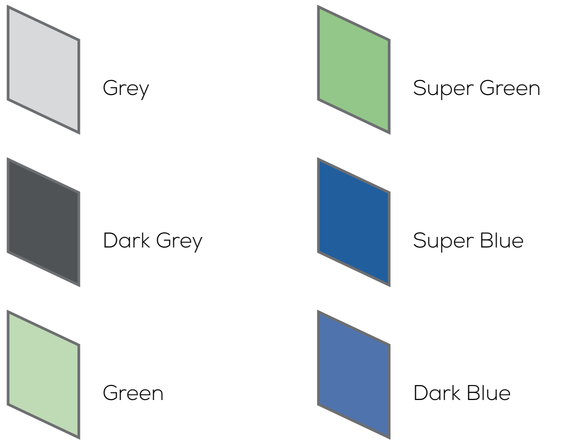
For more information refer to page 113.

Glass edges – Before glazing, annealed glass edges must be 'good' straight and clean cut with minimal defects. Under no circumstances should glass be glazed with damaged edges.

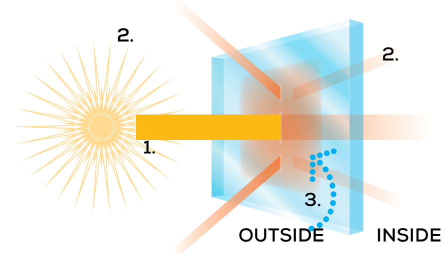
SPECIFICATIONS

MM	COLOUR
4,5,6,8,10,12	EuroGrey
5,6	Dark Grey
5,6	Green
6	Super Green
6	Super Blue
6	Dark Blue

COLOUR OPTIONS



HOW TINTED GLASS WORKS



1. Sun's direct intensity strikes the surface of the glass, the tinted glass partially absorbing and transmitting the energy.
2. The absorbed portion of heat in the glass is re-radiated both inside and outside.
3. Air movement helps to draw the heat away.

ENERGY PERFORMANCE			
TYPE	SHGC	U-VALUE	VLT%
5mm Grey	0.65	5.8	50
6mm Grey	0.61	5.8	44
6mm Green	0.56	5.8	70
6mm Super Green	0.52	5.8	67
6mm Super Blue	0.52	5.8	53
6mm Dark Blue	0.59	5.8	58

LOW-E GLASS

Low-E glass is an energy efficient glass with a unique, durable and virtually invisible coating providing improved solar control and thermal insulation. This glass works best when combined in an insulated glass unit for improved energy efficiency over ordinary single clear glass. There are two different types of coatings available, Hard coat or pyrolytic coatings which can be glazed as single glass, but are most efficient in IGU's and sputter coatings which can only be glazed in IGU's.

National Glass stock and supply a large range of Low-E coated glass to suit different climatic conditions and building energy requirements as per below.

LOW-E GLASS PRODUCT RANGE

Product	Low-E type	Single Glazed/ Duo Plus IGU	Specifications
SOL-R™	Hard Coat	Both	Clear and tinted in monolithic and laminated form
SOL-XT™	Hard Coat	Both	High performance laminated glass combining special solar control interlayer with SOL-R glass
Sunergy ®	Hard Coat	Both	Neutral and tinted solar control glass in both monolithic and laminated form
ComfortPlus™	Hard Coat	Both	Range of Viridian laminated glass
Evantage™	Hard Coat	Both	Range of Viridian solar control monolithic glass
Soltech™	Hard Coat	Both	Range of Viridian solar control monolithic glass
Duo Ultra™ IGU	Sputter Coat	IGU ONLY	High performance IGU's with new generation spectrally selective coated glass for superior thermal and solar control

FEATURES AND APPLICATIONS

- Low-E coating consists of a microscopically thin, virtually invisible, metal or metal oxide layer deposited on the glass during manufacture;
- Depending on climatic region and energy requirements, offers a broad range of solar and thermal control;
- Helps reduce summer heat gain and winter heat loss through improvements in SHGC and U-values when compared to ordinary non coated glass;
- Reduces heating and cooling energy costs;
- Reduces ultra-violet substantially;
- Improves occupant comfort, reduces condensation build up (with IGU's);
- Coatings are durable and most have low visual reflectivity.

DESIGN AND GLAZING NOTES

- Thermal breakage – Low-E coated glass absorb and reflect a greater amount of heat than ordinary clear glass and therefore are more prone to thermal breakage. Ask our technical department for a free thermal assessment. Toughening or heat strengthening will prevent these breakages; For more information refer page 113;
- Glass edges – Before glazing, annealed glass edges must be 'good' straight and clean cut with minimal defects. Laminated glass made up with tinted PVB's or body tinted lites should have flat ground edges on all sides as a minimum. Under no circumstances should glass be glazed with damaged edges;
- Cleaning – Under no circumstances can abrasive cleaner be used on any surface, See "Protection and Cleaning" guidelines page 117;
- Coating position: Single Glass - Always glaze with coating to surface #2 or inside of building. IGU - Position in IGU's is most commonly surface position #2. Duo Ultra Clear and Grey coated glass is position #3, whilst Duo Ultra Neutral is position #2;
- Visual appearance - Low-E coated products in certain lighting conditions may display slight visual distinctions when compared to ordinary non coated glass. This is an inherent characteristic of the coating and indicates the functional properties of the glass. We recommend samples be viewed under both natural and artificial lighting conditions for product acceptance.

THE 'E' IN LOW-E

The 'E' in Low-E refers to emissivity. Emissivity is a measure of a material's ability to radiate energy. A material with 'low' emissivity absorbs and radiates infrared energy poorly which is the key factor in reducing heat transfer.

Adding a Low-E coating greatly improves the insulation performance by reflecting re-radiated heat back into the room on cold days and back outside on warm days. Re-radiated heat occurs when short wave infrared heat energy (part of the infrared energy spectrum that we normally feel as heat) is absorbed in the interior of the building by carpets, curtains, furniture, walls etc., and is converted into long wave (low energy) infrared heat. The low-E coated glass reflects this long wave heat radiation back into the room on cold days. See Diagram 3.3.

Conversely, on warm days, short wave infrared heat energy is absorbed by the glass and by objects outside the house such as cars, footpaths, driveways, window sills etc and is converted into long wave infrared heat energy. The low-E coating now works to reflect this energy back outside reducing the overall heat gain through the window. See Diagram 3.4.

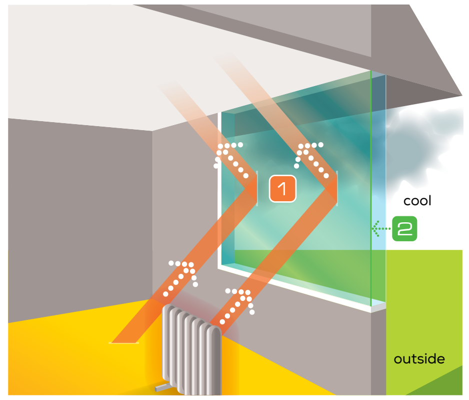
The lower the emissivity of a coating the better the glass performs in reducing heat transfer. A black body is the perfect emitter with a surface emissivity of 1.0. Comparatively, ordinary clear glass has a surface emissivity level of 0.84, meaning 84% of the absorbed heat is emitted through to the colder side.

The lower the emissivity number, the less absorbed and re-radiated heat is passed through to the colder side.

TABLE 3B: EMISSIVITY LEVELS

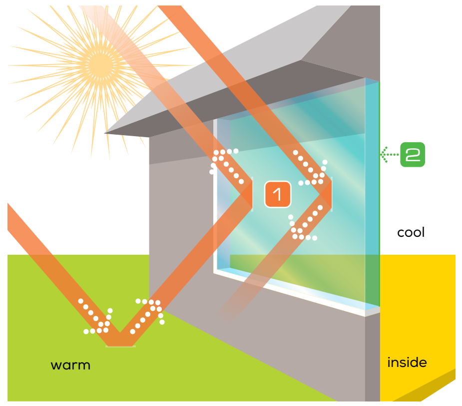
Ordinary clear	0.84
Sunergy®	0.27
SOL-R™ Low-E Clear	0.18
Duo Ultra™ Low-E	0.02

DIAGRAM 3.3: HOW LOW-E GLASS WORKS ON COLD DAYS



1. Typical oil bar heater energy and stored energy being released from floors (this stored energy may passively collect during the day from the sun's direct transmission).
2. The Low-E coating assists in reflecting this heat back inside.

DIAGRAM 3.4: HOW LOW-E GLASS WORKS ON WARM DAYS



1. Sun's direct intensity, short wave infrared heat energy, strikes the glass surface and surroundings converting this energy into long wave (low energy) infrared heat.
2. The Low-E coating assists in rejecting this heat back outside.

SOL-R™ LOW-E COATED GLASS RANGE

SOL-R™ is an energy efficient low-E coated glass available in single, laminated and IGU form. The glass is highly transparent with a unique, durable and virtually invisible coating providing improved solar control and thermal insulation. This glass works best when combined in an insulated glass unit for improved energy efficiency over ordinary single clear glass.

Available in 4/5/6/8 and 10mm thicknesses which can also be combined into laminated glass with different interlayer types to provide improved solar control, depending on building energy requirements. The SOL-R™ Clear range balances high levels of natural light transmission with improved thermal insulation providing a brighter and more comfortable interior space. For requirements where solar control is most important, SOL-R™ Grey, Neutral, Green or Blue options will lower the SHGC whilst maintaining moderate levels of natural light transmission depending on selection.

FEATURES AND APPLICATIONS

- Low-E coating consisting of a microscopically thin, virtually invisible, durable metal or metal oxide layer deposited on the glass during manufacture;
- Depending on climatic region and energy requirements, SOL-R™ offers a broad range of solar and thermal control;
- Helps reduce summer heat gain and winter heat loss through improvements in SHGC and U-values when compared to ordinary non coated glass;
- Reduces heating and cooling energy costs;
- Reduces ultra-violet substantially;
- Improves occupant comfort, reduces condensation build up (with IGU's);
- Coating is visually low reflecting in appearance.

CLIMATE REGIONS

In colder climates, with well-positioned windows, SOL-R™ Clear allows for direct winter sun to passively heat the room or building. The unique coating reflects this heat back into the room. Likewise, when the sun has set, it continues to retain generated heat from escaping the room.

In warmer climates select a product with a lower SHGC using either SOL-R™ Neutral, Grey, Green or Blue options. The coating works to reduce heat gain from the sun's energy, providing greater solar control and thermal insulation compared to ordinary single clear glass.

DESIGN AND GLAZING NOTES – REFER PAGES 16, 24

COLOUR OPTIONS

Clear

Green

Neutral

Blue

Grey

SPECIFICATIONS & ENERGY PERFORMANCE

MM	SHGC	U-VALUE	VLT%
4mm SOL-R Clear 73	0.73	3.8	82
6mm SOL-R Clear 70	0.70	3.7	81
4mm SOL-R Neutral 54	0.54	3.7	60
6mm SOL-R Neutral 53	0.53	3.7	60
10mm SOL-R Neutral 50	0.50	3.6	60
6.38mm SOL-R Clear 73	0.73	3.6	83
6.38mm SOL-R Neutral 51	0.51	3.6	59
6.38mm SOL-R Grey 50	0.50	3.6	39

For complete range including IGU's refer Section 14. All data listed with coating surface position #2. Laminated glass surface position #4

SOL-XT™ HIGH PERFORMANCE LOW-E COATED GLASS

SOL-XT™ is a high performance energy efficient laminated glass combining a unique solar control interlayer and a low-E coated glass such as SOL-R™. The interlayer itself utilises a solar absorbing technology designed to enhance solar heat gain performance whilst maintaining high visible light transmission as compared to ordinary clear and laminated glass made with standard interlayers. For single laminated glass the SHGC ranges from 0.44 to 0.30 with visible light transmission ranging between 68% to 26%. In IGU form, the SHGC ranges from 0.35 to 0.20 with visible light transmission ranging between 60% to 23%. These exceptional performance numbers give designers the opportunity to specify a high level of energy efficiency without sacrificing natural daylight inflows to the building.

SOL-XT™ laminated glass is always produced with a low-E coated glass such as SOL-R™. This low-E coated product is a high transparent glass with a unique, durable and virtually invisible coating providing improved solar control and thermal insulation over ordinary clear glass. The combination of interlayer and low-E coated glass in a laminated form is what makes SOL-XT™ a stand out performer for energy efficient glazing.

FEATURES AND APPLICATIONS

- High performance energy efficient laminated glass providing exceptional solar and thermal control with less sacrifice of natural daylight inflows;
- Depending on climatic region and energy requirements, SOL-XT™ offers a broad range of solar and thermal control;
- Helps reduce summer heat gain and winter heat loss through improvements in SHGC and U-values when compared to ordinary non coated glass;
- Reduces heating and cooling energy costs;
- Reduces ultra-violet substantially;
- Improves occupant comfort, reduces condensation build up (with IGU's);
- Low-E coating consists of microscopically thin, virtually invisible, durable metal or metal oxide layer deposited on the glass during manufacture. Coating is visually low reflecting in appearance.

DESIGN AND GLAZING NOTES – REFER PAGES 16, 24

COLOUR OPTIONS

Neutral

Green

Blue/Green

Blue

Grey

SPECIFICATIONS & ENERGY PERFORMANCE

MM	SHGC	U-VALUE	VLT%
8.76MM SOL-XT NEUTRAL 44	0.44	3.7	68
13.52MM SOL-XT NEUTRAL 43	0.43	3.5	65
8.76MM SOL-XT BLUE/GREEN 37	0.37	3.6	51
13.52MM SOL-XT BLUE/GREEN 37	0.37	3.5	51
13.52MM SOL-XT GREEN 34	0.34	3.5	49
13.52MM SOL-XT BLUE 33	0.33	3.5	39
13.52MM SOL-XT GREY 30	0.30	3.5	26

For complete range including IGU's refer Section 14. All data listed with coating surface position #4

SUNERGY® GLASS

Sunergy® is a toned glass with a unique, durable and virtually invisible metal oxide coating. The coating provides Sunergy® with improved solar control (lower SHGC) and thermal insulation (low U-values).

Compared to other low-E coated glass products on the market, Sunergy® is an excellent response to current architectural trends desiring neutrality and low visual reflectance.

The unique coating acts as a filter, blocking out the sun's direct heat while maintaining a high level of natural daylight. The same coating helps to reflect heat back into the building.

The product works best when combined in an insulated glass unit for improved energy efficiency over ordinary single clear glass.

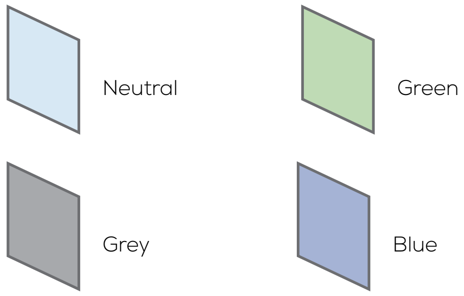
It is available in a range of tones or colours to blend or contrast any architecture. Each tone also offering a different level of energy performance.

FEATURES AND APPLICATIONS

- Transparent coating – Low-E coating consists of a microscopically thin, virtually invisible, metal or metal oxide layer deposited on the glass;
- Solar and thermal control whilst allowing higher levels of natural daylight or visible light transmission;
- Helps reduce summer heat gain and winter heat loss through improvements in SHGC and U-values when compared to ordinary non coated glass;
- Reduces heating and cooling energy costs;
- Reduces ultra-violet substantially;
- Improves occupant comfort, reduces condensation build up in IGU's;
- Coating is low reflecting and durable;
- Many colour options including Neutral, Grey, Cool (light grey), Green and Azur (blue);
- Best performance achieved in IGU's though when single glazed can still provide superior performance and higher thermal insulation compared to clear single glass;
- Available annealed, toughened and laminated form.

DESIGN AND GLAZING NOTES – REFER PAGES 16, 24

COLOUR OPTIONS



SPECIFICATIONS & ENERGY PERFORMANCE			
TYPE	SHGC	U-VALUE	VLT%
4mm Neutral	0.59	4.2	67
5mm Neutral	0.59	4.1	67
6mm Neutral	0.59	4.0	69
10mm Neutral	0.56	4.0	68
6mm Grey	0.41	4.0	33
6mm Green	0.42	4.0	56
6mm Cool	0.50	4.3	52
6.38mm Neutral	0.57	4.0	67
6.38mm Grey	0.44	4.0	34

For complete range including IGU's refer Section 14. Data listed with coating surface position #2. Laminated glass surface position #4.

INSULATED GLASS UNITS

When it comes to superior climate control, noise reduction and strength, two panels of glass are better than one. Duo Plus™ and Duo Ultra™ Insulated Glass Units (IGU's) or double glazed units, consist of two panes of glass bonded together by a spacer and separated by a hermetically sealed Argon gas filled space. This space or gap acts as an additional thermal barrier between the inner and outer pieces of glass, making the transfer of heat more difficult.

All units feature a warm edge Super Spacer® made of an extruded, thermoset polymer structural silicone foam which delivers exceptional performance through lower conductivity than aluminium spacer units, Argon gas retention and long term durability.

Duo Plus™ units represent the standard range of glass combinations with or without hard coat Low-E glass whereas Duo Ultra™ units have as standard, new generation 'sputter coat' Low-E glass for improved performance.

FEATURES & BENEFITS:

- Dual seal system with PIB primary, polysulphide or silicone secondary seals;
- Substantially reduced perimeter condensation;
- Lower thermal conductivity than aluminium spacer units (typical U-Value improvement of 0.2 W/m2k);
- Excellent UV resistance;
- Spacer appearance is a smooth matte dark grey finish;
- Spacer range 8/10/12/14/16/20mm;
- Secondary seal default is Polysulphide. Specify Silicone seal if edges of IGU are exposed.

APPLICATIONS

ENERGY & CLIMATE

For improved energy efficiency with greater solar and thermal control, specify Sunergy®, SOL-R™, SOL-XT™, or Duo Ultra™ high performance IGU's. Alternatively, laminated glass panels with solar control interlayers can also be incorporated into units. The unique properties of laminated glass also block out up to 99% of harmful UV light.

NOISE

Reducing noise is better achieved through Acousta™ laminated glass panels when compared to ordinary single glass.

Acousta™ laminated glass uses an advanced, three layer system designed to decouple and disseminate sound waves for superior sound damping performance. This patented system target sounds in the 1000 – 3000 Hz range which is the "most sensitive range of human hearing" that allows the most irritating of sounds to penetrate windows.

SAFETY & SECURITY

Duo Plus™ units can be made with either Grade 'A' Toughened or Laminated safety glass. Two panels of glass also make it harder to breach the window or door opening compared to ordinary single glass, but for greater security, build laminated panels with extra thick 1.52mm PVB or structural interlayers such as DG41 or SentryGlas®Plus. All Duo Ultra™ units are supplied as standard, with Grade 'A' safety glass.

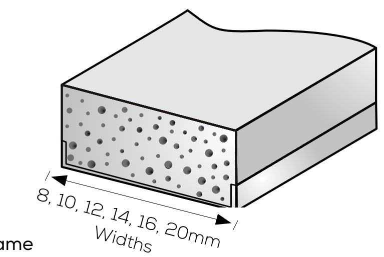
STRUCTURAL & STRENGTH

The air space in IGU's in conjunction with two panels of glass act as a 'shock absorber' or 'spring' allowing higher wind loads to be applied compared to equivalent single glass thickness. For glass of equal thicknesses, this feature also allows for larger areas to be glazed to human impact standards (See AS1288).

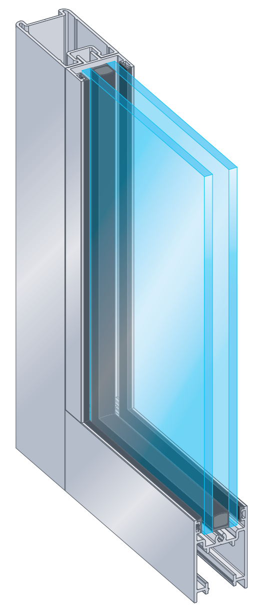
SUPER SPACER®

Super spacer is a flexible silicone foam spacer designed to meet the toughest commercial and residential captured glazing demands. It provides lower thermal conductivity than aluminium spacer units (typical U-Value improvement of 0.2 W/m2k).

Typical Super spacer profile with spacer widths available



Typical IGU in window frame



DUO PLUS™ IGU

INSULATED GLASS UNITS

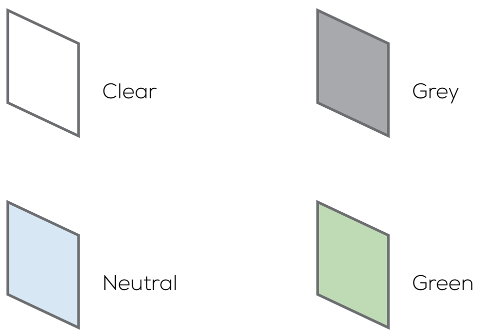
Duo Plus™ insulated glass units provide many features and benefits when compared to ordinary single clear glass including improved energy efficiency, lower energy costs, improved occupant comfort and reduced condensation. Other features include greater control of noise when combining units with Acousta™ laminated glass panels, safety and security when adding safety glass and greater strength for wind loading.

All units feature a warm edge Super Spacer® with a dual seal system for improved energy performance, longevity and durability. Duo Plus™ units can be supplied with or without Low-E coated glass. It is recommended that Low-E coated glass combinations are included in units for maximum energy performance. When offering an IGU solution to customers, account should be taken of factors such as housing/building energy rating requirements and specific orientation of windows where control of summer heat gain is important. Low-E coated glass such as SOL-R™ or Sunergy® should be considered in these applications. Out technical staff can assist with further information and advice.

FEATURES & BENEFITS:

- Exceptional performance in reducing summer heat gain and winter heat loss;
- Reduction of condensation build up;
- Lower air conditioning and heating energy costs;
- Improves occupant comfort, particularly next to windows by reducing hot and cold spots;
- Noise reduction in combination with Acousta™ laminated glass;
- Lower UV transmission;
- Increased wind load strength and security;
- Dual seal system for added durability.

COLOUR OPTIONS



DUO PLUS ™ SPECIFICATIONS & ENERGY PERFORMANCE	SHGC	U-VALUE	VLT%
4mm Clear/ 12mm Argon /4mm Clear	0.74	2.6	80
6mm Clear/ 12mm Argon /6mm Clear	0.70	2.5	78
4mm SOL-R Clear 73/ 12mm Argon/4mm Clear	0.65	1.7	74
6mm SOL-R Clear 70/ 12mm Argon/6mm Clear	0.61	1.7	72
4mm SOL-R Neutral 54/ 12mm Argon/4mm Clear	0.45	1.6	54
6mm SOL-R Neutral 53/ 12mm Argon/6mm Clear	0.44	1.6	53
4mm Sunergy® Neutral/ 12mm Argon /4mm Clear	0.50	1.9	60
6mm Sunergy® Neutral / 12mm Argon /6mm Clear	0.50	1.8	61
6mm Sunergy® Grey/ 12mm Argon /6mm Clear	0.32	1.8	30

Data shown represents glass only values.
[1]Sol-R™ LowE and Sunergy® coating on surface #2.

DUO ULTRA™ HIGH PERFORMANCE IGU

INSULATED GLASS UNITS

A high performance glazing option to suit different climatic conditions. Ranging from Duo Ultra™ Clear which offers moderate SHGC performance combined with high levels of natural light transmission to Neutral 50 super low SHGC, ideal for hot climates or where larger expanses of glazing need summer heat protection.

Duo Ultra™ units have as standard, new generation Low-E glass technology for improved performance over standard single glass and IGU's. All Duo Ultra™ units are supplied as standard, with Grade 'A' standard safety glass.

The Duo Ultra range is available in three options;

L0 - ENERGY - SAFETY

Basic level high performance glazing with toughened safety glass as standard.

L1 - ENERGY - SAFETY - UV BLOCKING

Upgrade performance with addition of a laminated safety glass panel for added UV protection.

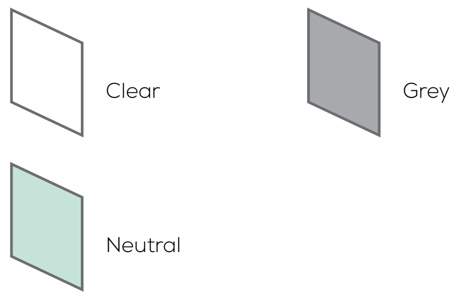
L2 - ENERGY - SAFETY - UV BLOCKING - NOISE REDUCTION

Upgrade performance with addition of an Acousta™ noise reduction laminated safety glass panel.

FEATURES AND APPLICATIONS

- Exceptional performance in reducing summer heat gain and winter heat loss;
- Reduction of condensation build up;
- Lower air conditioning and heating energy costs;
- Improves occupant comfort, particularly next to windows by reducing hot and cold spots;
- Noise reduction in combination with Acousta™ laminated glass;
- Lower UV transmission;
- Increased wind load strength and security;
- Dual seal system for added durability.

COLOUR OPTIONS



SPECIFICATIONS & ENERGY PERFORMANCE			
Duo Ultra L0	**SHGC**	**U-VALUE**	**VLT%**
Clear 4/12/4	0.56	1.37	80
Grey 4/12/4	0.41	1.37	50
Neutral 50 6/12/6	0.25	1.32	50
Duo Ultra L1			
Clear 6.38/12/4	0.53	1.36	79
Grey 6.38/12/4	0.36	1.35	39
Neutral 50 6/12/6.38	0.25	1.32	50
White Trans 6.38/12/4	0.44	1.37	61
Grey Trans 6.76/12/4	0.29	1.37	29
Duo Ultra L2			
Clear 6.76/12/4	0.52	1.35	79
Grey 7.14/12/4	0.34	1.36	38
Neutral 50 6/12/6.76	0.25	1.32	50

Performance data shown glass only values, based on Low-E glass positioned to surface #3. Neutral 50 glass options are positioned to surface #2, both with 12mm Argon fill.

IGU DESIGN AND GLAZING NOTES

PRODUCT SPECIFICATIONS

Maximum Size	4500mm x 2700mm
Minimum Size	350mm x 180mm
Maximum thickness	15mm glass + Spacer width + 19mm glass
Minimum thickness	4mm + 8mm space + 4mm
Glass Types	All clear, tinted and low-E float annealed, tempered, laminated, Acid etched – surface #4 for etched side Patterned glass - 4,5,6mm Satinlite/ 4,5mm Spotswood rough side surface #4 Lacobel ® T – with print or frit to surface #4
Gas filled	Argon Gas as standard fill
Edgework	Refer section 13 page 109
Spacer Details	
Type	SuperSpacer® silicone foam
Width	8,10,12,14,16,20mm
Finish	Matte dark grey
Dual Seal	Primary and secondary sealed units
Primary	PIB (Polyisobutyl)
Secondary	Default applied is Polysulphide; Silicone applied for exposed edged glazing, min inset depth of 6mm.
Stepped Units	14mm width spacer only, Silicone secondary seal minimum requirement
Spandrel Units	Silicone secondary seal with print or frit surface #4.
Edge Deletion	Only on sputter coat LowE – Duo Ultra units

BUILD UP DESCRIPTION

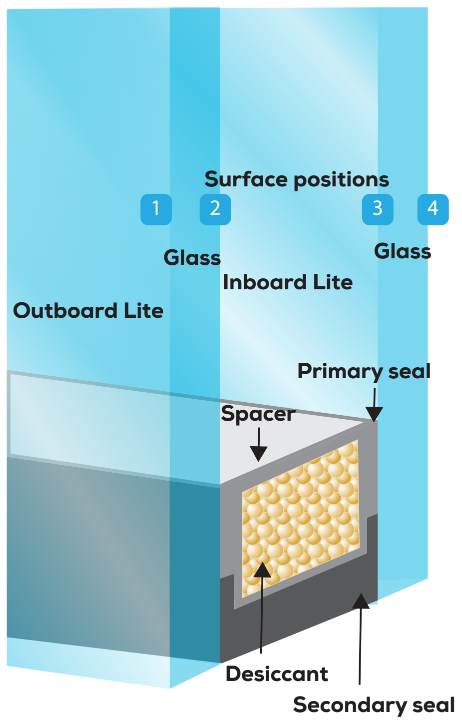
The IGU is typically made up of 2 panels of glass, called the outboard (facing the outside) and inboard lites (inside). There are also 4 glass surface positions (1,2,3,4) as shown which determines where a coated glass will be placed in the unit e.g., 6.38 Sunergy Low E#2 , which means the coating is on surface#2 of the unit (facing the inside of the unit).

PRIMARY AND SECONDARY SEALS

Duo Plus™ and Duo Ultra™ IGU's are manufactured with dual seals. Primary seals using Polyisobutyl and either Polysulphide or Silicone for the secondary seal. Polysulphide is the default secondary seal used when orders are placed. It is only used where the edges are fully covered (or 4 side full captive) and the sealants not exposed to UV.

Silicone sealed units should be used where one or more edges are exposed, no frame covering the edge of the glass. Example of this type of glazing is 90° butt joints and silicone structural glazing. Silicone secondary seals should also be used where IGU's are used in spandrel glazing.

FIG. 1: IGU CONFIGURATION

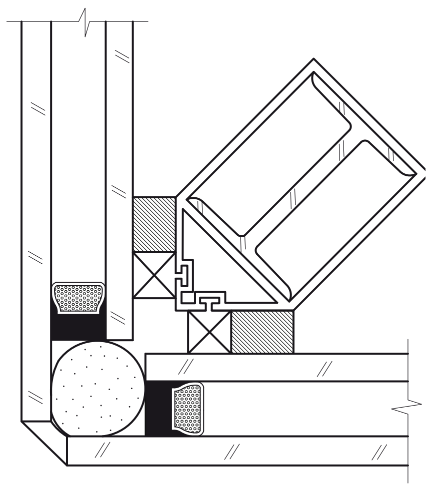


What is silicone structural glazing? This method of glazing is more often used in commercial buildings, where no vertical or horizontal aluminium members are seen. Basically the glass is siliconed to the aluminium section which is fixed to the building. This means the edges of the glass are exposed and the silicone is preventing the glass from falling out or being blown out of the building due to wind load actions. Note: default silicone secondary sealant depth is 6mm.

STEPPED UNITS

As shown in Fig2 below, stepped units are used mostly in exposed edge applications, such as structural glazing or 90o butt joint glazing (see note and comments in Primary and Secondary Seals). The stepped perimeter edges of these units can be printed a black colour to hide seal and spacer elements. The spacer width for stepped units is 14mm.

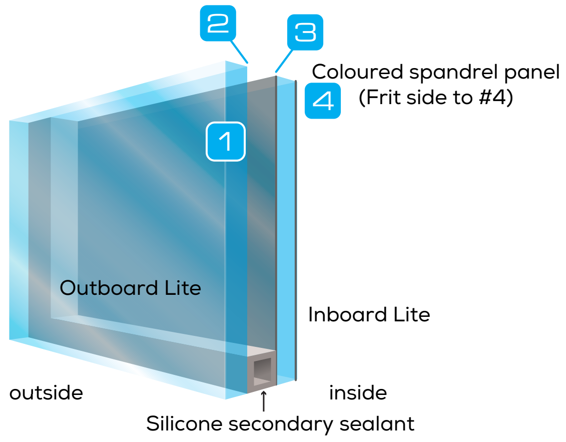
FIG.2 STEPPED IGU DETAIL



SPANDREL UNITS

Where the glazing design requires matching of vision and spandrel glass across the facade, IGU's are often used as they create the perception of depth similar to that of the vision panel. In this situation the ceramic printed side is on surface #4 of the assembled unit. (See Fig 3). Spandrel units shall have silicone as the secondary sealant. For more information go to page 65.

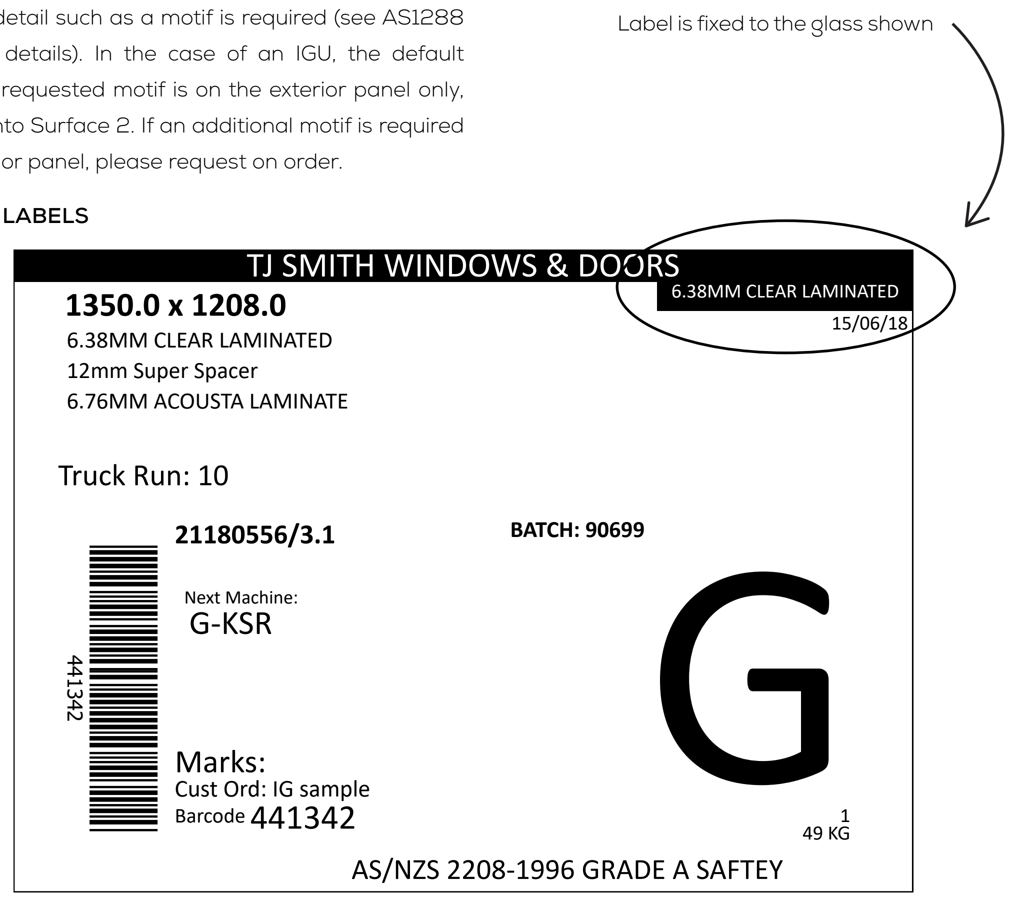
FIG 3: SPANDREL GLASS DETAIL



MAKING GLASS VISIBLE (MANIFESTATION)

For panels capable of being mistaken for a doorway or opening, a detail such as a motif is required (see AS1288 for specific details). In the case of an IGU, the default position for requested motif is on the exterior panel only, screened onto Surface 2. If an additional motif is required for the interior panel, please request on order.

IGU GLASS LABELS



IDENTIFYING GLASS TYPES IN AN IGU

The individual glass panels in IGU's have to be assembled to specific surface positions. This is especially relevant for tinted or coated glass such as Low-E, where the finished unit has to be glazed in the window opening such that the coating performs in the correct manner. Some glass types in IGU's are very similar in appearance and this becomes difficult to determine 'what glass is what'. National Glass produce a label that states the glass type, the label itself fixed to the glass (see label below as circled). In the example shown, 6.38mm Clear Laminated/12/6.76mm Acousta IGU, the label is placed on the 6.38mm Clear Laminated panel. Once the glass is delivered, it's then the responsibility of the fabricator or installer to correctly glaze the window to ensure performance outcomes are met.

GREATER THERMAL PERFORMANCE

To further improve the thermal insulation of IGU's, the unit cavity can be filled with a heavy gas such as Argon which lowers convection heat loss between the glass panes. The spacer width can be increased to a maximum of 16mm where performance peaks and using a spacer with low conductivity will also improve performance. Extreme climatic situations especially in cold climates will sometimes require double low-E's or triple glazing with combinations of low-E coatings, gas and low conductive spacers. National Glass IGU's are all supplied with Argon Gas and use Super Spacer for lower conductivity.

THERMAL STRESS

The use of solar control glass may affect the thermal safety of the unit. Careful consideration needs to be given to building design, frame type, glazing methods, proximity of blinds, screens or curtains and external shading.

See "Thermal Breakage" page 113.

SPACER WIDTH

It is always advisable to have a wider airspace for larger sized units as the deflection due to pressure change can reduce performance and cause Newton's rings (see below). Because there are many different IGU configurations in relation to size and wind load, Table 3B below is a guide to the thinnest spacer allowed (8mm), by glass thickness and size up to maximum of ULS 1.3kpa (N2 Corner window). Pressures above ULS 1.3kpa require a calculation to determine if a wider spacer is required and appropriate glass thickness.

A check will still need to be performed for maximum area of safety glass per AS1288 Table 5.1.

NEWTON RINGS

Newton rings is a visual effect created when the centre of the glass panes making up an IGU come so close as to touch each other. It will appear as a circular or semi-circular rainbow effect in central areas of the unit. This may indicate that the spacer width is too small, the result of temperature related pressure changes or improper pressure equalisation.

DISTORTION

Some solar control glass may experience slight visual distortion or bowing due to atmospheric/ air changes. This is not considered a defect. This distortion can be more obvious with tempered glass.

MULTIPLE REFLECTIONS

Multiple reflections can be present when viewing an object's reflected image in an IGU. The use of tinted or reflective glass as outside lites and low-E glass as the inside lite gives a greater reflection. Whilst it is not a common problem, a certain amount of double imaging is inherent in IGU's.

BREWSTERS FRINGES

Brewsters fringes is a visual effect manifesting itself as a rainbow visible within the unit. Brewsters fringes is not a deterioration of the unit or glass but an effect created when light passes through two panes of glass of the same thickness. The resulting light refraction becoming visible as a rainbow effect. Brewsters fringes can be confirmed by depressing one surface of the unit. The rainbow effect will move and colours change as the one glass surface is depressed and released. The effect can be avoided by using two different thicknesses of glass for each lite.

CONDENSATION

Water from condensation build-up and resultant water run-off can damage window frames/ sills and seep into walls and adjoining areas. Condensation will form when the moisture in the air condenses out on surfaces that are cooler than the 'dew' point. Insulated walls, ceilings and floors provide better thermal barriers than windows. Window surfaces being colder than other surfaces in the home or building are more prone to condensation build up. An IGU reduces the likelihood of condensation forming by providing a thermal barrier between the inside and the outside.

TABLE 3B SPACER WIDTH GUIDE

Up to ULS 1.3KPA Minimum 8mm spacer	Annealed Maximum size mm	Toughened Maximum size mm
4/ - /4	2000 x 1000	2200 x 1000
5/ - /5	2400 x 1150	2500 x 1400
6/ -/6	2500 x 1350	2600 x 1500
6.38/ - /6	2500 x 1350	2500 x 1350
6.38/ - /6.38	2500 x 1300	
8.38/ - /6	2700 x 1500	2700 x 1500
10/ - /10	3000 x 2000	3600 x 2500
10.38/ - /10	3100 x 2000	3100 x 2000
10.38/ - /10.38	3100 x 2000	

HIGH ALTITUDE

Pressure equalizer valves or capillary tubes are required for IGU's at altitudes greater than 800 metres above sea level. The reason being that when the unit is manufactured at lower altitudes and then installed at high altitudes, the increase in altitude causes the glass panels of the unit to bow out. This creates added stress to the seals that can reduce the life span of the unit and can be visually unacceptable. Ask our technical staff for more information.

