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We're Australia's leading glass manufacturer and processor using state of the art advanced automation and machinery to deliver high quality products and service. We're specialists 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.

A large range of stock types are available from clear, low-Iron, tinted, Low-E coated products, laminated, acid etched, silvered and patterned glass.

**PRODUCTS AND CAPABILITIES**

**LAMINATING**
Using the latest nip roller and autoclave technology to build custom laminated glass panels with standard PVB, Acoustic, Vanceva, HP and SGP 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.

**TEMPERED GLASS**
Producing toughened, heat strengthened and heat soaked glass from 4mm to 19mm thicknesses in many different substrates to AS2208 and AS2080 standards. Max size 5000mm 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.

**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 ImageTek and Lacobel T painted products, along with IGU’s and interactive Acoustic Laminated station.
INTRODUCTION TO GLASS

THIS SECTION INCLUDES:
» History
» Glass manufacture
» Common glass types
» Industry terms
» Glass surface positions
» Cutting orientation – raked and shaped 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 involves directing the molten glass mixture into a mould. The cylinder process involves 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.

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.

Typical cost in AUD of large float line (depending on size, location, complexity of plant).

Year 1952, Alastair Pilkington conceived the idea of float glass whilst washing the dishes.

TONNES 500-700

Days per year continuously producing.

LENGTH OF FLOAT LINE

Time between cold repair shutdown of plant.

FLOAT LINE STATS
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. 620°C 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 blunt granules.

LAMINATED SAFETY GLASS

A safety glass made up 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. Used most commonly in high windload areas or to prevent penetration of flying objects in extreme storm events. Also used for applications where in the event of breakage the glass must stay intact, in one piece or is able to support a temporary load until replaced eg. frameless glass balustrading.

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.
GLASS SURFACE POSITIONS
The sides of a sheet of glass or surface position are identified by a simple numbering method. As per the first example opposite page for single glass, #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.

CUTTING ORIENTATION – RAKED, SHAPED GLASS
Glass products such as Low-E, Acid Etched, Patterned, Mirror and pre-painted products (Lacobel) have a coated and non-coated side. Because these products are cut on a specific face, raked or shaped panel drawings upon ordering have to be presented to customer service staff in the same way as the glass is actually cut. Because of this, the customer may need to reverse the view of the drawing. The order drawing would not necessarily reflect how the glass is placed in the window opening. For example, Low-E single glass is glazed with the coating to the inside of the building, but it’s cut coating side up on the cutting table.

Diagram 2.2: Cutting Orientation – Rakes
LOW-E INC. SUNERGY, REFLECTIVES
ACID ETCHED
PATTERNED GLASS
MIRROR
LACOBEL PAINTED

Diagram 2.3: Glass surface positions
single monolithic

Diagram 2.4: Double glazing IGU
double glazing IGU with laminated glass*

* Laminated glass can also be glazed as the outboard lite.
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 houses. This has been proven by introduction and implementation of various codes and legislation. Energy efficient housing 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 window or glazing system to meet compliance requirements. Any information used from this publication should be cross-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.
- **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 regards 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.

**DID YOU KNOW?**

- 1930’s Tinted glass use
- 1940’s IGU’s commercialised (patented in 1865)
- 1960’s First Low-E glass development
- 1970’s Oil & energy crisis – building owners looking to save on heating and cooling costs
- 1980’s Global warming debate
- 1997 Kyoto Protocol on climate change signed
- 2003-2012 New build homes in Australia with energy efficiency standard based on star system 3.5-4 star to 6 stars
- 2015 Paris climate change conference agreement

**Diagram 3.0: Climate zones**

Brisbane
Sydney
Canberra
Hobart
Adelaide
Perth
Darwin

Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6
Zone 7
Zone 8

Tropical (Emphasis on cooling)
Temperate (Cooling and heating)
Cold (Emphasis on heating)
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/m². For example, the Sun’s direct energy typically radiates on a hot day 785 watts per m² and 6mm Sunergy® Green has a SHGC of 0.42. If you multiply 785 watts x 0.42 (SHGC) you get 329 watts per m² radiated into the building. In this example the Sunergy® glass is reducing the Sun’s direct energy through the glass into the building by 58%.

**Diagram 3.1: SHGC formula**

\[
\text{SHGC} = \frac{\text{Sun’s direct transmission energy (T)}}{\text{Re-radiated heat (R)}}
\]

**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. Let’s explain this further. 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). 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 (W/m²K) 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/m²°C and multiplying the difference between outdoor and indoor temperature (32°C outside and 24°C inside = 8°C) x 5.9 x 8°C = 47 watts 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) which reduces the effect of conduction and convection and, a low-E coating which reduces the effect of re-radiation.

**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. \( U = \frac{1}{R} \) or \( R = \frac{1}{U} \). 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.

**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.

**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 132), 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.

**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. In both situations to various degrees and dependent on circumstances, to maintain comfortable living conditions we artificially heat or cool the building or home. The amount of energy we put into cooling and heating is greatly affected by our glass selection. Poor selection leads to greater energy costs.

Heat is transferred through the glazing by three methods:

- Conduction;
- Convection;
- Re-radiation.

**Diagram 3.3: Conduction**

Conduction is the process where heat travels through a solid material or like a frying pan heating up.
**Diagram 3.4: Convection**

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

**Diagram 3.5: Radiation**

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, the Sun shining directly through the window (short wave radiation). Re-radiation (long wave radiation) occurs when the glass absorbs this short wave radiation and re-radiates it to the interior or exterior. Other objects outside the window such as the window sill, cars, the ground will also absorb and re-radiate the Sun’s direct heat towards the glass. Objects inside the room such as carpets, furniture etc will do likewise.

**Diagram 3.6: Typical double facade**

Double facades similar to the functional features of an IGU, the double facade (see Diagram 3.6) consists of an external facade, an intermediate space and the inner facade. The external facade provides protection from weather and acoustic benefits and with appropriate glass selection provides the first barrier to heat gain penetration. Vents in the external facade at intervals allow for the flow of air between the two facades, hot air rising and flowing through the vents, air or wind flowing in convection heat away. The internal facade is the second barrier to heat gain.

**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, Low-E 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, reflective 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 brealage when using these devices.

**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 also be of benefit during night time conditions (where daylight is not required). Tight fitting heavy drapes and pelmets around the window can assist in keeping the warmth in.

**DOUBLE FACADES**

Similar to the functional features of an IGU, the double facade (see Diagram 3.6) consists of an external facade, an intermediate space and the inner facade. The external facade provides protection from weather and acoustic benefits and with appropriate glass selection provides the first barrier to heat gain penetration. Vents in the external facade at intervals allow for the flow of air between the two facades, hot air rising and flowing through the vents, air or wind flowing in convection heat away. The internal facade is the second barrier to heat gain.

**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 matrices 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 window. 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 poly vinyl 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 further resist damage from visible and infrared components.
PRODUCT SELECTION

TINTED 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.

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

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 pages 123.

GREY TINTS

EURO GREY

Euro Grey is designed to reduce glare and heat entry. It is available in 4-12mm annealed, toughened and laminated forms.

DARK GREY

A rich dark tint for greater control of glare and heat entry over standard grey tints. Dark Grey is available in 5-6mm annealed and toughened.

DARKBLUE™

Panasap Dark Blue float is an excellent choice of glass for ocean front structures and poolside settings, with its dark blue tone complementing the natural beauty of surroundings. Available in 6mm thicknesses and can be custom laminated.

GREEN TINTS

GREEN

When compared to grey float, Green tints provide comparable solar control without sacrificing visible light transmittance. This makes it a popular choice for energy efficient glazing. Green tints are available in thickness of 4/5/6/10mm in annealed, toughened and laminated forms.

SUPERGREEN™

VFloat SuperGreen™ glass is the logical solution for improved performance over standard green tints with lower solar heat gain co-efficient (SHGC), high visible light transmittance and a rich emerald green appearance. Available in a 6mm thickness in annealed, toughened and laminated form.

BLUE TINTS

DARKBLUE™

Panasap Dark Blue float is an excellent choice of glass for ocean front structures and poolside settings, with its dark blue tone complementing the natural beauty of surroundings. Available in 6mm thicknesses and can be custom laminated.
LOW-E COATED GLASS

Low-E or Low Emissivity coated glass consists of a microscopically thin, virtually invisible, metal or metal oxide layer deposited on the glass. The coating on low-E glass is designed to improve thermal insulation similar to the function performed by roof or batt insulation.

Low-E products such as Sunergy and Low-E CLEAR are designed to improve the performance of windows in all climates. They reduce heat transfer by providing lower SHGC and U-value ratings compared to ordinary non-coated glass. Because the coating provides an insulation function similar to the function of roof or batt insulation, they perform day and night year around.

The glass should always be glazed with the coating to the inside in single glazing and on either surface position #2 or #3 in IGU’s to maximize performance. The coating on low-E glass is designed to reduce heat transfer by providing lower SHGC and U-value ratings compared to ordinary non-coated glass. The coating on low-E glass is designed to reduce heat transfer by providing lower SHGC and U-value ratings compared to ordinary non-coated glass. Because the coating provides an insulation function similar to the function of roof or batt insulation, they perform day and night year around.

The glass should always be glazed with the coating to the inside in single glazing and on either surface position #2 or #3 in IGU’s to maximize performance. Because the coating provides an insulation function similar to the function of roof or batt insulation, they perform day and night year around.

FEATURSE 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 (with IGU’s).
- Coating is low reflecting and durable (Sunergy or Low-E CLEAR).
- Best performance achieved in double glazed units (IGU’s) though in single glazing situations Sunergy® can still provide superior performance and higher thermal insulation to many tinted glass products.
- Available annealed, toughened and laminated.

HOW COATINGS ARE MADE

PYROLYTIC ON LINE COATING/HARD COAT

A coating is applied during glass manufacture. The coating is fused into the glass at 1200°C. The advantage of this product is its durability. It can be handled like a standard square of glass. It is ready to be cut, heat strengthened, toughened, laminated and bent. This product is sometimes referred to as a ‘hard coat’ glass (see Sunergy and Low-E CLEAR).

