9.0 Special purpose glass

9.1 Mirrors (Silver Glass)

In 1317 Venetian glass makers discovered the art of 'silvering' by applying a combination of mercury and tin to the glass surface. Six centuries later in 1840 the process of silvering, as we know it today, was patented.

Process

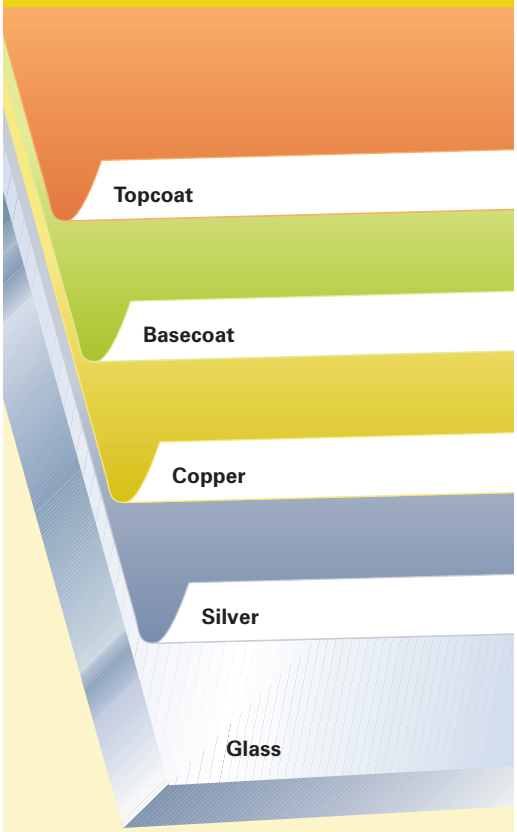
The production of mirror commences with float glass being thoroughly washed with de-ionised water and cerium oxide. A thin layer of tin is then sprayed onto the surface of the glass to promote the adhesion of the silver. The almost pure silver (99.9%) coating is next applied, followed by a coating of copper which protects the silver from tarnishing. Finally two layers of special backing paint; the first (basecoat) protects against chemical attack and corrosion and the second (topcoat) resists mechanical abrasion. (See Figure 9.1a)

Handling and Processing

Although the back of the mirror is protected, contaminates can still cause damage. Therefore it is recommended that only water soluble oils be used when cutting and processing silvered glass. For cutting purposes, only the mirror (non-coated) surface should be scored.

Automatic processing equipment such as peripheral edge working machines or drilling machines must be cooled by water with a PH level of between 6 - 8. After wet processing, mirrors should be washed, dried and stored in a manner that prevents water accumulating on the surface or along the bottom edge.

Figure 9.1a: Silvering Process



Applications

Aside from the obvious bathroom and bedroom applications, mirrors can also create the illusion of space and be an additional source of light:

Table 9.1a: Available Mirror Types

	Clear	Bronze	Grey	Venetian Strip
3mm	•			
4mm and 4mm Vinyl Backed	•	•	•	
6mm	•	•	•	•
6mm Vinyl Backed	•	•	•	

NB: Other colours available on request.

Mirror doors in bedroom application

- For increasing room width - use floor to ceiling mirrors at right angles (90˚) and where possible adjacent to windows
- To increase room height - fix mirrors to the ceiling
- To increase room length - fix mirrors to the end wall of a room
- To add light to a room - install mirrors adjacent or opposite to windows or doorways

NB: In all the above situations, consideration should be given to the type of mirror, fixings and number of fixings.

Mirror Doors

Wardrobe mirror doors are a means of providing a full height dress mirror and perception of increased space.

For this application, mirror with an adhesive vinyl backing is used so that in the event of breakage, the fragments of glass will remain attached to the vinyl backing, minimising the risk of injury.

G.James can supply, or supply and install fully fabricated aluminium mirror wardrobe doors in a range of fashionable colours to suit specific decorative needs.

Laminate Mirror

Comprising of standard mirror or venetian strip, and clear or tinted interlayer, the superior safety qualities of laminated mirror makes this product ideal for use in schools, childcare centres, lifts and gymnasiums. The interlayer ensures that should human impact occur, the glass fragments will remain intact reducing the risk of serious injury.

Mist Free Mirrors

The formation of condensation on bathroom mirrors can be avoided by installing an energy efficient heating element that warms the mirror preventing the unwanted build-up of mist on the surface. This element is available in a range of sizes, conveniently connects to any standard power point and reaches operating temperature within minutes.

Bathroom mirror

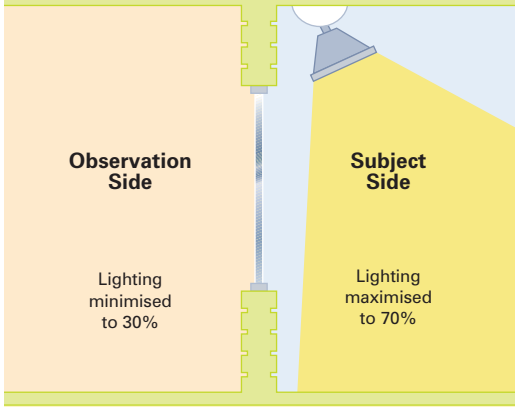
9.2 One-Way Mirror

Extensively used for security and discrete observation purposes, one-way mirror offers a reflective surface one side, and clear, see-through vision on the other. Such an effect is only possible with a specific balance of lighting between the observation and subject sides. The ratio of light from the observation side should be as specified in Figure 9.2a, with no light shining directly onto the glass.