INSTALLATION AND GLAZING

90% of double glazed units fail because of improper glazing techniques. Failure is most commonly characterised by the appearance of moisture in the cavity suggesting seal and/ or desiccant failure. The glazing system must be designed to drain out all water in the rebate and a void must exist under the unit so that moisture is not trapped against the edge of the glass. Setting blocks should be centred at the bottom quarter points of the unit (two per unit) and should always be an equal distance from the centre of the glass. Blocks must be made of a compatible material 80-90 shore hardness and allow no water to gather on the unit.

Dry glazing of units is always recommended but if units are to be glazed or bedded into compounds or sealants it is imperative that compatible sealants are used or edge failure may result. Linseed oil, acid cure silicones and small joint sealants must be avoided.

The sun's energy with its damaging UV radiation will have a detrimental effect on IGU seals. To prevent failure of the unit, it is critical to have all the edges protected from the sun. Exposed edges should be fully flashed over with an aluminium strip or similar using an adhesive such as neutral cure silicone. Do not use setting blocks which expose the spacer to sunlight. For structurally glazed IGU's where the edges are exposed, the minimum requirement for the secondary seal is silicone, due to its high resistance to UV radiation

SETTING BLOCKS

Setting blocks and their correct positioning are critical in order to ensure that the unit is uniformly supported and unit sealant is above entrapped water. Positioning of the blocks must allow for water drainage holes to be clear. See diagram 3.5 & Table 3C.

DIAGRAM 3.5: SETTING BLOCK LOCATIONS

Two blocks per sill;

Drainage holes or slots must exist (6mm holes or 10mm x 5mm slots);

Heel and toe blocks to doors and sashes.

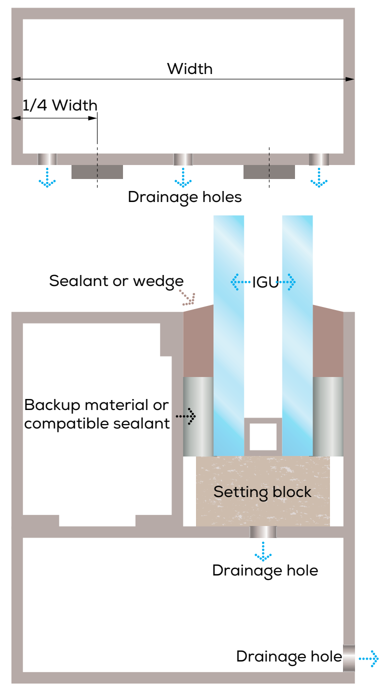


TABLE 3C: SETTING BLOCKS TABLE

AREA OF UNIT MIN LENGTH AT EACH (M2)	QUARTER POINT (MM)
Less than 2.0	50
2.0-3.0	75
3.0-4.0	100
4.0-5.0	125
5.0-6.0	150
Up to 7.0	175
Guide = 25mm/m² of glass	

04 NOISE REDUCTION

SOUND INSULATION

As a general rule, increasing mass will improve sound insulation. Brick and concrete walls have stronger sound insulating values because they are of greater mass when compared to glass. But because we need glass to see through, to provide natural daylight and to enhance a buildings look and appeal, the need for greater sound control when using glass becomes more important.

Sound originates from something that vibrates which generates changes in air pressure. Frequency is used to refer to the number of vibrations or changes in air pressure per second. The value given is usually expressed as hertz (Hz) (i.e. 750Hz). Different sounds produce different frequencies. Traffic noise as an example, produces sounds most intensely in the lower frequency range. The intensity or volume of a sound is of most concern to people. The volume of a sound is rated as Decibels or 'dB'.

Where there is a noise problem to solve, three areas have to examined:

1. Determine and/or measure the external noise;
2. Sound insulation rating of the window system/glazing and;
3. The resultant noise level in the room.

Table 4A provides a guide to examples of noise measured in decibels (dB) against the recommended noise levels for a room in a building. Table 4B shows the sound reduction ratings of many different types of glass, including float, laminated, Acousta™ Laminated and IGU's. Having determined the external noise level rating and the desired internal noise level for a given room, the next step is to subtract the glass reduction rating of Table 4B from the Table 4A noise levels.

FOR EXAMPLE:

› External noise source – Busy traffic 75dB

› Bed Room recommended noise level – 40dB

75dB – 40dB = 35dB rating required for window/glazing system

(from table 4B) 6.76 Acousta™ Laminated in single glass form

TABLE 4A:

Common Sound levels - Environment	dB
Threshold of hearing	0
Conversational speech	65
Average traffic (kerbside)	70
Busy traffic	75
Loud traffic	80
Live band (20 metres)	105
Recommended interior noise levels	**dB**
Bedroom	30-40
Classroom	35-40
Living room	40-45
Private office	40-45
Open office	45-50

DID YOU KNOW?

› Sound reduction will improve with increased glass thickness due to the greater mass involved;

› Sound reduction will decrease somewhat with increasingly larger glass areas but not enough to make much difference in the majority of architectural glass sizes;

› Sound reduction will improve with the use of Acousta™ laminated glass due to the vibration dampening effect of the interlayer. It's particularly effective for interior partitions as it reduces the 'coincidence dip' attributed to monolithic glass in the 1000–2000Hz range, a range attributed to the human voice;

› Structural or sometimes referred to as 'stiff' interlayers including DG41 and SGP do not perform as well as PVB or Acoustic layers;

› Sound reduction will improve with the use of glass/airspace combinations, but the performance is critically dependent upon the width of the airspace. An airspace of 100mm is generally regarded as a minimum for reasonable benefits at medium to high frequencies.

TABLE 4B: GLASS ACOUSTIC DATA COMPARISON			
Single Float Glass Thickness mm	dB REDUCTION Rw	IGU Configuration	dB REDUCTION Rw
3	30	4/12/4	32
4	30	5/12/5	33
5	31	6/12/6	34
6	31		
8	34		
10	35		
12	37		
19	39		
Laminated (PVB)		IGU Laminated (PVB)	
6.38	32	6/12/6.38	36
8.38	34	6/12/8.38	40
10.38	35		
12.38	36		
11.52	36		
13.52	37		
Acousta™ Laminated		IGU Acousta™ Laminated	
6.76	36	6/12/6.76	41
8.76	37	6/12/8.76	41
10.76	39	6/12/10.76	42
12.76	40	6/12/12.76	43
16.76	41	6/12/13.52	44
20.76	42	10/20/10.76	46

Note: The accuracy of the given indexes is +/- 2dB.

RW - SOUND REDUCTION INDEX

The table data above is measured as a single-number Rw rating of the sound reduction through the glass. Since the sound reduction may be different at different frequencies, test measurements are subjected to a standard procedure which yields a single number that is about equal to the average sound reduction in the middle of the human hearing range.

THE HUMAN EAR

Under typical field conditions the ear cannot detect a change of 1-2dB;

The ear will not pick up a change of 3dB if there is a time lapse between the two sounds and they are of moderate or low intensity;

A change of 5-7dB can always be detected;

For every 10dB increase/decrease in intensity we perceive the sound as being a doubling/halving of the noise level.

TABLE 4C:
PERCEIVED NOISE REDUCTION

Sound pressure level (dB) reduction	Perceived Noise Reduction	
1	Cannot be heard	
3	18%	Just audible
6	34%	Clearly audible
10	50%	Noise reduced by half
20	75%	Noise reduced by 3/4
30	87%	-
42	95%	-
51	97%	-
54	98%	-

The Rw is a simplified average rating across all frequencies. However noise produces different intensities at different frequencies. In certain situations, the Rw does not account for all noises generated. This is especially the case for low frequency noises such as traffic rumble or hi-fi system bass sounds. The Ctr value adjusts for these low frequency noises (Rw + Ctr) and is always a negative number. Smaller negatives are better than larger negative values.

COINCIDENCE DIP

This occurs where the panel vibrates in unison with the frequency of the sound. The result is that the sound insulation values of the glass panel are reduced at that specific frequency. The frequency at which the 'dip' occurs varies with the thickness and the stiffness of the glass. The thicker and stiffer the glass, the lower the frequency at which the 'dip' occurs. Where specific frequencies are targeted for noise reduction, an analysis of where the frequency 'dip' occurs for the glass type under consideration is important.

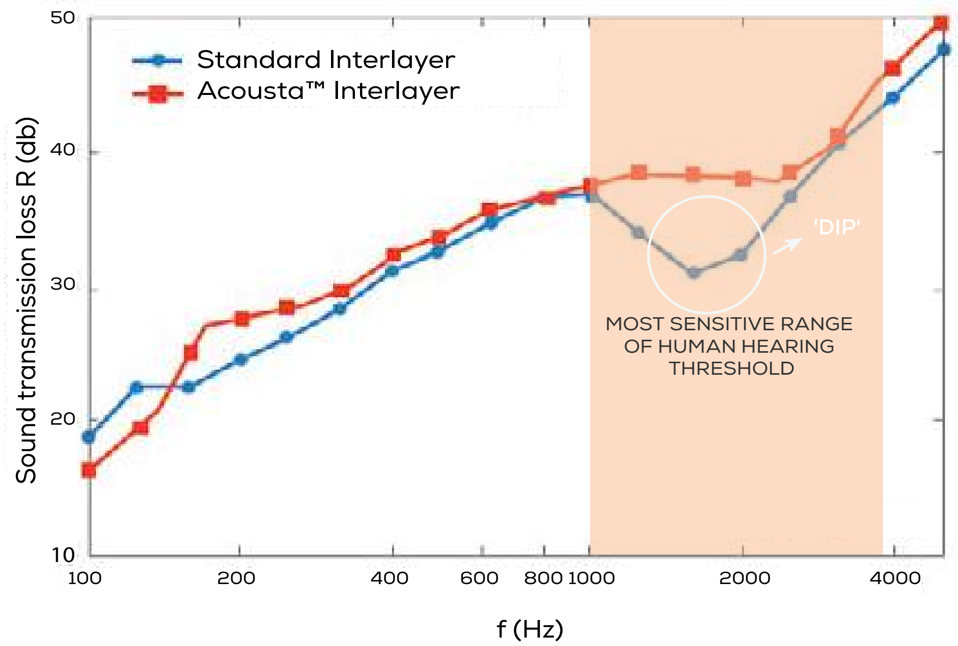
PRODUCT SELECTION

ACOUSTA™ LAMINATED

Acousta™ is a Grade A safety glass that uses a specially developed interlayer which dampens noise more effectively than ordinary single glass. Utilising an advanced, three layer system designed to decouple and disseminate sound waves for superior sound damping performance. This patented system targets sounds in the 1000 – 3000 Hz range which is the "most sensitive range of human hearing" that allows the most irritating of sounds to penetrate windows. Available in 6.76, 8.76, 10.76 and 12.76mm thickness range.

Graph 4.1 shows the sound transmission loss of glass across a low to high frequency range, comparing ordinary laminated and Acousta laminated glass. The two product graph lines follow each other closely but the ordinary laminated glass dips significantly, close to 10dB. This 'dip' means more noise is let through at these frequencies whereas the Acousta™ continues to perform. A 10dB increase in sound is perceived as a doubling of the sound level to the human ear. The frequencies at which the 'dip' occur are at the most sensitive range of human hearing.

GRAPH 4.1: SOUND TRANSMISSION LOSS- COINCIDENCE DIP



Sound Transmission Loss of Laminated Glass with Saflex Q series acoustic interlayer and Saflex R series interlayer. Configuration 8mm Laminated

05 STORMSAFE

STORMSAFE

Stormsafe is a specially constructed laminated glass, designed to resist and absorb the impact of objects, debris, and projectiles. During cyclones and severe storms, ordinary window glass and frames can fail under such pressures. This can lead to buildings having significant internal damage and even structural failure. Because of this, and glass being an integral part of the framing system, National Glass have developed and tested a range of Stormsafe products to lessen the impact of such events.

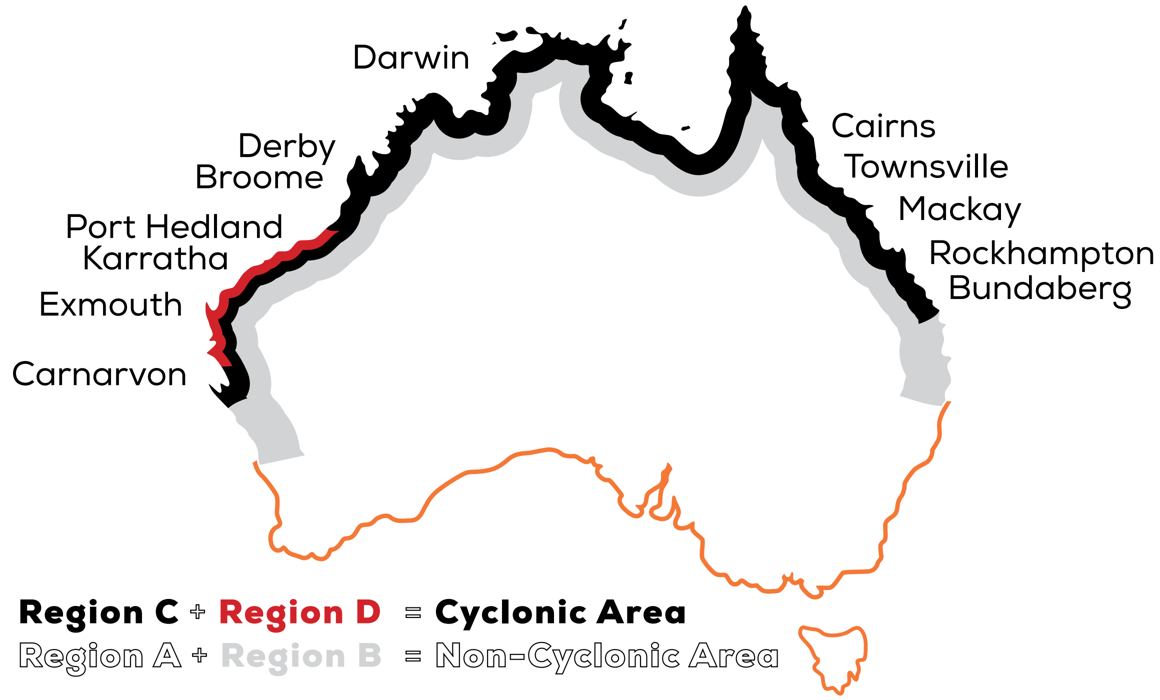
Stormsafe is manufactured to AS/NZS 2208: 1996 Safety glazing materials in buildings and is a certified Grade A Safety Glass. It provides added strength against natural forces such as high winds and is available in 14mm and 17mm thicknesses. In order to meet energy efficiency requirements for residential and commercial buildings, Stormsafe can be incorporated with energy efficient glass such as SOL-R™ and Sunergy® Low-E coated glass..

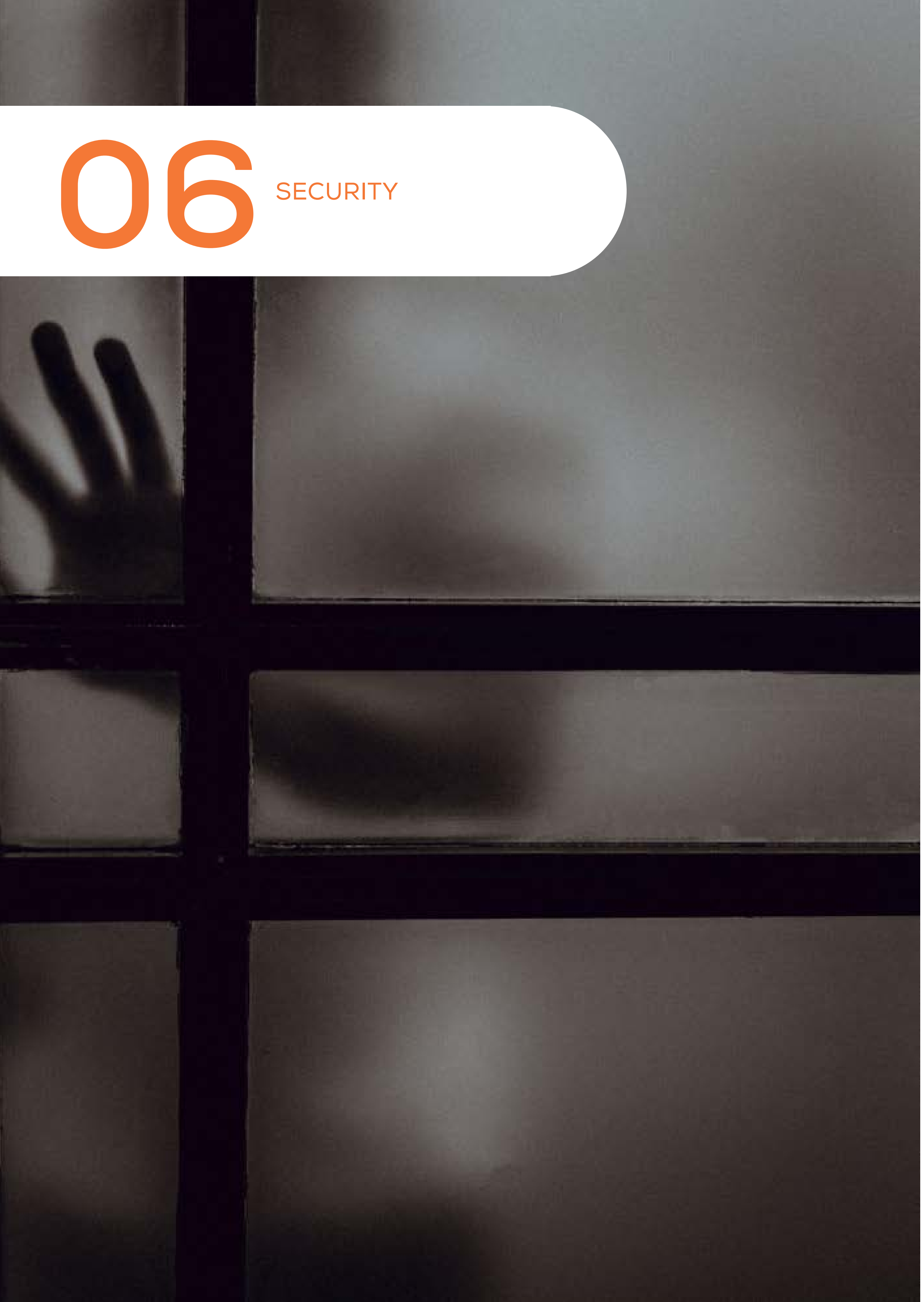
Stormsafe has undergone and successfully passed debris impact testing as per AS/NZS1170.2 Section 2.5.8. This test simulates the effect of impact on glass and frame, and involves firing a 4kg timber projectile from a cannon at a specified speed and velocity. The objective is to test the integral strength by preventing the projectile from penetrating through the glass.

Stormsafe products are primarily designed for cyclonic regions of Australia, which includes the Queensland, Northern Territory and Western Australia coastlines. These areas are categorised under regional wind speeds; A, B, C & D. Wind regions C & D are classified as cyclonic areas and may require protection from flying debris and projectiles. Regions A & B are classified as non-cyclonic areas and do not require specific cyclonic rated glass. Please refer to the image below.

For more information on Stormsafe systems, contact our technical team.

PRODUCT NAME	NOMINAL THICKNESS	WIND REGION	IMPACT SPEED TEST RESULT	SIZE TESTED
Stormsafe 14	14mm	Region C	Passed at 31 metres per second	2380mm x 1180mm
Stormsafe 17	17mm	Region D	Passed at 36 metres per second	2380mm x 1180mm





06 SECURITY

Security glazing can be broadly defined as products and systems designed to protect people and property. Security glazing in the case of criminal actions should be considered as just one component in the overall security system. Factors affecting which level of security glazing to choose include police response time, protection of people and goods and the availability of other forms of security such as alarms and electronic surveillance.

BASIC ATTACK RESISTANCE

Laminated glass is available using a 1.52mm PVB interlayer to make a 7.52mm and 11.52mm laminated glass. These products are ideal for situations where the noise generated by the attack alerts neighbours or occupants. The thicker interlayer is designed to increase the amount of time and effort required by the intruder to gain access through the glazing.

SECURITY GLAZING SYSTEMS

INTRUDER RESISTANT GLAZING SYSTEMS

As covered by AS3555 Building elements – Testing and rating for intruder resistance, specific types of forced entry resistant glazing systems have been developed to withstand physical attack with common hand tools, axes, sledges and power tools etc.

These systems utilise a multi-laminated glass which can include polycarbonate and polymer sheets with PVB interlayers. These products are supplied as a complete frame and glass unit. The standard AS3555 evaluates the maximum size opening allowed after a number of minutes and by a level of attack. This standard does not cover bullet resistant attack, but can be manufactured to do so.

BULLET RESISTANT GLAZING SYSTEMS

These systems consist of a complete frame and glass bullet resistant unit. A multi-laminated glass which can include polycarbonate and polymer sheets with PVB interlayers is laminated together to various thicknesses according to the level of protection required as per the seven classification levels in AS2343 Bullet resistant panels and elements (refer Table 6A). In common applications thicknesses vary from 19-65mm. Bullet resistant glazing systems can also be manufactured to meet AS3555 *Building elements – Testing and rating for intruder resistance.*

BOMB AND BLAST RESISTANT GLASS

Bomb blast generates energy in all directions, not just at the intended target. In many cases, people and buildings that are not targeted suffer injury and damage respectively. In fact with a small device, even buildings several hundred metres away from the targeted building suffer glass breakage.

To resist the blast effect of a bomb, the complete window assembly must withstand two specific assaults. First the blast wave, which expands in all directions from the bomb as it detonates and secondly the fragments from the bomb case or container, which may include nails, bolts, screws and other pieces of metal.

TABLE 6A: BULLET RESISTANCE (AS2343 1997)

CLASSIFICATION	CALIBRE	AMMUNITION	MEASURED VELOCITY WITHIN 2.5 METRES OF TARGET (METRES PER SECOND)	MINIMUM RANGE (METRES)	NUMBER OF STRIKES
G0	9mm Parrabellum	Mk22 7.4 gram bullet	405 +/- 15	3	3
G1	357 Magnum	10.2 gram semi jacket soft point	450 +/- 15	3	3
G2	0.44 Magnum	15.6 gram semi jacket soft point	480 +/- 15	3	3
R1	5.56mm	M193 5.56mm 3.6 gram FMJ	980 +/- 15	10	3
R2	7.62mm	NATO 9.3 gram FMJ	850 +/- 15	10	3
S0	12 Gauge (Full choke)	70mm case 32 gram SG shot	400 +/- 20	3	2
S1	12 Gauge (Full choke)	70mm case 28.5 gram solid slug	450 +/- 20	0	2

Note 1 – Shot centres 100mm apart, forming a square or equilateral triangle, centred on the target panel.
Note 2 – Special class shall be specified by the manufacturer and allows for oblique shots or elements that are not 420mm square etc.
G = resistant to hand gun attack. | **R** = resistant to rifle attack. | **S** = resistant to shotgun attack.

PRIVACY GLASS

Patterned glass may be an option in toilets and bathrooms. However in fact, they just obscure the object in view and therefore are not the ideal form of privacy glass. Tinted glass and specialist products such as SuperGrey™ are very dark in appearance and offer varying degrees of privacy during daylight. However, like all glass including reflective glass, at night time, when levels of illumination inside are much higher than outside, the opposite will occur where an unobscured 'view in' will be offered. Indeed, the best solution maybe to install a blind or curtain.

ONE WAY LAMINATED MIRROR

6.38mm SolarPlus S108 is ideal for surveillance, security and where discreet observation is required. A successful application requires a brightly lit subject side and a darker observation side with the correct use of lighting.

Please refer to the following glazing guidelines:

› Not suited for windows for outside applications;

› Glaze the more reflective surface to the subject side;

› Lighting must be maximised on the subject side to a ratio of 7:1 (see Diagram 6.1);

› This lighting must not shine directly on the glass;

› Lighting in the observers room must be kept away from the glazing. Any windows, doorways etc in the observers room that may emit light, must be prevented from doing so;

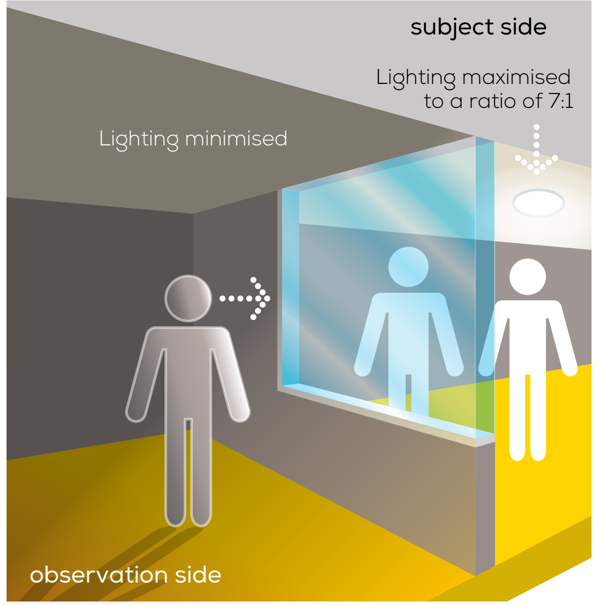
› Walls, floors and furnishings on observation side to be dark and subdued colours;

It is possible to use Solar Plus S108 in applications where daylight brightness is much greater than internal lighting levels as the reflectivity of the glass makes it difficult to look in. However, when the lighting conditions change when day becomes night with internal lights turned on, the situation is now reversed making it easy to see in and making it hard to see out. If Solar Plus S108 is used in external windows, a thermal assessment should be undertaken to determine risk of thermal heat breakage.

SWITCHABLE GLASS

Glass that allows transition between clear and opaque in milliseconds with the flick of an electrical switch.

Diagram 6.1: One way laminated mirror (6.38 S108)



Laminated one way mirror – Subject side view from outside of men's restroom, lighting maximised to prevent see through.

Switchable glass off.

Switchable glass on.

07 FIRE PROTECTION

FIRE PROTECTION

Ordinary annealed float glass in a heat or fire situation readily transmits heat and upon breaking allows the passage of flames and smoke. Provisions within the BCA and Australian standards require the use of fire resistant glazing in buildings. For bushfire prone areas, AS3959:2009 Construction of buildings in bushfire prone areas, provides for either a deemed to satisfy or alternative solutions for window glazing based on a **BushFire Attack Level (BAL) rating.**

LIMITATIONS OF STANDARD GLASS

Glass is not a combustible material but in the event of fire allows heat to transmit and upon breakage, passage of flame and smoke. Ordinary annealed float glass will break where the temperature difference is 40oC. Toughened glass can withstand temperature differences of up to 250oC.

BUSHFIRE RESISTANCE GLAZING SYSTEMS

For bushfire prone areas, AS3959:2009 Construction of buildings in bushfire prone areas, provides for either a deemed to satisfy or alternative solution for window glazing based on a BushFire Attack Level (BAL) rating. The deemed to satisfy section of this standard prescribes the use of glazing with bushfire resistant shutters and/or metal screens depending on the level of bush fire rating.

An alternative approach where shutters or screens are not desirable is to test the complete window assembly which must then pass the test procedures in AS1530.8.1.2007.

Always consult with your window manufacturer and local relevant authorities for the appropriate solution. Remember that windows and doors which attain a level of bushfire resistant are just one part of the building structure. Refer to AS3959:2009 for specific details.

FIRE RESISTANT GLAZING – COMPLETE WINDOW SYSTEMS

The advantages of using glass as part of a fire resisting wall or system is that it alerts people that a fire exists and can assist rescuers in finding people. The Building Code of Australia and relevant local authorities have stringent fire resistant regulations for building design and glazing requirements. These glazing requirements stipulate the use of fire resistant panels or windows which achieve specific **fire resistant levels** or **FRL**.

More importantly, in order for the window to pass the BCA regulations, the complete window assembly must have been tested. It must be identical in size, components and installation to a previously tested prototype. Obviously, it is advisable in terms of cost to search for an approved fire rated prototype and design the window opening around the prototype.

COMMON TERMS USED

- FRL – or 'Fire Resistant Levels' refers to the grading periods in minutes of fire windows for the following criteria;
- Structural adequacy – refers to the ability to maintain stability and adequate load bearing capacity as determined by AS1530.4;
- Integrity – refers to the glazing's ability to resist the passage of flames and hot gases as specified in AS1530.4;
- Insulation – refers to the ability to maintain a temperature on the glass surface not exposed to the fire below the limits as specified in AS1530.4;

Specifications for FRL could be expressed in this order –/60/30. This for example, refers to no structural adequacy requirement, a 60 minute integrity and a 30 minute insulation rating for a fire resistant glazing. (See example of FRL Table 7A below).

TABLE 7A: DEFINING AN FRL SPECIFICATION

– or no requirement	/60 or 60 min	/30 or 30 min
Structural Adequacy	Integrity Requirements	Insulation Requirements

FIRE RESISTANT GLAZING – TYPES OF GLASS

Fire resistant glazing systems can be categorised into non-insulated and insulated units. As stated, the fire resistant level or FRL can only be attained if the complete unit has been tested previously as a prototype. Framing for fire resistant windows is either made of steel or hardwood timber. Hardwood timber frames are naturally insulating while steel can be made either insulating or non-insulating.

NON-INSULATED

Wired glass is a typical non-insulating product. For clear through vision, clear polished wired is used. This product has been tested to achieve –/60/–, or only a 60 minute integrity fire resistance in a steel frame. Wired glass upon exposure, breaks but the wire retains the glass fragments in place. Wired glass is not a Grade A safety glass. Other non-wired glass products are also available providing basic integrity ratings and available as Grade A Safety Glass.

INSULATED

There are two types of insulating glass products:

- The first type uses a clear intumescent interlayer in a laminated or multilaminated glass make-up. Upon heating in excess of 120°C, the interlayer turns into a rigid and opaque fire shield. The higher the FRL requirement, the thicker the glass and the greater the number of interlayers;
- The second type consists of a gel interlayered glass in a sealed glazing unit. The cavity is filled with a clear heat absorbing gel. Both products can provide high levels of integrity and insulation and satisfy Grade A safety glass requirements.

HEAT RESISTANT GLASS PRODUCTS

Refers to types of glass which have been designed to handle temperatures in excess of 250°C such as Neoceram, Vycor and Neotherm® for specific applications. It also refers to applications where there are no BCA, legislative or Australian Standard requirements but where the use of a heat resistant glass is recommended.

NEOCERAM

This is a 5mm thick 'brownish tinged' transparent ceramic glass with very low thermal expansion and mechanical resistance. Suited for food ovens, fireplaces, combustion wood heaters and stoves where temperatures do not exceed 700°C. (This product can withstand short term temperatures of 800 °C). Its cutting and breakage characteristics are similar to annealed glass. Edges should be arrised prior to installation. When installing Neoceram, care must be taken to ensure the edges are not damaged. They must be protected by means of fire resistant cord or ribbon, glass fibre or some other non combustible material to prevent breakage. Direct metal to glass contact must be avoided.

GLASS SPLASHBACKS & STOVETOPS

Special note should be made here to protection of combustible surfaces near cooking appliances. The use of painted glass panels for kitchen splashback applications requires that this glass meets the requirements under AS4551/AG101 and AS5601/AG601.

These standards are designed to prevent excessive heat and possibly fire in combustible materials supporting the wall covering behind the glass splashback.
(See Diagram 7.1)

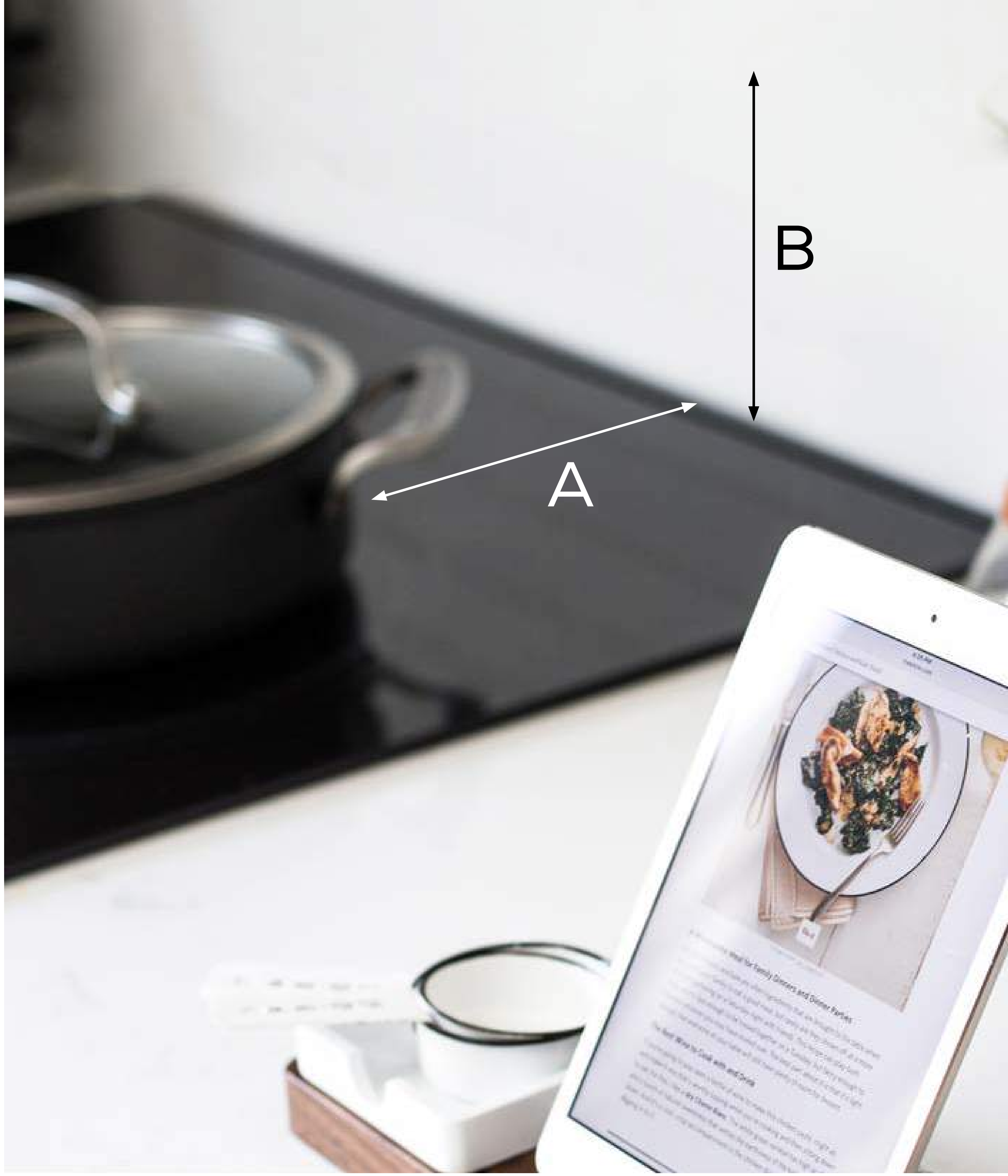


DIAGRAM 7.1: EXTRACT FROM AS5601/AG101 GLASS SPLASHBACKS AND COOKTOPS - DETAILING MEASUREMENT REQUIREMENT.

A = If less than 200mm from periphery of gas burner or electric element to vertical combustible surface under the glass splashback, the wall material must be constructed such that the temperature of the combustible surface does not exceed 65°C above ambient. Using a suitable non combustible wall material supplied, approved by the builder can satisfy this requirement.

B = Reading in conjunction with A, non combustible wall material behind splashback must be at least 150mm high.

08 TOUGHENED & HEAT TREATED GLASS

Toughened glass furnace.

TOUGHENED & HEAT TREATED GLASS

Producing toughened and heat strengthened glass begins with the feeding by conveyor of cut-to-size annealed sheets of glass (with minimum arrised edges) into a furnace. The glass oscillates back and forth on ceramic rollers to an approximate temperature of 620°C. Under computer control, the glass moves into the quench where it is rapidly cooled by high pressure cool air. This 'snap' cooling or quenching induces compressive stresses to the glass surface, while the centre remains in tension. Although the physical characteristics remain unchanged, the additional stresses created within the glass increases its strength by 4–5 times (for toughened glass) compared to that of annealed glass of equal thickness. Toughened safety glass produced by National Glass is manufactured to the requirements of AS/NZS2208 Safety glazing materials in buildings and AS/NZS2080 Safety glass for land vehicles.

TOUGHENED GLASS

FEATURES AND APPLICATIONS

- **SAFETY** – Toughened safety glass is manufactured to AS/NZS2208 and 2080 and is a Grade A safety glass as per AS1288;
- **STRONGER** – Up to 500% stronger than annealed glass and therefore is more resistant to thermal breakage and can withstand greater wind-loads. Can be used within a temperature range of minus 70°C to plus 250°C (surface temperature should not exceed 250°C if other surface is lower than 0°C ambient);
- **FRAMELESS** – Allows reduction of framing members to produce a cleaner frameless look;
- **EASE OF HANDLING** – Standard arrised edge makes handling easier;
- **MATCHING** – Ease of matching tinted toughened Safety Grade A glass and tinted annealed glass;
- **THICKNESSES** – Available 4–12mm Grade A Safety Glass and 15–19mm toughened glass. Flat automotive and marine toughened is available in 4–12mm;
- **APPLICATIONS** – In the event of breakage, toughened glass will fragment into small relatively harmless pieces. However, depending on the method of framing and means of breakage, the fragments may also clump and fall out into larger more potentially hazardous pieces. In addition because the glass can fall out of the frame, this would leave no barrier to prevent persons or objects falling through the opening. Toughened glass is used mostly in doors, side and low lites, frameless entries, low level balustrading and shower enclosures – refer to Australian Standards AS1288 for guidelines for use of toughened glass.

DESIGN AND GLAZING NOTES

- **SURFACE TREATMENTS** – Toughened glass cannot be drilled or edgeworked in any manner.
- **TEMPLATES** – For toughened glass ordered to templates refer to our template processing guidelines;
- **MINIMUM EDGEWORK** – Finish on toughened glass up to and including 8mm is standard arrised edge. Minimum edge work on greater thicknesses will be a flat ground edge;
- **BOWING** – Slight distortion or bowing may occur after toughening but is largely controllable. It will vary with substance, tint, surface treatment, size and shape of the glass. Ceramic painted, or coated glass has a greater tendency to bow and special tolerances would be advised. Flatness will be measured when the glass is standing on edge with a straight edge placed along the full length of the panel and a wedge measurement taken at the centre position;
- **VISUAL DISTORTION** – The furnacing of glass panels can produce slight corrugated distortion or roller waves. This visual effect is in the form of distortion bands 250–300mm apart. It is more noticeable in tinted and reflective toughened glass. It is recommended that the roller wave run horizontal on the glass subject to the sizing constraints of the toughening furnace.
- **QUENCH PATTERN** – During the quenching phase of the toughening process, the glass is rapidly cooled by high velocity blasts of air. Inevitably this results in slightly higher levels of compression at those areas adjacent to the air nozzles. The consequence of this is the occasional appearance of a strain pattern or iridescent spots or darkish shadows. This effect is referred to as the quench pattern as it occurs in the furnace quench. Typically, the pattern is only visible at times of polarised light (polarised sunglasses) or by viewing the glass from the inside at acute angles. Similarly, the thicker and more reflective the glass, the more obvious the pattern will be;
- **PLASTIC WRAP** on toughened glass is used to protect the glass during transport. The plastic wrap should be removed no later than one month after exposure to sunlight.