SPUTTER COATING/VACUUM/SOFT COATING

This process involves the deposition of double or triple coatings of metal particles onto the glass surface by a chain reaction in a vacuum vessel or chamber. It is sometimes called a ‘soft coat’ because the coating is more susceptible to damage when being handled and generally shouldn’t be glazed in monolithic form as the coating will corrode due to air exposure. Because of exposure issues, the stock has a limited shelf life which must be managed properly from a production and supply chain perspective. Sputter coated products generally have improved SHGC’s and lower ‘U’ values than pyrolytic products. New generation products can be tempered after coating, therefore improving lead times.

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.

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.

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.

See also “IGU” Section 9.

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.

The Low-E coating assists in rejecting this heat back outside.

TABLE 38: EMISSIVITY LEVELS

<table>
<thead>
<tr>
<th>Product</th>
<th>Emissivity</th>
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<tbody>
<tr>
<td>Ordinary clear</td>
<td>0.84</td>
</tr>
<tr>
<td>Sunergy®</td>
<td>0.28</td>
</tr>
<tr>
<td>Low-E CLEAR</td>
<td>0.16</td>
</tr>
<tr>
<td>Vacuum coatings</td>
<td>as low as 0.04</td>
</tr>
</tbody>
</table>

See Diagram 3.15.

Diagram 3.15: How low-E glass works on cold days

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).

The Low-E coating assists in reflecting this heat back inside.

See Diagram 3.16.

Diagram 3.16: How low-E glass works on warm days

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.

The Low-E coating assists in rejecting this heat back outside.
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 123.

- **Glass edges** - Before glazing, annealed glass edges must be ‘good’ straight and clean cut with minimal defects. Reflective, sputter coated low-E laminated and pyrolytic low-E 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 “Cleaning Instructions” page 128-129.

- **Spandrels panels** - Must always be heat strengthened.

- **Coating position**: Reflective - Some building authorities/local councils set limits on glass reflectivity. Most monolithic (non laminated) applications should be glazed with the reflective surface to the inside or surface position #2. This will only marginally decrease performance, but will enhance the colour of the glass avoiding the strong ‘mirror’ like appearance when viewed from the outside. #1 should be avoided due to the effects of weathering and pollutants and subsequent cleaning difficulties.

- **Coating position**: Low-E
  
  See page 23.

- **Sputter coated glazing** - Avoid use of coated monolithic glass as the coating will deteriorate to exposed air. Best used on surface #2 or #3 in IGU’s.

- **Edge deletion**: Sputter coatings - For IGU’s and laminated glass, sputter coated low-E glass must be edge deleted for proper adhesion and to minimize the chance of corrosion of the coating. Pyrolytic low-E such as low-E CLEAR and Sunergy® do not require edge deletion.

- **Visual distortion** - Toughening and heat strengthening will create some roller wave or visual distortion. It is recommended that a mock-up unit or on site installation be viewed. Heat strengthening will create less visual distortion than toughening.

- **Read through** - Read through of building structures is less likely where the visible light transmittance of the glass is less than or equal to 14%.

- **Colour differences** - Coated glass changes colour when viewed at different times of the day, depending on the weather, surrounding reflections and the angle at which the glass is viewed. With this in mind it is recommended that either a mock-up or on site visit to a completed building is undertaken before a glass choice is made.

RAKED AND OUT OF SQUARE PANELS

See pages 10 or 118 for drawing presentation when ordering.

IDENTIFYING THE LOW-E COATING

Suppliers of low-E coated glass to fabricators or installers should have an identification label on the non coated side, stating which side to position the glass in the window or opening. If this label is not present, electronic instruments are available which determine the coated side. Alternatively, by simply running the clean palm of your hand over both surfaces, quickly identifies the coated surface as being more resistant to touch than the non-coated surface.

Diagram 3.17: Low-E coating position

**Fig. 1:** Single monolithic  
**Fig. 2:** IGU  
**Fig. 3:** Laminated

- Inside  
  
  **Surface position**
  
  Provides for optimum performance.

- Inside  
  
  **Surface position**
  
  Improves U-Value.
  
  **Surface position**
  
  Is best for warm climates.

- Inside  
  
  **Surface position**
  
  Will not improve U-value.
  
  **Surface position**
  
  Provides for optimum performance.
GLASS SELECTION AND COATING POSITION

SINGLE GLAZED MONOLITHIC* LOW-E

Low-E glass was primarily designed for use in IGUs. However, there has been an increasing demand for use of low-E coated glass as single glazing.

Coating position – See Diagram 3.17 (pg 23).

Improvements of up to 30% in the U-value can be achieved with the low-E coating on surface position #2 for single monolithic (see Fig 1) and #4 for laminated glass (see Fig 3). No improvements in U-value are achieved with the low-E coating on surface position #2 or #3 for laminated glass. Low-E coating placement on surface position #1 should be avoided due to effects of weathering and pollutants and subsequent cleaning difficulties. However, you do get a reduction of direct heat gain through lower SHGC with the coating in any surface position.

IGU’S – INSULATED GLASS UNITS

WARM CLIMATES

Adding a low-E coating to surface position #2 acts like an additional barrier by further slowing the rate of the heating of the air gap. Having the coating on surface position #3 allows the air gap to be heated more quickly, because the low-E surface position #2 barrier is removed. This reduces the performance of the glazing in terms of heat gain to the interior of the building. See Diagram 3.17 – Fig 2 (pg 23).

LOW-E MUST BE AIR SIDE TO IMPROVE U-VALUE

Low-E coating placement on surface position #2 or #3 of a laminated pane will not improve the U-value as the coating is now in direct contact with the PVB and the glass (see Diagram 3.17, pg 23). Any re-radiated heat will now be conducted through PVB, coating and glass. The low-E coating must be air side to improve U-value. However, as previously noted, low-E coatings, in any position placement will improve the SHGC.

PRODUCT SELECTION

LOW-E CLEAR

A high transparent pyrolytic coated low-E glass used as a single glass or in IGU’s. The durable hard coat is easy to handle and process. Available in base thicknesses of 4/5/6mm and laminated in thicknesses of 6.38/8.38/10.38/12.38mm.

Diagram 3.18: Performance 4mm/6mm Low-E CLEAR: Single glass

Diagram 3.19: Performance 6.38mm/10.38mm Low-E CLEAR: Laminated glass

Diagram 3.20: Performance 6mm Low-E Clear #2/12mm Argon/6mm Clear Low-E CLEAR: IGU

Diagram 3.21: Performance 6.38 Low-E Clear #2/12mm Argon/6mm Clear IGU Laminated glass

SUENERGY® NEUTRAL

Suenergy® Neutral is a pyrolytic coated low-E glass with excellent performance properties and high thermal insulation. The glass displays a light grey hue in appearance. Suenergy® Neutral is available in 4/5/6/10mm and various laminated thicknesses.

Diagram 3.22: Performance 4mm/6mm Suenergy® Neutral

Diagram 3.23: Performance 6mm Suenergy® N #2/12mm Argon/6mm Clear IGU

Visual Characteristics – Low-E Glass

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 low-E coating and indicates the functional properties of the glass. We recommend samples be viewed under both natural and artificial lighting conditions for product acceptance.

Suenergy® glass is a pyrolytic low-E coated tinted glass which combines improved solar control (SHGC) and thermal insulation (U-value). It is also an excellent response to current architectural trends desiring neutrality and low reflection. Suenergy® is available in a range of thicknesses in colours neutral, grey, green and blue (Azur) and laminated.

*Monolithic refers in this context to a single panel of glass, including laminated glass.
**SUNERGY® GREY**

Sunergy® Grey is a durable pyrolytic low-E coating on grey tinted float glass. The excellent solar control performance and thermal control make this product an ideal energy efficient glass. Standard thickness available is 6mm. Also available in a 6.38mm laminated form utilising a grey PVB interlayer laminated to base 3mm Sunergy neutral.

**Diagram 3.24: Performance 6mm Sunergy® Grey**

- **U-value:** 1.6
- **VLT:** 34%
- **VLR:** 5%

Total solar radiation 100% / Total visible light 100%

**Diagram 3.25: Performance 6.38mm Sunergy® Grey PVB**

Made up of: 1 @ 3mm clear/1 @ 0.38mm grey PVB/1 @ 3mm Sunergy® Neutral #4

- **U-value:** 1.9
- **VLT:** 30%
- **VLR:** 6%

Total solar radiation 100% / Total visible light 100%

---

**SUNERGY® GREEN**

Sunergy® Green is a durable pyrolytic low-E coating on a green tinted float glass. The excellent solar control performance and high light transmission makes this product an ideal energy efficient glass. Standard thicknesses available is 6mm.

**Diagram 3.26: Performance 6mm Sunergy® Green**

- **U-value:** 4.1
- **VLT:** 33%
- **VLR:** 5%

Total solar radiation 100% / Total visible light 100%

**Diagram 3.27: Performance 6mm Sunergy® Green**

- **U-value:** 4.1
- **VLT:** 56%
- **VLR:** 7%

Total solar radiation 100% / Total visible light 100%

**Diagram 3.28: Performance 6mm Sunergy® Green #2/12mm Argon/6mm Clear IGU**

- **U-value:** 1.9
- **VLT:** 50%
- **VLR:** 10%

Total solar radiation 100% / Total visible light 100%

---

**SUNERGY® AZUR**

Sunergy® Azur is a durable pyrolytic low-E coating on a blue tinted float glass providing superior solar and thermal control. Standard thickness available is 6mm.