SPONTANEOUS BREAKAGE

On rare occasions, toughened glass can break for what seems to be no apparent reason. A variety of contaminants in the raw stock can lead to problems either during or subsequent to the toughening process. Investigation into some instances of spontaneous breakage has identified an impurity in the glass called nickel sulphide as the cause. Most often however, breakage is usually due to surface damage impact or excessive loading on toughened glass.

NICKEL SULPHIDE NiS

Microscopic nickel sulphide stones are a rare, undetectable contaminant in raw glass stock. The heating and rapid surface cooling processes of glass toughening is believed to change NiS stones from a stable to unstable state. Heat soaking is a method used to lower the chances of spontaneous breakage.

HEAT SOAKING

Heat soaking involves heating toughened glass in a special oven at temperatures close to 260°C for several hours to induce breakages that may be caused by inclusions or contaminants in the glass. However heat soaking does not guarantee detection of all inclusions or contaminants that may lead to spontaneous breakages. Heat Soak oven size is maximum 5050mm x 2600mm.

HEAT STRENGTHENING

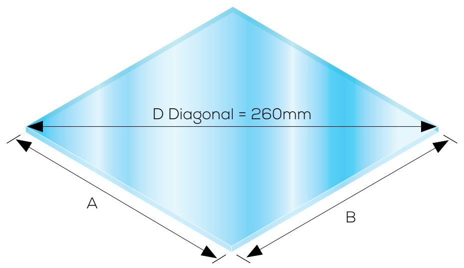
Though not suitable for Grade A safety glass applications, the probability of nickel sulphide inclusions inducing spontaneous breakage is practically non existent with heat strengthened glass where surface compression is less than 52Mpa.

MAXIMUM SIZE

The National Glass toughening furnace can produce sizes up to 5050mm x 2800mm.

MINIMUM SIZE

The smallest panel of glass that can be toughened must equal 260mm in the diagonal measurement. The minimum size for panels with Flat Ground/Polish (straight edges) will be 250mm x 100mm.



$A^2 + B^2 = C$
$\sqrt{C} = D$ (Diagonal measurement)

MINIMUM EDGEWORK

Clean cut edges for toughened glass is not permitted. Minimum finish is standard arris 4-8mm. Flat ground edge is required for 10mm thicknesses and over. The minimum size for panels with Flat Ground/Polish (straight edges) will be 250mm x 100mm.

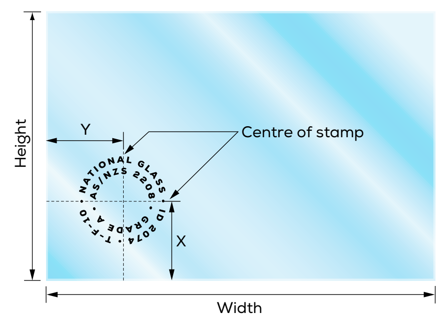
TOUGHENED IDENTIFICATION STAMP

Permanent stamps are located in the 'normal position' at the bottom left/right hand corner or 'special position' to customer specification. Please state either Glazing (or architectural), Automotive or special sized stamps for louvres.

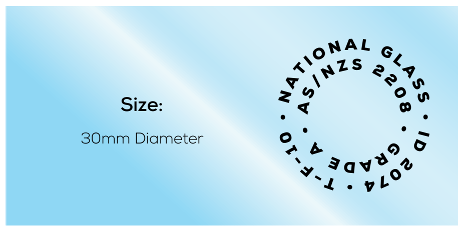
No stamp request: To assist with identification a small self destroying label is attached to all squares of toughened glass that are ordered without a permanent stamp. Our glass labels conform to the requirement under AS/NZS2208:1996 as a non-permanent marking. You may choose to remove the label in your factory or leave to confirm to your client that toughened safety glass has been used.

Stamps in special positions: Please nominate on drawing position of stamp.

POSITION OF STAMP



ARCHITECTURAL STAMP



LOUVRE FACE STAMP

Small discrete ID stamp placed on face of glass (41mm x 3mm).

AS/NZS 2208 GRADE A T-F-6 I.D. 2074

PRODUCT SPECIFICATIONS

TABLE 8A:

PRODUCT CHART-STANDARD GLASS (TOUGHENED, HEAT STRENGTHENED & HEAT SOAKED TOUGHENED)

MM	CLEAR	EXTRA CLEAR	GREY	DARK GREY	GREEN	DARK BLUE	SUPER GREEN	ACID	ACID GREY	PATTERN
4	✓	✓	✓	-	-	-	-	✓	✓	✓
5	✓	-	✓	✓	✓	-	-	-	-	✓
6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	✓	✓	✓	-	-	-	-	-	-	-
10	✓	✓	✓	-	-	-	-	✓	-	-
12	✓	✓	✓	-	-	-	-	✓	-	-
15/19*	TGH & HSK only	TGH & HSK only	-	-	-	-	-	-	-	-

TGH = Toughened HS = Heat Strengthened HSK = Heat Soaked Toughened

✓ = availability by thickness, type and heat treatment type

Where thicknesses not available, product can be made up using custom laminated glass

TABLE 8B : PRODUCT CHART – COATED GLASS (TOUGHENED, HEAT STRENGTHENED & HEAT SOAK TOUGHENED)

MM	SOL -R CLEAR	SOL-R NEUTRAL	SUNERGY NEUTRAL	SUNERGY GREY, GREEN, AZUR	SUNERGY COOL	SOLTECH	EVANTAGE	DUO ULTRA (IGU ONLY)	SPLASHGUARD LACOBEL T
4	✓	✓	✓	-	-	✓	-	✓	-
5	✓	-	✓	-	✓	-	-	✓	-
6	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	✓	-	✓	-	-	-	-	-	-
10	✓	✓	✓	-	-	✓	-	-	-

TABLE 8C: SIZING & OTHER SPECIFICATIONS

TYPE	MAX SIZE MM	MIN SIZE MM	THICKNESS MM	AUST STANDARD
TGH	5050x2800	250x100 FG/FP OR 260mm ACROSS DIAGONAL	4 to 12 4 to 12 15 & 19*	-AS2208 Building -AS2080 Auto -See below
HS	5050x2800	250x100 FG/FP OR 260mm ACROSS DIAGONAL	4 to 12	ASTM C12179 (as per AS1288)
HSK	5050x2600	100x400	4 to 19	BS EN 141791:2016

TGH = Toughened HS = Heat Strengthened HSK = Heat Soaked Toughened

✓ = availability by thickness, type and heat treatment type

Where thicknesses not available, product can be made up using custom laminated glass

*15 & 19mm toughened glass is not listed in the testing standard for safety glass in AS2208. However, the same testing procedure is applied to ensure the glass is safe to use but cannot be technically called a Grade A Safety glass.

Max sizes shown subject to AS1288, wind load and specific application.

HEAT STRENGTHENED GLASS

Heat strengthened glass is produced in the same manner as toughened safety glass except that the cooling process is slower. Heat strengthened glass is generally twice as strong as annealed glass, has more resistance to heat fracture and is subject to greater wind-loading than annealed glass. Heat strengthened float glass on its own is NOT a safety glass, but can be laminated to meet requirements. When heat strengthened glass breaks, it fragments into larger pieces and tends to stay intact in the opening until replaced. This is particularly useful in high rise spandrel glass panels as the fragments are less likely to fall out. Like toughened glass, it cannot be cut, drilled or edgeworked.

Less visual distortion is also evident when compared to toughened safety glass. Because heat strengthened glass has a flatter surface and less distortion than toughened glass it is commonly used in laminated form as an alternative to toughened glass. This allows the interlayer to adhere more evenly to both laminate lites for a flatter finish. In addition to these benefits, the probability of nickel sulphide inclusions inducing spontaneous breakage in heat strengthened glass is practically non-existent where surface compression is less than 52Mpa.

FEATURES AND APPLICATIONS

› Less visual distortion than toughened glass;

› Stronger – up to 200% stronger than annealed glass. Can resist temperature differential of 180°C;

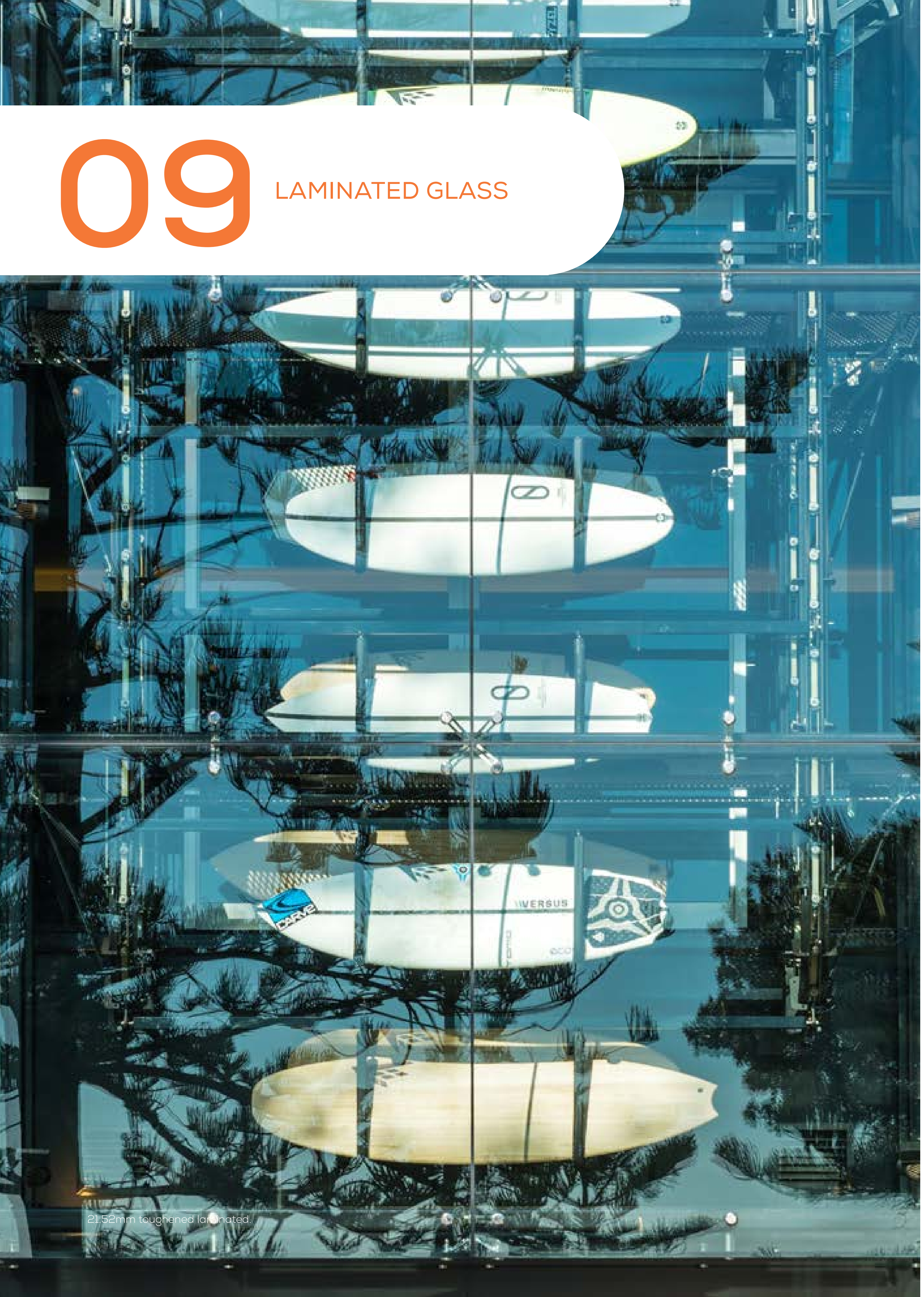
› Fall out protection – less likely to fall out of opening in the event of breakage as compared to annealed or toughened glass;

› Safety – when laminated complies to AS/NZS2208 as a Grade A Safety glass per AS1288;

› Applications – spandrels, overhead glazing as a H/S laminated, higher wind load areas and where visual appearances are critical.

CHEMICALLY TOUGHENED GLASS

Produced in a molten salt bath process, chemically toughened glass retains the optical quality and flatness of annealed glass. It is also claimed that chemically toughened glass is not affected by nickel sulphide inclusions and spontaneous breakages and has greater impact resistance than toughened glass. Chemically toughened float glass on its own is not a safety glass, but can be laminated to meet requirements.



09 LAMINATED GLASS

21.52mm toughened laminated.

LAMINATED GLASS

ImageTek™ Design custom image printed with 17.52mm clear toughened SGP laminated glass - Riley Hotel Cairns

Laminated glass is a safety glass made by laminating two or more panels of glass with a flexible plastic interlayer (PVB – Polyvinyl Butyral). The glass and interlayer are bonded together by heat and pressure in a specially built autoclave. Generally the interlayer is 0.38mm thick, but other thicknesses are available to suit particular applications.

National Glass offers the option to custom build laminated glass where the product can't be cut from original sized sheets (such as non standard or furnaced laminated products). Many different laminated glass 'make ups' are possible with the large range of glass and interlayer types stocked, which when combined meet most architectural glass requirements. For energy efficiency solutions, select either Sunergy® or Sol-R™ (Low-E) glass. For noise reduction, select Acousta™ Laminated Glass. For structural and strength, both lites of glass can be toughened or heat strengthened with thicker and stronger interlayers such as SentryGlas® or DG41. Decorative elements can be added with coloured interlayers and ImageTek™ printed panels.

FEATURES AND APPLICATIONS

SAFETY – Grade A safety glass manufactured to AS/NZS 2208. Depending on the severity of impact, glass will not splinter into jagged dangerous pieces and will remain intact in opening;

COLOUR RANGE – Wide range of colours and interlayer thicknesses including 0.38, 0.76, 1.14, and 1.52mm;

STRONGER – Heat strengthened and toughened laminated glass enabling larger panels to be glazed with greater resistance to wind-loading over ordinary annealed glass;

CLIMATE CONTROL – Solar and thermal control functions through use of tinted and low-E glass;

SECURITY – Security features which greatly aid prevention of illegal entry and/or vandalism (e.g., 1.52mm PVB, DG41 and SentryGlas® interlayers);

STORM PROTECTION (weather/disaster control features) – Depending on severity of impact, glass stays intact in the opening when broken thus preventing damaging effects of weather inside building unlike ordinary annealed glass. See also Stormsafe Section 5;

UV PROTECTION – Helps to protect carpets, curtains, and furniture by screening out 99% of all ultra-violet light. See also page 14;

FIRE PROTECTION (fire retardation) – Laminated glass though not used on its own as part of a fire resistant glazing, still provides longer evacuation time when compared to ordinary thin annealed glass;

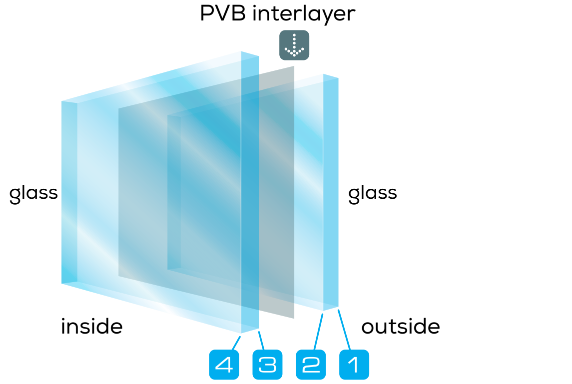
NOISE REDUCTION – Noise reduction benefits.

For more details refer Section 04;

DISTORTION FREE – visually distortion free in annealed form;

APPLICATIONS – suited for overhead glazing such as windows directly above doorways, rooflights, skylights and multi storey buildings, where upon impact glass is unlikely to fall to the ground below. Also suited for doors, internal partitions, side lites, lift wells, balustrading, laminated mirrors in walk through robe situations, wet areas and other areas as required by Australian Standards.

DIAGRAM 9.0: TYPICAL LAMINATED GLASS MAKE-UP



DESIGN AND GLAZING NOTES

- **INTERLAYERS:** – Standard stocked laminated glass uses the same thickness and colour interlayer (generally 0.38mm thick). Only slight colour variation will occur as the overall glass thickness increases;
- **FURNACED LAMINATED GLASS:** – Toughened or heat strengthened laminated glass will require a thicker PVB interlayer of 1.52mm. The process of tempering glass creates some distortion and roller waves. The glass is generally not as flat as ordinary annealed glass. Therefore a thicker interlayer is utilised to adequately bond the glass and interlayer;
- **GLASS PANEL EDGES** – Laminated glass must have 'good' straight clean cut edges with minimal defects. All reflective laminated, low-E laminated made up with tinted PVB's or body tinted lites should have flat ground edges on all sides as a minimum;
- **MATCHING** – Coloured interlayers do not closely match tinted floats. This may cause a problem where float and safety glass are required in the same glazing situation. Solutions may include using all laminated glass or laminating the tinted float;
- **THERMAL BREAKAGE** – Tinted, reflective and low-E coated laminated glass should have a thermal assessment carried out to determine risk of thermal breakage. Toughening or heat strengthening will prevent thermal breakage;
- **DISTORTION AND REFLECTION** – Due to the controlled nature of the laminating process, facades glazed with laminated annealed glass avoid the risk of visible distortions, providing significantly sharper reflections. These benefits are dependent on the nature of the final processed product;
- **EDGE DELAMINATION/BLUSHING** – Generally speaking, some degree of edge delamination or edge blush is inherent in most PVB laminated glass products. Edge delamination is usually the result of the breakdown of the bond between the glass and the interlayer by atmospheric moisture attack, or sealant degradation. Certain conditions will accelerate or retard the manifestation of edge delamination, but as a rule edge delamination should not extend more than 6mm for ordinary annealed laminated and no more than 10mm for heat strengthened or toughened laminated glass. This extent of delamination does not effect the structural integrity of the glass. As it is most noticeable when laminated glass is installed with an exposed edge, if discolouration and edge delamination is a concern, it is recommended that the edges be fully glazed in a frame. For frameless applications select either DG41 or SentryGlas® interlayers which have proven superior edge stability over standard PVB. In glazing applications such as frameless balustrading, a stainless steel trim or channel maybe fixed to the edges to cover any delamination. Care should be taken that these trims do not capture water and that the fixing sealant used is compatible.
- **SILICONE, SEALANTS AND PUTTY USE** – The edges of laminated glass should not be exposed to water, linseed oil putties or acid cure silicones.

MANUFACTURING SPECIFICATIONS*

TOUGHENED OR HEAT STRENGTHENED LAMINATED

MM	MIN BUILD UP	MAX SIZE	TOUGHENED OR HEAT STRENGTHENED
9.52	4mm + 1.52mm + 4mm	1500 x 2800	Toughened or Heat Strengthened
11.52	5mm + 1.52mm + 5mm	1800 x 3200	
13.52	6mm + 1.52mm + 6mm	2100 x 4200	
17.52	8mm + 1.52mm + 8mm	2600 x 5000	
21.52	10mm + 1.52mm + 10mm	2600 x 5000	
25.52	12mm + 1.52mm + 12mm	2600 x 5000	
31.52	15mm + 1.52mm + 15mm PVB Only	on application	Toughened Only
39.52	19mm + 1.52mm + 19mm PVB Only	on application	

ANNEALED LAMINATED

MM	MIN BUILD UP	MAX SIZE	
6.38-12.38	0.38 minimum pvb thickness	refer AS1288	Annealed Glass
16.76	8mm + 0.76mm +8mm	2440 x 5000	
16.76	10mm + 0.76mm + 6mm	2440 x 5000	
17.52	8mm + 1.52mm + 8mm	2600 x5000	
17.52	10mm + 1.52mm + 6mm	"	
19.52	10mm + 1.52mm + 8mm	"	
21.52	10mm + 1.52mm + 10mm	"	
25.52	12mm + 1.52mm + 12mm	"	
31.52	15mm + 1.52mm + 15mm PVB Only	on application	
39.52	19mm + 1.52mm + 19mm PVB Only	on application	

INTERLAYER SPECIFICATIONS

COLOUR	THICKNESS/WIDTHS (MM)			
Clear PVB	0.38/2440	0.76/2440	1.14/2440	1.52/2600
Std Colours* PVB	0.38/2440			
Translucent PVB	0.38/2440			
Acousta PVB		0.76/2440		
SG41 PVB		0.76/2440		
DG41 PVB		0.76/2440		
Vanceva PVB	0.38/2460			
SentryGlas® (SGP)				1.52/3660x2140

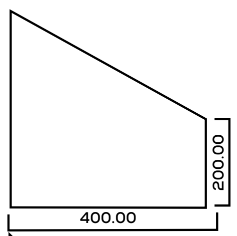
*Grey, Green, Cool Blue, Bronze

TRIPLE LAMINATED

TYPE	MAXIMUM OVERALL THICKNESS (3 GLASS PANELS)
PVB	33.04mm (Using 1.52 PVB)
SGP	Not allowed

* Please note dimensions are subject to limitations set out but not limited to Tables above.

- No allowance made for human impact per AS1288, wind or structural loads - these must be calculated separately;
- Toughened & Heat Strengthened minimum thickness 1.52mm for all interlayers;
- Different PVB interlayers can be built up together with exception of SentryGlas®;
- Maximum interlayers allowed - PVB - 4 layers but no greater than 3.80mm / SGP - 2 layers but no greater than 3.04mm.
- Mitred edge not available on furnaced laminated glass.



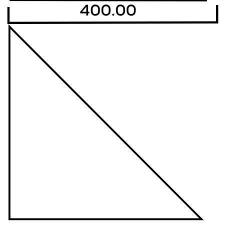
MINIMUM SIZES

Rectangular shapes

- Min 200mm x 400mm
- Under 200mm width possible only if length is greater than 1000mm but consult sales staff.

Triangular shapes

Min 200mm on trailing edge as shown on left.



This shape not allowed as furnaced laminated but possible if supplied as annealed (as cut down from a square panel)

FURNACED LAMINATED GLASS

Architects and building designers are pushing the size envelope for glazed panels. This is partly driven by people who live or occupy buildings wanting more natural daylight and the desire to create grand designs and bold architectural statements. Larger window panels also create a number of considerations including public liabilities in the event of glass breakage, what type of glass to use, panels that are sufficiently strong enough to meet appropriate wind loading and issues around energy efficiency.

Many of these issues can be resolved with the use of furnaced laminated glass products where depending on glazing application the product is safer in the advent of breakage, stronger to meet wind load demands and energy efficient glass panels can be added or even incorporated into insulated glass units.

Furnaced laminated glass is produced by toughening or heat strengthening glass panels and then laminating with selected interlayers. The process of toughening heats the glass to approx. 620°C which if not properly controlled, introduces distortion in the glass (called roller wave and/or edge kink). This distortion makes it more difficult to achieve a flat enough surface for maximum adhesion between interlayer and the glass. Advanced furnace technology scanners are designed to pick up 'out of standard' distortion, therefore improving the chances of successful lamination and producing glass which has less visual distortions.

TOUGHENED LAMINATED VS HEAT STRENGTHENED LAMINATED

There are two types of furnaced laminated glass, toughened or heat strengthened. Australian Standard AS1288 Glass in Buildings – Selection and Installation provides guidance on practical uses of either one. It focuses on the fracture characteristics of the panels if broken and possible consequences of use. Where the glazing design can't be clearly proven by the provisions in AS1288, specialist glass engineering advice should be undertaken.

TOUGHENED LAMINATED

This type of laminated glass consists of two or more lites of toughened glass and is required where there is a risk of breakage due to high loads (wind, permanent and imposed etc), heat stress or combinations of both. A 1.52mm thick interlayer is the minimum requirement and is considered an A Grade safety glass.

A possible characteristic if both lites of the laminated panel are simultaneously broken is that the glass fragments into small pieces which may cause the glass to sag under it owns weight and completely fall out of the opening and therefore posing a risk to people below e.g. Overhead glazing or structural balustrading with no handrail to support the load.

To improve the overall strength of toughened laminated glass and to improve the post breakage characteristics as described above, structural interlayers (sometimes referred to as 'stiff' interlayers) have been developed, such as DG41 and SentryGlas®. Engineering advice should be undertaken when intended for use in situations such as overhead glazing and frameless balustrading.

HEAT STRENGTHENED LAMINATED

This type of laminated glass consists of two lites of heat strengthened glass and is required where there is a risk of breakage due to high wind load and heat stress or combinations of both. A 1.52mm thick interlayer is a minimum requirement and is considered an A Grade safety glass.

The breakage behaviour of heat strengthened glass is generally characterised by the formation of larger pieces of glass, closer to that of ordinary annealed glass. This is useful for overhead glazing where the glass is less likely to sag and fall out of the opening unlike the post breakage characteristics of toughened laminated glass. To improve the overall strength in these situations DG41 or SentryGlas® interlayer can be added and engineered to meet load requirements.

Other advantages of heat strengthened over toughened laminated are related to production yield and visual appearance. Heat strengthening of glass produces less roller wave and edge kink than toughening, making the glass surface flatter and easier to laminate. This also means less visual distortion when glazed in the window.

SENTRYGLAS® LAMINATED (SGP)

In response to architectural demands for stronger window systems, SentryGlas® ionoplast interlayer has been developed to meet these needs. SentryGlas® laminated glass is suitable where single toughened or traditional PVB furnaced laminated glass can't meet the structural or wind load requirements. For example, where frameless glass balustrades have to be designed in such a way that if the glass breaks it will stay intact and hold the load imposed until people can move away safely. SentryGlas® offers five times the tear strength and 100 times the rigidity of conventional PVB laminated glass interlayer.

FEATURES AND APPLICATIONS

SentryGlas® laminates offer extended functionality versus laminates with traditional interlayers and makes them very suitable for the applications where the following features are required:

- Stronger laminates, particularly when bending stress state is dominant – In 2-sided/1-sided support conditions;
- In point-support configurations;
- In high aspect ratio (>1.5) plates with 4-side support;
- Lower deflection;
- High tear strength;
- High stiffness;
- Low creep;
- Impact and structural performance over a wide temperature range (-20° to 50°C);
- Superior post-glass breakage properties;
- Improved edge stability over standard PVB's;
- High Clarity;
- Low optical distortion (in some cases SentryGlas® can eliminate the need to use toughened or heat strengthened glass).

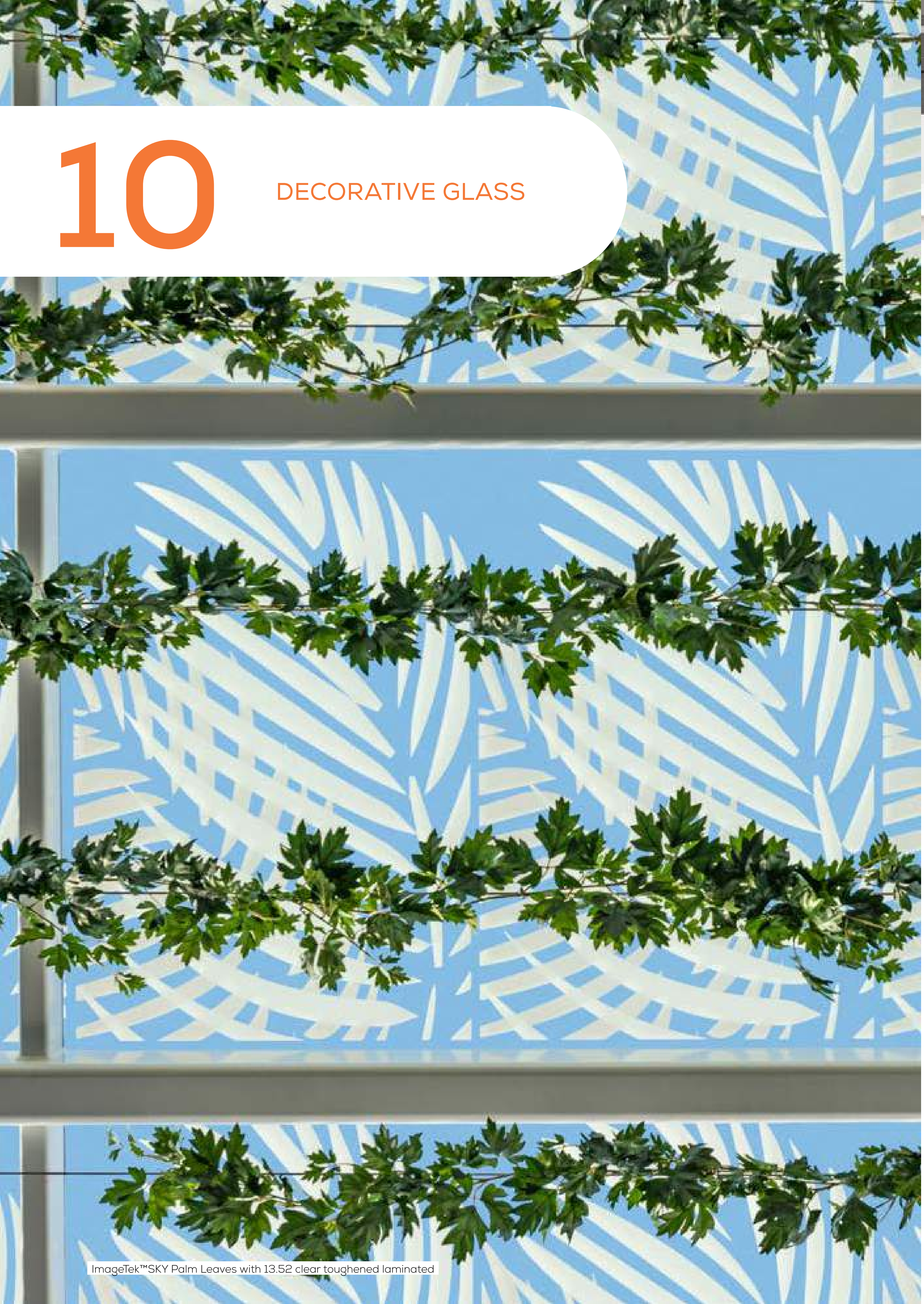
INTERLAYERS AND THICKNESSES

Available in clear only 1.52mm and 2.28mm ionoplast interlayer thicknesses. For colours, a body tinted glass must be incorporated in the make-up. SentryGlas® cannot be laminated with conventional PVB interlayer.

EDGE STABILITY AND DELAMINATION

SentryGlas® laminates are displaying excellent weathering performance. After more than 7 years of natural weathering in Florida, USA no defects were observed in the laminated glass samples and along the edges. Tests with neutral cure structural silicone sealants have also revealed excellent performance. This provides the opportunity to use exposed edge laminated glass with less concern of edge delamination.

30.56mm Cyclone resistant laminated – Make-up 10mm Azuria toughened/ 2.28mm SGP/10mm clear toughened/2.28mm SGP/6mm Energy Advantage low-E (#4) toughened. Fletcher Construction American Samoa. Glazed by National Glass. Architect – Lively Architects.



ImageTek™SKY Palm Leaves with 13.52 clear toughened laminated

10 DECORATIVE GLASS

Interiori City Lights.

A large range of contemporary and stylish decorative products are available to complement, accentuate or present as key features for interior design and exterior architecture. Transparent, translucent or opaque glass colours or patterns are possible. Products include ImageTek™ digital printed glass, Lacobel® T, acid etched, translucent and Vanceva® coloured products. These decorative elements are typically installed as single glass, but can be built into laminated and even insulated glass units.

ImageTek™ - DIGITAL PRINTING ON GLASS

Combining the latest innovation in digital printing technology with specially developed ceramic fused inks, ImageTek™ allows almost limitless design possibilities for the printing of images on glass. Ceramic inks are fused onto the glass surface during toughening to provide unmatched resistance to scratching, acid, UV light and weathering. ImageTek™ has the ability to combine transparent, translucent and opaque details in any way with full freedom in colours and shades.

FEATURES AND APPLICATIONS

- Design – ability to combine transparent, translucent and opaque details in any way, full freedom in colours and shades and the possibility to create double vision designs for different front and back experiences. Precise micro-drop printing allows accurate photorealistic and graphic designs;
- Graphic Design – full in-house graphic design services working with either customer, architect or client;
- Durability - ceramic based inks fired onto the glass surface during tempering offering outstanding durability;
- Safety – ability to offer coatings and designs on both toughened and furnaced laminated safety glass;
- Glass types – clear, extra clear low iron, low-E, tinted and acid etched;
- Applications - splashbacks, robe and shower panels, partitions, screens and internal wall cladding, external cladding such as spandrel glass, reducing glare with light filtering patterns, non-slip glass surfaces, anti-bird collision, public art displays and signage.

SIZES & THICKNESSES

- Max Size Toughened up to: 19mm 5000mm x 2700mm;
- Max Size Furnaced laminated: 5000mm x 2600mm

Interiori Bright Strip Oak

ImageTek™ PRODUCT RANGE	
ImageTek™DESIGN	Enables the printing of artwork, images and patterns working with high resolution digital files
ImageTek™INTERIORI™	Design collection mimicking stone, marble, wood and other themes
ImageTek™GRAPHIC	Wide range of designs and patterns to different themes and effects
ImageTek™COLOUR	100% paint coverage for spandrel cladding applications
ImageTek™S1 EXTRA DURABLE	White colour paint designed for external exposure
ImageTek™SKY	Overhead glazing print designs
ImageTek™FLOOR	Glass flooring anti slip patterns

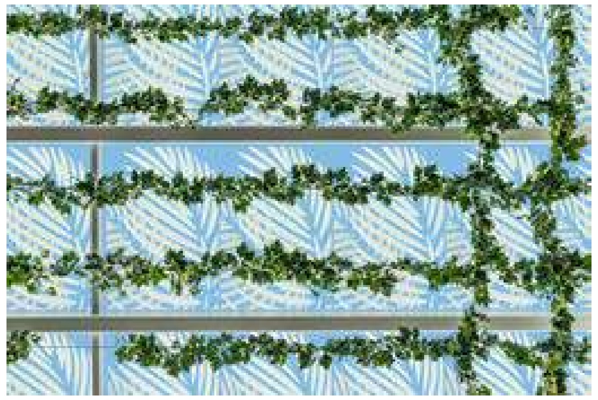
ImageTek™DESIGN

DESIGN is a fully customised service allowing the printing on glass of customer artwork, images, patterns or design ideas. In conjunction, a full in-house graphic design service is offered to bring customer ideas to life.


" Turtle_01" image was printed across two splashback panels.


Beach image printed for shower wall

ImageTek™DESIGN

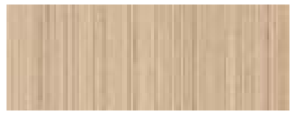

ImageTek™ Design custom printed image with 13.52mm clear toughened laminated glass - Eat St, Harbour town


ImageTek™ Design custom printed image with 9.52mm SOL-XT Neutral 44 toughened laminated glass - Gold Coast Cultural Centre

ImageTek™INTERIORI™

A range of realistic designs reproducing stone, marble, wood and other materials and finishes. Application is mostly for internal cladding and/or splashbacks. Some designs also suitable for 'two way viewing' such as partitions and doors. For the full range see our INTERIORI collections book.

INTERIORI (SMELL THE FOREST)


White Wash Oak


Zebrano Chocolate

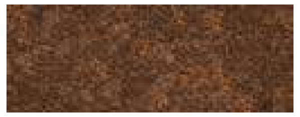

Zebrano Zig


Washed White Wood

INTERIORI (TOUCH THE STONE)


Calacatta


Deep Ocean


Ruggine Lumi


The Gold Rush

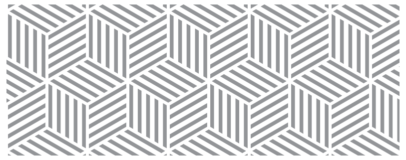

Interiori City Lights

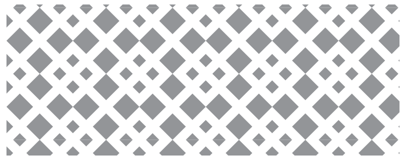

Interiori The Gold Rush

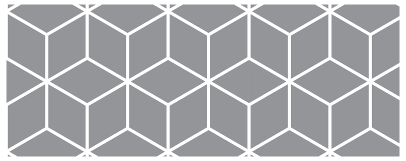
ImageTek™GRAPHIC

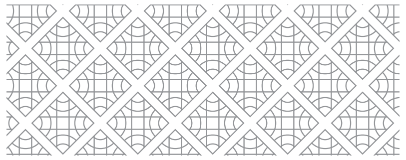
Select from a library of designs and patterns to different themes and effects including titles such as Abstract, Fusion, Geometric, Organic, Material and Natural. For the full range go www.nationalglass.com.au

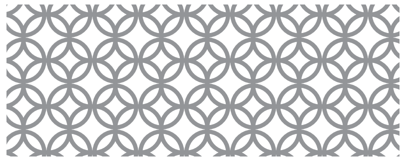
PATTERNS

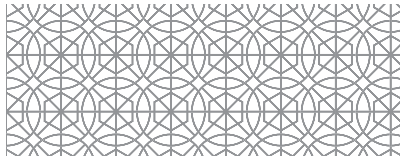

Geo 009

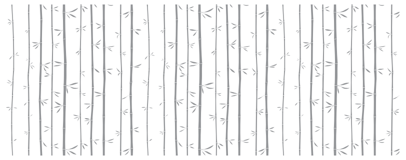

Geo 010

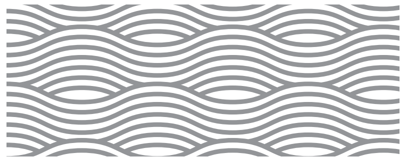

Geo 007


Ori 001

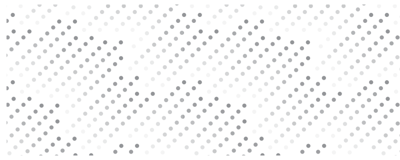

Ori 018

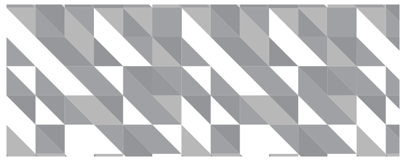

Ori 009

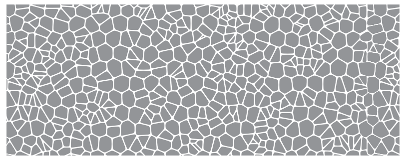

Org 018

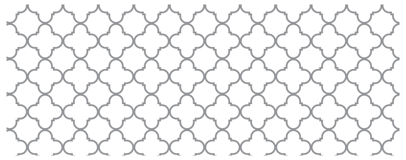

Org 011

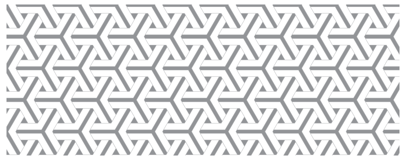

Org 010

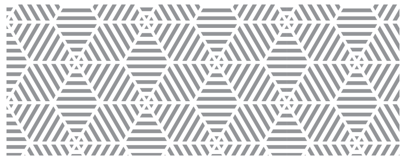

Abs 007

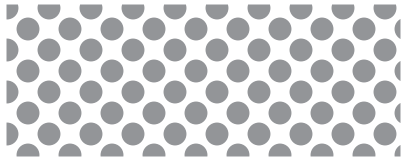

Abs 010

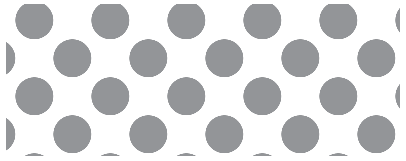

Abs 014

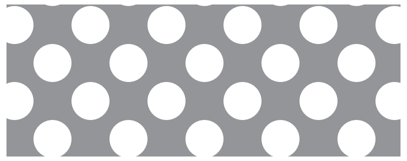

Fus 002

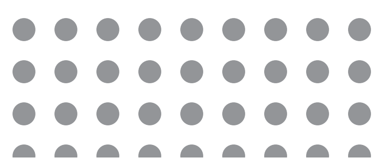

Fus 009

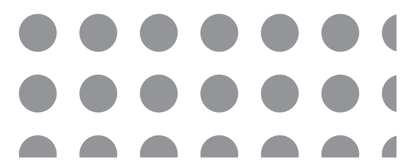

Fus 020

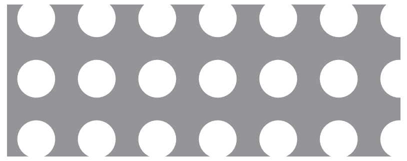

Dot 3mm @ 45°


Dot 5mm @ 45°


Dot 5mm Reversed @ 45°


Dot 3mm @ 90°


Dot 5mm @ 90°


Dot 5mm Reversed @ 90°

ImageTek™COLOUR

ImageTek™COLOUR is a 100% paint coverage product suitable for spandrel and cladding glass that creates brilliantly smooth surfaces, adding perspective and contrast to indoor and outdoor spaces. The print process uses high quality ceramic based inks which are fused onto the glass surface during toughening.

SPANDREL

Spandrel glass panels are used to hide building structures between floors. Ceramic printed glass such as ImageTek™COLOUR or Lacobel® T are the most common products used in these applications. These products are always tempered, either toughened or heat strengthened depending on the application. Tempering is required because of the excessive heat build up within spandrel cavities where temperatures over 90°C are possible. Where glass is not subject to human impact, heat strengthened glass is recommended, where in the event of breakage, the glass tends to fragment into large pieces and stay intact in the opening or framework.

Generally spandrel panels in buildings allow for viewing of the glass from the outside only. Some applications are designed to be viewed from both sides of the glass. Though this is possible, we do not recommend this 'two way' viewing or any sort of 'backlighting' especially from the printed side of the glass due to print surface imperfections. These imperfections in a true spandrel cavity are not seen. For more information on spandrel glass design including matching to vision panels, see Design and Glazing notes page 65.

STANDARD COLOUR RANGE[1]

BRONZE	COOL GREY	MONUMENT
SANDBANK	CEMENT GREY	
DEEP BLACK*	COOL WHITE*	ANTHRACITE GREY*

*Lacobel® T range
[1]Colours indicative only. Request sample for approval.

6mm Dark Blue vision glass with contrasting coloured spandrel glass

ImageTek™ Colour Sandbank spandrel panels

ImageTek™ S1 EXTRA DURABLE

S1 is a specially formulated ceramic based ink that is more suitable in applications where the print surface is likely to be exposed to open weathering. Available in white colour only. Ask our technical staff for more information on whether S1 is suitable for the glazing application.

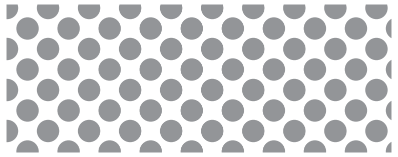
Barker St Apartments

Regis aged care

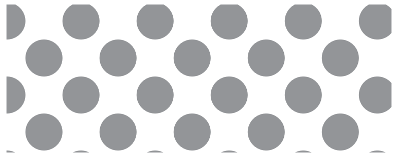
ImageTek™SKY

A range of standard and customised designs are available for overhead glazing applications. Typically printed on clear or extra clear glass, then tempered and laminated to comply with Australian Standards.

TW image printed with 17.52mm clear toughened SGP laminated - Riley Hotel Cairns

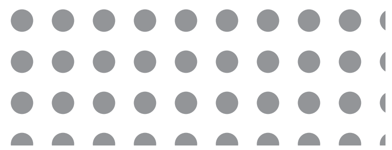


Dot 3mm @ 45°

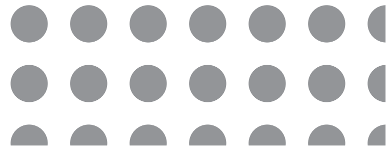


Dot 5mm @ 45°

Lines 5mm

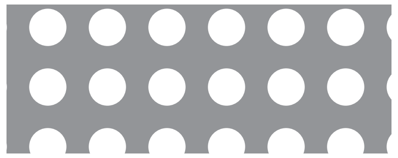


Dot 3mm @ 90°

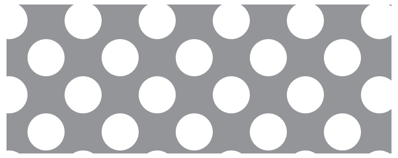


Dot 5mm @ 90°

TW (blue showing visible sections)



Dot 5mm Reversed @ 90°



Dot 5mm Reversed @ 45°

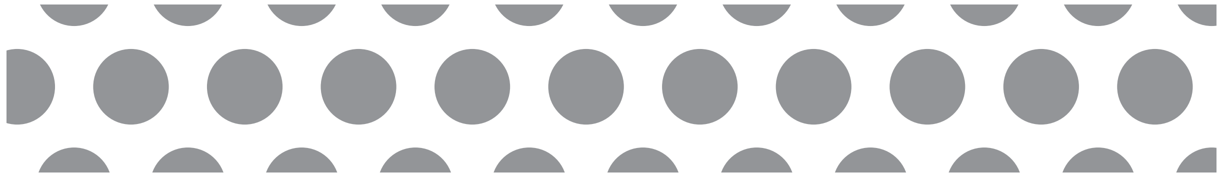
Palm Leaves (blue showing visible sections)

ImageTek™FLOOR

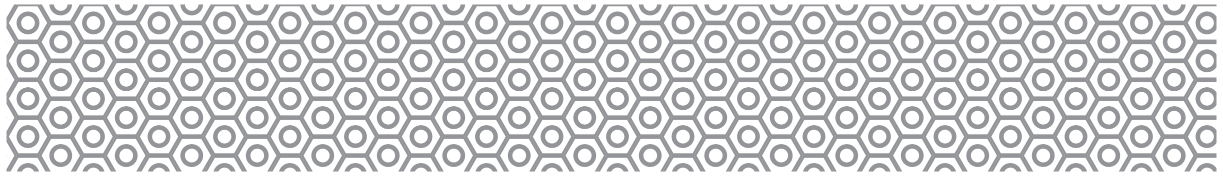
A range of standard slip resistant printed patterns are available for trafficable glass floor panels. The ImageTek™ FLOOR ink is colourless and partially light-transmissive providing a slip-resistant walking surface in the wet and dry together with an etched glass-like appearance. The ink is both hard-wearing and non-abrasive unlike other slip-resistant coatings, which work by creating either a very rough or rubbery surface.

The slip resistant ink is based on a carefully engineered mineral crystal formulated to create a surface that "sticks" to water or other liquid contamination, preventing them from becoming lubricants that would otherwise create slippery conditions. Suitable for use in both interior and exterior applications, as well as around pools and water features that contain chemically treated water. ImageTek™ FLOOR patterns are typically printed on clear or extra clear glass, then tempered and laminated to comply with Australian Standards.

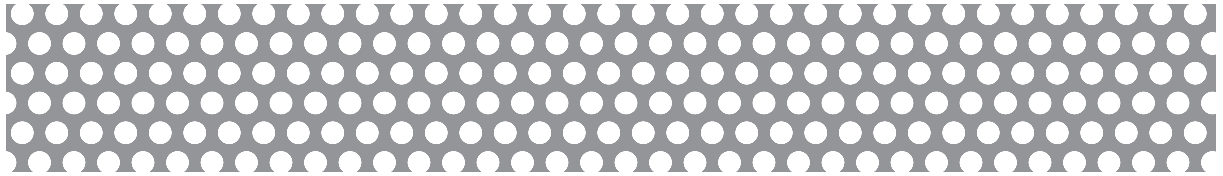
Trust Pattern



Double Dot Pattern



Techno Pattern



Trypophile Pattern

ImageTek™ FLOOR - Windsor

LACOBEL® T

The Lacobel® T range is a high opacity painted glass suitable for internal wall cladding and spandrel applications. The product is imported in a pre-painted stock sheet form. It is then cut, edged and processed similar to ordinary glass and is always tempered, either toughened or heat strengthened depending on the application. Lacobel® T uses a high quality durable ceramic based industrial paint that is hard to scratch. The tempering process fuses the paint onto the surface of the glass. It cannot be supplied in an annealed form. Available in 6mm thickness, 3210mm x 5100mm in Cool White, Deep Black and Anthracite Grey.

For cladding applications, paint side of glass is fixed directly to the wall. We do not recommend 'two way' viewing or any sort of 'backlighting' especially from the painted side of the glass due to surface imperfections. (For more information refer to ImageTek™ COLOUR/Spandrel glass page 60 and Design and Glazing notes page 65). IGU and laminated glass applications are possible with paint surface to position #4 only for both.

Lacobel T Cool White

Lacobel T Colours

Lacobel T Deep Black - Unilodge Park Central

Lacobel T Cool White - Richmont Hotel Spring Hill

ImageTek™ DESIGN & GLAZING NOTES

- External applications – the printed surface of the glass should always be glazed to the inside of the building away from the effects of weathering and pollution. For overhead glazing, the printed surface should face the ground or where tempered laminated glass is used, the print surface is sandwiched between for added protection;
- Backlighting – where a 100% glass surface coverage colour is applied, certain imperfections such as visible pin holes can occur. These will be noticeable if glass is to be viewed from both sides. Our warranty conditions prohibit the use of backlit glass in these applications. Where used in spandrel applications or wall cladding, imperfections will not be seen. Some ImageTek™ designs are intended for 'two way viewing', but these are generally not a 100% glass surface coverage colour;
- Translucent cladding – Spandrel openings are usually non-ventilated and generate a lot of heat within the confined space. Chemical vapours may also be released from the silicones or adhesives used in glazing the panel. These vapours deposit themselves onto the inside of the glass surface upon cooling of the glass. These deposits may then become visible when using a transparent glass. For these spandrel applications, it is recommended that an opaque ceramic fired paint colour be specified such as ImageTek™COLOUR or Lacobel® T. Any vapour deposits will not be seen from the outside. Ceramic printed glass has been used in these applications for over 40 years and is a proven technology. The paint is highly resistant to this type of chemical attack when enclosed. Where translucent type glass products (such as acid etched, translucent laminated) are specified, it should be asked where or how these products are to be used in the building. In some instances, where the space is ventilated, translucent ceramic printed glass, translucent laminated or acid etched maybe used provided that the coated or etched surfaces are not exposed to weathering;
- Read through – Spandrel panels are designed to hide the building structure, to provide a uniform glass facade, panels either matching or contrasting. "Read through" of the spandrel is a possibility if the paint selected is not opaque enough. Specified colours should be tested against actual painted samples for 'read through';
- Matching – If matching vision and spandrel panels, the general rule is that products with a visible light transmittance greater than 20% are difficult to match. Greater matching is achieved with high reflecting products with lower visible light transmittance (14% or below). One method to assist in matching is to use IGU's with the ceramic print on surface position #4. IGU's create the perception of depth similar to that of the vision panel;
- Colour approval - it is always recommended that the customer view a mock up sample for approval.
- Low-iron (ExtraClear) or standard clear glass – For true clarity and consistency of colour, low-iron glass is generally recommended. Colour mismatches may occur with standard clear glass especially where the glass supplier uses glass from different sources. Mismatches may occur if there is a rework of a panel and glass is then cut from a different source. Though there is less chance of mismatching with regards to low-iron glass, we still recommend the policy of 'one source' low-iron glass. For the above reasons, low-iron glass is the first choice for suppliers of splashback glass. The exception to the above is when dark colours are specified where the colour overrides the clarity characteristics of low-iron glass, standard clear glass can be used;
- Air side or tin side – Colour differences maybe noticeable if printing the different faces of a glass panel. During the manufacture of glass, molten tin is used to float the glass. This creates a tin and air side. To avoid colour differences, it is recommended that the paint medium be applied to the air side of the glass.

ACID ETCHED GLASS

Applying an acid wash to one surface of the glass produces a frosted type finish similar to that of sandblasted glass. Acid etched glass is designed to offer a level of privacy, diffuse light and to provide a design feature in the home or building interior.

SPECIFICATIONS		
mm	**COLOUR**	**SIZE**
4,6,10,12	WHITE	2140x3660
4,5,6	GREY	2140x3660

FEATURES AND APPLICATIONS

- Permanent and durable surface;
- Can be readily toughened or laminated as safety glass;
- Sizes & thicknesses – 2140mm x 3660mm (clear 4/6/10/12mm, grey 4/5/6mm);
- Applications - shower panels, partitions and screens. Exterior applications include balustrading and windows and doors where privacy is needed.

PERIMETER BORDER

Please note original sheets of our acid etched glass have a clear border of 10mm to 15mm around the entire perimeter of the sheet. This border should be noted when calculating final glass sizes. We supply finished glass sizes without this clear border.

LAMINATING

Laminating can only be achieved with the acid etched coating to the outside or surface position #1 or #4. Laminating the etched surface to the inside next to the interlayer would render the glass clear.

ENERGY PERFORMANCE			
TYPE	**SHGC**	**U - VALUE**	**VLT%**
6mm CLEAR	0.83	5.8	89
6mm GREY	0.61	5.8	46

GLASS HANDLING AND INSTALLATION

Though acid etched glass is more resistant to fingerprint marks and soiling when compared to sand blasted glass, extra care should still be taken when handling and installing. Hands should be clean and free of oil, grease and particularly silicone.

When installing and where silicone is used, all glass should be protected or taped near the siliconed edge. Immediately clean silicone marks with suitable glass cleaners. If let to dry, marks cannot be removed without damaging the surface.

For internal applications such as shower screens, it is recommended that the etched surface be glazed to the outside of the screen away from water contact or direct touch. In external applications, it should be noted that because the surface is etched, it will tend to attract dirt particles and building run-off more readily than ordinary glass. Careful consideration should be given to external applications.

Acid Etched

Grey Acid Etched

TRANSLUCENT WHITE GLASS

TRANSLUCENT LAMINATED

A range of white coloured interlayers for laminated glass are now available offering different levels of privacy screening and diffusion of incoming light. White translucent laminated glass is available in 3 white interlayer colours, Arctic Snow (standard translucent laminated glass offer), Cool White and Polar White. Minimum thickness is 6.38mm.

Arctic Snow - With a medium light transmission (66%), provides comfortable privacy without complete opacity and is the standard product offer;

Cool White - Beautifully frosted Cool White has a high light transmission level (81%) –allowing light to enter a space while maintaining privacy;

Polar White - With a low light transmittance (7%), Polar White has superior capability to block visibility while offering color uniformity. It is ideal for designers who want a crisp white glazing or two different colors of glass in a single unit, i.e., white on one side and an opaque color on the other.

Translucent laminated glass can also be supplied in other colours by adding an additional coloured interlayer such as grey or green etc. Typical starting thickness is a minimum of 6.76mm. Note that the colour of these tinted translucent laminates will vary from one side to the other. With this in mind where panels are adjacent to each other, it is important they are glazed the same way for colour consistency.

Artic Snow (Std Translucent offer)

Cool White

Polar White

PURE WHITE DECOWHITE AND DECOWHITE GLASS

Designed for wardrobe doors and internal wall panelling, Pure DecoWhite and DecoWhite panels are a painted glass with a vinyl backing applied to the painted surface to meet Grade A safety glass. Pure DecoWhite has a pure white tone aesthetic while DecoWhite is painted on standard clear glass with a soft white slightly 'green' tone. Not recommended for applications where moisture is present including, but not restricted to kitchen splashbacks and bathrooms. Also available in Classic Black colour finish. Available in 4mm thickness as a Grade A Safety vinyl backed glass in sizes 2440mm x 914/1220mm.

ENERGY PERFORMANCE- TRANSLUCENT LAMINATED			
TYPE	**SHGC**	**U-VALUE**	**VLT%**
6.38mm Translucent (Artic Snow)	0.67	5.7	66
6.38mm Cool White Translucent	0.73	5.7	81
6.38mm Polar White Translucent	0.23	5.7	7

PATTERNED GLASS

Patterned or figure rolled glass is used to diffuse, not totally obscure an object when viewing, but can also be used in a decorative application. The product is made through the process of running molten state glass across a patterned roller, reproducing the roller pattern. Available in a range of thicknesses most commonly from 4mm to 6mm (see thickness chart below), patterned glass can be toughened to meet Grade A Safety Glass per Australia standards. Not available in laminated form.

Though not a stocked item, Wired Glass is produced in a similar manner to patterned glass except that a sheet of welded wire is introduced into the molten glass before introduction to the patterned rollers. The rough wires in the glass after cutting, means edgework is restricted to a rough arris finish. Wired glass is also more susceptible to thermal breakage being a result of the higher heat absorbency associated with the wire along with the difficulty of achieving 'good' defect free edges. Wired glass such as 6mm Squarelite is considered a Grade B Safety Glass per AS1288. Alternatives to wired glass is to reproduce the design as an ImageTek™ printed glass.

TYPE	THICKNESS	SHEET SIZE
Cathedral	4/5mm	1840 x 2440
Desert Sand	6mm	1830 x 2440
Satinlite	4/5/6mm	1840 x 2440
Spotswood	4/5mm	1840 x 2440


Cathedral


Desert Sand


Satinlite


Spotswood

MIRROR GLASS

Mirrors or silvered glass are more than just vanity pieces. Mirror products are used as design features in home, retail or commercial interiors or to brighten up small spaces due to the effect of mirror reflections. One common method of mirror glass manufacture is called the 'dual coat' process. This involves coating clear or tinted glass with silver and then layering protective coats of copper and paint which help protect the mirror from corrosive chemical attack and abrasion. The most recent technology in mirror manufacturing produces a product which is copper and virtually lead free (lead content of the paint <0.5%) and offers longer resistance to corrosion and aggressive chemical agents than conventional mirrors..

PRODUCT SPECIFICATIONS	
THICKNESS & TYPE	SIZES
4MM SILVER	3660MM X 2440MM
6MM SILVER	3660MM X 2440MM
6MM LOW IRON SILVER	3210MM X 2550MM
4MM GREY SILVER	3660MM X 2134MM
6MM GREY SILVER	3660MM X 2440MM
6MM BRONZE SILVER	3660MM X 2440MM
8.38MM LAMINATED	CUSTOM SIZES

DESIGN AND GLAZING NOTES

EDGE CORROSION

Essentially, mirror contains metals such as silver and sometimes copper which can tarnish or corrode when exposed to moisture over a period of time. This is often evident through black edge/creep and clouding. Though the paint protects against abrasion and chemical attack, it does not protect the edges that are disturbed during edge working. Exposed, frameless mirrors are more susceptible to edge corrosion in this sense. Framed mirrors have more protection from moisture and corrosion.

INSTALLATION

There are a number of ways to install mirrors which include screw fixing mirrors to the wall or use of adhesive tapes and glues. With the use of vinyl backed mirrors, compatibility between the tape / adhesive and the vinyl material backing is critical to prevent mirror from falling off the wall. We also recommend vinyl back mirrors be supported by a bottom ledge. Before fixing mirrors, it is best to consult the tape/adhesive supplier for a product that best suits the vinyl material backing and recommendations on methods of application and fixing. For bathroom vanity applications, vinyl backed mirrors do not always have to be used. AS1288 Glass in Buildings – Selection and Installation allows restricted use of ordinary annealed mirror over vanities. Direct application of tape/adhesive to the mirror paint rather than the vinyl back provides a better bond and less chance of the vinyl backing 'slipping' or 'peeling' away from the mirror. Refer to AS1288 for specific details.


6mm Grey Silver

VINYL BACKED ORGANIC SAFETY MIRROR – GRADE A

Available in 4mm and 6mm thicknesses and manufactured to AS/NZS2208 and satisfies AS1288 human impact requirements. A large range of sizes are kept up to 2760mm x 1220mm to suit most robe door panels. National Glass does not manufacture vinyl back mirror at its production facilities, the product instead being purchased in ready to cut sheet form.

HANDLING

Mirrors should be stored in moisture and chemical free environments and clean butcher's paper should be used when separating mirrors. Newspaper should not be used. When mirrors have clean cut edges, direct handling without gloves should be avoided.

EDGEWORKED MIRRORS

All edgeworked mirrors processed at National Glass are wrapped and edge corner protected.

CLEANING

The best method to clean mirrors is to wipe the mirror face with a soft cloth and a few drops of diluted methylated spirits. Ensure no cleaning fluid spills over the edge on to the backing paint or edges. It must be noted that standard household cleaners contain chemicals which can damage the mirror coating. Wherever possible, avoid contact with the edges and backing paint and do not use abrasive cleaners.

EXTRA CLEAR GLASS

Manufactured by removing a large proportion of the glass iron content, the green tinge usually associated with ordinary clear float glass, (particularly noticeable on the edges) is removed.

Products such as Extra Clear are ideal for displaying the true colours of a viewed object. It is widely used as a base for printed or painted glass applications such as internal cladding and splashbacks where the colour selected and painted is not tainted by the green tinge of ordinary float glass.

The low-iron content of the glass increases the solar energy transmission, thus making the glass also ideal for solar heat collectors, commercial greenhouses and photovoltaics.

Available in 6 / 8 / 10 / 12 / 15 / 19 mm thicknesses in annealed, toughened and laminated.

FEATURES AND APPLICATIONS

- Avoids the 'greening' inherent in ordinary clear glass;
- Displays true colours, ideal for retail shopfronts and displays;
- Displays true colours in painted glass use;
- Clarity emphasizes skylights and entranceways, reception areas, lobbies or entire building facades.

ENERGY PERFORMANCE - EXTRA CLEAR vs STANDARD CLEAR

THICKNESS	SHGC		U-VALUE		VLT%	
MM	EXTRA CLEAR	STD FLOAT	EXTRA CLEAR	STD FLOAT	EXTRA CLEAR	STD FLOAT
6	0.91	0.81	5.8	5.8	92	88
8	0.90	0.77	5.7	5.7	91	87
10	0.89	0.75	5.7	5.7	91	86
12	0.88	0.72	5.6	5.6	90	84
13.52 (6+6)	0.84	0.70	5.4	5.4	89	84
17.52 (6 + 10)	0.83	0.66	5.3	5.3	89	81
21.52 (10 + 10)	0.82	0.63	5.2	5.2	88	78

COLOUR DIFFERENCE BETWEEN STANDARD CLEAR AND EXTRA CLEAR

SPLASHGUARD™

SplashGuard™ is a dark grey mirror like coated glass designed for interior applications such as splashbacks. Available in a 6mm thickness as toughened glass (but can be processed as annealed if sizes are too small for toughening).

SPECIFICATIONS

- Thickness: 6mm Toughened and Annealed (where safety glass or heat absorption is not required - annealed sample may differ in tone to toughened version if adjacent viewing)
- Edgework – minimum FP all edges
- Colour: Dark grey reflective tone (opposite surface is bronze/gold tone which is the coated side and mounted direct to the wall)
- Sizes: sheet sizes 5100mm x 3210mm

INSPECTION GUIDELINES

Please follow the guidelines outlined below to avoid false rejections;

- Glass must never be backlit and always mounted with coated surface to wall;
- Coated surface is identified as bronze/gold in appearance. Reflective surface is a dark grey tone. See photo insert above;

Inspection to be done via reflection mode only;

- SplashGuard to be kept against a solid opaque background with coated side against the surface;
- Refer to Image 1. A below- light coloured and/or a dark coloured surface may be used as a background in consideration of the different paint used on walls.

ACCEPTANCE CRITERIA

Pinholes and Clusters

- Pinholes ‹ 2 mm are acceptable if not more than 1 per m2
- A cluster is defined as 2 or more pin holes ‹ 2 mm each that are readily apparent.
- Clusters of pin holes that are visually disturbing are not acceptable.

Scratches

- Scratches on coating visible on the glass side are not acceptable.

COATED SURFACE TO WALL (bronze/gold reflective tone)   NON-COATED (grey reflective tone)

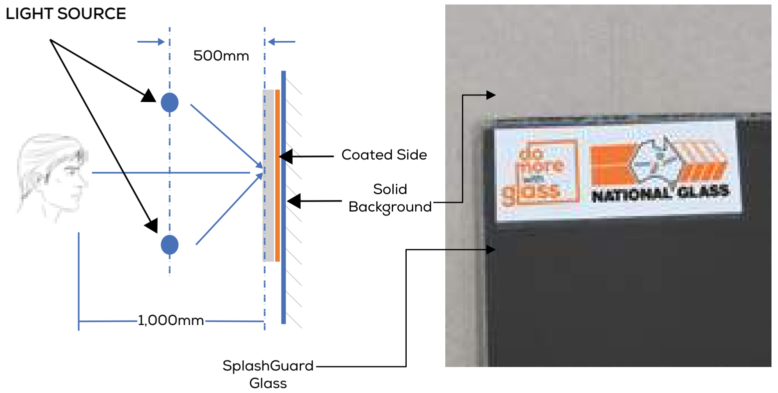
INSTALLATION

- A neutral cure silicone (free of solvent) or a double sided adhesive can be used. The best way is to apply silicone with beads running in vertical lines with gaps between.

CLEANING

- Can easily be washed using a clean cloth with standard and non-abrasive glass cleaners. Do not use any acid or alkali cleaners.

IMAGE 1. A



Internal partitions - Ballina State High School

VANCEVA® COLOURED GLASS

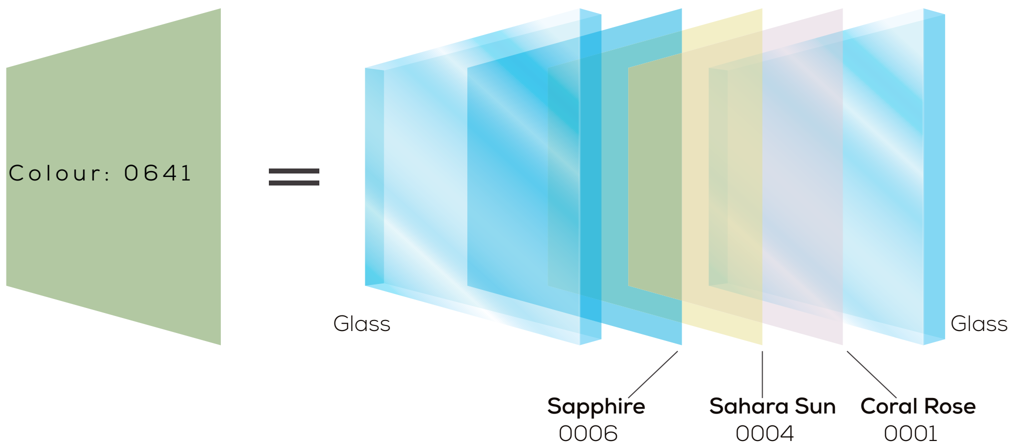
Vanceva® is a coloured PVB interlayer system enabling laminated glass to be produced in a wide range of colours. Customers, architects and designers can feature glass like never before – combining a wide choice of colour interlayers to produce transparent, translucent, or opaque colours that create just the right look and ambience.

Available in 16 base colours of 0.38mm thickness up to widths of 2460mm wide. The base colours can be combined together through the Vanceva® online colour selector tool (www.vanceva.com). Up to 4 interlayers can be combined together in a laminated glass panel to create a whole new aesthetic to both interior and exterior applications, including windows, doors, curtain walls, atriums, skylights, partitions, and conference rooms.

VANCEVA® COLOURED PVB'S

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

Example of how colours are built up



Custom laminated 17.52mm heat strengthened glass panels with Vanceva®coloured interlayers - Baxter St Apartments

11 FRAMELESS GLASS DESIGN

Norfab – JCU Townsville: 13.52mm Toughened Laminated

FRAMELESS GLASS DESIGN

Glass is used to make dramatic statements in architecture. Its smooth surface, clean and angular lines feature and complement interiors and exteriors either on its own or in combination with other building materials or elements. Glass design is about emphasising its remarkable visual aesthetic, transparency, creating that minimalist look with less traditional framing.

Frameless glass is a general term for glass with little to no visible framing members. Most common applications are retail shop fronts where the unimpeded visual display of goods is most important. Frameless glass is also increasingly being installed in residential applications such as shower panels and balustrading where clean glass lines are preferred to framing members. This section highlights the many different frameless glass applications and installations.

Typically minimum glass thickness will be 10mm toughened safety glass, but this depends on the size, application and location of the glazing. Table 11A shows typical glass thickness by type.

PIVOT DOORS

Pivoting glass doors and associated panels such as sidelites and highlights must be a minimum of 10/12mm toughened safety glass (Please check with AS1288 to determine actual thickness required). These doors are the most common frameless type used in commercial and residential applications. The doors use either a concealed top or bottom self closer mechanism with a pivot point connecting to a discrete metal patch fitting at the top and bottom corners of the door or alternatively, a full width metal door rail can also be used.

CORNER PATCH FITTING DOORS

Shown as Type B combination and Type C doors on Diagram 11.0, patch fittings are simply a bolt through glass metal fitting requiring a corner cutout and hole in the glass. These discrete patches provide a sleek and clean frameless look, ideal for shop displays.

A lock body patch fitting can also be installed. The patch body covers are available in a variety of finishes including anodised, powder coated, plated brass and stainless finishes.

Maximum door sizes using 10/12mm thickness glass is 2400mm x 1000mm. 15mm glass thickness 2400mm x 900mm. Bigger size doors should use a top and bottom full length rail. Please note that wind-loading and other loading considerations may override the sizes and thicknesses noted above. Please check with the appropriate standards.

FULL LENGTH RAIL DOORS

Shown as Type A and combination Type B doors on Diagram 11.0, these metal rails are clamped onto the glass edge. No holes or cutouts required. The main features of the rail are to act as a 'kick plate' to lesson chance of glass breakage and for oversize doors, where the patch fitting is not suited. Rail body covers are available in a variety of finishes including anodised, powder coated, plated brass and stainless finishes.

Type A top and bottom rail toughened entry doors.

Type C top and bottom corner patch toughened entry door.

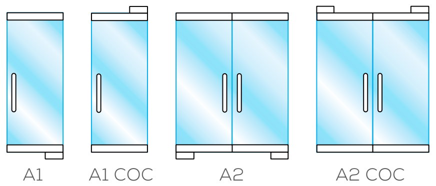
TABLE 11A: GLASS TYPES FOR FRAMELESS GLASS

	10mm	12mm	15mm	19mm
Clear	✓	✓	✓	✓
Extra Clear	✓	✓	✓	✓
Grey	✓	✓		
Bronze	✓			
Acid Etched	✓	✓		
SOL-R™ Low E Clear, Soltech, Neutral Sunergy®	✓			

DIAGRAM 11.0: FRAMELESS PIVOT DOOR AND ENTRY TYPES.

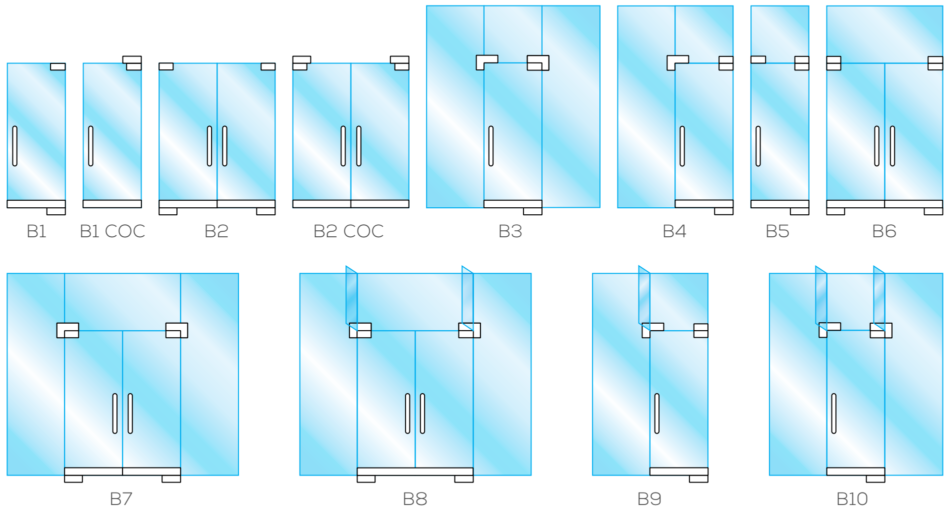
TYPE A:

Full length top and bottom rails.



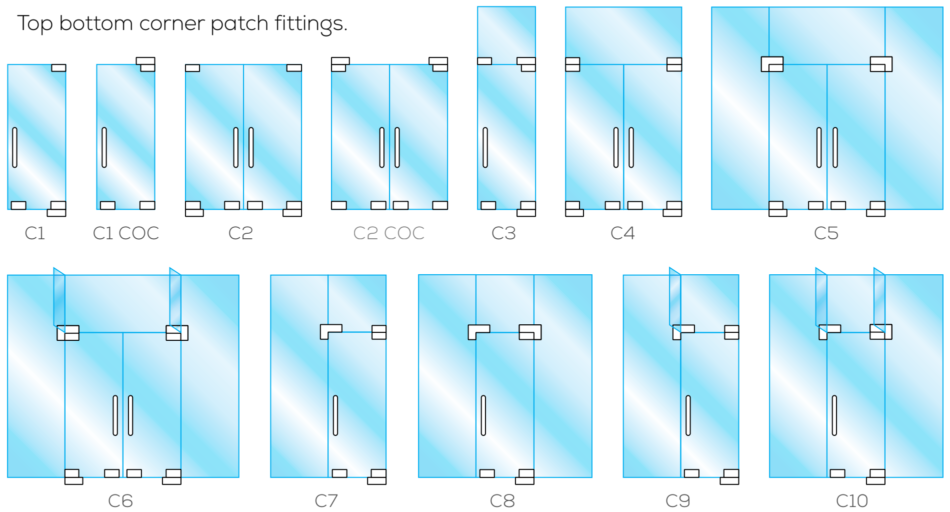
TYPE B:

Top corner patch fitting and full length bottom rails



TYPE C:

Top bottom corner patch fittings.



HIGHLITE GLASS FIN DESIGN

Some frameless door entry types require stabilising toughened fins to reduce deflection created by the loads acting on the entry. These include external and internal wind loading, human impact and the motion of the door during operation.

Minimum design requirements are:

- Fins should always be mechanically fixed to the structure by means of a back to back steel or stainless steel fin bracket;
- Structural fins should not be less than 12mm in thickness and should always be toughened (see Diagram 11.2 over page);
- Internal entries – When the width of the sidelite (A) plus the height of the highlite (B) exceeds a total of 1000mm a structural fin is required (see Diagram 11.1);
- External entries – A wind-load design should always be carried out to determine thickness and width of fin.

DIAGRAM 11.1:

Typical cantilevered fin with bolt through back to back stainless steel head mounted fin bracket.

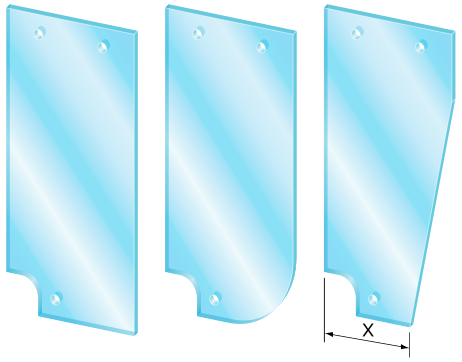
Cantilevered glass with bolt through stainless steel head mounted bracket and 2 way spider fixing for face glass connection.

12mm clear toughened door with centre fix pivot

Offset pivot detail.

12mm grey toughened door with offset pivot.

DIAGRAM 11.2: CANTILEVERED FIN DETAIL



With highlite fin designs, (X) must be no less than 2/3 of the fin width required.

CENTRE FIX PIVOT DOORS

This pivot system is used when a larger door width is required. (e.g. greater than 1000mm). The pivot point is moved towards the centre of the door. One point to be aware of is that the door glass will extend out more so than a normal pivoting door when open. Centre fix bottom patch shown is also available in rails.

OFFSET PIVOT DOORS

In this pivot system the pivot centre is not directly under the glass. It is offset to one side allowing the door to swing back 180°, finishing parallel with the sidelite. This pivot system can only work on floor springs or free pivots and additional lock troughs are required to hold the door open in the open position. The offset bottom patch is as shown, but it is also available in rails.

PIVOT DOOR CLOSERS

Self closing concealed overhead closers and floor spring closers are required to prevent the door from opening or shutting forcefully during normal use and high wind situations. Different closer mechanisms or types allow the door to always close (NHO non hold open) to its correct position and stay closed, or stay open at a specific angle (90° HO – hold open at 90° angle). These closers are double action, meaning that the door can swing fully through a 180° angle.

Because of the large variation of door sizes and applications, the closers are manufactured in varying closing strengths. A stronger strength spring action is required with larger doors. The stronger spring prevents the wind from opening the door and forces the door shut. The disadvantage is that the door may be more difficult to open for some people or may contravene disability regulations.

Closers can be installed over the top of the doors in the ceiling in an aluminium transom box (COC – Concealed overhead closer) or in the floor (floor spring).

A door stop is recommended where the door leaf is over 900mm wide. The stop should be located in the 100° position to prevent damage to the COC.

Floor springs require the installer to fix the device inside the floor. Floor springs are generally specified for larger door applications or where a ceiling mounted closer is not possible.

FREE PIVOT DOORS

CASMA SMALL DOOR PIVOT SETS

Pivot doors can be installed without self closers. However, they are only recommended for doors with infrequent use or showcases. It is advisable to use door stops to prevent breakage or damage to walls. An alternative style of free pivoting door patches is the Casma 12790 small door pivot set. These top and bottom patches are suited for 8/10/12mm thickness glass up to 60kg in door glass weight. They are fixed to the head and sill and swing one way only.

Casma offset small door pivot sets.

CD131 PATCH HINGE – SIDE HINGED

Butt type hinge to suit 8/10/12mm glass thickness for glass doors up to 60kg. Maximum size doors 2100mm x 900mm. These doors are only suited for fixing into id jamb framework and swing one way only.

Dorma CD131 hinge – side hinged.

Free pivot door using Casma 12790 door pivot set.

SR PIVOT DOOR SYSTEM

A design alternative to standard corner patch, door rail systems SR or stainless rod components are made from stainless steel with either proud or countersunk flush glass fixings.

To suit 10/12mm toughened glass, door leaf sizes up to 2400 x 1000mm.