**Diagram 3.29: Performance 6mm Sunergy® Azur (Blue)**

- **U-value:** 4.1
- **VLT:** 56%
- **VLR:** 7%

Total solar radiation 100% / Total visible light 100%

**Diagram 3.30: Performance 6mm Sunergy® Azur #2/12mm Argon/6mm Clear IGU**

- **U-value:** 1.9
- **VLT:** 50%
- **VLR:** 10%

Total solar radiation 100% / Total visible light 100%

---

6.38mm Sunergy Neutral
NOISE REDUCTION

THIS SECTION INCLUDES:

> Sound levels
> Recommended interior noise levels
> Glass acoustic data (Rw)
> Product selection
  > Acousta™ Laminated

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 Loudness of a sound is of most concern to people. The loudness 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 annealed, laminated, Acousta™ Laminated and IGU’s. Having determined the external noise level 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
- Bedroom recommended noise level – 40dB

\[ 75dB - 40dB = 35dB \text{ rating required for window/glazing system} \]

\[ \text{(from table 4B) 6.76 Acousta™ Laminated in single glass form} \]

### TABLE 4A:

<table>
<thead>
<tr>
<th>Common Sound levels - Environment</th>
<th>dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threshold of hearing</td>
<td>0</td>
</tr>
<tr>
<td>Conversational speech</td>
<td>65</td>
</tr>
<tr>
<td>Average traffic (kerbside)</td>
<td>70</td>
</tr>
<tr>
<td>Busy traffic</td>
<td>75</td>
</tr>
<tr>
<td>Loud traffic</td>
<td>80</td>
</tr>
<tr>
<td>Live band (20 metres)</td>
<td>105</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recommended interior noise levels</th>
<th>dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedroom</td>
<td>30-40</td>
</tr>
<tr>
<td>Classroom</td>
<td>35-40</td>
</tr>
<tr>
<td>Living room</td>
<td>40-45</td>
</tr>
<tr>
<td>Private office</td>
<td>40-45</td>
</tr>
<tr>
<td>Open office</td>
<td>45-50</td>
</tr>
</tbody>
</table>

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 laminated glass due to the vibration dampening effect of the PVB interlayer. Laminated glass is 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.
> 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.
The table data shown opposite page is measured as a single-number Rw rating of the sound reduction through a wall or other building element. 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.

**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 is a Grade A safety glass that uses a specially developed interlayer which dampens noise more effectively than ordinary single glass. Acousta™ Laminated uses 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.

**TABLE 4B: GLASS ACOUSTIC DATA**

<table>
<thead>
<tr>
<th>SINGLE GLASS Thickness mm</th>
<th>dB REDUCTION Rw</th>
<th>IGU Configuration</th>
<th>dB REDUCTION Rw</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>29</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>4/12/4</td>
<td>29</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
<td>5/12/5</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>31</td>
<td>6/12/6</td>
<td>31</td>
</tr>
<tr>
<td>8</td>
<td>32</td>
<td>8/12/8</td>
<td>34</td>
</tr>
<tr>
<td>10</td>
<td>34</td>
<td>10/12/10</td>
<td>36</td>
</tr>
<tr>
<td>12</td>
<td>35</td>
<td>12/12/12</td>
<td>36</td>
</tr>
<tr>
<td>19</td>
<td>39</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Laminated</th>
<th>IGU Laminated</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.38</td>
<td>32</td>
</tr>
<tr>
<td>8.38</td>
<td>34</td>
</tr>
<tr>
<td>10.38</td>
<td>35</td>
</tr>
<tr>
<td>12.38</td>
<td>36</td>
</tr>
<tr>
<td>11.52</td>
<td>36</td>
</tr>
<tr>
<td>13.52</td>
<td>37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acousta™ Laminated</th>
<th>IGU Acousta™ Laminated</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.76 Acousta™</td>
<td>36</td>
</tr>
<tr>
<td>8.76 Acousta™</td>
<td>37</td>
</tr>
<tr>
<td>10.76 Acousta™</td>
<td>38</td>
</tr>
<tr>
<td>12.76 Acousta™</td>
<td>39</td>
</tr>
<tr>
<td>16.76 Acousta™</td>
<td>41</td>
</tr>
<tr>
<td>20.76 Acousta™</td>
<td>42</td>
</tr>
</tbody>
</table>

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

THIS SECTION INCLUDES:

» Cyclone/Storm resistant glass
» SGP Laminated glass
» Basic attack resistance
» Security glazing systems
» Privacy glass
» One way Mirror glass
» Switchable glass

STORM AND CYCLONE DEBRIS IMPACT GLASS

Storm and cyclone debris impact glass has been designed and tested to reduce the devastating effects of extreme winds and flying debris that impact upon buildings. Ordinary glass and window frames can fail under these extreme wind pressures and airborne projectiles. The glass should be an integral part of the framing system designed to prevent the frame and glass from blowing in or out when impacted.

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.

CYCLONE DEBRIS IMPACT GLASS

A range of laminated products using either PVB or SGP interlayers have successfully passed debris impact tests as per AS/NZS 1170.2:2011 Clause 2.5.8. Part of the test involves the firing by canon of a 4kg timber missile at a specified velocity. The objective of the test to prevent the missile from penetrating the glass panel. 13.80mm PVB Laminated and 14.56mm SGP Laminated glass passed this test at a velocity of 34 metres per second. It should be noted that the glass still breaks upon impact, but lessens the probability of the object breaching the panel into the building. The glass should be an integral part of the framing system designed to prevent the frame and glass from blowing in or out of the opening.

SGP LAMINATED GLASS

In response to architectural demands for tougher window systems, SGP SentryGlas® Plus ionoplast interlayer has been developed. In properly designed window systems, this technology has passed demanding hurricane protection codes in Southern Florida. It also offers improved ballistic protection or thinner constructions than are now possible with conventional laminated glass. SGP offers five times the tear strength and 100 times the rigidity of conventional PVB laminated glass interlayer.

FEATURES AND APPLICATIONS

SGP laminates offer extended functionality versus laminates with traditional interlayers and make 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;
» Superior post-glass breakage properties;
» Improved edge stability over standard PVB’s,

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. SGP cannot be laminated with conventional PVB interlayer.

EDGE STABILITY AND DELAMINATION

SGP 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.
BASIC ATTACK RESISTANCE
Laminated glass is available using a 1.52mm 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, sledge hammers 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 of an opening allowed after a number of minutes and define specific levels in AS2343 Bullet resistant panels and elements (refer Table 5.0). 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.

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 5.0). In common applications, thicknesses vary from 19–65mm. Bullet resistant glazing systems can also be manufactured to meet AS3355 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 aspects of energy. Firstly, 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.

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 may lie in choosing a glass to suit your other intended glazing needs in combination with a blind or curtain.

SECURITY LAMINATED ONE WAY MIRROR GLASS
National Glass stocks 6.38mm SolarPlus S108 for one way mirror applications. This glass 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 for ordering:
- 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 5.1);
- 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 an observation side to be dark and subdued colours;

SWITCHABLE GLASS
Windows normally allow you to see as well as to be seen. However, sometimes it may be desirable to be shielded from prying eyes. Switchable glass offers you this privacy at the flick of a switch. The unique technology allows it to be switched from clear glass to a translucent glass, ensuring optimal vision control. All it takes is a simple electrical switch, like turning the lights on.

### TABLE 5.0: BULLET RESISTANCE (AS2343 1997)

<table>
<thead>
<tr>
<th>Classification</th>
<th>Calibre</th>
<th>Ammunition</th>
<th>Measured velocity within 2.5 metres of target (metres per second)</th>
<th>Minimum range (metres)</th>
<th>Number of strikes</th>
</tr>
</thead>
<tbody>
<tr>
<td>G0</td>
<td>9mm</td>
<td>Parabellum</td>
<td>Mk22 7.4 gram bullet</td>
<td>405 +/- 15</td>
<td>3</td>
</tr>
<tr>
<td>G1</td>
<td>357</td>
<td>Magnum</td>
<td>10.2 gram semi jacket soft point</td>
<td>450 +/- 15</td>
<td>3</td>
</tr>
<tr>
<td>G2</td>
<td>0.44</td>
<td>Magnum</td>
<td>15.6 gram semi jacket soft point</td>
<td>480 +/- 15</td>
<td>3</td>
</tr>
<tr>
<td>R1</td>
<td>5.56mm</td>
<td>Mag53 5.56mm 3.6 gram FMJ</td>
<td>980 +/- 15</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>7.62mm</td>
<td>NATO 9.3 gram FMJ</td>
<td>850 +/- 15</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>S0</td>
<td>12 Gauge (Full choke)</td>
<td>70mm case 32 gram SG shot</td>
<td>400 +/- 20</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>12 Gauge (Full choke)</td>
<td>70mm case 28.5 gram solid slug</td>
<td>450 +/- 20</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Note 1:** Shot centre = 100mm apart, forming a square or equilateral triangle, centred on the target panel.

**Note 2:** Special classes shall be specified by the manufacturer and allows for oblique shots or elements that are not 420mm square etc.

- S = resistant to hand gun attack
- R = resistant to rifle attack
- G = resistant to shotgun attack
Switchable glass off.

Switchable glass on.

30.56mm Cyclone resistant laminated – Make-up 10mm Azuria toughened / 2.28mm SGP/10mm clear toughened/2.28mm SGP/10mm Energy Advantage low-E (4) toughened.
**HEAT LIMITATIONS AND STANDARD GLASS**

- Ordinary float glass up to 40–50°C.
- Toughened float glass up to 250°C. It can be used in food ovens where temperatures will not exceed 250°C. However, upon impact and breakage, glass fragments may spoil oven contents.

**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 bushfire 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 should be expressed in the above order – e.g. –/60/30. This refers to no structural adequacy requirement, a 60 minute integrity and 30 minute insulation rating for a fire resistant glazing.

**DEFINING AN FRL SPECIFICATION**

**TABLE 6A:**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>FRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>No requirement</td>
<td>/60</td>
</tr>
<tr>
<td>Structural adequacy</td>
<td>60 minutes</td>
</tr>
<tr>
<td>Integrity</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Insulation</td>
<td>requirements</td>
</tr>
</tbody>
</table>

**SPRINKLERS AND NON-FIRE RATED WINDOWS**

The use of sprinklers or deluge systems with non-fire rated glass or windows present some issues of concern. One reason is that we are relying on a mechanical system that may fail. Mechanical fault is also the result of a poor maintenance regime. Secondly, thermal shock associated with glass breaking due to excessive differences in temperature may result in flames and smoke breaching the opening. Therefore, where sprinklers are used, it is best to rely on a tested fire rated window assembly to meet fire rating 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.

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. Sheet sizes are 1880mm x 1590mm.

GLASS SPLASHBACKS & STOVETOPS

Special note should be made here with regards 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 6.1)
TOUGHENED GLASS

FEATURES AND APPLICATIONS

- **Safety** – Toughened safety glass is manufactured to AS/NZS2208 and AS2080 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 windloads. 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.
- **Delivery** – Plastic wrapped or papered to avoid scratches during delivery.
- **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, it 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.

**WHAT IS HEAT TREATED GLASS?**

In this section heat treated will refer to heat strengthened and heat soaked glass.

**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 and 15–19mm toughened glass.

**DESIGN AND GLAZING NOTES**

- **Surface treatments** – Toughened glass cannot be drilled or edged worked in any manner. Sand blasting and other surface treatments should be carried out prior to toughening. Deep sand blasted patterns greater than 1mm are not permissible.
- **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.
- **Bowling** – 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, sand blasted or reflective 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. Less visual distortion is evident with a heat strengthened glass. Talk to our staff about specific optical requirements.
- **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.

**WHAT INCLUDES THIS SECTION:**

- Toughened glass
- Ordering guidelines
- Heat soaking
- Max and min sizes
- Toughened ID stamps
- Heat Strengthened
- Chemically toughened
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 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 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 280°C to 290°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 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.

ORDERING GUIDELINES

For edgework and processing guidelines for toughened glass refer to Section 13. Before ordering, please refer to the following for your order’s compliance:

- Product type and thicknesses;
- Maximum size;
- Minimum size;
- Minimum edgework;
- Toughened identification stamp and position placement on glass.

RECOMMENDED GLASS THICKNESS AND TYPES

- 4–12mm clear/tinted;
- 4–12mm clear/tinted (AS/NZS2080 Auto.);
- 15–19mm clear;
- 4–19mm extra clear Low Iron;
- Sunergy®/ Other hard coat low-E;
- 6mm Lacobel® T;
- Acid Etched;
- Cathedral;
- Gluechip;
- Satinlite;
- Spotswood;

MAXIMUM SIZE

The National Glass toughening furnace can produce sizes up to 5000mm x 2700mm.

CALCULATING MINIMUM TOUGHENED GLASS SIZE

\[ A^2 + B^2 = C \]

\[ \sqrt{C} = D \] (Diagonal measurement)

MINIMUM EDGWORK

Clean cut edges for toughened glass is not permitted. Minimum finish is standard arris 3–8mm. 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.

For more information on edgework profiles and edge working in general, refer “Edgework and Processing”, Section 13.

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: Our glass labels conform to the requirement under AS/NZS2208:1996 as a non-permanent marking. To assist with identification we also attach a small self-destroying label to all squares of toughened glass that are ordered without a permanent stamp. 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 an drawing position of stamp.

POSITION OF STAMP

ARCHITECTURAL STAMP

Size: 30mm Diameter

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

LOUVRE FACE STAMP

Small discrete ID stamp placed on face of glass (41mm x 3mm).
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 windloading 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 and above ground floor panels because the fragments do not fall to the ground below. 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.

See also “Heat Strengthened Laminated Glass” page 54.

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 and 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.
LAMINATED GLASS

THIS SECTION INCLUDES:

» Custom laminated glass
» Interlayers, max and min sizes
» Furnaced laminated glass
» SGP Laminated glass

Laminated glass is a safety glass made by laminating two or more panels of glass with a flexible plastic interlayer (PVB – poly vinyl 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.

CUSTOM LAMINATED

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 stacked, which when combined meet most architectural glass requirements. For energy efficiency solutions, select either Sunergy Low-E or Low-E Clear glass. For noise reduction, include a AcoustA™ laminated glass panel. For structural and strength, both lites of glass can be toughened or heat strengthened with thicker and stronger interlayers such as SentryGlas® Plus. Decorative elements can be added with coloured interlayers and ImageTek printed panel.

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 giving user many performance options;
» Security – Security features which greatly aid prevention of illegal entry and/or vandalism (eg. 1.52mm PVB and SentryGlass® Plus 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;
» UV protection – Helps to protect carpets, curtains, and furniture by screening out 99% of all ultra-violet light;
» 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, rooflites, skylites 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.
Thermal breakage

Matching

Glass panel edges

Furnaced Laminated Glass: Interlayers:

Diagram 8.0: typical laminated glass make-up

DESIGN AND GLAZING NOTES

Interlayers: – Standard stacked 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 generally require a thicker PVB interlayer than the standard 0.38mm thickness (usually 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, vacuum cooled laminated glass and pyrolytic 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 discoloration and edge delamination is a concern, it is recommended that the edges be fully glazed in a frame or a SentryGlas® Plus interlayer be used. 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

<table>
<thead>
<tr>
<th>Interlayer Thickness (mm)</th>
<th>Toughened &amp; Heat Strength Laminated</th>
<th>Annealed Laminated</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVBColour</td>
<td>0.38</td>
<td>0.76</td>
</tr>
<tr>
<td>Clear</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Grey, Green, Cool Blue, Brown, Translucent</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Solar SG41</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Vanceva</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Acoustic PVB QS41</td>
<td>Clear</td>
<td>✓</td>
</tr>
<tr>
<td>SGP® Clear</td>
<td>✓</td>
<td>-</td>
</tr>
</tbody>
</table>

EXAMPLE OF HOW TO BUILD A CUSTOM LAMINATED PRODUCT

1. Minimum interlayer thickness must equal 1.52mm
2. Select 0.38mm Grey PVB + 1.14mm Clear PVB + 1.52mm of PVB
3. Select glass type specific to project.

*Note:*

- Annealed min. starting overall thickness is 6.38mm or 3mm + 0.38mm + 3mm.
- Tough/Heat Strength min. starting overall thickness is 9.52mm or 4mm + 1.52mm + 4mm.
- SG41/QS41 min. starting overall thickness is 6.76mm or 3mm + 0.76mm + 3mm.
- SGP min. starting overall thickness is 7.52mm or 3mm + 1.52mm + 3mm.
- SGP cannot be built up with PVB interlayers.
- 3mm Base glass restricted to 3660mm.
- Sizes over 3660mm in length should be engineered for suitable overall thickness and manufacturing capability.
- All specifications above subject to AS1288 Guidelines.
- Minimum size 400mm x 400mm.
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 liability in the event of glass breakage, what type of glass to use, panels that are 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 and iLOOK 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 focusses 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 generally a 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 its own weight and completely fall out of the opening and therefore posing a risk to people below eg. 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, Sentry Glass Plus (SGP) interlayers have been developed. Engineering advice should be undertaken when SGP’s are 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 generally 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 an SGP 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.

SGP LAMINATED

In response to architectural demands for stronger window systems, SentryGlas Plus (SGP) ionoplast interlayer has been developed to meet these needs. SGP 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. SGP laminated glass is also used in cyclone or hurricane resistant window and door systems, where the ability to resist the penetration of flying projectiles and high wind loads is of utmost importance. SGP offers five times the tear strength and 100 times the rigidity of conventional PVB laminated glass interlayer.

FEATURES AND APPLICATIONS

SGP 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.
› Superior post–glass breakage properties,
› Improved edge stability over standard PVB’s,
› High Clarity,
› Low optical distortion (in some cases SGP 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. SGP cannot be laminated with conventional PVB interlayer.

EDGE STABILITY AND DELAMINATION

SGP 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.
Insulated glass units (IGU’s) or double glazed units are a significantly more energy efficient glazing system than single glazing. IGU’s consist of two or more layers of glass separated by a void normally filled by air or gas such as Argon. The combination of airspace and glass panels act as an additional barrier, making the transfer of heat by convection, conduction and radiation more difficult. The glass panels are separated by a spacer normally made of thermoplastic material (Super spacer) or metal types (aluminium, stainless steel). The spacer is placed around the edges, hermetically sealed to the perimeter in controlled conditions. Common spacers range in width from 8mm up to 16mm. The spacer contains a desiccant (drying agent) which eliminates moisture vapour in the cavity. IGU’s are not to be confused with double glass windows or secondary sashes/windows, where the two panes have not been hermetically sealed.

**Features and applications**

- **Solar and thermal control;**
- **Reduction of heat build up in summer;**
- **Reduction of winter heat loss and condensation;**
- **Lower air conditioning and heating energy costs;**
- **Improves occupant comfort, particularly next to windows by reducing hot and cold spots;**
- **Lower noise penetration;**
- **Lower UV transmission;**
- **Increased windload strength;**
- **Increased security.**

**Primary functions**

- **Solar control** – The energy emitted from our Sun is referred to as solar energy or radiation. When glazed with select tinted, reflective and low-E glass, IGU’s reduce the sun’s direct heat energy through the glass more efficiently than ordinary single glazing. Solar control also refers to the ability of a glass to reduce visible light and UV transmittance. These select IGU’s perform a solar control function by limiting to various degrees the transmittance of direct heat energy, visible light and UV transmission; 
  See also “Solar Heat Gain Co-efficient (SHGC).”

- **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). IGU’s greatly improve the thermal control properties of a glazing over ordinary non-coated single glazing. Adding a low-E coating further improves performance. These thermal or insulation improvements work day and night in both summer and winter conditions, reducing heat entry and heat loss.
  See also “U-value.”
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).

Features & Benefits:
- Dual seal system with PIB primary, polysulphide or silicate 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.
- Smooth matte surface appearance finish.
- Spacer range B/10/12/16mm (others widths available on application).

ENERGY EFFICIENT GLAZING

WARM CLIMATES
The primary consideration for warm climates, where glazed openings have little or no protection from the sun's direct energy, is the reduction of heat gain. The air gap in IGU's slow down the rate of heat gain thus improving the thermal properties or energy efficiency when compared to a standard single glazed window. Adding a low-E coating greatly improves the insulation performance by reflecting re-radiated heat back into the room. 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 infrared heat. The low-E coated glass reflects this long wave heat radiation back into the room.

For more information see “Low-E Coated Glass” page 20.