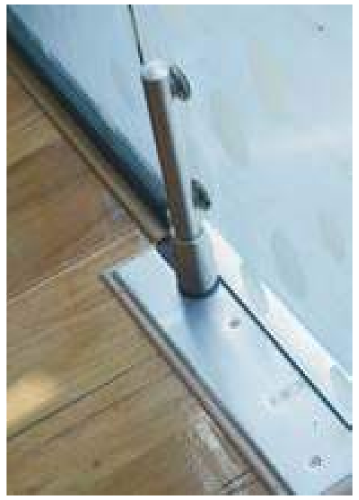
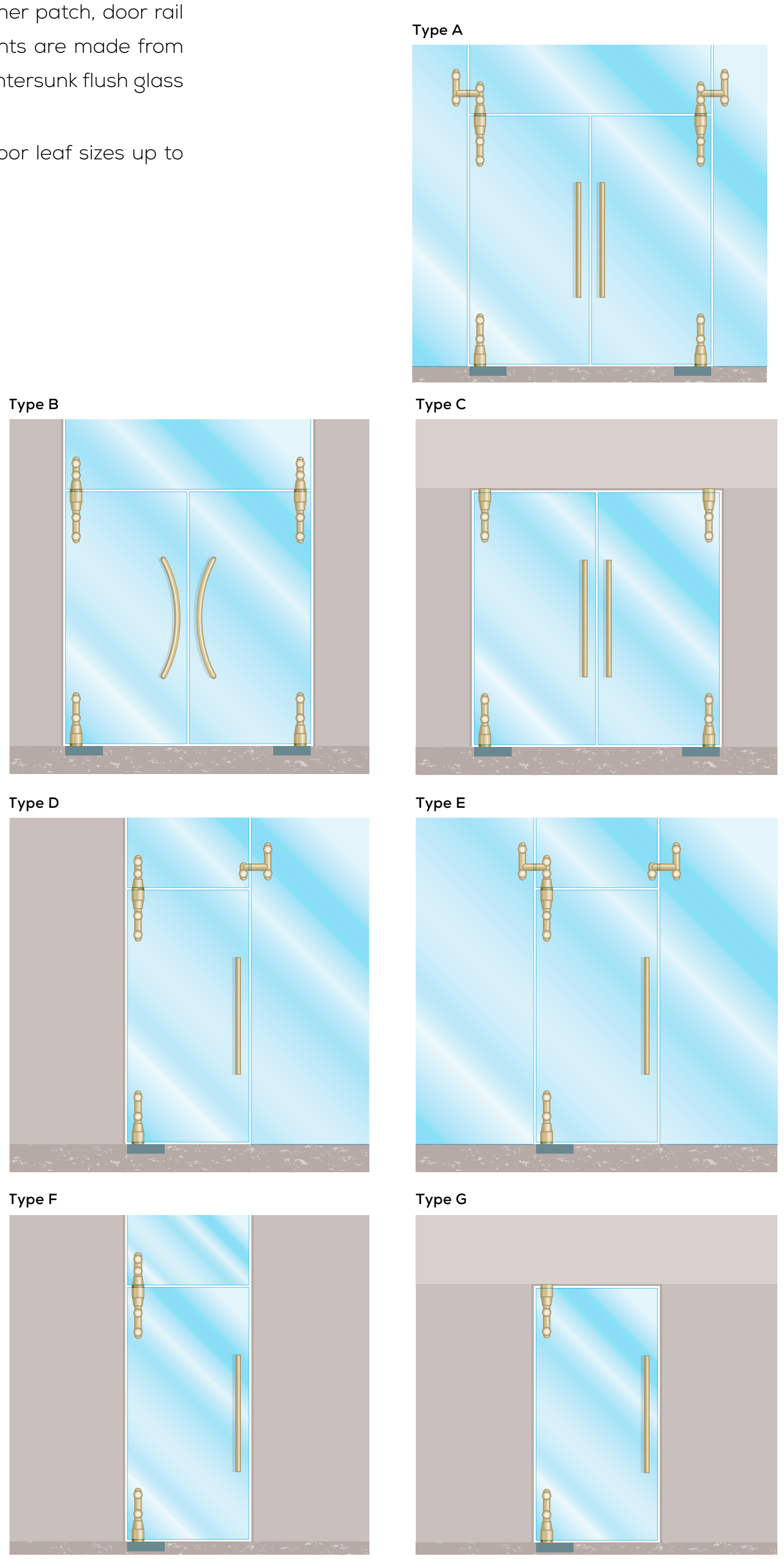


DIAGRAM 11.3: SR PIVOT DOOR TYPES.



Top hung sliding door.

Top hung sliding door.

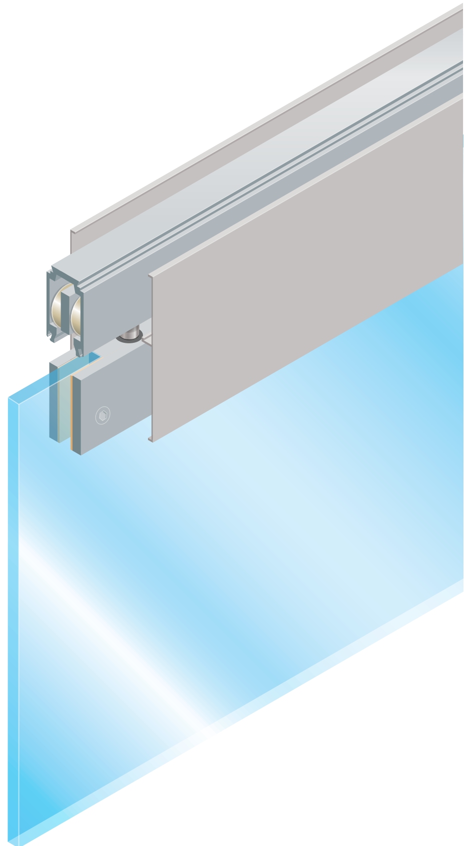
MANUAL SLIDING DOORS

There are two manual sliding systems available:

- Top hung sliding doors – These doors have suspended rollers fitted to a top patch and slide in a track in the ceiling. A floor guide is mounted on the floor at the sliding end of the opening to keep the door plumb;
- Bottom track – These doors have rollers fitted in the bottom of a rail which roll on a continuous bottom track. The top guide is a continuous top channel recessed into the ceiling. Door stops have to be fitted to the top and bottom to stop the doors at full opening and closing.

  The bottom track system has a continuous track running the full length of the opening. This may affect the floor finish and may create a stepping problem. The track will also allow dirt or rubbish to collect and the door panel must be securely locked to prevent direct lifting out of its opening.

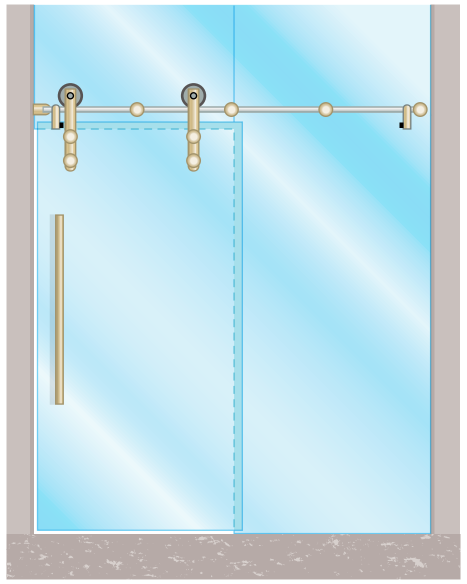
TOP HUNG SLIDING DOOR.



SR SLIDING DOOR SYSTEM

A design alternative to standard top hung and bottom track sliding systems, SR or stainless rod components are made from stainless steel material to suit 10/12mm toughened glass.

Sliding panel door sizes up to 2400mm x 1200mm or 90kg. Glass fixings available in either proud or countersunk flush fittings.



SR sliding door wall mounted.

BI-FOLD DOORS

These systems provide for the open shopfront look. The panels are hinged together, fold back against each other when opened and stack against the walls at either end of the opening.

STACKING DOORS

These frameless glass door systems have been designed so that shopfronts can be left completely open during trading hours and securely locked after hours. The panels slide in a top track with a roller system and are stacked away in a storage/stacking bay either parallel or at right angles to the main track or in a stacking bay located away from the shopfront line. The stacking bays can also be located in a cupboard so that the panels will be completely out of view. Pivot doors can also be included in the system.

DIAGRAM 11.4: BI-FOLD DOORS.

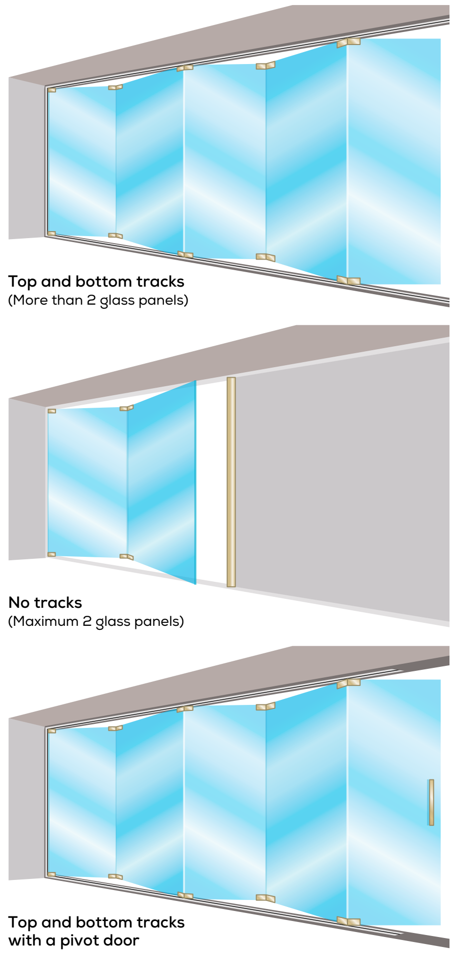
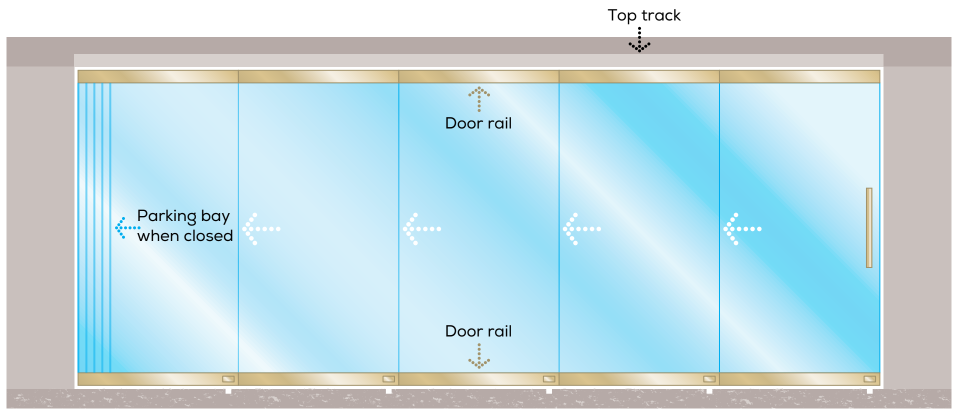


DIAGRAM 11.5: STACKING DOORS.



GLAZED WALLS – SINGLE TIER

These glazed structures are generally bottom loaded or the glass is dead load supported by the floor. Where there is a large open expanse to be glazed, glass support fins may be required to prevent panels from being blown in or pulled out during high wind load conditions.

FIN SUPPORT

Fins which are silicone glazed to facing panels as shown, provide a four-sided support or fully framed support for these facing panels. Fins are used to prevent glass facing panels from deflecting, breaking or falling out through wind-load pressures. AS1288 requires fins where two edge only supported glazings are insufficient in coping with applicable windloads. Glass fins in most cases must run the full length of the panel height and be channel glazed or mechanically secured depending on the application. Fin thickness and width is determined by wind-load, facing panel size and silicone joint bite size.

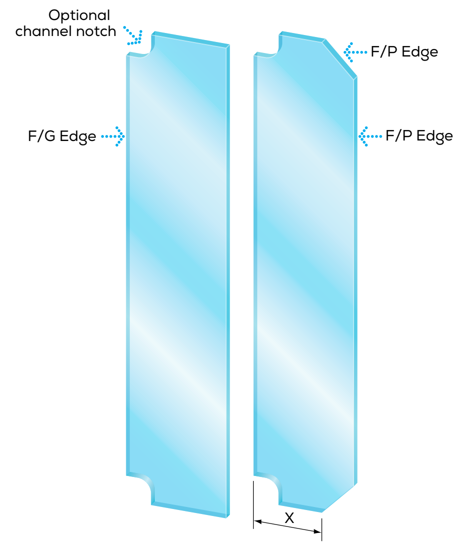
NO FIN SUPPORT

Where fins are not desired for appearance or other reasons, wind-load is a critical factor in determining glass thickness. Areas not subject to wind-load, such as enclosed shopping centres/malls, may in some situations utilise this type of shopfront design.

Single tier shopfront with full height supporting fin.

DIAGRAM 11.6: FULL HEIGHT FIN DESIGN.

With full height fin designs, (X) must be no less than 2/3 of the fin width required.



Single tier shopfront with full height supporting fin.

Multi-tier suspended glass facade system using 10mm green toughened glass.

GLAZED WALLS – MULTI TIER

Where openings require multi tiers or levels of glass panels, self supporting structural glass walls are mandatory. There are three types of structural glass glazing methods, suspended, stacked and structural stand-off systems. Designed for glazing large openings in buildings, these systems provide maximum visibility and daylighting. Traditional aluminium mullions or transoms are replaced by thick toughened glass fins or steel tension trusses. These fins and trusses are designed to resist wind load.

SUSPENDED GLASS WALLS

The glass panels are hung from the building structure like a curtain. The top tier panels are connected to the structure by adjustable hangar brackets and subsequent lower panels are connected by metal fittings such as spiders, at their corners. The facade is located into channels at the perimeter and all glass joints and channels are sealed with silicone sealant. The support structure, top tier glass and hangar brackets must be able to sustain the vertical weight of the glass below as well as wind loading.

The adjustable suspension system in conjunction with perimeter channels permits the system to move independently of the building structure. This compensates for construction dimensional variations and overcomes problems associated with building movement, vibration and seismic loads.

The hanging assembly is normally stabilised against wind load by glass fins located and fixed to the support structure with fittings at the corner joints. It is also possible to fix the glass panels to metal mullions, trusses, space frames or other support structures for lateral support. Depending on engineering specifications glass walls as high as 20 metres can be installed.

STACKED GLASS

The opposite of suspended systems, stacked systems allow multiple tiers to be stacked on top of each other. The glass dead load is imposed on the bottom tier panels and to the floor. The glass panels are located into channels at the perimeter and all the glass joints are sealed with silicone sealant. Like suspended systems, the glass facade is stabilised against wind load by fins or other structures. The glass panels are connected by special metal fittings to the glass fins. Depending on engineering specifications a maximum glazed height of 8 metres and no more than 2 tiers are recommended.

STRUCTURAL STAND-OFF SYSTEMS

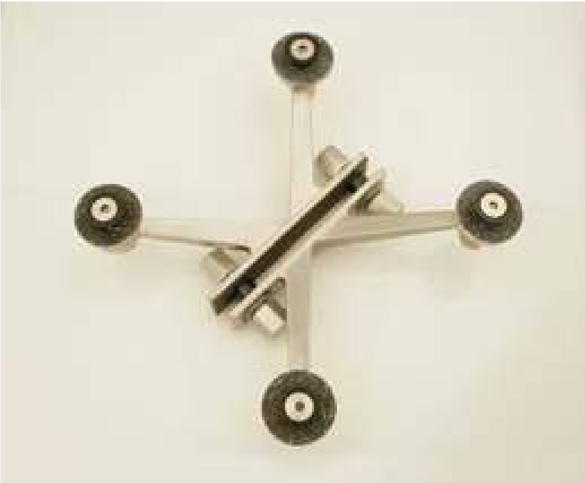
Stainless steel stand-offs or spiders are fixed to building support structures such as concrete columns, steel mullions and posts or metal/cable truss systems. This method allows the glass to be cantilevered off the support structure. The system can allow for an unlimited height in glazing provided that there are intermediary structural supports at given spans.

STRUCTURAL FITTINGS – SPIDERS

Used in glass wall and canopy openings, spider point fixings are primarily designed to connect multiple tiers or panels of glass. Spider fixings are also used in high wind load areas where conventional silicone and glass fin support are not sufficient to cope with loadings.

TYPICAL SPIDER FITTINGS.

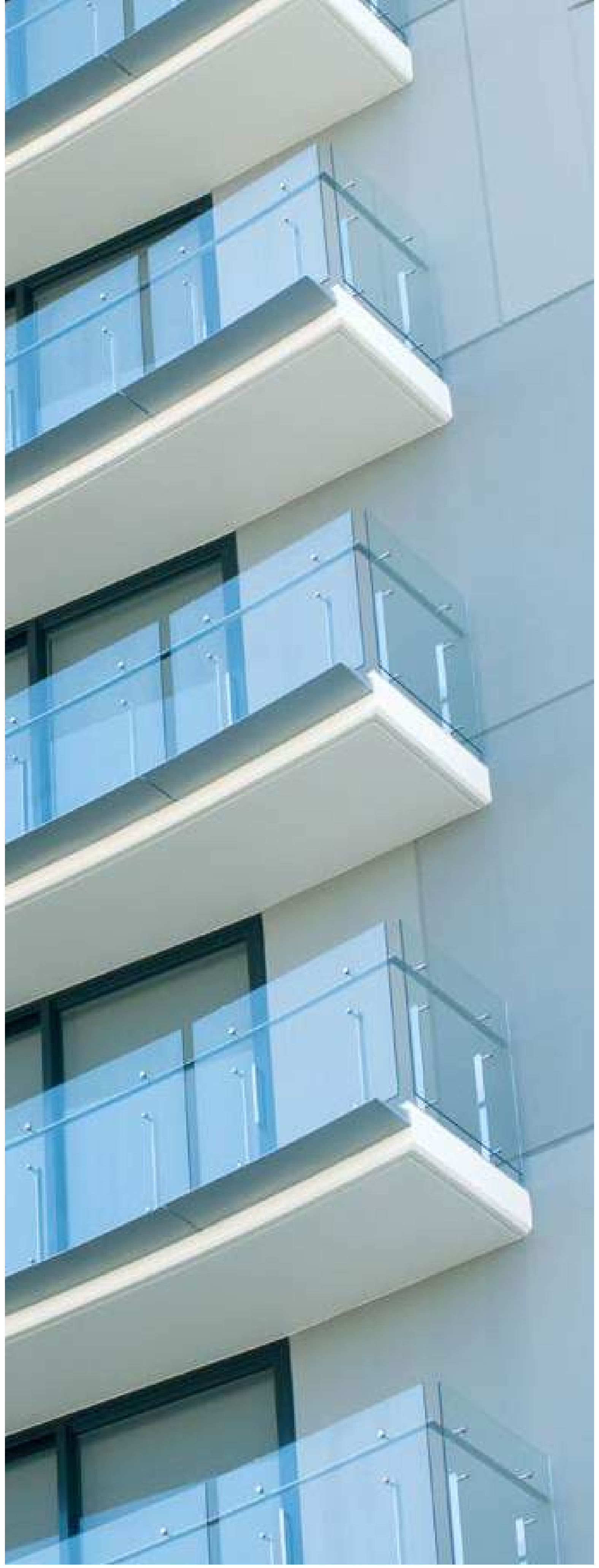
Two way spider fixing.



Four way spider fixing.

Multi tier structural stand-off system glass facade using 30.56mm thick Cyclone resistant multi-laminated glass connected to bolt through stainless steel point fixings, fixed to stainless steel full height supports behind glass.

Multi tier structural stand-off system glass facade using four way spider fixing bolted off stainless steel fins – 12mm grey toughened glass .



STRUCTURAL BALUSTRADING

Structural glass balustrading refers to systems which generally have few vertical or horizontal supports, where the glass has to be a safe and structurally sound component of the building. Depending on the application and as per AS1288 provisions, thickness starts at a minimum of 10mm toughened, but may need to be heat soaked toughened or a toughened laminated glass. Balustrades protecting a difference in levels equal to greater than 1000mm shall have a structural interlinking handrail so that in the event of breakage, the handrail will sustain the required loading.

Some systems are designed with no handrails (generally where protecting a difference in level equal to greater than 1000mm) and require testing and engineering certification for compliance. These systems typically use toughened laminated panels with high strength SentryGlas® (SGP) interlayers, supplied in thicknesses ranging from 14.28mm to 22.28mm depending on the requirements. In the event of breakage of both lites of the laminated panel, the glass must be designed to still provide a barrier to falling.

Like all aspects of glass in buildings, frameless glass

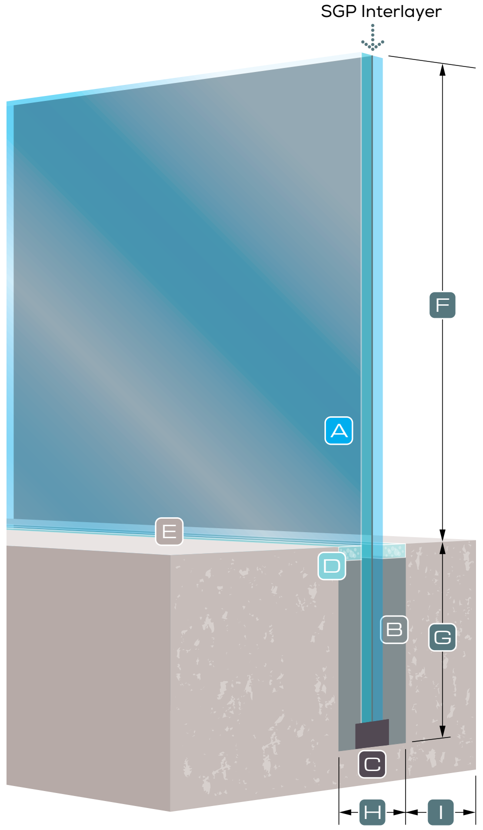
12mm clear toughened glass bottom grouted cantilevered.

balustrading and pool fences/gates are subject to strict standards and regulations many of which have to be cross checked for compliance. Some of these include;

› BCA (Building Code of Australia) local authority requirements;
› AS1170: Wind load, dead load and live requirements;
› AS1288: Glass in Buildings;
› AS1926: Fences for swimming pools;
› AS2820: Gate units for private swimming pools.

DIAGRAM 11.7:

Structural glass balustrade with no handrail utilising high strength SGP interlayer.



A. Toughened glass panel (Heat soaked treated) or laminated toughened.

B. Continuous non-shrinkable grout.

C. Neoprene setting block 25mm wide x 10mm high. 100mm long strips at 750mm centres.

D. Silicone topping as required.

E. Concrete channel continues the length of the balustrade. Alternative pressed steel channel may be used.

F. Height of balustrade or pool fence to standard.

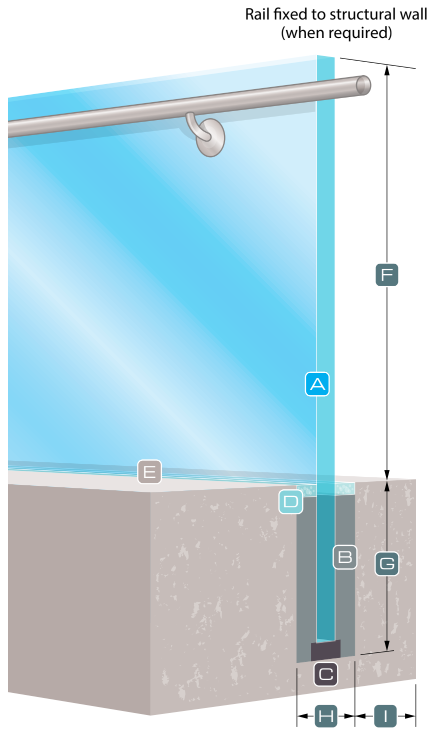
G. Depth of recess 90-100mm.

H. Width of recess 50mm.

I. Minimum distance from glazing channel to concrete perimeter – refer structural engineer.

DIAGRAM 11.8:

Structural glass balustrade with handrail.



POINT FIXED

This structural balustrade system fixes the glass to concrete hobs, walls, timber and metal framing via bolt through stainless steel point fixings or stand offs. Most intended glazing applications require specialist engineering to determine the following (see Diagram 11.10):

› Glass thickness, type, width of panel (A);
› Number of fixings, diameter size, length of point fixing or stand off and length of fixing rod (B) (see also stand-off detail, Diagram 11.9);
› Minimum distance between holes, hole to glass edge and concrete edge (C);
› Type of hob/structure construction and width to determine adequacy or strength of the hob/structure to take loading imposed by the balustrade (D).

Further to the above, the balustrade must comply to minimum height regulations (E) with no ability to use the backing hob or fixing structure as a climbable mount (F). Gap between glass must be in accordance with minimum regulations (G).

All balustrades protecting a difference in level equal to greater than 1000mm shall have a structural interlinking handrail so that in the event of glass breakage, the handrail will sustain the required loadings as per AS1288 and AS1170.

DIAGRAM 11.9: TYPICAL STAINLESS STEEL POINT FIXING (STAND OFF).

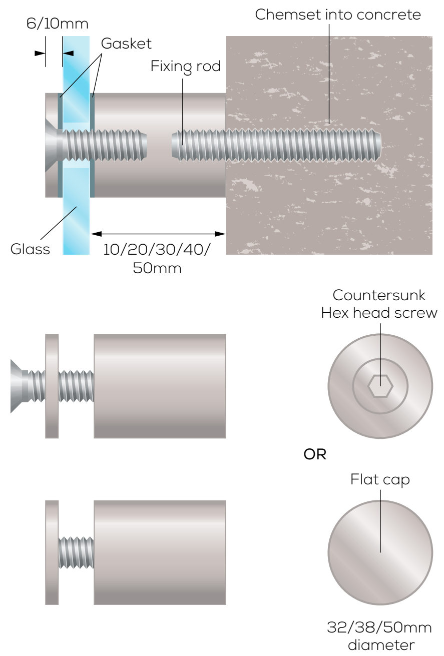
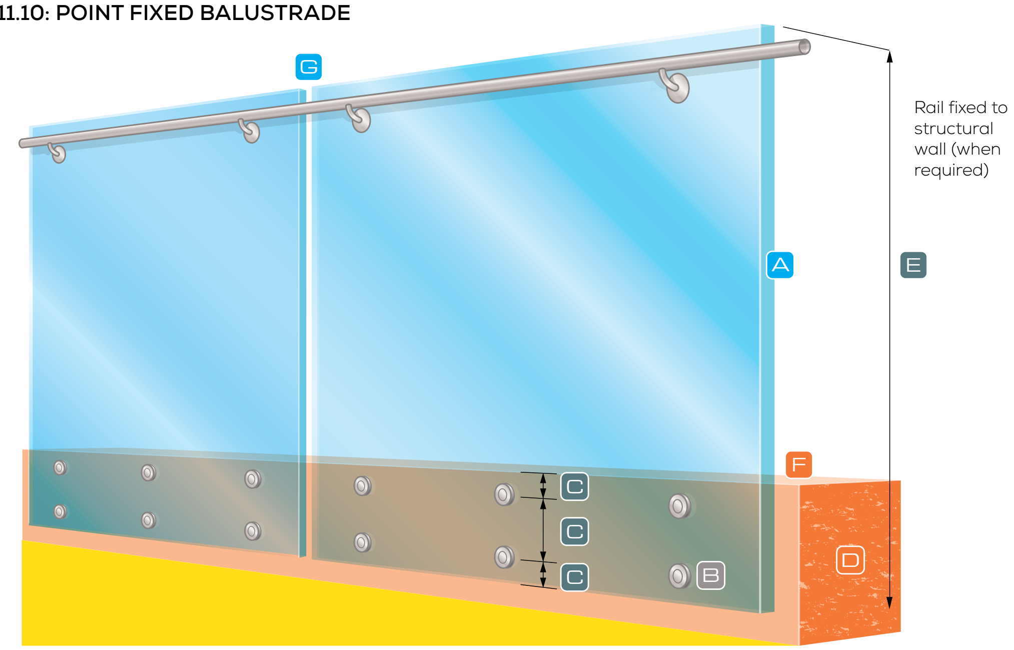


DIAGRAM 11.10: POINT FIXED BALUSTRADE



Spider fixing 2 edge supported.

Close up detail of spider fixing.

OTHER BALUSTRADING INSTALLATIONS

STUB POST FIXING

Glass panels are bolted together with stainless steel stub posts which are fixed into concrete through core drilled holes or surface mounted.

CLAMP FITTINGS – 2 EDGE SUPPORT

Glass panels are supported by stainless steel clamp fixings to vertical posts on each side. No holes required in glass.

See Diagram 11.11

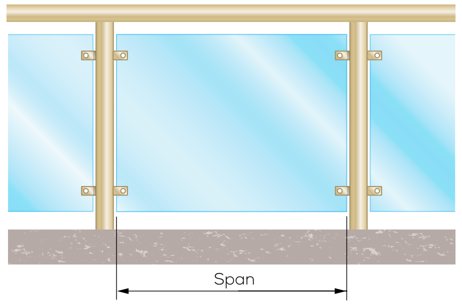
SPIDER FIXING – 2 EDGE SUPPORT

Glass panels are supported by bolt through 2 way stainless steel spider fittings to vertical posts on each side. Provides 2 panel link with flush or proud glass connectors.

CHANNEL GLAZED – 2 EDGE SUPPORT

Glass panels are supported in a channel fixed to vertical posts on each side.

DIAGRAM 11.11: CLAMP FITTINGS - 2 EDGES SUPPORT.



The glazing panels are supported by clamp fittings to vertical posts at each side.

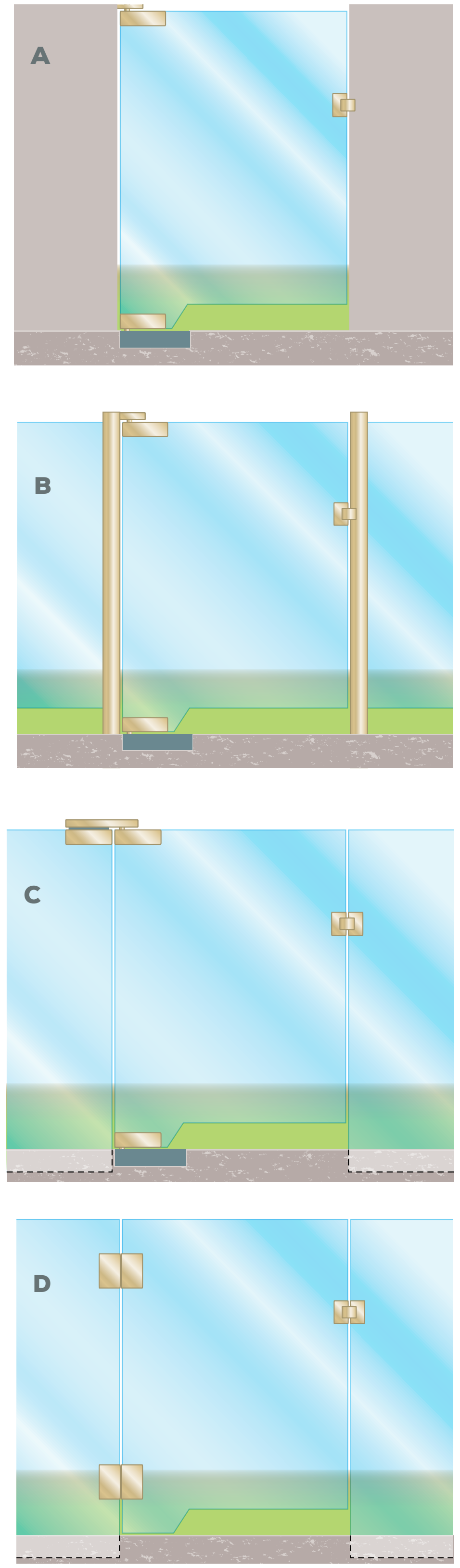
Typical 316 stainless steel clamp fitting – 10/12mm glass.

POOL GATES

When gates are required, there are 2 options available. The first option uses corner fixed metal patch fittings with non-hold open floor springs (see diagram 11.12, A,B,C). The floor spring is concealed in the concrete slab. The second option uses self closing hinges without the requirement of a floor spring (see diagram 11.12, D). All options must have latches. All components are subject to relevant codes and regulations.

Frameless 12mm clear toughened pool gate with top/bottom corner patches and floor spring.

DIAGRAM 11.12:



FRAMELESS SHOWER SCREENS

Frameless toughened safety glass can provide an alternative to standard aluminium framed shower screens.

Minimum recommended thickness should be 10mm toughened safety glass.

FIXING METHODS

Subject to AS1288 guidelines, there are two main methods of installing frameless toughened shower screens:

- The recommended method is to mechanically fix the glass with special bolt through plated brass or stainless steel angle brackets;
- A second method is to use an aluminium or plated brass "U" channel which is screw fixed to the wall and floor and the glass is fixed into the channel using structural grade silicone.

TABLE 11B: MAXIMUM SHOWER DOOR WIDTH/HEIGHT	
WIDTH	**(MM)**
Wall hung doors	600-700
Glass hung doors	550-650
HEIGHT	**(MM)**
Wall & glass hung doors	1850-2100

STRUCTURAL BRACING HEADER BARS

For any glass to glass hinge shower panels and free standing fixed shower panels, structural bracing will be required to reduce excessive deflection of the glass.

OPTIONS INCLUDE:

- 6-10mm toughened glass panel, 100-150mm wide, running the length from sidelite to sidelite or wall to return panel, over the door;
- Metal header bar in the same finish as hinges etc;
- 10mm toughened glass quadrant (as shown right) UV adhesive or silicone fixed to glass and wall.

DIAGRAM 11.13: FRAMELESS SHOWER SCREEN TYPES

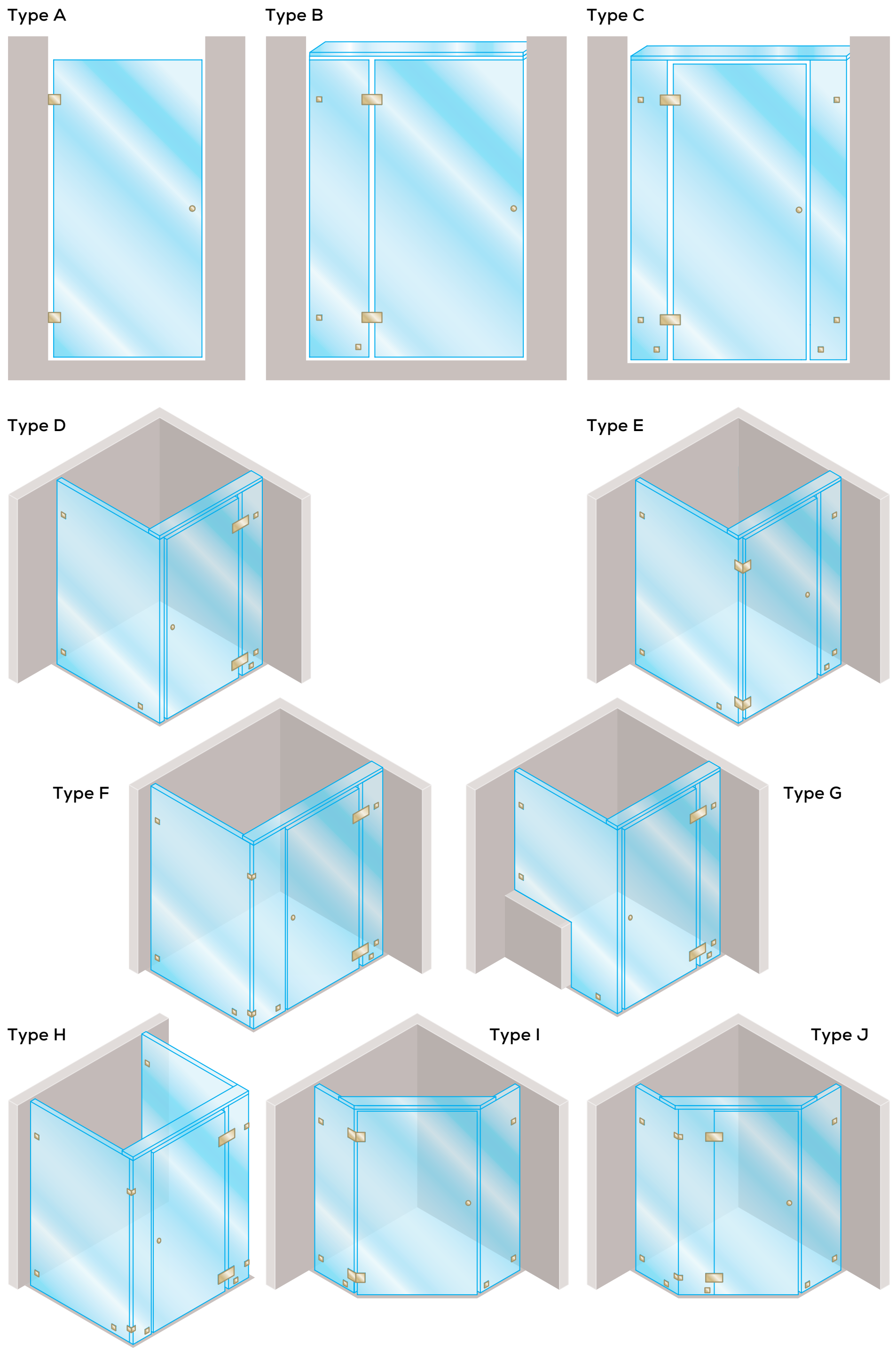
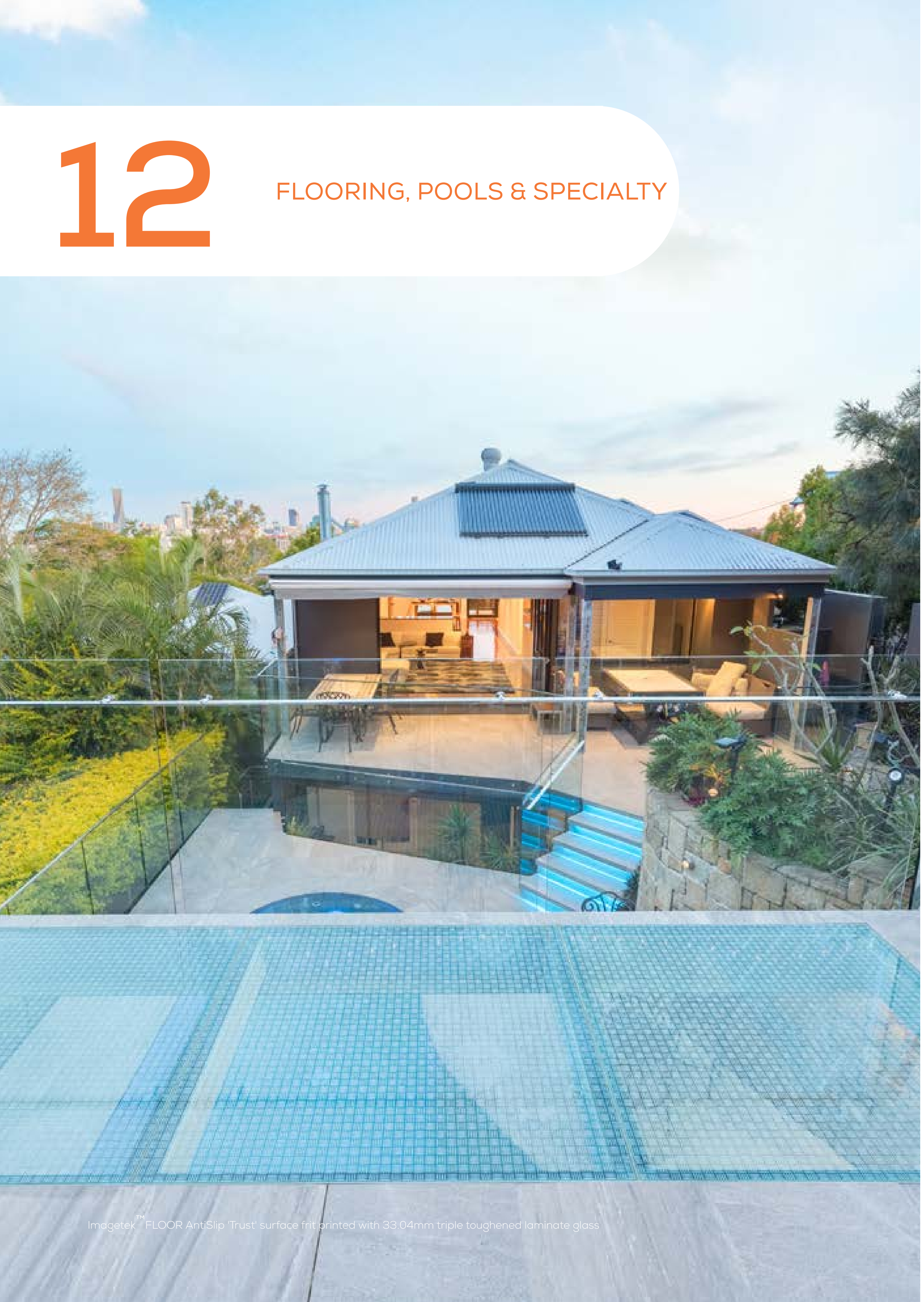


DIAGRAM 11.14: TYPICAL FRAMELESS SHOWER DOOR HARDWARE


180° glass to glass chrome shower hinge.