DESIGN AND GLAZING NOTES

PRIMARY AND SECONDARY SEALS
National Glass manufactures IG's with a PIB (Polyisobutyl) for the primary seal and default polysulphide for the secondary seal. Silicone is used as a secondary seal where edges are exposed such as in structural glazing. Where there is concern about the exposure of the edges of the IG, specify silicone secondary seal upon enquiry.

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.

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.

THERMAL STRESS
The use of solar control glass may affect the thermal safety of the glazing 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 123.

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.

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 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.

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 the 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.

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.

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.

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 neoprene or rubber of 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 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 structural silicone, due to its high resistance to UV radiation.
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 of the IG, screened onto Surface 2. If an additional motif is required for the interior panel, please request on order.

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.

### TABLE 9A: SETTING BLOCKS TABLE

<table>
<thead>
<tr>
<th>Area of unit Minimum length at each (m²)</th>
<th>Quarter point (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 2.0m²</td>
<td>50</td>
</tr>
<tr>
<td>2.0–3.0m²</td>
<td>75</td>
</tr>
<tr>
<td>3.0–4.0m²</td>
<td>100</td>
</tr>
<tr>
<td>4.0–5.0m²</td>
<td>125</td>
</tr>
<tr>
<td>5.0–6.0m²</td>
<td>150</td>
</tr>
<tr>
<td>Up to 7.0m²</td>
<td>175</td>
</tr>
</tbody>
</table>

Guide = 25mm per m² of glass.

Diagram 9.3: Typical Super spacer profile

Diagram 9.4: 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.
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 into the glass 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 inhouse 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 5000mm x 2700mm: Toughened – up to 19mm Glass
- Max Size 5000mm x 2600mm: Furnaced laminated
Choose an image or pattern to use from our large themes library. Includes artwork from categories such as Interiori, Natural and Material. Some examples shown below and on following pages. Refer to National Glass website for full library range.

Examples of custom images printed on glass:

*“Turtle” image was printed across two splashback panels.

*“Wave” image was printed on a 1965mm x 2025mm partition.

*“NYC” image was printed on a 1965mm x 2025mm partition.

INTERIORI™ design collection is the result of a sophisticated mixture of ceramic inks, innovative digital printing technology for glass and unique graphic design techniques.
DESIGN AND GLAZING NOTES

- **External applications** – For external glazing, the painted surface should always be glazed to the inside surface away from the effects of weathering. Glazing techniques should provide for an adequate seal.

- **Backlighting** – Though this glass is used as a decorative feature internally, backlighting should be avoided. One way viewing through the non-paint side is always preferable.

- **Translucent cladding** – There has been an increasing trend in the use of more transparent and less reflective glass. A notable example is the growth in demand of acid etched or other translucent type glass. 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 deposits may become visible when using a transparent glass. For these non-ventilated traditional spandrel applications, it is recommended that an opaque (non-see through) ceramic fired paint colour be specified on heat strengthened glass. (With ground floor glazing, where human impact is a consideration under AS1288, then toughened or laminated glass must be used as a minimum). Any vapour deposits will not be seen from the outside. Ceramic fired painted glass has been used in these applications for over 30 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 or sand blasted glass) are specified, it should be asked where or how these products are to be used in the building. Ceramic painted glass should be opaque or with no see through when used in these non-ventilated applications. In some instances, where the space is ventilated or a double window facade is constructed, translucent ceramic painted glass, translucent laminated or acid etched maybe used provided that the coated or etched surfaces are not exposed to weathering. The client should also be aware of edge delamination if using exposed edged laminated glass.

- **Internal glass cladding (splashbacks)** – Minimum thickness is generally 6mm in either clear or low-iron glass. Low-iron glass is recommended for true clarity and consistency of colour. Colour mismatches may occur with ordinary 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. Toughened glass is always recommended. Special note should be made here with regards to protection of combustible surfaces near cooking appliances. The use of painted glass panels for kitchen splashbacks applications requires that this glass meets the requirements under AS4551/AG101 and AS5601/AG601. See also pages 42/43.

- **Air face or tin side** – Colour differences maybe noticeable if painting 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 face or the non-tin side of the glass.

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**LACOBEL® T**

The Lacobel® T range is a pre-painted glass which can be processed and toughened, which means faster lead times. Lacobel® T uses a high quality industrial paint that is hard to scratch, even before toughening or processing which results in a lower risk of scratching during transport. In addition to the obvious use in internal wall cladding such as splashbacks, Lacobel® T is also designed for use in external facades. Available in 6mm thickness, dimensions 2250/2550 x 3210mm.

- **Lacobel® T Colours**
  - SUNSHINE
  - SANDSTORM
  - DUSK
  - BREEZE
  - ZEN GREY
  - ANTHRACITE GREY
  - DEEP BLACK
  - COOL WHITE

---

**Toughened laminated ceramic painted patterned glass in overhead glazing application.**

**Lacobel® T Cool White**

**Lacobel® T Colours**

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**Toughened laminated ceramic painted patterned glass in overhead glazing application.**
SPANDREL GLASS

Spandrel glass refers to glass used to hide the building structure between floors. Ceramic base painted glass or Lacobel® T are the common products used in these applications.

In spandrel panels it is always recommended that glass be heat strengthened because of the excessive heat build up generated (upwards of 70°C). In this situation the other benefit of heat strengthening is apparent, where upon breakage the glass tends to fragment into large pieces and stay intact in the opening or framework.

The spandrel glass should always be viewed from the outside only. Two way viewing is not recommended due to surface imperfections.

- **Read through** – Spandrel panels are designed to hide the building structure, to provide a uniform glass façade, panels all 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).

- **IGU’s** – One method to assist in matching is to use IGU’s or insulated glass units with the reflective coated surface position #2 and an opaque ceramic painted frit on surface position #4. IGU’s create the perception of depth similar to that of the vision panel.

- **Contrasting panels** – monolithic or single glazed ceramic painted panels is commonly used here with the painted surface facing to the inside of the building. Where an IGU is specified, the painted panel is positioned as the exterior panel with the painted surface on #2 facing the inside of the unit.

- **Mock ups** – With spandrel panels it is always recommended that the customer view a mock up sample or inspect a completed building before confirmation is given to glass design/specification.
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.

FEATURES AND APPLICATIONS
- Permanent and durable surface, marks less and easier to handle than sandblasted glass;
- Can be readily toughened or laminated as safety glass;
- Glass types – clear and grey;
- Sizes & thicknesses – 2134mm 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.

ETCH DEPTH CONSISTENCY
Separate batches of acid etched glass may have slight variances in etch depth which may effect the transparency or visual obscurity when viewed. This is a common result of the manufacturing method.

RAKED AND OUT OF SQUARE PANELS
See page 118 for drawing presentation when ordering acid etched glass.

ACID ETCHED GLASS HANDLING AND INSTALLATION GUIDELINES
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 where silicone is used, all glass should be protected or taped near the silicone edge. Immediately clean silicone marks with suitable glass cleaners. If let to dry, marks cannot be removed without damaging the surface.

WHICH WAY TO GLAZE THE ACID ETCHED 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.

See “Translucent Cladding Glazing” note page 66.

TRANSLUCENT PVB LAMINATED
Translucent 0.38mm PVB interlayers with clear glass are used to make-up this product. Where a coloured translucent is required, a tinted PVB interlayer is generally added. This will increase the interlayer thickness to a minimum of 0.76mm.

DECORPANEL™
A painted coated glass, with a vinyl backing applied to the painted surface to provide Grade A safety glass protection. DecorPanel™ is purpose designed for wardrobe doors and internal wall paneling, using a superhard grade paint specifically for decorative glass applications. Not recommended for applications where moisture is present including, but not restricted to, kitchen splashbacks or bathrooms. Available in 4mm thickness, colours of soft & pure white. Sizes up to 2760 x 1220mm.
EXTRA CLEAR (LOW IRON) 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 and Starphire® are ideal for displaying the true colours of a viewed object. It is widely used as a base for 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 6/8/10/12/15/19mm 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.

PATTERNED AND WIRED GLASS

Patterned or figure rolled glass is made by running molten glass over a patterned roller which reproduces the pattern on the glass. Figured roll glass is used to diffuse, not obscure, an object when viewing. The glass is also used as a popular decorative product.

WIRED GLASS

6mm wired glass is produced in a similar manner to figured roll glass except that a sheet of welded wire is introduced into the molten glass before running it through the pattern rollers.

> Thermal breakage – The combination of wire and the resultant high heat absorbancy along with the difficulty in achieving 'good' defect free edges when cutting, make this product highly susceptible to thermal breakage. (i.e. shower panels are most notable for thermal breakage where excessive heat on a cold surface can cause breakage);
> Glass edge – finishes to wired glass are restricted to a rough arris;
> Safety glass – Wired glass is a Grade B safety glass restricted to applications as per AS1288. It can be cast in place laminated (CIP) to meet Grade A safety standards.
MIRROR GLASS
MIRRORS OR SILVERED GLASS ARE MORE THAN JUST VANITY PIECES. LIGHT IS ALSO REFLECTED FROM THE MIRROR’S SURFACE TO BRIGHTEN SMALL SPACES. MIRROR PRODUCTS ARE USED AS DESIGN FEATURES IN THE HOME, RETAIL OR COMMERCIAL INTERIORS. ONE COMMON METHOD OF MIRRORED 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.

MIRROR TYPES
AVAILABLE IN STANDARD CLEAR, GREY AND BRONZE COLOURS.
STANDARD CLEAR MIRROR USES CLEAR FLOAT GLASS WHILE TINTED MIRROR USES BODY TINT BRONZE AND GREY FLOAT GLASS.
- Clear mirror – 3/4/6mm and 6.38mm laminated.
- Grey/Bronze mirror – 4/6mm thickness.

VINYL BACKED ORGANIC SAFETY MIRROR – GRADE A
AVAILABLE IN 4MM AND 6MM THICKNESS, NATIONAL GLASS SAFETY ORGANIC COATED VINYL BACKED MIRROR IS MANUFACTURED TO AS/NZS2208 AND MEETS AS1288 HUMAN IMPACT REQUIREMENTS.
THIS PRODUCT CAN ONLY BE CUT FROM ORIGINAL Sized SHEETS.
MIRROR DESIGN AND GLAZING NOTES

EDGE CORROSION
Essentially, mirror contains metals such as silver. Conventionally manufactured mirror contains copper that tarnishes or corrodes 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.