Wall to glass shower hinge.

12 FLOORING, POOLS & SPECIALTY



Imagetek™ FLOOR AntiSlip 'Trust' surface frit printed with 33.04mm triple toughened laminate glass

GLASS FLOORING

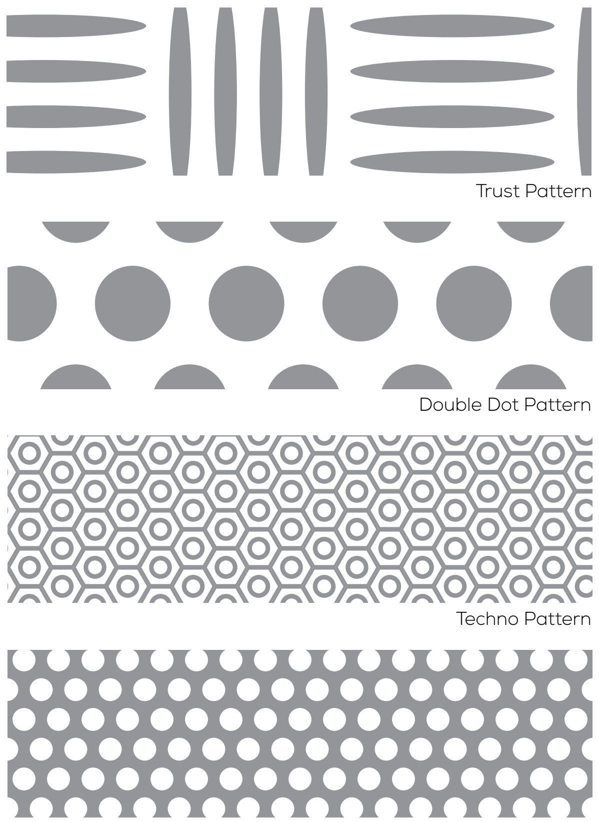
The glass supplied for these applications are custom laminated make-ups, most commonly a triple laminated glass with toughened panels. Heat soaking of toughened glass is recommended for these applications. Panels can be designed with two layers of glass depending on application. Interlayers used can be either PVB or structural such as DG41 or SGP. Engineering is required to determine the thickness and make-up and the type of activity and specific uses are required from client eg., domestic, commercial, shopping area. A full list of these is available through AS1170 Table 3.1.

Trafficable flooring should have an anti-slip coating applied using a ceramic printed frit pattern design as shown (see also ImageTek™FLOOR page 63). Alternatively, a sacrificial sheet of 6mm toughened glass with printed frit is placed on top of the laminated panel, designed to be replaced in the event of breakage. This avoids the costly replacement of the more expensive laminated panel. Care should be taken that sacrificial sheet is sealed adequately to avoid dirt and water getting between panels. Patterns tested to AS4586-2013 Slip resistance classification of new pedestrian surface materials.

INSTALLATION DETAILS

- It is recommended that the glazing block shall have shore hardness 80 to 90;
- The joints between the floor panels and structure shall be 6mm minimum;
- The recommended support width for the floor panels shall be 20mm minimum;
- Framing and support should be engineered to withstand loads imposed.

ImageTek™FLOOR PATTERNS



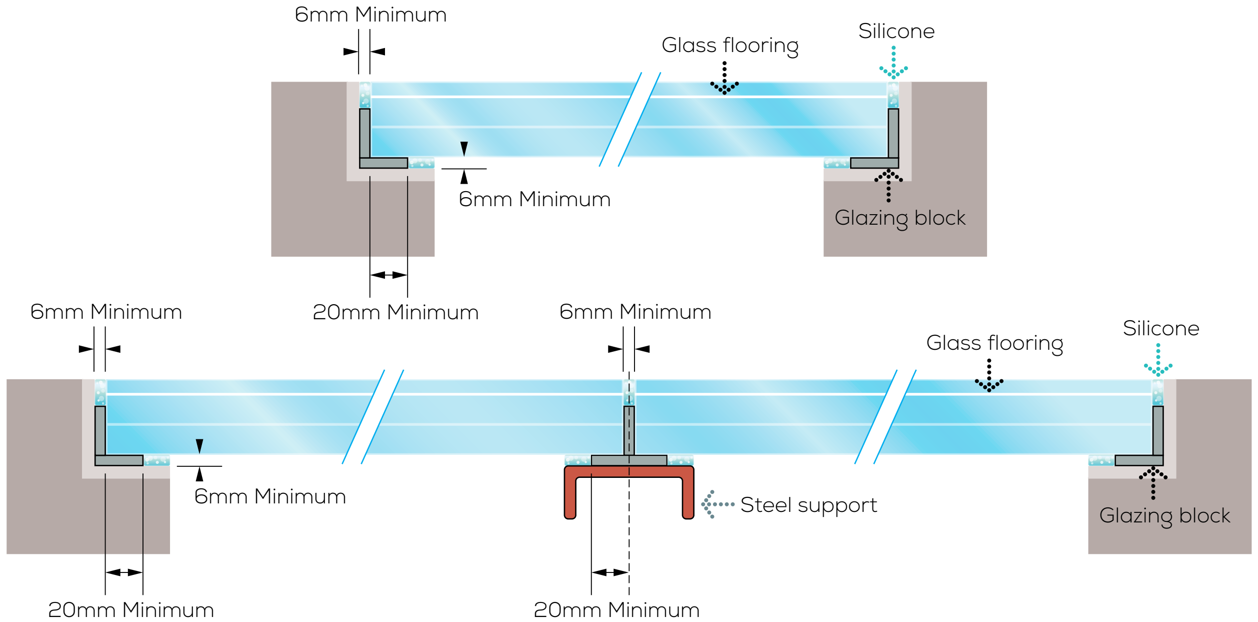
Trust Pattern

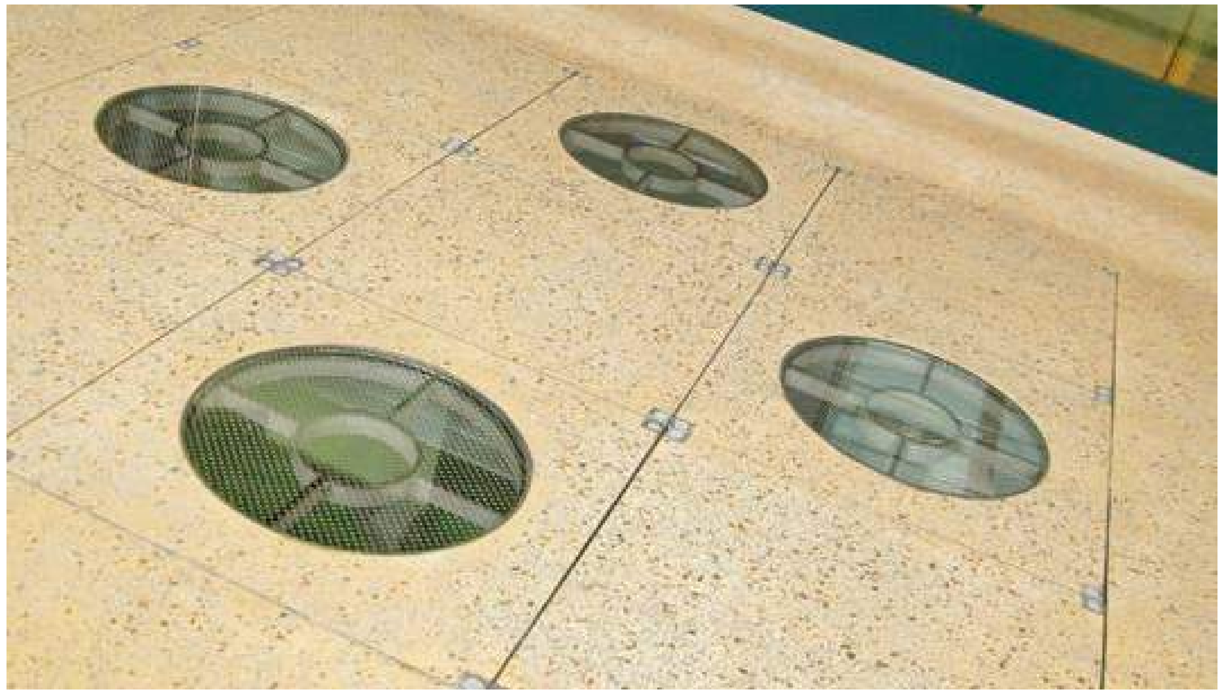
Double Dot Pattern

Techno Pattern

Trypophile Pattern

DIAGRAM 12.1: GLASS FLOORING INSTALLATION DETAILS – 4 SIDE SUPPORT.




Glass flooring 29.04mm thick using Low-iron glass.


Glass stair treads.

POOL PANELS

The glass supplied for these applications are custom laminated make-ups, most commonly a triple or quadruple laminated glass with toughened panels. Because of risk of catastrophic failure, panels are specially engineered and usually designed with redundancy eg, one panel can fail but the rest of the panels can still withstand and hold the water load. Upon inquiry, the activity or application is also required, whether it be for domestic/residential use or public pools, aquariums or commercial underwater viewing panels to determine glass panel design.

Interlayers are susceptible to damage from moisture and chemicals and all efforts should be made to prevent ingress. Panels that have exposed edges or partially submerged should be avoided or edges should be protected in some way.

SPECIALTY PRODUCTS

RENEW GLASS™

Viridian Renew™ glass has a special coating that helps to keep glass free from organic dirt. The coating is completely transparent and is applied during the manufacture of clear glass. It works by having a dual action. Once exposed to daylight it reacts with the UV rays to breakdown and disintegrate organic dirt deposits such as bird droppings and tree sap. Secondly when water hits the glass, Renew has a hydrophilic quality that assists in washing dirt away without leaving spots or streaks.

Applications include residential and commercial windows, roof lights and generally where windows or roofs are inaccessible or access is not safe.

Renew is supplied in a minimum of 6.38mm laminated thickness, but can be combined with other glass substrates to meet specifications. Renew glass uses pyrolytic coating technology meaning that it can be laminated, toughened, curved, stored and handled in the same way as normal glass.

THICKNESS	SIZES
6.38 / 10.38 / 12.38mm	2440 x 3660mm; 3210 x 5100mm

DESIGN AND GLAZING NOTES

Talk to our sales staff about specific design requirements as self cleaning type products have limitations in certain applications.

- Can be used in almost any exterior application, vertical or sloped roofs of no less than 10°, 30° is recommended;
- Not suitable for internal use;
- It doesn't function immediately – The coating will provide photocatalytic and hydrophilic properties when it has been properly energised by ultraviolet light (UV) and is not masked from UV exposure. Materials on the glass that block UV light or that isolate the coating will limit its function;
- Hard water: inorganic substances – If hard water or water with high mineral content gets onto the glass, it may require special cleaning procedures, since such water would likely contain inorganic material that the coating would not remove by the self cleaning process;
- Salt buildup: Ocean front glazing – Salt is an inorganic substance and therefore the coating cannot fully function. However, the salt build-up can be washed away and the hydrophilic benefits of minimized spots and streaking stand out. Essentially, the hydrophilic feature of the coating makes the glass easier to clean than conventional glass;
- Flushing the surface – Glass will require from time to time flushing of the surface with water. This is particularly important where –
    - The glass is installed under eaves or overhangs where rain cannot naturally flush the surface;
    - When it doesn't rain for long periods of time, and;
    - Exterior screens are installed;
- Large deposits of dirt – Organic materials such as bird droppings may overwhelm the coating and therefore hosing or hand cleaning may be required.

ANTI-REFLECTING GLASS

Viridian OptiView™ reduces glass reflection to less than 2% compared with 7-8% for standard float glass when viewed both inside and outside. This unique glass is designed for applications where transparency is required in combination with an extremely low reflective appearance. These characteristics provide OptiView™ with very high clarity for viewing through the glass. It effectively removes any apparent 'barrier' between the object and the observer.

This product is available in laminated form combining a transparent anti-reflecting coating on clear glass using pyrolytic coating technology. The coatings, one exterior (surface #1) and one interior (surface #4), work in unison and both are required to achieve the significant reduction in reflectivity.

Applications include showrooms, museum and retail display cases, retail shopfronts, restaurants, corporate boxes, apartments, hotels etc. This glass can be cleaned using the same methods as ordinary non coated float glass.

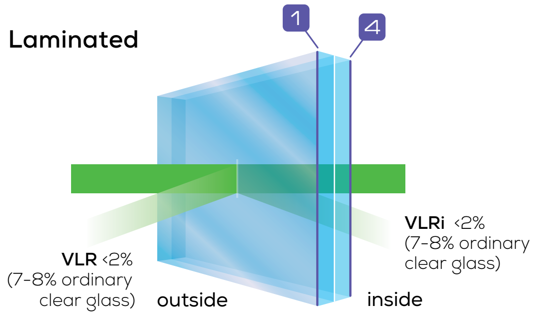
SIZES AND THICKNESSES (VIRIDIAN OPTIVIEW™)

- 6.38 & 12.38mm;
- Sizes up to 2438 x 3302mm.

RADIATION SHIELDING LEAD GLASS

This visually transparent product is used in medical, laboratory and other institutions to protect the operators or observers from radiation. The percentage of lead contained in the glass is dependent upon the type and radiation dose rate. The level of protection afforded by the glass is determined by its lead equivalent in mmPb referring to the equivalent of a solid lead wall.

DIAGRAM 12.2: COATING POSITIONS – VIRIDIAN OPTIVIEW™ ANTI-REFLECTING GLASS



VLR = Visible light reflectance.
VLRi = Visible light reflectance (internal).
1 and 4 coatings on both surfaces.

The top half of this shopfront is ordinary glass and anti-reflecting glass is glazed in the bottom half.

Radiation Shielding lead glass application.

13 EDGEWORK & PROCESSING

EDGEWORK TYPES

CLEAN CUT

Edges are cut clean and sharp.

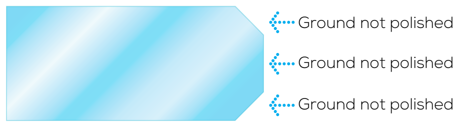
ROUGH ARRIS STANDARD ARRIS

This edge is produced by a rough stone, wet belt or vertical machine arriser. The edge of the glass is left with a white arrised edge. This type of edge is typically used for toughened glass, edges not exposed 3mm–8mm.

FLAT GRIND

This edge is produced on a straight line rectilinear or CNC machine leaving a diamond smooth unpolished finish. It is the normal type of finish for silicone butt glazing. It is available on glass thicknesses of 4mm–25mm.

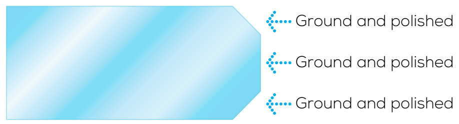
Minimum size 250mm x 100mm



FLAT POLISH

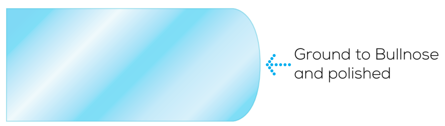
This is the standard edge produced by a straight line rectilinear or CNC machine and produces a fine polished flat edge suitable for all furniture glass and frameless toughened panels 4mm–25mm.

Minimum size 250mm x 100mm



LOUVRE GRIND AND POLISH

This edge is produced for 6mm louvre blades only. Available as a polished edge.



MITRES

Rectilinear machines produce mitred edges with a ground or polished edge. These edges are used for glass silicone butt joints at all angles and exposed edges. They are available on thicknesses of 6mm+ thicknesses.

ORDERING MITRES

- Mitres are calculated by how many degrees taken off the 90° square edge or angle.

  (see Diagram 13.1 - Fig 1)

- Mitres should be expressed as the angle taken off. e.g. 15°, 22.5°, 45° etc.

  (see Diagram 13.1 - Fig 2)

- Glass width measurements shall be given from long points of glass as shown.

  (see Diagram 13.1 - Fig 3)

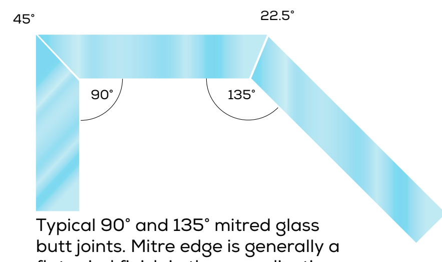
- Drawings sent should indicate back or face mitre view with degrees.

  (see Diagram 13.1- Fig 4 and Fig 5)

For reflective, low-E, Sunergy®, acid etched and patterned glass refer page 118 for drawing presentation.

DIAGRAM 13.1: MITRE DETAILS

FIGURE 1:



Typical 90° and 135° mitred glass butt joints. Mitre edge is generally a flat grind finish in these applications. Exposed mitres are generally flat polished.

FIGURE 2:

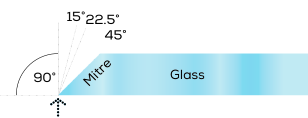
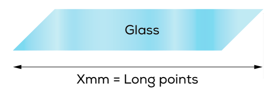


FIGURE 3:



MITRES continued

DIAGRAM 13.1: MITRE DETAILS

Figure 4:

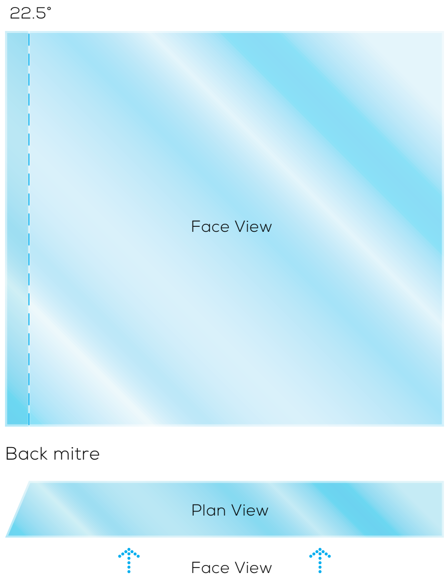
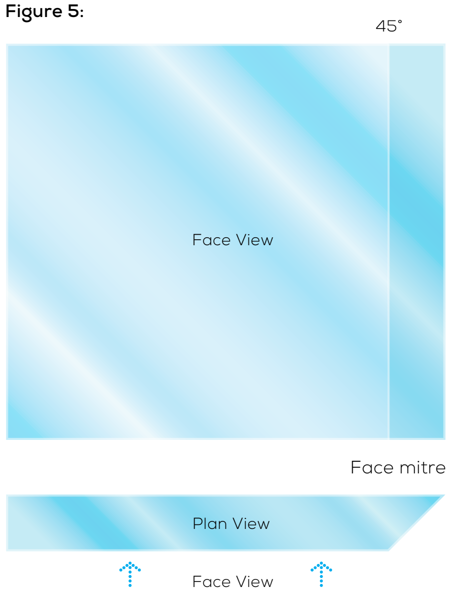


Figure 5:

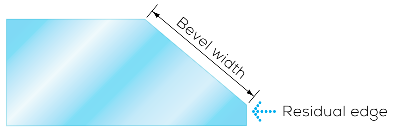


BEVELLED EDGES

Bevelled edges are produced on specialty machinery at various widths dependent on glass thickness. Available on thicknesses of 4mm–19mm.

- All bevelled glass 4–6mm thick has a satin ground edge as a standard finish. Flat polishing is an optional extra;
- 8–19mm glass is always priced with flat polished edges in addition to the bevelled edge price.

SINGLE BEVEL



- Minimum glass of 350mm x 350mm
- Maximum size of 1500mm x 1500mm - 4mm glass, 2400mm x 2400mm - 5mm-19mm glass, and up to maximum weight of 250kg.
- Tempered glass with bevels not permissible due to high risk of breakage during furnacing and inconsistent residual edge.

MAXIMUM BEVEL WIDTHS

Thickness (mm)	Maximum bevel widths (mm)
4	20
5	30
6+	35

BEVELLED TRUNCATED CORNERS

- Minimum 200mm truncated corners (X) on 10mm and 12mm glass up to a maximum size of 2000mm x 1200mm;
- Minimum 100mm truncated corners (X) on 10mm and 12mm glass up to a size of 1500mm x 1000mm.

EXPOSED CUTOUTS

EXPOSED SIDE/CORNER/CENTRE CUTOUTS

For a consistent high quality edge finish, specify a 'CNC' flat polished finish where glass edge is seen or exposed. For corners, where a 'CNC' flat polished finish is specified, request 'CNC' external radius corners (see following page).

Cutouts for splashbacks may be produced on a waterjet cutter, which leaves a white coloured ground edge. This is generally acceptable as the edge is painted and covered by powerpoint.

CORNER FINISHES

- **Standard tipped corner** – 2mm across the face as shown in a white colour arrised finish which is supplied on all 8mm+ toughened glass with rough/standard arris peripheral edge (see Photo A). Where two flat polish edges meet, the minimum corner finish is a polish tipped;
- **Polish tipped corner** –up to 2mm across the face as a manual 'buffing' of tip (see Photo B);
- Polish radius corner - up to 3mm across the face as a manual process (see Photo B);
- **CNC external radius corners** – Minimum size is 5mm for flat ground and polished high quality corner finishes. Flat polish ideal for exposed edges (see Photo C);
- **≤6mm glass** – Corners not tipped unless requested.

(A) Standard tipped corner

(B) Polish tipped corner

(C) CNC external radius corner

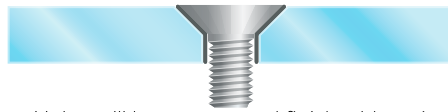
DRILLED HOLES LESS THAN 74MM

DRILLED HOLE SIZES

SMALL	6							
Medium	8 19	10 20	12 *21	13 23	14 26	16 30	17 31	18 32
Large	36	40	45	50	57	60	65	74

*21mm Ringset

DIAGRAM 13.2:



- Holes will have a ground finish with arris.
- Other drill hole sizes are available POA.

FLAT GROUND AND POLISHED HOLES

- For exposed holes requiring a flat ground or polished finish, CNC machine drilled holes are available per the following:
  - **Flat ground finish** – Holes greater than 40mm diameter
  - **Flat polished finish** – Holes greater than 60mm diameter

COUNTERSUNK HOLES

- Available on glass thicknesses 10mm and over and countersunk to 45°. (On application for glass thicknesses under 10mm)
- Holes will have a ground finish arris.

SIZING AND LOCATION (SEE DIAGRAM 13.3)

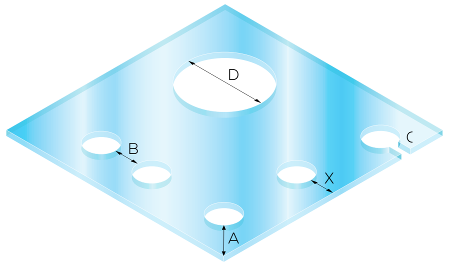
- X = Distance between hole edge and glass edge:
  - 3-6mm thickness - 6mm minimum
  - 8mm thickness - 8mm minimum
  - 10-12mm thickness - 1.5x the glass thickness
  - 15-19mm thickness - 2.0x the glass thickness
- A = Distance between hole edge and glass corner point shall be at least 4.0x the glass thickness.

- › B = Distance between holes shall be no less than 2.0x the glass thickness.
- › C = If a hole is placed in a position closer than the above recommendations, a saw cut slot can be made to minimise the stresses and chances of breakages. Width of slot shall be at least 1/2 the glass thickness and hole radius must be the same as glass thickness.
- › D = Diameter of hole shall be a minimum of 6mm or no less than the glass thickness, and no greater than 1/3 of the panel's measurement at its narrowest point.

OTHER POINTS

- › The minimum width of a panel with a hole shall be 8.0x the glass thickness.

DIAGRAM 13.3:



OTHER HOLES GREATER THAN 74MM AND NON CIRCULAR CENTRE CUTOUTS (SEE DIAGRAM 13.5)

SIZING AND LOCATION

- › XX = Distance between hole/cutout and glass edge shall be:
  - For hole/cutouts less than 150mm diameter or dimension - No less than 2.0x the glass thickness;
  - For holes/cutouts over 150mm diameter or dimension - No less than 100mm from both edges.
- › YY = The height and width of hole/cutout shall not exceed:
  - For hole/cutouts less than 150mm diameter or dimension - 1/3 of the overall panel height or width dimension;
  - For hole/cutouts over 150mm diameter or dimension - 1/4 of the overall panel height or width dimension.
- › AA = Distance between hole/cutout and glass corner point shall be:
  - For hole/cutouts less than 150mm diameter or dimension - No less than 4.0x the glass thickness. If glass edge is flat ground or polished, the minimum distance shall be 100mm from one edge;
  - For holes/cutouts over 150mm diameter or dimension - No less than 5.0x the glass thickness. If glass edge is flat ground or polished, the minimum distance shall be 100mm from one edge.
- › BB = Distance between hole/cutouts shall be:
  - For hole/cutouts less than 150mm diameter or dimension - No less than 2.0x the glass thickness;
  - For hole/cutouts over 150mm diameter or dimension - Refer to our staff for technical advice..

TABLE 13A		
R = INTERNAL RADIUS CORNER MINIMUMS		
Glass	**Flat grind**	**Flat polish**
(mm)	(FG)	(FP)
4/5/6	9mm	20mm
8	12mm	20mm
10	12mm	20mm
12	12mm	20mm
15	15mm	20mm
19	19mm	20mm

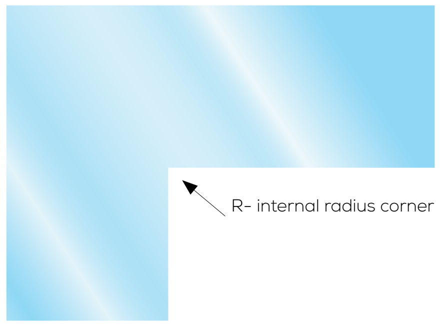
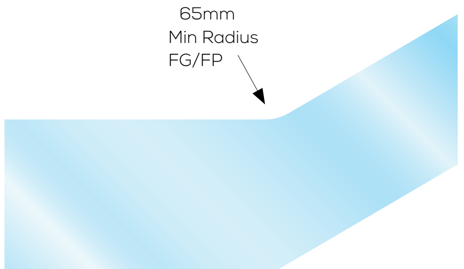


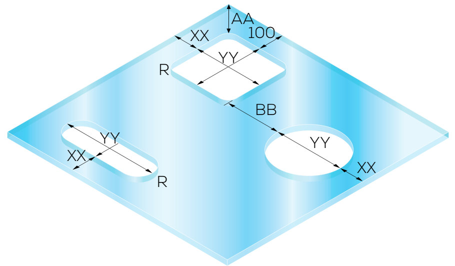
DIAGRAM 13.4: RADIUS MINIMUM FG/FP ON INVERTED RAKES.



SMALLEST SIZED CUTOUTS

- › Diameter or width (YY):
  - Flat ground finish – 40mm diameter or 40mm x 40mm
  - Flat polish finish – 60mm diameter or 60mm x 60mm

DIAGRAM 13.5:



SIDE CUTOUTS

SIZING AND LOCATION (SEE DIAGRAM 13.6)

- › X1 = Distance from glass corner to cutout edge shall be no less than 100mm. Two side cutouts next to each other shall have a minimum distance of 100mm between them.
- › Z1 = Height of cutout shall not be wider than 1/3 of the glass panel's measurement at its narrowest points.
- › Y1 = Width of cutout shall be no wider than 2/3 of the glass panel's longest measurement.

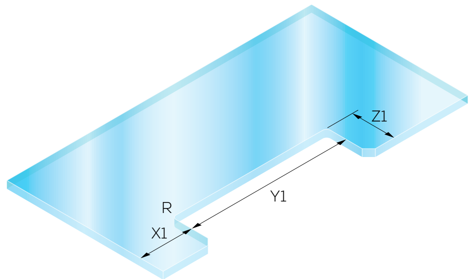
SMALLEST SIZED CUTOUTS

- › Width (Y1) and height (Z1):
  - Flat ground finish – 9mm
  - Flat Polish finish – 20mm

OTHER POINTS

- › Observe internal radius (r) rules as previously detailed (See table 13A & diagram 13.4).
- › External corners of cutouts shall be standard tipped, polished tipped or specify CNC minimum radius flat ground or polished finish.

DIAGRAM 13.6:



CORNER CUTOUT

SIZING AND LOCATION (SEE DIAGRAM 13.7)

- › Less than 2 square metres – Total area of all cutouts must not exceed 1/2 of total glass area. The minimum size of (X2) can be 100mm when the length of (Z2) does not exceed 1000mm. If the length of (Z2) exceeds 1000mm then (X2) must not be less than 1/3 width of the glass.
- › More than 2 square metres – Total area of all cutouts must not exceed 1/4 of total glass area. The minimum size of (X2) must not be less than 1/3 of the length or width of the panel.

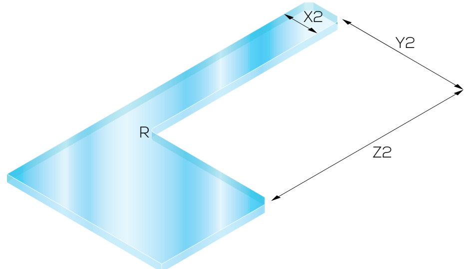
SMALLEST SIZED CUTOUTS

- › Width (Y2) and height (Z2):
  - Flat ground finish – 9mm
  - Flat Polish finish – 20mm

OTHER POINTS

- › Observe internal radius (r) rules as previously detailed (see table 13A & diagram 13.4).
- › External corners of cutouts shall be standard tipped, polished tipped or specify CNC minimum radius flat ground or polished finish.

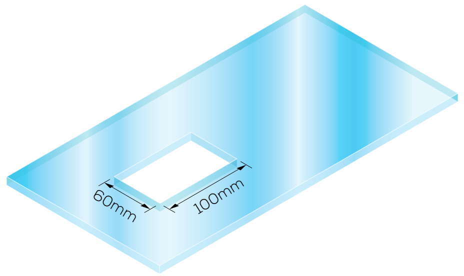
DIAGRAM 13.7:



POWER POINT CUTOUTS (SEE DIAGRAM 13.8)

Standard size of 100mm x 60mm.

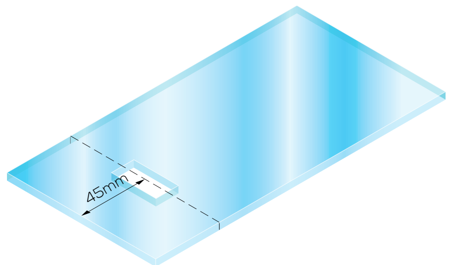
DIAGRAM 13.8



FINGER SLOT GUIDELINES (SEE DIAGRAM 13.9)

Single slots are only available on annealed glass thicknesses of 4mm+ and laminated glass 10.38mm+. Not available on toughened glass. Slots are positioned 45mm from edge of glass to centre line of slot.

DIAGRAM 13.9:



RAKED, OUT OF SQUARE AND SHAPED DRAWINGS

The drawings by product below, show the way we would like you to present your raked, out of square, shaped orders to our glass cutters and cutting machines:

› Reflective, low-E, Sunergy® cut on the coated side;

› Acid etched is cut on the smooth non-etched side (to avoid cutting oil marks on etched surface);

› Patterned is always cut on the smooth side;

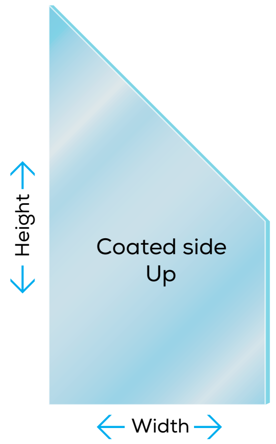
› Mirror is cut on the mirror face (non-paint side);

› Lacobel is cut glass up (non-paint side).

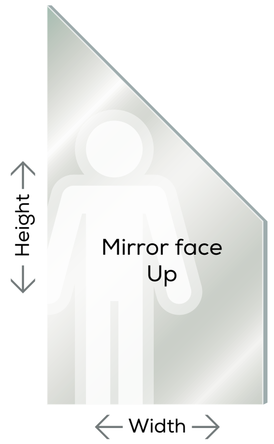
Please note you may need to reverse the drawing depending on which view was drawn originally from your measure or take-off. The drawings sent to us would not necessarily reflect how the glass is placed in the opening. For example reflective, low-E and Sunergy® have the coated side glazed to the inside of the building, meaning you may have to reverse your drawing in order for us to cut it.

CUTTING ORIENTATION - RAKES

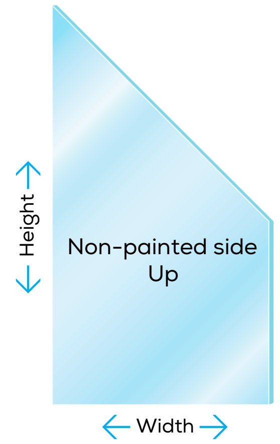
LOW-E, SUNERGY®, REFLECTIVES



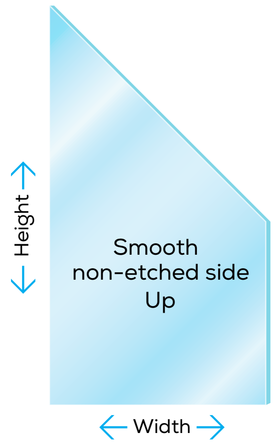
MIRROR



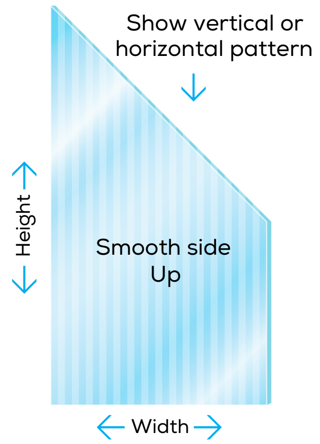
LACOBEL PAINTED



ACID ETCHED



PATTERNED GLASS



MINIMUM / MAXIMUM WIDTH TO HEIGHT PROCESSING GUIDELINES

This table is a guide to min/max width to height cutting and processing for either float or toughened glass. It does not take into account requirements as per AS1288 including maximum areas of glass, whether safety glass is required or any other imposed load including windloads.

TABLE 13B
WIDTH TO HEIGHT PROCESSING GUIDELINES (SLENDER RATIOS)*

Glass thickness	Width	Max Height
4/5mm	Minimum 100mm - 150mm	2000mm
	Over 150mm	2400mm
6mm	Minimum 100mm - 150mm	2100mm
	150mm - 250mm	2500mm
	250mm - 300mm	2700mm
	300mm - 350mm	3500mm
8 to 19mm	Minimum 100mm - 150mm	2400mm
	150mm - 250mm	2800mm
	250mm - 300mm	3000mm
	300mm - 350mm	4500mm
	On application	5000mm

TEMPLATE GUIDELINES

Due to advances in technology, templates are no longer required in most cases. Simple shapes with straight edges and curved edges with a true radius can be drawn for processing. For processing of glass to templates please refer to guidelines as set out below.

1. A full, finished size template must accompany all orders for glass to templates, with no taped, nailed or screwed joints with protruding metal edges.
2. Templates are acceptable in any 4mm thick material excluding paper and corrugated cardboard. Where flat cardboard is used it must be a minimum of 6mm thick.
3. Glass templates will not be accepted, due to the risk of breaking or damaging customer's templates (Broken glass templates are not acceptable).
4. All templates must have smooth and clearly defined edges.
5. Templates must be clearly marked with the client's name, order number (if applicable), contact name for any queries and accompanied by a written order.
6. Templates for products involving coated, patterned or mirrored glass must clearly state which surface is the coated, smooth or mirrored face.
7. All orders cut from templates will incur a complex shape charge, plus a Template Handling Fee – please ask your sales representative for more information.
8. Holes and cut out positions on templates must have a clearly defined centre point marked with a cross.
9. Stamp positions for Toughened Safety Glass and Automotive Glass must be clearly marked on template.
10. Standard industry tolerances apply to all glass produced to templates. (As per AS4667-2000).

Templates will be handled with all care but no responsibility. If you have a template outside these guidelines which you believe is acceptable, please contact our sales team for approval.

EDGEWORK - MINIMUM BY GLASS TYPE (EDGES FRAMED)

The Tables below list different requirements and recommendations of edgework for single glass and glass in IGU's. Reference is also made to our order entry process for the different glass types (See Order Entry Process column).

'Default' - refers to our order software system assigning the edgework automatically for standard products. For example 6mm toughened glass, typically fully framed defaults to standard arris as the minimum edgework. If different edgework is required, this must be specified at time of order.

'Edgework optional' - Some glass products such as Clear laminated and annealed float do not require edgework normally so are 'optional' on order. Another example is single Tinted laminated glass which is often requested by customer as clean cut, but to lessen the chance of thermal breakage, FG edge is 'optional' or recommended.

'Add to order' - requires our order entry team to enter the required edgework manually as requested eg. For customised products such as custom laminated panels.