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

INSTALLATION
There are a number of ways to install mirrors. One method is to screw fix the mirror to the wall or alternatively using adhesive tapes and glues. With the use of vinyl backed mirrors, compatibility between the tape and/or adhesive and the vinyl material backing is critical to prevent mirror from falling off the wall. 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.

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.

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 onto 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.

VANCEVA® COLOURED PVB’S
Vanceva® is an interlayer system that incorporates colour to create a unique range of laminated glass. The Vanceva® interlayer is a permanently bonded advanced laminated glass solution that is easily maintained. Vanceva®’s coloured interlayers enables laminated glass to be produced in a wide choice of colours.

Arctic Snow 0009
Cool White 000A
Polar White 000F
Coral Rose 0001
Sahara Sun 0004
Golden Light 0008
Sapphire 0006

Aquamarine 0002
Evening Shadow 0007
Ruby Red 0005
Deep Red 001C
True Blue 000D
Absolute Black 000G
Sahara Sun 0004

Coral Rose 0001
Deep Red 001C
Sahara Sun 0004
Coral Rose 0001

Mix and match colours to create dramatic effects.
For more colour choices visit www.vanceva.com/color-selector
GLASS DESIGN & INSTALLATION

THIS SECTION INCLUDES:

» Frameless pivot door types
» Fin design
» Sliding doors
» Glazed walls
» Balustrading
» Pool gates
» Frameless shower screens
» Glass flooring and pool panels

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.

PIVOT DOOR TYPES
Corner patch fittings .................Type B and C
Full length rails .......................Types A and B
Offset pivot doors ....................Types A, B and C
Centre fix pivot doors ..............Types A, B and C
SR pivot doors ......................See pages 84-87

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 windloading 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 II.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 lessen 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.

<table>
<thead>
<tr>
<th>TABLE 11A: GLASS TYPES FOR FRAMELESS GLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass Type</td>
</tr>
<tr>
<td>Clear</td>
</tr>
<tr>
<td>Extra Clear</td>
</tr>
<tr>
<td>Grey</td>
</tr>
<tr>
<td>Green</td>
</tr>
<tr>
<td>Bronze</td>
</tr>
<tr>
<td>SuperBlue</td>
</tr>
<tr>
<td>Acid Etched</td>
</tr>
<tr>
<td>Sunergy Neutral LowE</td>
</tr>
</tbody>
</table>
Diagram 11.0: Frameless pivot door and entry types.

Type A – full length top and bottom rails

Type B – top corner patch fittings and full length bottom rails

Type C – top and 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 windload design should always be carried out to determine thickness and width of fin.

Diagram 11.1:
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 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.

Diagram 11.2: Cantilevered fin detail
With highlite fin designs, (X) must be no less than 2/3 of the fin width required.
SR PIVOT DOOR SYSTEM

A design alternative to standard corner patch and door rail systems, SR 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.

Type A

Type B

Type C

Type D

Type E

Type F

Type G
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.

Typical SR sliding door hanger set.

SR SLIDING DOOR SYSTEM

A design alternative to standard top hung and bottom track sliding systems, SR 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.
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.

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 windload 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 windload, facing panel size and silicone joint bite size.

NO FIN SUPPORT
Where fins are not desired for appearance or other reasons, windload is a critical factor in determining glass thickness. Areas not subject to windload, such as enclosed shopping centres/malls, may in some situations utilise this type of shopfront design.
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 the 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 façade 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.
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, the glass must be a minimum of 10mm toughened, but may need to be heat soaked toughened or a toughened laminated. 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 engineering certification for compliance. These systems typically use toughened laminated panels with high strength SentryGlas Plus (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 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;
- AS1288: Glass in Buildings;
- AS1170: Wind load, dead load and live requirements;
- AS2820: Gate units for private swimming pools.

Diagram 11.7:
Structural glass balustrade with no handrail utilising high strength SGP interlayer.

Diagram 11.8:
Structural glass balustrade with handrail.

A Toughened glass panel (Heat soaked treated) or laminated toughened. Typically thicknesses of 12/15/19/25mm or 14.28mm to 22.28mm SGP Laminated.
B Continuous non-shrinkable grout.
C Neoprene setting block 25mm wide x 10mm high.
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.

12mm clear toughened glass bottom grouted cantilevered – Tewantin Glass.
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 fix balustrade
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.
**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.

**Diagram 11.12:**

A

B

C

D

**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**

<table>
<thead>
<tr>
<th>Width</th>
<th>(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall hung doors</td>
<td>600-700</td>
</tr>
<tr>
<td>Glass hung doors</td>
<td>550-650</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Height</th>
<th>(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall &amp; glass hung doors</td>
<td>1850–2100</td>
</tr>
</tbody>
</table>

**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 left) UV adhesive or silicone fixed to glass and wall.
Diagram 11.13: Frameless shower screen types

- Type A
- Type B
- Type C
- Type D
- Type E
- Type F
- Type G
- Type H
- Type I
- Type J

Diagram 11.14: Typical frameless shower door hardware

- 180° glass to glass chrome shower hinge
- Wall to glass Satin chrome shower hinge
- Wall to glass bracket
- Wall to glass header bar
GLASS FLOORING

The glass supplied for these applications is generally a custom laminated make-up of 2-3 panels of glass. Sometimes a sacrificial sheet of 6mm toughened glass 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. Trafficable flooring should have an anti-slip coating applied with ceramic paint or alternatively a toughened 6mm anti-slip acid etched pattern glass can be used. Glass flooring and stair treads require specialist engineering to determine correct glass type and thickness.

Please consult our technical staff for more information.

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.
- Maximum allowable deflection in support framing is span over 500.

Diagram 11.15: glass flooring installation details – 4 side support.

Diagram 11.16: Typical standard anti-slip glass patterns.
POOL OBSERVATION SIDE PANELS

For panels in swimming pools, large commercial aquariums and other underwater observation situations where loads other than water pressure exist and/or where the top edge of the vertical panel is below the head of water level, specialist engineering is required to determine glass type and thickness (This product will generally be a multi-laminated glass).

DESIGN AND GLAZING NOTE

Some sealants used for pool observation glass require UV protection. Protection can be achieved through black ceramic banding on the perimeter of the glass edge. Size of banding must cover rebate size.
SPECIALTY PRODUCTS

THIS SECTION INCLUDES:
» Renew Glass
» Anti-Reflecting Glass
» Radiation Shielding Glass

RENEW™

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 cleaning 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.

SIZES & THICKNESS
» 6.38/8.38/10.38/12.38mm

SIZES
» 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.

» 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.

Diagram 12.1: Coating positions – Viridian Optiview™ anti-reflecting glass

Laminated

VLR <2% (7-8% ordinary clear glass)
VLRi <2% (7-8% ordinary clear glass)
Visible light reflectance
Visible light reflectance (internal)
Coatings on both surfaces.

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.

When requesting a quotation, please state:
› the window size;
› the millimetres of lead, (mmPb) or percentage lead equivalent; and
› the radiation dose rate in voltage (kV).

A surcharge is applicable for cut to size panels. Larger panels are available on extended leadtimes. Therefore it is advisable where permissible to build the opening around these standard sizes. For human impact considerations, laminated glass is available on extended leadtimes.

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

- Edgework types
- Mitred Glass
- Hole sizes
- Cutout location and rules
- Raked, out of square guidelines
- Width to height processing
- Template Guidelines

EDGEWORK TYPES

**CLEAN CUT**

Edges are cut clean as the cutter cuts the glass. Edges are 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.

**SMOOTH ARRIS**

Not available. Refer “Flat Polish”.

**MITRE DETAILS**

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 8mm+ 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 1)
- Glass width measurements shall be given from long points of glass as shown.
  (see Diagram 13.1 - Fig 2)
- Drawings sent should indicate back or face mitre view with degrees.
  (see Diagram 13.1 - Fig 3 and Fig 4)

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

Diagram 13.1: Mitre details

**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 1:

Figure 2:
**MITRES continued**

Diagram 13.1: Mitre details

Figure 3

22.5°

Back mitre

Face View

Plan View

Figure 4

45°

Face View

Plan View

**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.
- 8–18mm glass is always priced with flat polished edges in addition to the bevelled edge price.

Refer sales staff for minimum residual edge thickness.

**SINGLE BEVEL**

**STRAIGHT LINE BEVELLING**

- Minimum glass height of 120mm;
- Maximum size of 2800mm x 1200mm up to maximum weight of 250kg.

**MAXIMUM BEVEL WIDTHS**

<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>Maximum bevel widths (mm)</th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>6+</td>
<td>35</td>
</tr>
</tbody>
</table>

**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. See also “Corner finishes” for corner detailing. For corners, where a “CNC” flat polished finish is specified, request “CNC” external radius corners (Photo C opposite).

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 arissed finish which is supplied on all 8mm+ toughened glass with rough/standard ariss peripheral edge (see Photo A). Where two flat polish edges meet, the minimum corner finish is a polish tipped.
- Polish tipped corner – If corner finish is critical, specify polished tipped corners. Polish tipped corners are up to 2mm across the face (see Photo B).
- CNC external radius corners – Minimum size is 2mm 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.

**CNC MAXIMUM SIZE**

The largest size glass panel that can be processed through our CNC machines is 5000mm x 2700mm.
DRILLED HOLES LESS THAN 74MM

DRILLED HOLE SIZES

<table>
<thead>
<tr>
<th></th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>6</td>
<td>8-10</td>
<td>36-40</td>
</tr>
<tr>
<td>Medium</td>
<td>12-13</td>
<td>14-16</td>
<td>40-45</td>
</tr>
<tr>
<td>Large</td>
<td>17-18</td>
<td>19-20</td>
<td>50-57</td>
</tr>
</tbody>
</table>

Holes will have a ground finish with arris.

OTHER POINTS

The minimum width of a panel with a hole shall be B 0x the glass thickness.

SIZING AND LOCATION

- 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.

SMALLEST SIZED HOLES

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

OTHER HOLES GREATER THAN 74MM AND NON CIRCULAR CENTRE CUTOUTS

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.

CUTTERSUNK HOLES

- Available on glass thicknesses 5mm and over and countersunk to 45°.
- Holes will have a ground finish arris.

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 5mm and over and countersunk to 45°.
- Holes will have a ground finish arris.

Diagram 13.2:

Diagram 13.3:

Diagram 13.4: Radius Minimum FG/FP on Inverted rakes.

Diagram 13.5:

R = INTERNAL RADIUS CORNER MINIMUMS

<table>
<thead>
<tr>
<th>Glass (mm)</th>
<th>Flat grind (FG)</th>
<th>Flat polish (FP)</th>
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</thead>
<tbody>
<tr>
<td>4/5/6</td>
<td>9mm</td>
<td>20mm</td>
</tr>
<tr>
<td>8</td>
<td>10mm</td>
<td>20mm</td>
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<tr>
<td>10</td>
<td>12mm</td>
<td>20mm</td>
</tr>
<tr>
<td>12</td>
<td>12mm</td>
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</tr>
<tr>
<td>15</td>
<td>15mm</td>
<td>20mm</td>
</tr>
<tr>
<td>19</td>
<td>19mm</td>
<td>20mm</td>
</tr>
</tbody>
</table>

Diagram 13.5:
SIDE CUTOUTS

SIZING AND LOCATION
- 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.
- External corners of cutouts shall be standard tipped, polished tipped or specify CNC 2mm minimum radius flat ground or polished finish.

Diagram 13.6:

CORNER CUTOUT

SIZING AND LOCATION
- 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.
- External corners of cutouts shall be standard tipped, polished tipped or specify CNC 2mm minimum radius flat ground or polished finish.

Diagram 13.7:

INTERNAL RADIUS CORNERS – ‘MOUSE EAR’ CUTOUTS

As previously detailed on there are rules on the minimum size of internal radius corners. For ‘mouse ear’ type cutouts as shown on diagram 13.8, internal radius must be no less than glass thickness. If this radius is now too big because of the minimum size rule, it can be offset as shown in 13.9. However, please note, check with your patch or fittings supplier to ensure fitting will still fit the cutout and/or clamping area changes don’t compromise the structural integrity of the glazed panel.

Diagram 13.8:

POWER POINT CUTOUTS

Standard size of 100mm x 60mm.

Diagram 13.10:

FINGER SLOT GUIDELINES

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 13.11:
RAKED, OUT OF SQUARE AND SHAPED DRAWINGS

The drawings by product type to the right, 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

ACID ETCHED

PATTERNED GLASS

MIRROR

LACOBEL PAINTED

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

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

* 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.

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.
### General Data

**Table 14A: Major Components of Glass**

<table>
<thead>
<tr>
<th>Component</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica SiO₂</td>
<td>70–74</td>
</tr>
<tr>
<td>Soda Na₂O</td>
<td>12–15</td>
</tr>
<tr>
<td>Lime CaO</td>
<td>8–10</td>
</tr>
<tr>
<td>Magnesium Oxide MgO</td>
<td>3.5–4.5</td>
</tr>
<tr>
<td>Potassium Oxide K₂O</td>
<td>0.3–0.8</td>
</tr>
<tr>
<td>Alumina Al₂O₃</td>
<td>0.0–2.0</td>
</tr>
<tr>
<td>Iron Oxide FeO₃</td>
<td>0.08–0.11</td>
</tr>
</tbody>
</table>

**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**
- **Compressive Strength** (25mm cube): 248MPa
- **Tensile Strength**
  - Annealed: 19.3–28.4 MPa
  - Toughened: 175 MPa
- **Co-efficient of Linear Expansion**
  - Room temperature to 350°C: 9.0 x 10⁻⁶/°C
- **Hardness Mohs’ Scale**: 6.0
- **Density**: 2500 kg/m³
- **Young’s Modulus (Elasticity)**: 69 GPa
- **Poisson’s Ratio**: 0.23

**Table 14C: Glass Weights**

<table>
<thead>
<tr>
<th>mm</th>
<th>kg/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>7.5</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>12.5</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>12</td>
<td>30</td>
</tr>
<tr>
<td>15</td>
<td>37.5</td>
</tr>
<tr>
<td>19</td>
<td>47.5</td>
</tr>
<tr>
<td>25</td>
<td>62.5</td>
</tr>
</tbody>
</table>

**Table 14D: Conversions and Calculations**

- **Inches to Millimetres**: 1 inch = 25.4mm
- **Fahrenheit to Celsius**: \( C = \frac{f - 32}{9} \times 5 \)
- **Square feet to Square metres**: 10.764 square foot = 1m²
- **PI**: \( \pi = 3.142857 \)
- **Radius of a circle (r)**: Centre to outer edge
- **Diameter of a circle (D)**: \( D = 2 \times r \)
- **Circumference of a circle (C)**: \( C = \pi D \)
- **Area of a circle**: \( \pi r^2 \)
- **Area of a square/rectangle**: Height x Width
- **Perimeter or linear measurement of a square/rectangle (Linear metre)**: Height + Width x 2

### 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.

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
**BREAKEAGE 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 on its PVB 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: Glazing types and surface positions**

- **single monolithic**
  - outside
  - inside

- **laminated**
  - outside
  - inside
  - PVB Interlayer

- **double glazing IGU**
  - Airspace
  - Low-E Coating #2 or #3
  - Inboard Lite
  - Outboard Lite

- **double glazing IGU with laminated glass**
  - Airspace
  - PVB Interlayer

* 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.

---

**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 as high as 70°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 or double glass units**
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.

**Film application**
Application of film products, paper, posters or paint will increase the possibility of thermal breakage.
TABLE 14E: THERMAL BREAKAGE RISK

<table>
<thead>
<tr>
<th>Glass type</th>
<th>Solar absorption</th>
<th>Risk factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>18%</td>
<td>Low</td>
</tr>
<tr>
<td>Coloured/Tinted/Low-E</td>
<td>30–40%</td>
<td>Medium</td>
</tr>
<tr>
<td>High light transmitting coating on coloured or tinted</td>
<td>45–55%</td>
<td>Medium to high</td>
</tr>
<tr>
<td>Reflective coating on clear</td>
<td>60–70%</td>
<td>High</td>
</tr>
<tr>
<td>Reflective coating on coloured or tinted</td>
<td>80–85%</td>
<td>Very high</td>
</tr>
</tbody>
</table>

TABLE 14F: THERMAL STRENGTH

<table>
<thead>
<tr>
<th>Glass type</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toughened glass</td>
<td>Strong</td>
</tr>
<tr>
<td>Heat strengthened glass</td>
<td></td>
</tr>
<tr>
<td>Thin annealed float glass</td>
<td></td>
</tr>
<tr>
<td>Laminated annealed float glass</td>
<td></td>
</tr>
<tr>
<td>Thick annealed float glass</td>
<td></td>
</tr>
<tr>
<td>Thick annealed laminated glass</td>
<td></td>
</tr>
<tr>
<td>Patterned annealed glass</td>
<td></td>
</tr>
<tr>
<td>Wired glass</td>
<td>Weak</td>
</tr>
</tbody>
</table>

STANDARDS LIST

Listed on this page 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;

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS1288</td>
<td>Glass in Buildings – Selection and Installation;</td>
</tr>
<tr>
<td>AS/NZS2208</td>
<td>Safety glazing materials in buildings;</td>
</tr>
<tr>
<td>AS/NZS2080</td>
<td>Safety glass for land vehicles;</td>
</tr>
<tr>
<td>AS/NZS4666</td>
<td>Insulating glass units;</td>
</tr>
<tr>
<td>AS/NZS4667</td>
<td>Quality requirements for cut to size and processed glass;</td>
</tr>
<tr>
<td>AS/NZS4668</td>
<td>Glassory of terms used in the glass and glazing industry;</td>
</tr>
<tr>
<td>HB125</td>
<td>The glass and glazing handbook;</td>
</tr>
<tr>
<td>AS1170</td>
<td>Structural design actions;</td>
</tr>
<tr>
<td>AS2047</td>
<td>Windows in Buildings;</td>
</tr>
<tr>
<td>AS4055</td>
<td>Wind loads for housing;</td>
</tr>
<tr>
<td>AS4128</td>
<td>Design for access and mobility;</td>
</tr>
<tr>
<td>AS3959</td>
<td>Construction of buildings in bushfire prone areas;</td>
</tr>
<tr>
<td>AS3740</td>
<td>Waterproofing of wet areas within residential buildings;</td>
</tr>
<tr>
<td>AS1926</td>
<td>Swimming pool safety;</td>
</tr>
<tr>
<td>AS2820</td>
<td>Gate units for private swimming pools;</td>
</tr>
<tr>
<td>AS/NZS4284</td>
<td>Testing of building facades;</td>
</tr>
<tr>
<td>AS/NZS2343</td>
<td>Bullet resistant panels and elements;</td>
</tr>
<tr>
<td>AS3555</td>
<td>Building elements – Testing and rating for intruder resistance;</td>
</tr>
<tr>
<td>AS1735</td>
<td>Lifts, escalators and moving walks;</td>
</tr>
<tr>
<td>AS1530</td>
<td>Methods for fire tests on buildings materials, components and structures;</td>
</tr>
<tr>
<td>AS/NZS1905</td>
<td>Components for the protection of openings in fire resistant walls;</td>
</tr>
<tr>
<td>AS2366</td>
<td>Repair of laminated glass windscreens fitted to road vehicles;</td>
</tr>
<tr>
<td>AS1799</td>
<td>Small pleasure boat code;</td>
</tr>
<tr>
<td>AS5601</td>
<td>Gas installations;</td>
</tr>
<tr>
<td>AG601</td>
<td>Gas installations;</td>
</tr>
<tr>
<td>AS4551</td>
<td>Domestic gas cooking appliances;</td>
</tr>
<tr>
<td>AG101</td>
<td>Domestic gas cooking appliances;</td>
</tr>
<tr>
<td>AS/NZS4586</td>
<td>Slip resistance classification of new pedestrian surface materials;</td>
</tr>
<tr>
<td>HB197</td>
<td>An introductory guide to the slip resistance of pedestrian surface materials</td>
</tr>
<tr>
<td>AS1418</td>
<td>Cranes;</td>
</tr>
<tr>
<td>AS2380</td>
<td>Electrical equipment for explosive atmospheres – explosion protection techniques;</td>
</tr>
<tr>
<td>AS4114</td>
<td>Spray painting booths.</td>
</tr>
</tbody>
</table>

STANDARDS LIST

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
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 discolor 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.”