TABLE 13C:
MINIMUM EDGEWORK BY GLASS TYPE – SINGLE GLASS (EDGES FRAMED)

Single Glass Type	Min Edge Finish	Order Entry Process
4 to 8mm TGH, HS, HSK	Std Arris	Default
10 & 12mm TGH, HS, HSK	FG	Default
15 & 19mm TGH, HSK	FG	Default
6mm Extra Clear TGH for splashback applications	FP	Default
6mm Lacobel T TGH, HS, HSK	FG	Default
6mm SplashGuard TGH for splashback applications	FP	Default
Float annealed including clear, tint, lowE, patterned and acid etch	Clean Cut	Edgework Optional
Laminated annealed including clear, tinted PVB and translucent	Clean Cut	Edgework Optional
SOL-R Clear lowE laminated annealed	Clean Cut	Edgework Optional
Tinted laminated lowE including SOL-R, SOL-XT, Cplus Neutral, Sunergy	FG	Default
Laminated with a body tinted float glass	FG	Add to order
6.38mm Solarplus S108	FG	Default

TGH = Toughened / HS = Heat Strengthend / HSK = Heat Soaked Toughened

TABLE 13D:
MINIMUM EDGEWORK BY GLASS TYPE DUO PLUS IGU (EDGES FRAMED)

IGU Type	Min Edge Finish	Order Entry Process
Float annealed including clear, tint, lowE, patterned and acid etch	Std Arris	Default
Laminated annealed including clear, tinted PVB, clear lowE (SOL-R Clear)	Std Arris	Default
Tinted laminated lowE including SOL-R, SOL-XT, Cplus Neutral, Sunergy	FG	Default
Laminated with a body tinted float glass	FG	Add to order

TABLE 13E:
MINIMUM EDGEWORK BY GLASS TYPE DUO ULTRA (EDGES FRAMED)

IGU Type	Min Edge Finish	Order Entry Process
All combinations and options	Std Arris	Default

14 PERFORMANCE DATA & TECHNICAL SUPPORT

DESIGN & SELECTION

The use of glass in construction and buildings is regulated by government codes and Australian Standards. The peak regulatory framework is the National Construction Code (NCC) with the Building Code of Australia provisions (BCA).For glazing elements, the BCA references compliance to Australian Standards AS2047 Windows in Buildings and AS1288 Glass in Buildings – Selection and Installation. The NCC also has provisions that require the use of energy efficient windows and doors.

The code and standards give guidance and boundaries to what is required or possible. However with the greater complexity and size of glazing applications along with the increasing risks of litigation, correct design and engineering fit for purpose glazing is essential. Where the codes and standards do not give adequate guidance, engineering services should be sought to confirm structural integrity, fit for purpose glazing and overall safety.

GENERAL DATA

TABLE 14A: MAJOR COMPONENTS OF GLASS

CLEAR SODA LIME GLASS		%
Silica	SiO^2	70–74
Soda	Na^2O	12–15
Lime	CaO	8–10
Magnesium Oxide	MgO	3.5–4.5
Potassium Oxide	K^2O	0.3–0.8
Alumina	Al^2O^3	0.0–2.0
Iron Oxide	FeO^3	0.08–0.11

TABLE 14B: GENERAL PROPERTIES OF GLASS

Refractive Index	1.50–1.58
Surface Reflectance	4% each side (total of 8%)
Softening Point	720–730°C
Specific Heat 0–100°C	0.20
Compressive strength (25mm cube)	248MPa
Tensile Strength – Annealed	19.3–28.4 MPa
Tensile Strength – Toughened	175 MPa
Co-efficient of Linear Expansion (Room to 350°C)	9.0 x 10–6/°C
Hardness Mohs' Scale	6.0
Density	2500 kg/m³
Young's Modulus (Elasticity)	69 GPa
Possion's Ratio	0.23

Depending on the building location or type – builders, designers and architects have to work within the technical provisions of the BCA and will need to give consideration to the following;

- Type, size and functionality of glazed elements
- Wind loads including cyclonic areas
- Energy efficiency
- Noise reduction
- Fire protection within and between buildings
- Bush fire prone areas
- Security & safety
- Earthquake prone areas.
- Disability access and mobility

TABLE 14C: GLASS WEIGHTS

mm	kg/m²
2	5
3	7.5
4	10
5	12.5
6	15
8	20
10	25
12	30
15	37.5
19	47.5
25	62.5

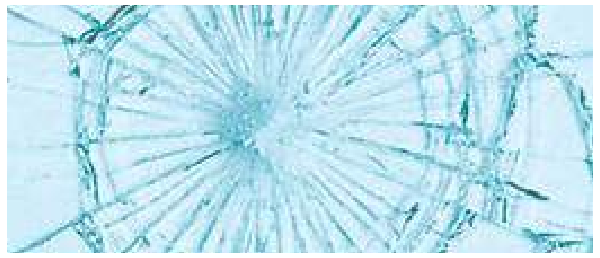
TABLE 14D: CONVERSIONS AND CALCULATIONS

Inches to mm	1 inch = 25.4mm
Fahrenheit to Celsius	C = (f – 32) x 5 ÷ 9
Square feet to Square metres	10.764 square foot = 1m²
π = 3.142857	
Radius of a circle (r)	Centre to outer edge
Diameter of a circle (D)	D = 2 x r
Circumference of a circle (C)	C = πD
Area of a circle	πr^2
Area of a square/rectangle	Height x Width
Perimeter or lineal measurement of a square/rectangle (Lineal metre)	(Height + Width) x 2

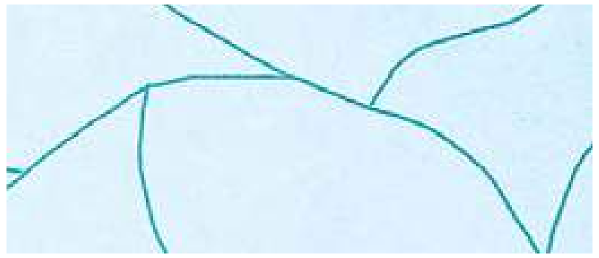
BREAKAGE PATTERNS

Annealed float glass does not resist high stresses from the impact of an object. When broken, it shatters into large sharp pieces.

Laminated safety glass has the about the same impact strength resistance as that of annealed float glass (e.g. 6mm = 6.38mm). If broken, glass remains intact to the interlayer and depending on impact shards do not fly out.



Heat strengthened glass is about twice as strong as annealed float glass and is used generally as a protection against thermal breakage. It is not a Grade A Safety Glass.



Toughened safety glass is up to five times stronger than annealed float glass and offers the highest resistance to impact. If broken, the whole panel of glass shatters into small pieces of blunt granules which are relatively safe. Additionally, the shattered glass falls out quite easily.

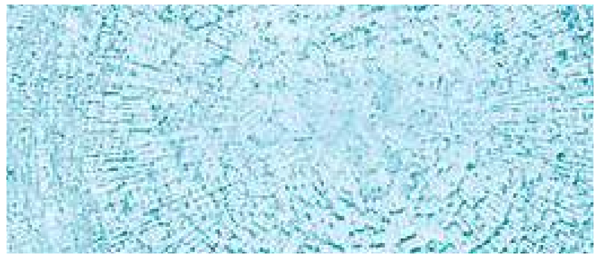
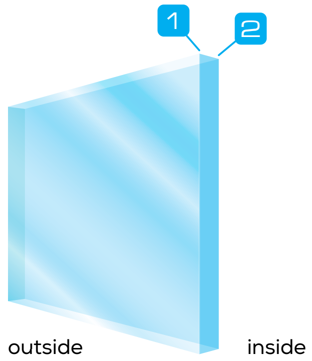
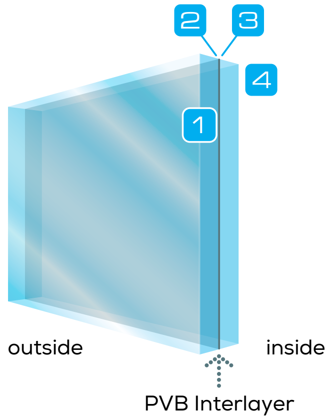


DIAGRAM 14.1:

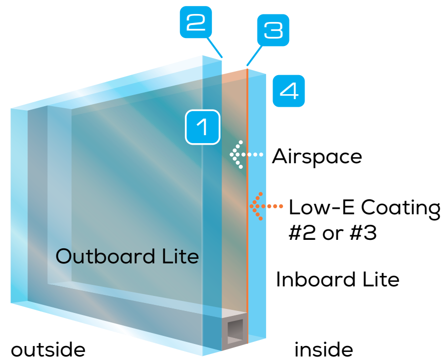
SINGLE MONOLITHIC



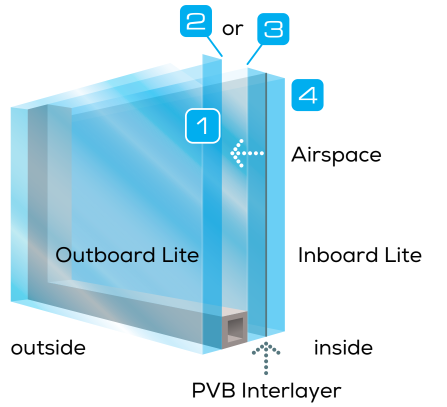
LAMINATED



DOUBLE GLAZING IGU



DOUBLE GLAZING IGU WITH LAMINATED GLASS



* Laminated glass can also be glazed as the outboard lite.

THERMAL BREAKAGE

Thermal breakage occurs where annealed glass breaks due to excessive temperature differences between the centre and the edges of the glass. In this situation while the centre of the glass starts to warm and expand, the edges remain cool thus restricting the expansion, resulting in breakage.

Wired, tinted, reflective, low-E coated glass and IGU's are most susceptible to thermal breakage. Toughening or heat strengthening will prevent thermal breakage. It is recommended that a thermal assessment be carried out to determine the level of stress and/or the possibility of breakage. Consult our technical staff for more information.

FACTORS INFLUENCING THERMAL BREAKAGE

Climate

Consideration should be given to minimum and maximum daytime temperature differences. Breakages can occur, for example with morning temperature rises where the glass can heat up quickly while the edges remain cool.

Edge quality

Annealed glass edges should be clean cut with minimal defects. Thermally suspect laminated glass should have edges flat ground.

Panel size and thickness

The chances of thermal breakage increase as the area of glass and thickness increases because of potential cutting, glazing and handling problems. Any damage introduced to the edge at these stages can impact adversely on the thermal safety of the panel.

Edge cover

The chance of breakage increases with edge cover over 40mm.

Glazing material

Dark coloured materials will promote fewer edge temperature differences than light coloured frames. Concrete and wood have a higher thermal breakage factor than metal or plastic frames.

External shading devices

External shading devices, building overhangs and mullion or column depth which may cast unfavourable shadows will increase the possibility of breakage.

Internal shading and back-up material

Confined spaces can create excessive heat build up. Light coloured blinds or venetians which reflect heat have a higher thermal breakage factor than dark coloured ones. If there is a gap of 50mm or more around the perimeter of the internal shading device, the glass is considered ventilated and a lower breakage factor is applied. In confined spaces such as spandrel glass applications, the glass may be exposed to temperatures over 90°C.

Cooling and heating sources

Direct air streams from these sources onto the glass surface can create excessive temperature differences with resultant breakages.

IGU's

Multiple panel glazing creates higher thermal stress on the outside pane. Thus in certain situations, this pane may have to be heat strengthened or toughened. For spandrel IGU's refer page 25 & 65.

Film application

Application of film products, paper, posters or paint will increase the possibility of thermal breakage.

TABLE 14E: THERMAL BREAKAGE RISK

Glass type	Solar absorption	Risk factor
Clear	18%	Low
Tinted/Low-E	30–40%	Medium
High light transmitting coating on tinted	45–55%	Medium to High
Reflective coating on clear	60–70%	High
Reflective coating on tinted	80–85%	Very high

TABLE 14F: THERMAL STRENGTH

Glass type	Strength
Toughened glass	Strong
Heat strengthened glass	
Thin annealed float glass	
Laminated annealed float glass	
Thick annealed float glass	
Thick annealed laminated glass	
Patterned annealed glass	
Wired glass	Weak

STANDARDS LIST

Listed below are some of the common standards, codes and regulations used in our industry. Please note that this list is a guide only and the year that the standard was released has been omitted. For the latest releases please consult the Building Code of Australia, your local regulatory authority and Standards Australia.

BUILDING CODE OF AUSTRALIA;

Relevant local and state statutory and regulatory requirements;

AS1288	Glass in Buildings- Selection and Installation;
AS/NZS2208	Safety glazing materials in buildings;
AS/NZS2080	Safety glass for land vehicles;
AS/NZS4666	Insulating glass units;
AS/NZS4667	Quality requirements for cut to size and processed glass;
AS/NZS4668	Glossary of terms used in the glass and glazing industry
HB125	The glass and glazing handbook;
AS1170	Structural design actions;
AS2047	Windows in Buildings;
AS4055	Wind loads for housing;
AS1428	Design for access and mobility;
AS3959	Construction of buildings in bushfire prone areas;
AS3740	Waterproofing of wet areas within residential buildings;
AS1926	Swimming pool safety;
AS2820	Gate units for private swimming pools;
AS/NZS4284	Testing of building facades;
AS/NZS2343	Bullet resistant panels and elements;
AS3555	Building elements – Testing and rating for intruder
AS1735	Lifts, escalators and moving walks;
AS1530	Methods for fire tests on buildings materials, components and structures;
AS/NZS1905	Components for the protection of openings in fire resistant walls;
AS2366	Repair of laminated glass windscreens fitted to road vehicles;
AS1799	Small pleasure boat code;
AS5601	Gas installations;
AG601	Gas installations;
AS4551	Domestic gas cooking appliances;
AG101	Domestic gas cooking appliances;
AS/NZS4586	Slip resistance classification of new pedestrian surface materials;
HB197	An introductory guide to the slip resistance of pedestrian surface materials
AS1418	Cranes;
AS2380	Electrical equipment for explosive atmospheres – explosion protection techniques;
AS4114	Spray painting booths.

GLASS SURFACE DAMAGE[1]

For hundreds of years, the lustrous, hard and inert characteristics of glass, coupled with its transparency, have made it one of the world's most desirable and used building materials. Glass has been used in the construction industry for many years on thousands of projects involving billions of square metres of glass.

No glass by itself, exudes, leaches or bleeds any residue or stain causing materials.

WATER DAMAGE

Location of water sprinklers in relation to glass surfaces should be considered early in design. Direct or wind blown hard water spray from water sprinklers can produce tenaciously bonded inorganic residues on glass surfaces. If spraying is repeated and/or wet, dry spray cycles are permitted to remain in contact with glass surfaces, for even short periods of time, costly cleaning procedures may be required. Extended periods of cyclic water spray without frequent cleaning of glass may allow residue build up to develop which cannot be removed. Glass replacement may be the only practical remedy.

RUNOFF AND GLASS DAMAGE

When water reaches a building, it is either reflected, absorbed into the building materials, or allowed to run down the facade. When this water is permitted to run down over masonry, sealants etc., and onto the glass, the water can carry with it contaminants that may react with and adhere with the glass surface. These contaminates could lead to a residue or staining that cannot be removed, which will permanently damage the glass surface.

"Glass may be damaged, etched or stained by a number of materials typically used at a job site. Surface damage may be caused by weld splatter and wind blown debris. Alkaline materials such as concrete wash off and certain cleaning agents may chemically attack the glass surfaces. Rust (iron oxide) will not usually deteriorate the glass surface, but may be very difficult to remove. Silicone concrete sealing materials can discolour glass surfaces. It is good practice to protect glass surfaces whenever practical during construction of the building. Special attention should be paid to reflective glass. These are not any more susceptible to damage than uncoated glass. However, scratches and other damage on the coating are more noticeable."[2]

SEALANTS

Organic sealants used in today's glazing systems may exude, bleed or leach solvents, oils and/or plasticisers etc., under normal weathering conditions. Depending on the type of sealant used and the weathering conditions encountered, residue from sealants can vary dramatically in content, degree and the time period over which the residue continues to exude from the sealant. Generally, the degree of residue from sealants will diminish asymptotically over time. In the great majority of projects, frequent cleaning of glass will remove deposits or residue using normal wash and rinse glass cleaning methods.

When residue from sealants is allowed to remain in contact with glass surfaces over a long period of time without frequent washing of the glass, the residue may become tenaciously bonded to the surface of the glass due to normal weathering. If the residue is permitted to have a long residence time, very costly cleaning techniques may be required to remove the residue from glass surfaces.

Due to exuding, leaching or bleeding, sealants need not necessarily be in direct contact with glass to produce a residue on glass. If sealants are used in areas surrounding the glass e.g. in metal expansion joints, parapet sealing, metal or masonry weatherseals etc., residue from these sealants may still run down and deposit on the glass surfaces either by gravity or through the action of rain.

1. Extract from: C.O. Peterson, Jr, Director, Technical Services and Product Development PPG November 30, 1981 Residue on Glass bulletin.
2. Extract from: Metal Curtain Wall, Window, Store Front and Entrance Guide Specifications Manual 1976 by Architectural Aluminium Manufacturers Association.

METALS

Weathering steels, for example, release oxides while aging. These oxide deposits should be removed from glass by regular cleaning methods initiated during construction. If the metal oxides are permitted to wash over glass and are permitted to accumulate, they can leave a deposit that is tenaciously adhered, requiring costly cleaning techniques to remove the residue from the glass surface.

MASONRY

Staining (and in some cases, etching) of glass can result from substances released from concrete facades and concrete window frames. Rainfall can permeate concrete and then leach alkaline materials from it and deposit them on the glass. In some instances this may cause surface staining and etching.

Concrete frames at window heads should be designed so that any runoff is directed away from the glass. Edge drips and a second drip, as another line of defence, should be provided. Precast panels and all other concrete for outdoor walls should be processed for thorough mixing, full hydration and complete curing. Concrete surface treatments (with acid, sandblasting, grouting, waterproofing etc.) must be completed before glazing begins. Any loose particles resulting from these operations should be removed by normal wash, rinse and dry cleaning.

It is essential that these surface treatments be completed prior to glazing. Glass should be examined weekly during construction when it is installed adjacent to or below concrete or other masonry surfaces which are exposed to weather. When inspections reveals dirt, scum, alkali deposits or staining, glass should be immediately washed.

DESIGN RECOMMENDATIONS

Early in the design stage, architects should consider glazing details designed to avoid water run-off onto glass surfaces. The use of reveals, splays, flashing, drips etc. from sealants, masonry or metals can minimize run-off and avoid the deposition of residue onto the glass.

PROTECTIVE COATINGS

A number of protective coatings are available including temporary roll on and peel off coatings for protection during construction and more permanent coatings which offer greater resistance to scratching and provide ease of cleaning. Both are particularly relevant where there are lowE coatings which are more susceptible to construction and cleaning damage. Window fabricators also tape the frames for the same protective purposes.

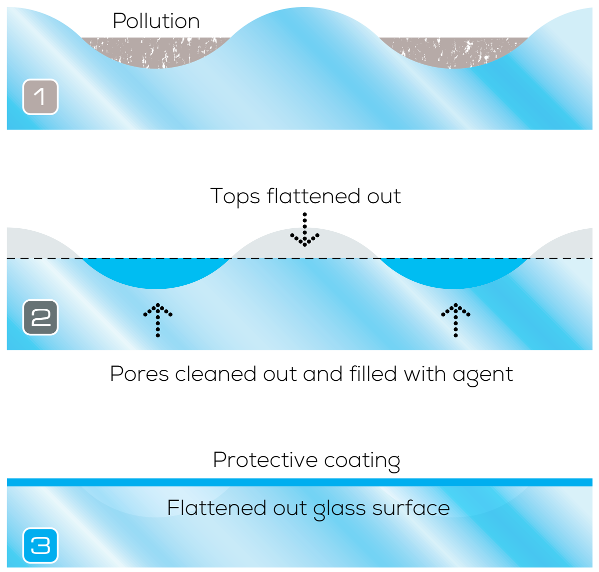
RESTORING SURFACE DAMAGE

Depending on the level of glass surface damage, there are a few restoring agents available that can remove mineral deposits, hard stains, rainbow stains etc. These products renovate and protect the glass in a single application (Diagram 14.2 illustrates how restoring agents work).

- A glass surface is not flat. Pollution will collect in the open pores and is normally very difficult to remove (1);
- During the restoration with agents, the structure of the glass surface will be altered. The "tops" of the glass will be flattened out and pores are cleaned and filled with a protective coating up. This is possible through the agents special chemical structure. During this process all existing pollution will be removed from the surface of the glass (2);
- The result is a flat glass surface, free from pollution. The surface now has very low friction. This makes it very difficult for pollution to stick to the surface. In addition, a silicone based protecting layer has been added to the surface, making future cleaning easier, cheaper and faster. Cleaning will also be required less frequently. Storage problems like fungus, stains, rainbow-stains will be avoided after application (3).

For instructions on protection and cleaning of low-E coated surfaces (Reflective, Low-E, Sunergy®) and mirror, refer to the relevant section in this catalogue.

DIAGRAM 14.2: GLASS RESTORING AGENTS



PROTECTION & CLEANING

FILMS

Since National Glass has been manufacturing toughened glass, this product has been supplied with a clear semi-bonding film applied to both sides. This was done to protect toughened glass, as a value added product, during handling and transportation. Over time, customers have seized an opportunity to leave this film in situ as a site protection measure, often for long periods.

NATIONAL GLASS SUPPLIES PLASTIC FILM COATED GLASS ON THE FOLLOWING BASIS:

- It should be removed within the manufacturers recommended time frame. This time frame is generally within one month of glazing and exposure to sunlight;
- If used onsite, no responsibility is taken for (1) the effects of damage to glass surface as a result of partial or full removal of the film by wind and/or rain and (2) staining that may occur as a result and (3) other contaminants that may leach between the glass and film.

SCREENS

Temporary screens may be required if other trades (i.e. welding, sand blasting, floor sanding and cutting) are in progress near to the glass to protect it from damaging off spray and particles.

STORAGE

When storing glass, it should be leaned against a structural frame with full vertical and horizontal support. The angle of lean should be approximately 7° from the vertical. Paper should be placed between the sheets to prevent rubbing or scratching during storage or transport. If the glass is wet, the panels should be removed and dried and paper interleaved with butcher paper.

CLEANING AND MAINTENANCE GUIDE

GENERAL

- Carefully read and comply to any chemical agent or detergent material data sheets or instruction documents before use. When in doubt, contact the manufacturer. Try to limit their use to the very strict minimum.
- All products containing hydrofluoric acid or fluorine derivatives are prohibited since they can damage the coating and the surface of the glass.
- Highly acidic and alkaline products are prohibited, as they are abrasive products.
- Ensure chemical compatibility between products used and other components (seals, paints used on the frame, aluminium, stone, etc.).
- When carrying out the special cleaning regime as listed below, always start with a trial on a small area.
- Do not wash glass when it is fully exposed to the sun. Avoid washing it when it is too cold or hot.
- Make sure that cloths, sponges, squeegees and other tools are in good condition at all times and are free of grit.

Low-E coated – Sunergy Coated glass – the coatings on these glass products are generally more difficult to clean than ordinary non-coated glass. Running the clean palm of your hand across the surface of the glass will indicate that the coated side is more resistant or less smooth on touch than the non-coated side. Therefore, some caution should be applied with regards processing, handling, protection and cleaning of the glass.

1. NORMAL CLEANING

ORDINARY GLASS

- In most cases, glass can be washed with plenty of clean water or with mild soap, detergent or recommended glass cleaner solution.
- Before starting the clean, ensure jewelery and watches are removed and gloves should be worn.
- Use only soft clean cloths, sponges free from grit.
- Flood the glass surface with selected cleaning solution or with a cloth saturated with the cleaning solution. Be generous with the amount of solution applied.
- Wipe dry with a dry, clean, lint free towel or cloth and excess cleaning solution can be removed with squeegee.
- Never use abrasive cleaners on the glass surface.
- Paint spots can attempt to be removed with a gem blade or scraper in conjunction with glass cleaner. Care should be taken not to damage or scratch the surface.

Low-E coated/Sunergy Glass – As per ordinary glass above, however, do not use squeegee on interior coated glass surfaces and avoid contact with metal objects.

2. FREQUENCY

How often the glass needs to be cleaned will depend on the surrounding environmental conditions and pollution levels. Glass gets dirtier in dusty, industrial areas, in areas with lots of road traffic, near the sea or when it is not exposed to very much rain. Failure to take certain precautions when designing the facade or installing the glass can also play a role. (e.g roof glazing shall have a minimum slope of 10° vs horizontal). Glass should be cleaned frequently enough to the normal cleaning procedure described above. The recommended minimum frequency is every six months.

3. SPECIAL CLEANING

When normal cleaning methods are not enough, other steps can be taken:

- Before starting the clean, ensure jewelery and watches are removed and gloves should be worn.
- Oily spots, fingerprint marks, mastic or silicone stains and other organic pollution can attempt to be removed with solvents such as isopropyl alcohol or acetone applied with a soft, clean cloth. Follow manufacturers guidelines and instructions before use.
- Paint spots can attempt to be removed with a gem blade or scraper in conjunction with glass cleaner. Care should be taken not to damage or scratch the surface.
- Rinse thoroughly and then follow the normal cleaning procedure.

4. SPECIAL INSTRUCTIONS FOR COATED GLASS

Coated glass – such as Low- E or Sunergy Glass have a metal oxide coating that is applied to the glass. These coatings are very resistant and durable. No particular precautions need to be taken when the coating is positioned on the inside of an insulated glass unit (position 2 or 3, i.e. in contact with the air/gas layer).

For single glazing when the coating is facing the inside of the building, the normal and special cleaning procedures described above are also suitable. However, bear in mind that a transparent and very thin metal surface is being washed and that;

- Any scratching will penetrate the surface of the coating and cannot be repaired.
- Do not use squeegee on interior coated glass surfaces.
- Any excessive mechanical treatment might remove the coating in localised areas.
- Avoid all contact with metal objects.
- Avoid all chemicals that would attack the surface and damage it irreparably.

Consequently, special care should be taken to follow the guidelines and precautions set out in this document. In areas with high levels of pollution, treatments and products supplied by experienced professionals could be a preferred solution.

5. SPECIAL INSTRUCTIONS FOR ACID ETCHED GLASS

In most cases, acid etched glass can be washed with plenty of clean water and a soft sponge or glass cleaner. The following points should also be adhered to;

Never use aggressive cleaning materials such as razor blades, steel wool, abrasive materials to clean glass.

Always clean the full surface of the acid etched glass using water or glass cleaner even if only one small area of the glass is dirty. Never do spot cleaning, because it might create halos on the glass.

Once cleaned, the glass should be rinsed with clean water and wiped off all over with a soft lint free cotton cloth. If any stain still remains, repeat the sequence.

Use plenty of water to avoid scratching or damaging the surface of the glass. Never try to remove impurities with a dry and/or dirty cloth, as this may cause scratches on the glass surface by rubbing impurities on the glass.

During the whole cleaning process, never apply any excessive pressure as this may damage the acid etched glass surface by polishing it too much.

Heavily soiled surfaces may be washed using a high pressure cleaning device with water temperature of at least 30oC.

Always use standard glass cleaners containing alcohol to clean the acid etched glass.

Never use products containing hydrofluoric acid, fluorine, chlorine or ammonia derivatives because they can damage the surface of the glass.

Never use acidic or alkaline products as they can abrade the glass surface.

Consequently, special care should be taken to follow the guidelines and precautions set out in this document. In areas with high levels of pollution, treatments and products supplied by experienced professionals could be a preferred solution.

6. PREVENTION

Taking steps to prevent the build-up of dirt is the best way to prevent cleaning problems and also to lower cleaning costs. For example:

DURING THE DESIGN PHASE:

- Make sure that water drainage and discharge systems are in place to prevent runoff of polluted water over the glass. Water tends to gather pollutants as it runs over bricks, concrete, zinc, roofing materials and so on.
- Make sure that it is possible to gain access to the glass so that it can be cleaned.

DURING THE INSTALLATION PHASE:

- Prevent runoff from plaster, concrete, rust, excessive dust, etc.
- Prevent pollution and spatters of paint, facade treatment products, etc.
- Prevent metal particles from welding or grinding works to come in contact with the glass. This kind of damage cannot be repaired.
- Where necessary, protect the glass with tarpauling or other suitable sheeting to provide a dry, well ventilated air space.
- Do not use sealants, putties, oils, silicones, etc. that leave streaks on the glass.

GLASS PERFORMANCE DATA

CALCULATING GLASS PERFORMANCE DATA – WINDOW

WINDOW is an MS-Window based software-modelling program used to determine the optical and thermal performance properties of glass and windows. The program was developed by LBNL (Lawrence Berkeley National Laboratory USA). This program contains the International Glass Database (IGDB), which is an extensive collection of glazing products from around the world.

NFRC 100-2010

A National Fenestration Rating Council (NFRC–USA) document specifying the environmental conditions, (e.g. wind speeds, internal and external temperatures, solar radiation levels and heat transfer coefficients); and procedure used to determine the performance characteristics of a glazing. The Australian glass and glazing industry has adopted the NFRC 100-2010 methodology. The AFRC (Australian Fenestration Rating Council) is an international partner to the NFRC by which all the same processes and procedures are followed.

The NFRC is a 'non-profit organisation that administers the only uniform, independent rating and labeling system for the energy performance of windows, doors, skylights, and attachment products' in the United States. One of their main functions is to 'establish uniform procedures for determining the various energy performance ratings' of glazing materials.

Different environmental conditions, e.g. European, alter the parameters used in the calculation of glass performance data, resulting in different values. Care should be taken when comparing performance figures to ensure they are calculated using the same environmental conditions.

DEFINITIONS OF PERFORMANCE VALUES

SOLAR CONTROL

The energy emitted from our Sun is referred to as solar energy or solar radiation. Solar control makes reference to the ability of glass to control or reduce the sun's direct heat energy on a window. Solar control also refers to the ability of a glass to reduce visible light and UV transmittance.

Look for the following performance values to measure solar control:

- Solar heat gain co-efficient (SHGC);
- Visible light transmittance;
- UV transmission.

THERMAL CONTROL

The Sun's direct transmission on the glass is not the only way in which heat is transferred. Heat is also transferred by method of re-radiation, conduction and convection. Thermal control refers to the ability of a glazing to resist heat transfer through these three methods. (Similar to the functional performance of batt or insulation foil for walls and ceilings).

Adding an additional pane of glass (IGU) and modifying the surface of the glass with a low-E coating will improve the insulation properties of the glass when compared to ordinary non coated glass. These thermal or insulation improvements work day and night in both summer and winter conditions, reducing heat entry and heat loss. Only low-E coated glass and IGU's can provide improved thermal control.

See also "U-value".

VISIBLE LIGHT TRANSMITTANCE (VLT)

This term is used to describe the percentage level of interior daylight that a particular glass lets through. The higher the number the brighter the interior will be.

VISIBLE LIGHT EXTERNAL REFLECTANCE (VLR)

This refers to the percentage level of visible light that is reflected externally by a glass as detected by the human eye. This is a useful measure for glass where:

- Restrictions exist on the level of reflection allowed;
- The higher the percentage number the greater the mirror like appearance.

VISIBLE LIGHT INTERNAL REFLECTANCE VLRi

This refers to the percentage level of visible light that is reflected internally by a glass as detected by the human eye. This is a useful measure when determining the level of internal reflectance at night time. All glass products (apart from specialty anti-reflecting) have internal reflectances which make it difficult to see clearly out of a window at night time (with lights on inside) conditions. Internal reflectances increase with the use of reflective coated glass products.

SOLAR HEAT GAIN CO-EFFICIENT (SHGC)

Refers to the total amount of solar energy transmittance entering a building through the glazing as heat gain. This measure equates to the Sun's direct transmittance energy plus the part of this energy absorbed by the glass and re-radiated inside. The lower the number the less heat gain. It's most commonly used in regards to the cooling of the building. SHGC can also be calculated as 86% of the Shading Co-efficient. 3mm clear float for example, has a SHGC of 0.86.

THE SHGC CAN ALSO BE STATED IN THE FOLLOWING WAYS:

- 3mm clear lets in 86% of the sun's total direct heat;
- 3mm clear keeps out only 14% of the sun's total direct heat.

Another way to describe how the SHGC is used is in terms of energy consumption in watts/m^2.

For example the sun's direct energy typically radiates on a hot day 785 watts per m^2 and 6mm Sunergy® Green has a SHGC of 0.41. If you multiply 785 watts x 0.41 (SHGC) you get 322 watts radiated into the building. In this example the Sunergy® glass is reducing the sun's direct energy through the glass into the building by 59%.

SHGC has a trade-off relationship with visible light transmittance. In general, the lower the SHGC, the lower the levels of visible light which will be transmitted. This can in some instances affect the amount of artificial lighting needed and the interior brightness of a room. SHGC is sometimes also referred to as the solar factor (SF).

SHADING CO-EFFICIENT

This term indicates the total amount of solar energy that passes through a glass as compared to 3mm clear float (3mm clear float has a base factor of 1.00). The lower the shading co-efficient value, the lower the level of heat entry into a room or interior.

UV TRANSMISSION

This refers to the percentage of the sun's harmful ultra violet light (UV) that is transmitted through glass. Ultra violet light aids in fading and damaging furniture, carpets etc and can be harmful to people. It is most commonly measured in the 300–400nm wavelength range.

U-VALUE

U-value measures the rate of heat flow through the glazing by conduction, convection and re-radiation. It does not measure heat transfer by the Sun's direct transmittance as measured by the SHGC. It is a rating system used almost exclusively by the window/glass industry worldwide. Other industries use the "R" value for measuring insulation. U-value is measured in watts per square metre per degree Celsius (Wm^2K) difference. The amount of heat energy transferred as measured by the U-value can be calculated by taking for example 4mm clear float with a U-value of 5.9w/m^2°C and multiplying the difference between outdoor and indoor temperature (32°C outside and 24°C inside = 8°C) › 5.9 x 8°C = 47watts per m^2 heat transferred between the outside and inside. The lower the U-value the better the thermal insulation properties of the glazing system.

The U-value is the reciprocal of the "R" value and either can be calculated from the other e.g. U = 1/R or R = 1/U.

U and R values are variable and dependent upon climatic conditions. That means that the transmittance of heat through a glazing system changes. Therefore glass transmits heat at varying rates depending upon the prevailing climatic condition. When comparing glazing systems based upon U-value, it is important that the climatic conditions used to model all the systems are the same. The standard climate conditions used to calculate U-values in this catalogue are based upon NFRC 100 – 2010 methodology.

RELATIVE HEAT GAIN RHG W/M²

Relative heat gain combines the shading co-efficient with U-value to measure the total heat gain for summer time conditions. This is particularly useful for building designers to determine air-conditioning loads.

The formula is:

SC (Shading co-efficient) x W/m^2 (Direct solar intensity)

\+

U-value W/m^2 (Summer U-value) x 8°C (Difference between outdoor and indoor temperature)

The conditions formulated to determine the RHG are by ASHRAE (American Society for Heating, Refrigeration and Air-conditioning Engineers).