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 i.e. 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.

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.

RESTORING SURFACE DAMAGE
Depending on the level of glass surface damage, there are a few restoring agents available. Products such as Calc-Off and Renotec 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 Calc-Off, 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 Calc-Off’s 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

When the glass is wet, the panels should be removed and dried immediately. If the glass is clean, this product has been supplied for short-term use. For longer periods, the glass should be removed and stored in a dry and clean environment.

SCREENS
Temporary screens may be required if other trades (i.e. welding, sand blasting, floor sanding, etc.) are in progress near to the glass 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.

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, 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 jewellery and watches are removed and gloves should be worn.
- Use only soft clean cloths, 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 ensure that 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 jewellery 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.

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. 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 THE GLASS PERFORMANCE DATA – WINDOW 6.3
Window 6.3 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 Data Base (IGDB), which is an extensive collection of glazing products from around the world. It is available to download from the internet at: http://windows.lbl.gov/software/window/window.html.

NFRC 100-2010
A National Fenestration Rating Council (NFRC-USA) document specifying the environmental conditions, (i.e. wind speeds, internal and external temperatures, solar radiation levels and heat transfer coefficients), and procedure used to determine the performance characteristics of 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 organization that administers the only uniform, independent rating and labelling 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 glass to reduce visible light and UV transmission.

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 fail 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 IGUs 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 (VLI)
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. 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 equals 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 coating of the building. SHGC can also be calculated as 88% 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/m².
For example the sun’s direct energy typically radiates on a hot day 785 watts per m² and 6mm Sunergy® Green has a SHGC of 0.42. If you multiply 785 watts x 0.42 (SHGC) you get 329 watts per m² radiated into the building. In this example the Sunergy® glass is reducing the sun’s direct energy through the glass into the building by 58%.
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, 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 (W/m²K) difference. The amount of heat energy transfered as measured by the U-value can be calculated by taking for example 4mm clear float with a U-value of 5.9w/m²°C and multiplying the difference between outdoor and indoor temperature (32°C outside and 24°C inside = 8°C) 5.9 x 8°C = 47 watts per m² heat transferred between the outside and inside. The lower the U-value the better the thermal
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 coefficient 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:

\[ SC \times \text{Direct solar intensity} + U \times \text{Difference between outdoor and indoor temperature} \]

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

### TABLE 14G: GLASS PERFORMANCE VALUES

<table>
<thead>
<tr>
<th>Colour and type</th>
<th>VLT Visible light transmission</th>
<th>VLR Visible light reflectance</th>
<th>VLRI Visible light reflectance</th>
<th>Shading co-efficient</th>
<th>SHGC</th>
<th>U-value W/m²K</th>
</tr>
</thead>
<tbody>
<tr>
<td>brz = bronze</td>
<td>EV = EVantage</td>
<td>grn = green</td>
<td>gry = grey</td>
<td>LEC = Low-E Clear</td>
<td>N Sunergy = Neutral Sunergy</td>
<td>QS41 = Acousta™ PVB sg = supergreen</td>
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### CLEAR FLOAT

<table>
<thead>
<tr>
<th>Thickness</th>
<th>VLT %</th>
<th>VLR %</th>
<th>VLRI %</th>
<th>Shading</th>
<th>SHGC</th>
<th>U-value</th>
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<td>5.9</td>
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<td>8</td>
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<td>6mm</td>
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<td>7</td>
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<td>0.77</td>
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**TABLE 14G:**

<table>
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<tr>
<th>Colour and type</th>
<th>VLT (%)</th>
<th>VLR (%)</th>
<th>VLR (%)</th>
<th>Shading coefficient</th>
<th>SHGC</th>
<th>U-value (W/m²K)</th>
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<tr>
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<td>6</td>
<td>5</td>
<td>0.71</td>
<td>0.62</td>
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<td>8</td>
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<td>Colour and type</td>
<td>VLT Visible light transmission</td>
<td>VLR Visible light reflectance</td>
<td>VLRi Visible light reflectance</td>
<td>Shading co-efficient</td>
<td>SHGC</td>
<td>U-value (W/m²K)</td>
</tr>
<tr>
<td>----------------</td>
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<tr>
<td><strong>LOW-E COATED</strong></td>
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<th>Thickness</th>
<th>VLT</th>
<th>VLR</th>
<th>VLRi</th>
<th>Shading co-efficient</th>
<th>SHGC</th>
<th>U-value</th>
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<td>Internal %</td>
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<th>VLR</th>
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<th>Shading co-efficient</th>
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<th>U-value</th>
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<td><strong>SUENERGY® (12MM ARGON GAS FILLED)</strong></td>
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<td>Internal %</td>
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<tr>
<td>10mm N Sunergy</td>
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<td>12</td>
<td>15</td>
<td>0.56</td>
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</table>
STOCKLINES & DISCONTINUED GLASS

This section includes:
- Stocklines
- Glass types and sheet sizes
- Discontinued lines

National Glass carry a large range of stock types and sheet sizes for either cutting and processing in house or to be sold as original sheets to customers. Please note other glass types can be sourced depending on project size and requirements. Some laminated glass sizes depending on substrate type can be custom made in house if the stock sheet size listed is not large enough. Talk to our sales representatives for more information. Also listed is the discontinued range of patterned and wired glass types. These products have been marketed in Australia over the past 30-40 years. They are generally no longer available, difficult to source or not stocked by National Glass.

<table>
<thead>
<tr>
<th>Glass type</th>
<th>Sheet size (mm)</th>
<th>Glass type</th>
<th>Sheet size (mm)</th>
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<tr>
<td>CLEAR FLOAT</td>
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<td>TINTED FLOAT</td>
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<tr>
<td>3mm</td>
<td>1220 x 1830</td>
<td>BRONZE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1830 x 2440</td>
<td>5mm</td>
<td>2440 x 3660</td>
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<tr>
<td></td>
<td>2760 x 4600</td>
<td>6mm</td>
<td>2250 x 3210</td>
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<tr>
<td>4mm</td>
<td>1220 x 1830</td>
<td>DARK GREY</td>
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<td>1220 x 2440</td>
<td>5/6mm</td>
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<td>EURO GREY</td>
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<td>3210 x 4600</td>
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<td></td>
<td></td>
<td>3210 x 4600</td>
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<tr>
<td></td>
<td>5mm</td>
<td>GREEN</td>
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<tr>
<td></td>
<td>1220 x 1830</td>
<td>5/6mm</td>
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<td>EXTRA CLEAR (LOW IRON)</td>
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<td>6/8/10/12/15/19mm</td>
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<td>Glass type</td>
<td>Sheet size (mm)</td>
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<tr>
<td>COMFORT PLUS CLEAR/NEUTRAL/GREY</td>
<td>6.38mm/10.38mm 2440 x 3660</td>
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<td>EVANTAGE</td>
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<td>SUNERGY</td>
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<td>1840 x 920</td>
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<td>5mm Gluechip 1220 x 2140</td>
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<td>6mm Satinlite 1840 x 2440</td>
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<td>4mm Soft White/Pure White 2440 x 914</td>
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<td>LACOBEL T Cool White/Deep Black/Zen Grey</td>
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<td>Dusk/Breeze</td>
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<td>6mm</td>
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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:

- Atlantic
- Autumn
- Borealis
- Bottle
- Bullion
- Checkered
- Confetti
- Cosmos
- Crystal Cut (Clear)
- Discus
- Driftwood
- Everglade
- Festival
- Frostite
- Hammerstripe
- Karatachi
- Kasuri
- Kanoka (Carnival)
- Koto
- Linkon
- Lozenge
- Manhattan
- Mersey (Cirrus)
- Midori
### 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.

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<tr>
<th>Tandarra Amber</th>
<th>Tandarra Bronze</th>
<th>Tandarra White</th>
<th>Wired Abstracto White</th>
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<td>Seadrift White</td>
<td>Staccato</td>
<td>Strata</td>
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<td>Wired Delta White</td>
<td>Wired Obscura Bronze</td>
<td>Wired Scintilla White</td>
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<td>Kosciusko</td>
<td>Narrowreed</td>
<td>Roughcast</td>
<td>Screenview</td>
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<td>Narrow Reedlite (Stipled)</td>
<td>Patchwork</td>
<td>Patio</td>
<td>Pinhead</td>
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<tr>
<td>Pimpernel</td>
<td>Pimpernel</td>
<td>Pinhead</td>
<td>Pinhead</td>
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<tr>
<td>Rattan</td>
<td>Rattan</td>
<td>Reeddrop</td>
<td>Reedlite (Stipled)</td>
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<td>Shiplite</td>
<td>Shiplite</td>
<td>Sweet Pea</td>
<td>Travertino</td>
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<tr>
<td>Twist</td>
<td>Twist</td>
<td>Webb Sparkle (Sandblast)</td>
<td>Yazora</td>
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Moon and Star | Narrow Reedlite (Stipled) | Nomichi | Orbit
| Patchwork | Patio | Pimpernel | Pinhead |
| Pimpernel | Pimpernel | Pinhead | Pinhead |
| Rattan | Rattan | Reeddrop | Reedlite (Stipled) |
| Shiplite | Shiplite | Sweet Pea | Travertino |
| Twist | Twist | Webb Sparkle (Sandblast) | Yazora |
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While National Glass Pty Ltd has exercised
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Reference Guide, the data contained in it
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other comparable sources. Accordingly, in
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and advice is required, users should make
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