SINGLE GLASS PERFORMANCE VALUES

COLOUR AND TYPE	VLT VISIBLE LIGHT TRANSMISSION %	VLR VISIBLE LIGHT REFLECTANCE EXTERNAL %	VLRi VISIBLE LIGHT REFLECTANCE INTERNAL %	SHGC	U-VALUE W/M2K
CLEAR FLOAT					
3mm	90	8	8	0.86	5.9
4mm	89	8	8	0.84	5.9
5mm	88	8	8	0.82	5.8
6mm	88	7	7	0.81	5.8
8mm	87	7	7	0.77	5.7
10mm	86	7	7	0.75	5.7
12mm	84	7	7	0.72	5.6
15mm	83	6	6	0.71	5.5
19mm	81	6	6	0.67	5.4
LOW-IRON EXTRA CLEAR					
6mm	92	8	8	0.91	5.8
8mm	91	8	8	0.90	5.7
10mm	91	8	8	0.89	5.7
12mm	90	8	8	0.88	5.7
13.52mm (6+6)	89	8	8	0.84	5.4
17.52mm (6+10)	89	8	8	0.83	5.3
21.52mm (10+10)	89	9	8	0.82	5.2
TINTED FLOAT GLASS					
5mm Bronze (VFloat™)	54	6	6	0.64	5.9
6mm Bronze (VFloat™)	51	5	5	0.65	5.8
10mm Bronze (VFloat™)	34	5	5	0.54	5.7
5mm Dark Grey	22	4	4	0.57	5.8
6mm Dark Grey	15	4	4	0.53	5.8
5mm Green (Guardian ME)	79	8	8	0.65	5.8
6mm Green (Panasap)	70	6	6	0.56	5.8
10mm Green (Guardian ME)	68	7	7	0.53	5.7
4mm Grey (Euro)	56	6	6	0.69	5.9
5mm Grey (Euro)	50	5	5	0.65	5.8
6mm Grey (Euro)	44	5	5	0.61	5.8
8mm Grey (Euro)	34	5	5	0.55	5.7
10mm Grey (Euro)	26	4	4	0.50	5.7
12mm Grey (Euro)	20	4	4	0.47	5.6
6mm Dark Blue	58	6	6	0.59	5.8
6mm Super Blue	53	6	6	0.52	5.8
6mm Super Green	67	6	6	0.52	5.8
6mm Super Grey	9	4	4	0.35	5.8
LAMINATED					
CLEAR					
6.38mm	88	8	8	0.80	5.7
8.38mm	87	7	7	0.76	5.7
10.38mm	85	7	7	0.73	5.6
11.52mm	85	7	7	0.72	5.4
12.38mm	84	7	7	0.71	5.6
13.52mm	84	7	7	0.70	5.4
TINTED PVB					
6.38mm Bronze	52	6	6	0.64	5.7
6.38mm Green	71	7	7	0.73	5.7
6.38mm Grey	44	5	5	0.63	5.7
8.38mm Bronze	51	5	5	0.62	5.7

SINGLE GLASS PERFORMANCE VALUES

COLOUR AND TYPE	VLT VISIBLE LIGHT TRANSMISSION %	VLR VISIBLE LIGHT REFLECTANCE EXTERNAL %	VLRi VISIBLE LIGHT REFLECTANCE INTERNAL %	SHGC	U-VALUE W/M2K
TINTED PVB CONTINUED					
8.38mm Green	70	6	6	0.69	5.7
8.38mm Grey	44	5	5	0.60	5.7
10.38mm Bronze	50	5	5	0.60	5.6
10.38mm Green	68	6	6	0.67	5.6
10.38mm Grey	43	5	5	0.58	5.6
11.52mm Grey	43	5	5	0.57	5.4
12.38mm Bronze	50	5	5	0.59	5.6
12.38mm Green	69	6	6	0.66	5.6
12.38mm Grey	42	5	5	0.57	5.6
13.52mm Grey	42	5	5	0.56	5.4
WHITE TRANSLUCENT PVB					
6.38mm	66	7	7	0.67	5.7
8.38mm	66	7	7	0.67	5.7
10.38mm	64	7	7	0.64	5.6
12.38mm	64	6	6	0.64	5.6
ACOUSTA™					
6.76mm Clear	87	8	8	0.78	5.7
8.76mm Clear	86	7	7	0.75	5.6
10.76mm Clear	84	7	7	0.72	5.6
12.76mm Clear	84	7	7	0.70	5.5
7.14mm Grey	42	5	5	0.61	5.6
9.14mm Grey	41	5	5	0.59	5.6
11.14mm Grey	40	5	5	0.57	5.5
13.14mm Grey	40	5	5	0.56	5.4
LOW-E COATED					
SUNERGY® (2) LOW-E					
4mm Neutral	67	9	10	0.59	4.2
5mm Neutral	67	9	10	0.59	4.1
6mm Neutral	69	9	10	0.59	4.0
8mm Neutral	67	8	10	0.56	4.0
10mm Neutral	68	8	10	0.56	4.0
6mm Dark Blue	41	6	9	0.39	4.0
6mm Green	56	7	9	0.42	4.0
6mm Grey	33	5	9	0.41	4.0
5mm Cool	50	7	9	0.50	4.4
6mm Cool	52	7	9	0.50	4.3
SUNERGY® LAMINATED (4) LOW-E					
6.38mm Neutral	67	9	11	0.57	4.0
8.38mm Neutral	65	8	10	0.54	4.0
10.38mm Neutral	65	8	10	0.54	3.9
12.38mm Neutral	66	8	10	0.53	3.9
17.52mm Neutral (8 + 8)	63	8	10	0.49	3.7
21.52mm Neutral (10 + 10)	62	8	10	0.49	3.7
6.38mm Grey	34	5	9	0.44	4.0
8.38mm Grey	33	5	9	0.42	4.0
10.38mm Grey	33	5	9	0.42	3.9
12.38mm Grey	33	5	9	0.41	3.9
17.52mm Grey (8 + 8)	32	5	9	0.39	3.7
21.52mm Grey (10 + 10)	31	5	9	0.38	3.7

SINGLE GLASS PERFORMANCE VALUES

COLOUR AND TYPE	VLT VISIBLE LIGHT TRANSMISSION %	VLR VISIBLE LIGHT REFLECTANCE EXTERNAL %	VLRi VISIBLE LIGHT REFLECTANCE INTERNAL %	SHGC	U-VALUE W/M2K
SUNERGY® LAMINATED (4) LOW-E CONTINUED					
11.52mm Sunergy Grey	32	5	9	0.40	3.8
13.52mm Sunergy Grey	32	5	9	0.39	3.8
6.38mm Green	54	7	10	0.51	4.0
8.38mm Green	52	7	10	0.49	4.0
10.38mm Green	54	7	10	0.49	3.9
12.38mm Green	53	7	10	0.48	3.9
11.52mm Sunergy Green	54	7	9	0.40	3.8
13.52mm Sunergy Green	53	7	9	0.40	3.8
SOL-R™ (2) LOW-E					
4mm SOL-R Clear 73	82	11	12	0.73	3.8
5mm SOL-R Clear 71	82	10	11	0.71	3.7
6mm SOL-R Clear 70	81	10	11	0.70	3.7
8mm SOL-R Clear 69	81	10	11	0.69	3.7
10mm SOL-R Clear 66	80	10	11	0.66	3.7
4mm SOL-R Neutral 54	60	7	9	0.54	3.7
6mm SOL-R Neutral 53	60	8	9	0.53	3.7
10mm SOL-R Neutral 50	60	8	9	0.50	3.6
SOL-R™ LAMINATED (4) LOW-E					
6.38mm SOL-R Clear 73	83	11	11	0.73	3.6
8.38mm SOL-R Clear 66	80	10	11	0.66	3.7
9.52mm SOL-R Clear 65	79	10	11	0.65	3.6
10.38mm SOL-R Clear 65	80	10	11	0.65	3.5
11.52mm SOL-R Clear 62	78	10	11	0.62	3.5
12.38mm SOL-R Clear 61	77	10	11	0.61	3.6
13.52mm SOL-R Clear 60	77	10	11	0.60	3.5
6.38mm SOL-R Neutral 51	59	7	9	0.51	3.6
8.38mm SOL-R Neutral 50	60	8	10	0.50	3.6
9.52mm SOL-R Neutral 50	59	8	10	0.50	3.5
10.38mm SOL-R Neutral 50	62	8	9	0.50	3.6
11.52mm SOL-R Neutral 50	61	8	9	0.50	3.5
12.38mm SOL-R Neutral 49	61	8	9	0.49	3.5
13.52mm SOL-R Neutral 48	60	8	9	0.48	3.5
6.38mm SOL-R Grey 50	39	6	9	0.50	3.6
8.38mm SOL-R Grey 49	40	6	9	0.49	3.7
9.52mm SOL-R Grey 49	40	6	9	0.49	3.6
10.38mm SOL-R Grey 47	39	5	9	0.47	3.6
11.52mm SOL-R Grey 47	39	5	9	0.47	3.5
12.38mm SOL-R Grey 46	39	5	9	0.46	3.6
13.52mm SOL-R Grey 45	39	5	9	0.45	3.5
8.38mm SOL- R Grey 41	38	6	9	0.41	3.6
9.52mm SOL-R Grey 41	37	6	9	0.41	3.5
10.38mm SOL-R Grey 41	39	6	8	0.41	3.6
11.52mm SOL-R Grey 41	39	6	8	0.41	3.5
12.38mm SOL-R Grey 36	30	5	8	0.36	3.5
13.52mm SOL-R Grey 36	30	5	8	0.37	3.5
8.38mm SOL-R Green 59	64	8	10	0.59	3.7
9.52mm SOL-R Green 59	64	8	10	0.58	3.6
10.38mm SOL-R Green 56	63	8	10	0.56	3.6
11.52mm SOL-R Green 56	63	8	10	0.56	3.5

SINGLE GLASS PERFORMANCE VALUES

COLOUR AND TYPE	VLT VISIBLE LIGHT TRANSMISSION %	VLR VISIBLE LIGHT REFLECTANCE EXTERNAL %	VLRi VISIBLE LIGHT REFLECTANCE INTERNAL %	SHGC	U-VALUE W/M2K
SOL-R™ LAMINATED (4) LOW-E CONTINUED					
12.38mm SOL-R Green 54	62	8	10	0.54	3.6
13.52mm SOL-R Green 54	62	8	10	0.54	3.5
12.38mm SOL-R Super Green 35	46	6	9	0.35	3.5
13.52mm SOL-R Super Green 35	46	7	9	0.35	3.5
8.38mm SOL-R Blue 61	66	9	11	0.61	3.7
9.52mm SOL-R Blue 60	66	8	11	0.60	3.6
10.38mm SOL-R Blue 58	65	8	10	0.58	3.6
11.52mm SOL-R Blue 58	65	8	10	0.58	3.5
12.38mm SOL-R Blue 56	64	8	10	0.56	3.6
13.52mm SOL-R Blue 56	64	8	10	0.56	3.5
12.38mm SOL-R Super Blue 34	36	6	8	0.34	3.5
13.52mm SOL-R Super Blue 34	36	6	8	0.34	3.5
SOL-XT™ LAMINATED (4) LOW-E					
8.76mm SOL-XT Neutral 44	68	9	11	0.44	3.7
9.52mm SOL-XT Neutral 44	67	9	11	0.44	3.6
10.76mm SOL-XT Neutral 43	66	8	10	0.43	3.6
11.52mm SOL-XT Neutral 44	66	8	10	0.43	3.5
12.76mm SOL-XT Neutral 43	65	8	10	0.43	3.6
13.52mm SOL-XT Neutral 43	65	8	10	0.43	3.5
8.76mm SOL-XT Blue/Green 37	51	7	9	0.37	3.6
9.52mm SOL-XT Blue/Green 37	50	7	9	0.37	3.5
10.76mm SOL-XT Blue/Green 37	52	7	9	0.37	3.5
11.52mm SOL-XT Blue/Green 37	52	7	9	0.37	3.5
12.76mm SOL-XT Blue/Green 37	51	7	9	0.37	3.5
13.52mm SOL-XT Blue/Green 37	51	7	9	0.37	3.5
8.76mm SOL-XT Grey 37	43	6	10	0.37	3.7
9.52mm SOL-XT Grey 37	42	6	9	0.37	3.6
10.76mm SOL-XT Grey 36	42	6	9	0.36	3.6
11.52mm SOL-XT Grey 36	41	6	9	0.36	3.5
12.76mm SOL-XT Grey 33	33	5	9	0.33	3.6
13.52mm SOL-XT Grey 33	33	5	9	0.33	3.5
8.76mm SOL-XT Grey 32	32	5	9	0.32	3.6
9.52mm SOL-XT Grey 32	32	5	9	0.32	3.5
10.76mm SOL-XT Grey 32	33	5	8	0.32	3.5
11.52mm SOL-XT Grey 32	33	5	8	0.32	3.5
12.76mm SOL-XT Grey 30	26	5	8	0.30	3.5
13.52mm SOL-XT Grey 30	26	5	8	0.30	3.5
10.76mm SOL-XT Green 35	51	7	10	0.35	3.7
11.52mm SOL-XT Green 35	50	7	10	0.35	3.6
12.76mm SOL-XT Green 34	50	7	10	0.34	3.6
13.52mm SOL-XT Green 34	49	7	10	0.34	3.5
10.76mm SOL-XT Blue 33	40	6	9	0.33	3.7
11.52mm SOL-XT Blue 33	40	6	9	0.33	3.6
12.76mm SOL-XT Blue 33	39	6	9	0.33	3.6
13.52mm SOL-XT Blue 33	39	6	9	0.33	3.5

SINGLE GLASS PERFORMANCE VALUES

COLOUR AND TYPE	VLT VISIBLE LIGHT TRANSMISSION %	VLR VISIBLE LIGHT REFLECTANCE EXTERNAL %	VLRi VISIBLE LIGHT REFLECTANCE INTERNAL %	SHGC	U-VALUE W/M2K
COMFORTPLUS™ (4) LOW-E					
6.38mm Neutral 59	59	7	9	0.51	3.6
6.38mm Clear 82	82	10	11	0.68	3.6
6.38mm Grey 40	39	6	9	0.50	3.6
ETECH GREY (2) LOW-E					
6mm Etech Grey	40	6	9	0.47	3.7
EVANTAGE™ (2) LOW-E					
6mm Clear EV	68	23	26	0.63	3.8
6mm Grey EV	32	10	27	0.41	3.8
6mm Super Green EV	49	16	27	0.37	3.8
6mm Blue/Green EV	56	19	27	0.45	3.8
6mm Super Blue EV	39	12	27	0.36	3.8
6mm Bronze EV	38	11	27	0.45	3.8
SOLTECH™ (2) LOW-E					
4mm Soltech	61	8	10	0.53	3.7
6mm Soltech	63	9	10	0.53	3.7
10mm Soltech	60	8	9	0.50	3.6
6mm Soltech Grey	30	5	8	0.36	3.7

INSULATED GLASS UNITS PERFORMANCE VALUES

COLOUR AND TYPE	VLT VISIBLE LIGHT TRANSMISSION %	VLR VISIBLE LIGHT REFLECTANCE EXTERNAL %	VLRi VISIBLE LIGHT REFLECTANCE INTERNAL %	SHGC	U-VALUE W/M2K
DUO PLUS (IGU'S)					
CLEAR					
4mm Clear 12mm/ 4mm Clear	80	14	14	0.74	2.6
5mm Clear 12mm/ 5mm Clear	78	14	14	0.71	2.5
6mm Clear 12mm/ 6mm Clear	78	13	13	0.70	2.5
8mm Clear 12mm/ 6mm Clear	77	13	13	0.66	2.5
10mm Clear 12mm/ 8mm Clear	75	12	12	0.62	2.5
6.38mm Clear 12mm/ 6mm Clear	78	14	14	0.68	2.5
6.38mm Clear 12mm/ 6.38mm Clear	78	14	14	0.68	2.5
6.76mm ACOUSTA™ Clear 12mm/ 6mm Clear	77	14	14	0.67	2.5
TINTED					
4mm Grey 12mm/ 4mm Clear	50	8	12	0.58	2.6
5mm Grey 12mm/ 5mm Clear	44	7	12	0.52	2.6
6mm Grey 12mm/ 6mm Clear	39	7	11	0.48	2.5
6.38mm Grey 12mm/ 6mm Clear	39	7	11	0.50	2.5
6mm Dark Grey 12mm/ 6mm Clear	13	5	11	0.39	2.5
6mm Green 12mm/ 6mm Clear	62	10	12	0.44	2.5
6mm SuperBlue 12mm/ 6mm Clear	47	8	12	0.39	2.5
6mm SuperGreen 12mm/ 6mm Clear	59	10	12	0.40	2.5
6mm SuperGrey 12mm/ 6mm Clear	8	4	11	0.21	2.5
7.14mm ACOUSTA™ Grey 12mm/ 6mm Clear	39	7	11	0.49	2.5
SUNERGY® LOW-E					
4mm Sunergy Neutral (2) 12mm/ 4mm Clear	60	12	16	0.50	1.9
6mm Sunergy Neutral (2) 12mm/ 6mm Clear	61	12	16	0.50	1.8
8mm Sunergy Neutral (2) 12mm/ 6mm Clear	60	12	15	0.47	1.8
10mm Sunergy Neutral (2) 12mm/ 8mm Clear	59	12	15	0.47	1.8
6mm Green Sunergy (2) 12mm/ 6mm Clear	49	9	15	0.32	1.8
6mm Grey Sunergy (2) 12mm/ 6mm Clear	30	6	14	0.32	1.8
6.38mm Sunergy Neutral (2) 12mm/ 6mm Clear	60	12	16	0.48	1.8
6.38mm Sunergy Grey PVB (2) 12mm/ 6mm Clear	30	6	15	0.34	1.8

INSULATED GLASS UNITS PERFORMANCE VALUES

COLOUR AND TYPE	VLT VISIBLE LIGHT TRANSMISSION %	VLR VISIBLE LIGHT REFLECTANCE EXTERNAL %	VLRi VISIBLE LIGHT REFLECTANCE INTERNAL %	SHGC	U-VALUE W/M2K
DUO PLUS (IGU'S)					
SOL-R™ LOW-E (2)					
4mm SOL-R Clear 73 / 12mm / 4mm Clear	74	16	17	0.65	1.7
5mm SOL-R Clear 71 / 12mm/ 5mm Clear	73	15	16	0.63	1.7
6mm SOL-R Clear 70 / 12mm/ 6mm Clear	72	15	16	0.61	1.7
8mm SOL-R Clear 69/ 12mm/ 6mm Clear	72	15	16	0.60	1.7
10mm SOL-R Clear 66 / 12mm/6mm Clear	71	15	16	0.58	1.7
4mm SOL-R Neutral 54/ 12mm /4mm Clear	54	10	15	0.45	1.6
6mm SOL-R Neutral 53 / 12mm / 6mm Clear	53	10	15	0.44	1.6
10mm SOL-R Neutral 50/ 12mm /6mm Clear	54	11	15	0.42	1.6
6.38mm SOL-R Clear 73 / 12mm/ 6mm Clear	73	15	16	0.63	1.6
8.38mm SOL-R Clear 66 / 12mm/ 6mm Clear	71	15	16	0.57	1.7
9.52mm SOL-R Clear 65 / 12mm/ 6mm Clear	71	15	16	0.56	1.7
10.38mm SOL-R Clear 65 / 12mm/ 6mm Clear	72	15	16	0.58	1.6
11.52mm SOL-R Clear 62 / 12mm/ 6mm Clear	69	14	16	0.54	1.6
12.38mm SOL-R Clear 61 / 12mm/ 6mm Clear	69	14	16	0.52	1.6
13.52mm SOL-R Clear 60 / 12mm/ 6mm Clear	68	14	16	0.51	1.6
6.38mm SOL-R Neutral 51 / 12mm/ 6mm Clear	52	10	15	0.43	1.6
8.38mm SOL-R Neutral 50 / 12mm/ 6mm Clear	53	11	15	0.41	1.6
9.52mm SOL-R Neutral 50 / 12mm/ 6mm Clear	53	10	15	0.41	1.6
10.38mm SOL-R Neutral 50 / 12mm/ 6mm Clear	55	11	15	0.41	1.6
11.52mm SOL-R Neutral 50 / 12mm/ 6mm Clear	54	11	15	0.41	1.6
12.38mm SOL-R Neutral 49 / 12mm/ 6mm Clear	54	11	15	0.40	1.6
13.52mm SOL-R Neutral 48 / 12mm/ 6mm Clear	54	10	15	0.39	1.6
6.38mm SOL-R Grey 50 / 12mm/ 6mm Clear	34	7	14	0.41	1.6
8.38mm SOL-R Grey 49 / 12mm/ 6mm Clear	36	7	15	0.40	1.7
9.52mm SOL-R Grey 49 / 12mm/ 6mm Clear	36	7	15	0.39	1.7
10.38mm SOL-R Grey 47 / 12mm/ 6mm Clear	35	7	14	0.38	1.6
11.52mm SOL-R Grey 47 / 12mm/ 6mm Clear	35	7	14	0.37	1.6
12.38mm SOL-R Grey 46 / 12mm/ 6mm Clear	35	7	14	0.36	1.6
13.52mm SOL-R Grey 45 / 12mm/ 6mm Clear	34	7	14	0.36	1.6

INSULATED GLASS UNITS PERFORMANCE VALUES					
	VLT VISIBLE LIGHT TRANSMISSION	VLR VISIBLE LIGHT REFLECTANCE	VLRi VISIBLE LIGHT REFLECTANCE	SHGC	U-VALUE
COLOUR AND TYPE	%	EXTERNAL %	INTERNAL %		W/M2K
DUO PLUS (IGU'S)					
SOL-R™ LOW-E (2) CONTINUED					
8.38mm SOL- R Grey 41 / 12mm/ 6mm Clear	33	7	14	0.32	1.6
9.52mm SOL-R Grey 41 / 12mm/ 6mm Clear	33	7	14	0.32	1.6
10.38mm SOL-R Grey 41 / 12mm/ 6mm Clear	34	7	14	0.32	1.6
11.52mm SOL-R Grey 41 / 12mm/ 6mm Clear	34	7	14	0.32	1.6
12.38mm SOL-R Grey 36 / 12mm/ 6mm Clear	27	6	14	0.27	1.6
13.52mm SOL-R Grey 36 / 12mm/ 6mm Clear	27	6	14	0.27	1.6
8.38mm SOL-R Green 59 / 12mm/ 6mm Clear	57	11	16	0.50	1.7
9.52mm SOL-R Green 59 / 12mm/ 6mm Clear	57	11	16	0.49	1.7
10.38mm SOL-R Green 56 / 12mm/ 6mm Clear	56	11	15	0.48	1.6
11.52mm SOL-R Green 56 / 12mm/ 6mm Clear	56	11	15	0.47	1.6
12.38mm SOL-R Green 54 / 12mm/ 6mm Clear	55	11	15	0.46	1.6
13.52mm SOL-R Green 54 / 12mm/ 6mm Clear	55	11	15	0.45	1.6
12.38mm SOL-R Super Green 35 / 12mm/ 6mm Clear	41	8	14	0.25	1.6
13.52mm SOL-R Super Green 35 / 12mm/ 6mm Clear	41	8	14	0.25	1.6
8.38mm SOL-R Blue 61 / 12mm/ 6mm Clear	59	12	16	0.52	1.7
9.52mm SOL-R Blue 60 / 12mm/ 6mm Clear	59	12	16	0.51	1.7
10.38mm SOL-R Blue 58 / 12mm/ 6mm Clear	58	11	15	0.49	1.6
11.52mm SOL-R Blue 58 / 12mm/ 6mm Clear	58	11	15	0.49	1.6
12.38mm SOL-R Blue 56 / 12mm/ 6mm Clear	57	11	15	0.47	1.6
13.52mm SOL-R Blue 56 / 12mm/ 6mm Clear	57	11	15	0.47	1.6
12.38mm SOL-R Super Blue 34 / 12mm/ 6mm Clear	32	7	14	0.24	1.6
13.52mm SOL-R Super Blue 34 / 12mm/ 6mm Clear	32	7	14	0.24	1.6
SOL-XT™ LOW-E (2)					
8.76mm SOL-XT Neutral 44 / 12mm/ 6mm Clear	60	12	16	0.35	1.7
9.52mm SOL-XT Neutral 44 / 12mm/ 6mm Clear	59	12	16	0.35	1.7
10.76mm SOL-XT Neutral 43 / 12mm/ 6mm Clear	59	12	15	0.34	1.6
11.52mm SOL-XT Neutral 44 / 12mm/ 6mm Clear	58	11	15	0.34	1.6
12.76mm SOL-XT Neutral 43 / 12mm/ 6mm Clear	58	11	15	0.34	1.6
13.52mm SOL-XT Neutral 43 / 12mm/ 6mm Clear	58	11	15	0.34	1.6
8.76mm SOL-XT Blue/Green 37 / 12mm/ 6mm Clear	45	9	15	0.28	1.6

INSULATED GLASS UNITS PERFORMANCE VALUES					
	VLT VISIBLE LIGHT TRANSMISSION	VLR VISIBLE LIGHT REFLECTANCE	VLRi VISIBLE LIGHT REFLECTANCE	SHGC	U-VALUE
COLOUR AND TYPE	%	EXTERNAL %	INTERNAL %		W/M2K
DUO PLUS (IGU'S)					
SOL-XT™ LOW-E (2) CONTINUED					
9.52mm SOL-XT Blue/Green 37 / 12mm/ 6mm Clear	44	9	15	0.28	1.6
10.76mm SOL-XT Blue/Green 37 / 12mm/ 6mm Clear	46	9	14	0.28	1.6
11.52mm SOL-XT Blue/Green 37 / 12mm/ 6mm Clear	46	9	14	0.28	1.6
12.76mm SOL-XT Blue/Green 37 / 12mm/ 6mm Clear	46	9	14	0.28	1.6
13.52mm SOL-XT Blue/Green 37 / 12mm/ 6mm Clear	45	9	14	0.28	1.6
8.76mm SOL-XT Grey 37 / 12mm/ 6mm Clear	38	7	15	0.27	1.7
9.52mm SOL-XT Grey 37 / 12mm/ 6mm Clear	37	7	15	0.27	1.7
10.76mm SOL-XT Grey 36 / 12mm/ 6mm Clear	37	7	15	0.26	1.6
11.52mm SOL-XT Grey 36/ 12mm/ 6mm Clear	37	7	15	0.26	1.6
12.76mm SOL-XT Grey 33 / 12mm/ 6mm Clear	29	6	14	0.23	1.6
13.52mm SOL-XT Grey 33 / 12mm/ 6mm Clear	29	6	14	0.23	1.6
8.76mm SOL-XT Grey 32 / 12mm/ 6mm Clear	28	6	14	0.22	1.6
9.52mm SOL-XT Grey 32 / 12mm/ 6mm Clear	28	6	14	0.22	1.6
10.76mm SOL-XT Grey 32 / 12mm/ 6mm Clear	29	6	14	0.22	1.6
11.52mm SOL-XT Grey 32 / 12mm/ 6mm Clear	29	6	14	0.22	1.6
12.76mm SOL-XT Grey 30 / 12mm/ 6mm Clear	23	5	14	0.20	1..6
13.52mm SOL-XT Grey 30 / 12mm/ 6mm Clear	23	5	14	0.20	1.6
10.76mm SOL-XT Green 35 / 12mm/ 6Mm Clear	45	9	15	0.25	1.7
11.52mm SOL-XT Green 35 / 12mm/ 6mm Clear	45	9	15	0.25	1.6
12.76mm SOL-XT Green 34 / 12mm/ 6mm Clear	44	9	15	0.25	1.6
13.52mm SOL-XT Green 34 / 12mm/ 6mm Clear	44	9	15	0.25	1.6
10.76mm SOL-XT Blue 33 / 12mm/ 6mm Clear	36	7	15	0.23	1.7
11.52mm SOL-XT Blue 33 / 12mm/ 6mm Clear	35	7	15	0.24	1.6
12.76mm SOL-XT Blue 33 / 12mm/ 6mm Clear	35	7	15	0.23	1.6
13.52mm SOL-XT Blue 33 / 12mm/ 6mm Clear	35	7	15	0.23	1.6

INSULATED GLASS UNITS PERFORMANCE VALUES					
	VLT VISIBLE LIGHT TRANSMISSION	VLR VISIBLE LIGHT REFLECTANCE	VLRi VISIBLE LIGHT REFLECTANCE	SHGC	U-VALUE
COLOUR AND TYPE	%	EXTERNAL %	INTERNAL %		W/M2K
DUO PLUS (IGU'S)					
EVANTAGE™ LOW-E					
6mm Clear EV (2) 12mm/ 6mm Clear	61	27	28	0.56	1.7
6mm Grey EV (2) 12mm/ 6mm Clear	29	10	29	0.33	1.7
6mm SuperGreen EV (2) 12mm/ 6mm Clear	44	18	29	0.30	1.7
6mm Blue / Green EV (2) 12mm/ 6mm Clear	51	21	29	0.38	1.7
6mm SuperBlue EV (2) 12mm/ 6mm Clear	35	13	29	0.28	1.7
6mm Bronze EV(2) 12mm/ 6mm Clear	34	12	29	0.37	1.7
SOLTECH™ LOW-E					
4mm Soltech (2) 12mm/ 4mm Clear	55	11	16	0.46	1.6
6mm Soltech (2) 12mm/ 6mm Clear	56	12	15	0.45	1.6
10mm Soltech (2) 12mm / 6mm Clear	55	11	15	0.44	1.6
6mm Soltech Grey (2) 12mm/ 6mm Clear	27	6	13	0.28	1.6
DUO ULTRA™ LOW-E (IGU'S)					
DUO ULTRA™ L0					
Clear 4mm/12mm/ 4mm (#3)	80	13	13	0.56	1.37
Grey 4mm/12mm/ 4mm (#3)	50	8	12	0.41	1.37
Neutral 50 6mm/ 12mm/6mm (#2)	50	14	13	0.25	1.32
DUO ULTRA™ L1					
Clear 6.38mm/ 12mm/4mm (#3)	79	13	13	0.53	1.36
Grey 6.38mm/ 12mm/4mm (#3)	39	6	11	0.36	1.35
Neutral 50 6.38mm/ 12mm/6mm (#2)	50	14	14	0.25	1.32
White Trans 6.38mm/ 12mm/4mm (#3)	61	9	12	0.44	1.37
Grey Trans 6.76mm/ 12mm/4mm (#3)	29	5	11	0.29	1.37
DUO ULTRA™ L2					
Clear 6.76mm/ 12mm/4mm (#3)	79	13	13	0.52	1.35
Grey 7.14mm/ 12mm/4mm (#3)	38	6	11	0.34	1.36
Neutral 50 6.76mm/ 12mm/6mm (#2)	50	14	14	0.25	1.32

NOTES

15 STOCKLINES & DISCONTINUED GLASS

STOCKLINES

Listed below are stock types by sheet stock sizes. Other sizes available on application.

GLASS TYPE	SHEET SIZE (MM)
CLEAR FLOAT	
3mm	1220 x 1830
	1830 x 2440*
	2760 x 4600
4mm	1220 x 1830
	1830 x 2440
	3210 x 4600 / 5100
5mm	1220 x 1830
	1830 x 2440
	3210 x 4600 / 5100
6mm	1220 x 1830
	1830 x 2440
	3210 / 3300 x 5100
8mm	3210 x 5100
10/12mm	3210 x 5100
15mm	3210 x 5100
19mm	3210 x 5100
EXTRA CLEAR (LOW IRON)	
4mm SuperClear	2440 x 3660
6/8/10/12/15/19mm	3300 x 4880 / 5100
TINTED FLOAT	
BRONZE	
6mm	3210 x 5100
DARK GREY	
5/6mm	3210 x 4600
EURO GREY	
4mm	1830 x 2440*, 2440 x 3660
5mm	1830 x 2440*, 3210 x 4600 / 5100
6/8mm	3210 x 5100
10/12mm	3210 x 5100
GREEN	
5/6/10mm	3210 x 5100
SUPERBLUE	
6mm	2438 x 3302
DARKBLUE	
6mm	3210 x 5100
SUPERGREEN	
6mm	2438 x 3302
SUPERGREY	
6mm	3210 x 5100
LOW- E COATED	
COMFORTPLUS NEUTRAL/GREY	
6.38mm/10.38mm	2440 x 3660
EVANTAGE	
Grey, SuperBlue, SuperGreen, Clear, Bronze, Blue Green	
6mm	2438 x 3302/2440 x 3660
LOW-E CLEAR (SOL-R™)	
4/5/6/8/10mm	3210 x 5100

GLASS TYPE	SHEET SIZE (MM)
LOW-E NEUTRAL (SOL-R™)	
4/6mm	2440 x 3660
6.38/10.38mm	2440 x 3300
10mm	3210 x 5100
SOLTECH	
4/6mm	2440 x 3660
10mm	2440 x 3660/3210 x 5100
SOLTECH GREY	
6mm	3210 x 5100
ETECH GREY	
6mm	3210 x 5100
SUNERGY	
4/5/6/8/10mm Neutral	3210 x 5100
6mm Grey	3210 x 5100
6mm Green & Azur Blue	3210 x 5100
6.38mm Neutral/Grey	2440 x 3210
IPLUS ADV 1.0T	
4/5/6mm	2550 x 3210
VISION 51 T	
6mm	3210 x 5100
LAMINATED	
6.38mm Clear	920 x 1830/1840
	915/920 x 2140
	1220 x 1830/1840*
	915/920 x 2440*
	1220 x 2440*
	1830 x 2440*
	2440 x 3660
6.38mm Grey	915/920/1220 x 2140
	1220 x 2440*
	1830 x 2440*
	2440 x 3660
7.52mm Clear	2440 x 3660
8.38mm Clear	2440 x 3660
8.38mm Grey	2440 x 3660
10.38mm Clear	2760/2800 x 3660
	3210 x 5100
10.38mm Grey	2440 x 3660
12.38mm Clear	2760/2800 x 3660
6.38mm White Trans	2440 x 3660
6.76mm Grey Trans	2440 x 3660
LAMINATED ACOUSTA™	
6.76mm	2550 x 3210
10.76mm	2550 x 3210
12.76mm	2550 x 3210
ONE WAY LAMINATED MIRROR	
6.38mm S108	2440 x 3660

* Subject to stock availability

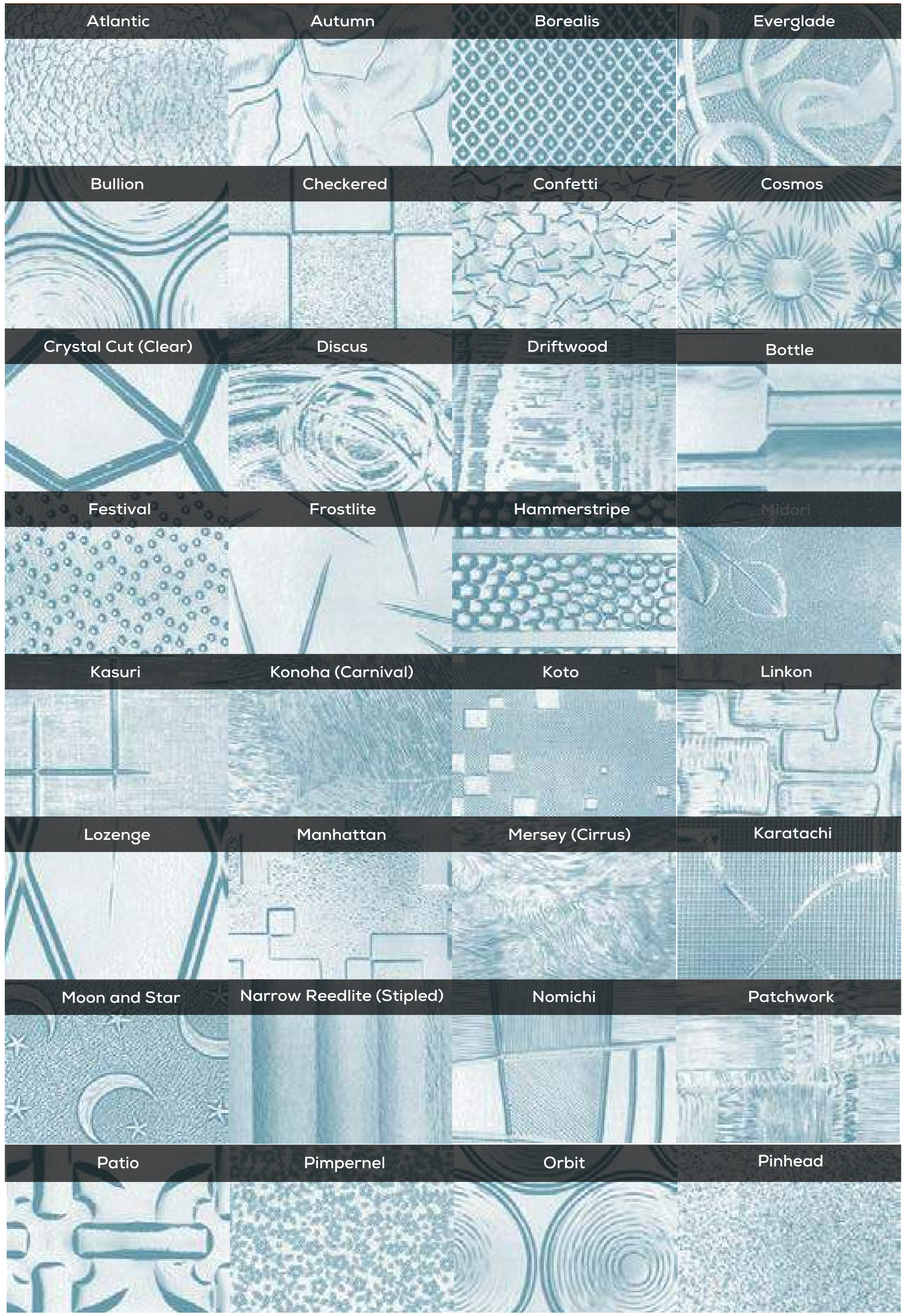
STOCKLINES

GLASS TYPE	SHEET SIZE (MM)
ACID ETCHED	
4/6/10/12mm	2140 x 3660
4/6mm Grey	2140 x 3300/3660
PATTERNED	
4mm Cathedral	1840 x 2440
4mm Spotswood	1840 x 2440
4mm Satinlite	1840 x 2440
5mm Cathedral	1840 x 2440
5mm Spotswood	1840 x 2440
5mm Satinlite	1840 x 2440
6mm Desert Sand	1830 x 2440
6mm Satinlite	1840 x 2440
MIRROR	
4mm	2440 x 3660
6mm	1830 x 2440
	2440 x 3660
TINTED	
4mm Grey	2134 x 3660
6mm Grey	2440 x 3660
6mm Bronze	2440 x 3660

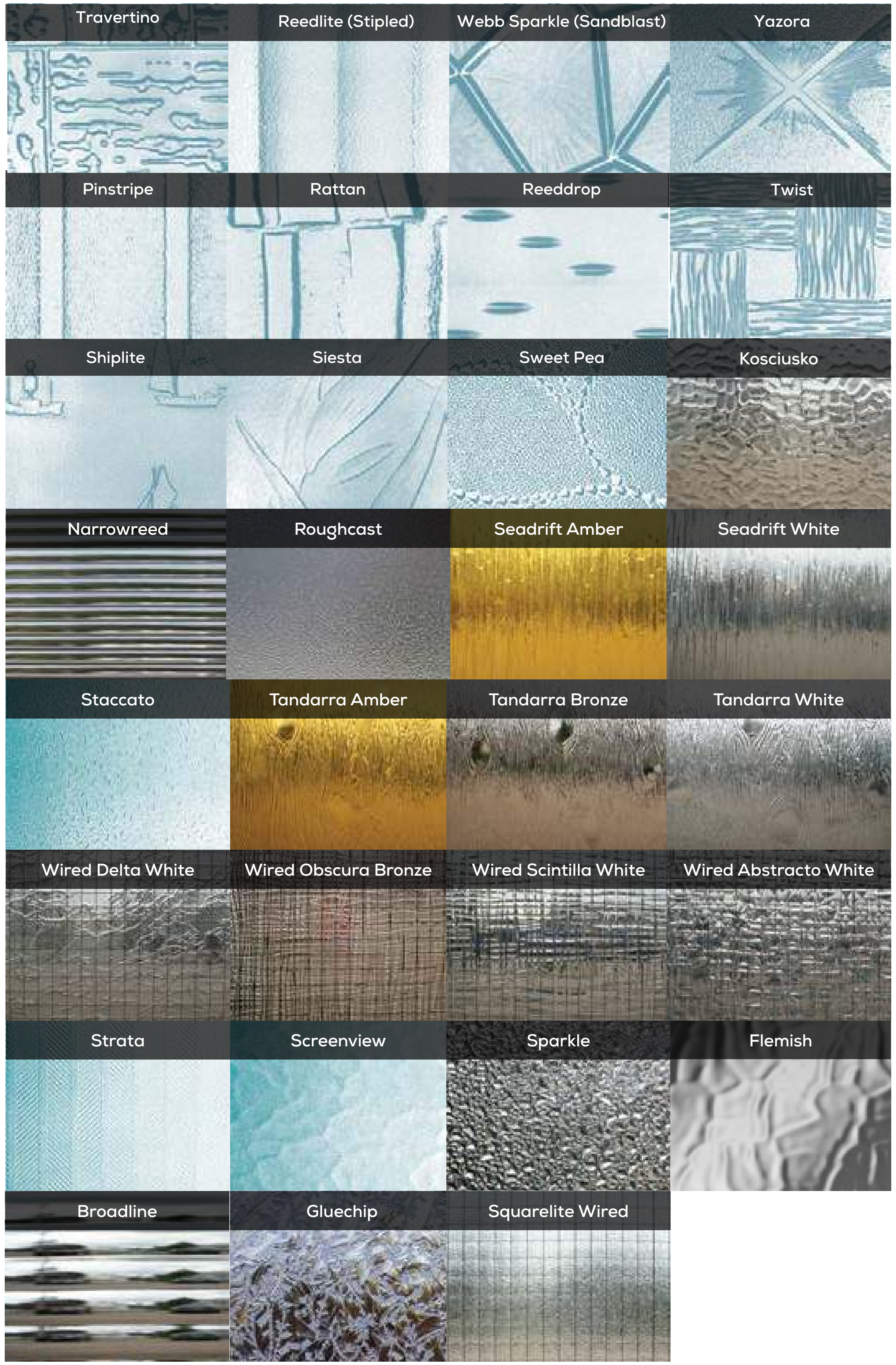
GLASS TYPE	SHEET SIZE (MM)
GRADE A VINYL BACK	
4mm	2140 x 800
	2140 x 920
	2140 x 1070
	2140 x 1220
	2440 x 920
	2440 x 1070
	2440 x 1220
	2760 x 1220
6mm	2440 x 1220
	2760 x 1220
4mm Decowhite (Pure White)/ Decowhite (Soft White)	2440 x 920 2440 x 1220 2760 x 1220
4mm Black (Classic)	2440 x 1220
LACOBEL T	
Cool White/Deep Black	
Anthracite Grey	
6mm	3210 x 5100
SPLASHGUARD	
6mm	3210 x 5100

DISCONTINUED GLASS

The following obscure glass patterns have been marketed in Australia over the past 30-40 years but are no longer offered by National Glass or no longer available.



DISCONTINUED GLASS



INDEX

National Glass Brisbane showroom


www.nationalglass.com.au
do more with glass