Solarplus SS08 Grey Laminate

G.James can supply Solarplus SS08 grey laminate where one-way vision is required. The product combines stainless steel and titanium nitride coated glass, grey interlayer and clear glass, and can be supplied as a single laminate or incorporated into a Twin-Glaze unit or ArmaClear product.

Figure 9.2a: Lighting Conditions required for One-Way Mirror



When lighting is installed to maximise one-way observation, the lighting source must not shine directly on the glass as this will only increase the brightness on the observation side and reduce the effect intended.

Venetian Strip Mirror

Venetian strip mirror is produced by applying alternate strips of 99.9% pure silver to clear glass. It is an excellent low cost alternative to Solarplus SS08 Grey Laminate making venetian strip suitable for medium security applications such as supermarkets, administration offices, chemist shops and doctor's surgeries.

Although vision through the clear strips is still possible from either side, the mirrored reflection ensures any vision is limited and extremely difficult.

For the best results, venetian strip mirror should be installed with the strips running vertically.

9.3 Convex Mirrors

Convex mirrors are useful in both indoor and outdoor situations to control vandalism and theft, or where blind corridors, corners or intersections are an issue.

The types of convex mirrors available are:

- Indoor (Only)
- Outdoor (Only)
- Combined Indoor/Outdoor

The size of the mirror depends mainly upon the distances involved and the degree of clarity required in the reflected image. To select the appropriate mirror, estimate the distance from the viewer to the mirror and from the mirror to the area or point to be observed. Add the two, and use Table 9.3a (Indoor Only) or Table 9.3b (Outdoor Only & Combined Indoor/Outdoor) as an approximate guide. If in doubt choose a larger size.

Table 9.3a: Convex Mirrors – Indoor (Only)

Mirror Diameter	Best Distance
300mm	To 6m
450mm	To 8m
600mm	To 12m
760mm	Over 12m

Distances are an indication only - most mirrors provide satisfactory service well beyond this range.

Table 9.3b: Convex Mirrors – Outdoor (Only) & Combined Indoor/Outdoor

Mirror Diameter	Best Distance
300mm	To 12m
450mm	To 15m
600mm	To 20m
800mm	To 25m
1000mm	Over 25m

Distances are an indication only - most mirrors provide satisfactory service well beyond this range.

Ceiling Domes

Where general surveillance of a broader area is needed, or central observation is preferred ceiling domes are recommended. Full domes may be suspended on chains or fastened directly to the ceiling and provide a 360° view, with half domes supplying a 180° view and corner domes a 90° view.

9.4 Lead Glass

Float glass offers no barrier to the harmful effects of X-rays and gamma rays. In addition, continual exposure to such rays will eventually destroy the atomic structure of the glass causing dark discolouration.

By including heavy metal oxides into the raw mix, it was discovered that glass could prevent the penetration of damaging radiation. Today most 'shielding' glass contain over 60% heavy metal oxide, of which a minimum 55% is lead oxide. With such a high metal content, 5mm lead glass provides the same protection as 1mm lead sheet (See Table 9.4a).

Observation window for angiography room. LX lead glass is manufactured by Nippon Electric Glass Co. Ltd. Japan

Table 9.4a: Lead Glass Comparison Table

Glass Thickness	Minimum Lead Equivalent	X-ray peak voltage (KV)
5mm ± 0.3	1.0mm	150
7mm ± 0.3	1.5mm	150
8mm ± 0.3	1.8mm	150
9mm ± 0.3	2.0mm	150
11mm ± 0.3	2.5mm	150
14mm ± 0.3	3.0mm	200

Produced as a cast glass, both the surfaces are ground and polished to achieve the necessary optical quality, i.e. supplying light transmittance similar to clear float. The maximum size available is 1100mm x 2400mm which allows an excellent field of vision for X-ray, C.T. scanning and angiography observation rooms.

Lead glass can be processed as with normal glass and can be curved and/or toughened where required.

9.5 Diffused Reflection Glass (Picture Glass)

With a light reflectance of 8%, clear float often obscures framed images or portraits with surrounding reflections. For this purpose, 2mm diffused picture glass is specifically produced with fine textured surfaces to eliminate disturbing reflections, ensuring true representation and improved clarity of the picture or photograph. Standard sheet size is 920mm x 1220mm.

9.6 Non-Reflecting Glass

Shopfront windows are designed to display a store's products and/or image with the purpose of encouraging customers into the store. However annoying reflections from ordinary glass can obscure the shopfront and the products on offer, particularly when viewed at a distance.

To combat this problem, multi-coated glass products such as Amiran and Luxar were developed. These products have a low reflectance of 1 - 2 % (compared to a single piece of clear glass with 8% and a clear Twin-Glaze unit with 15%) and is an ideal product for applications where near perfectly clear vision is desired.

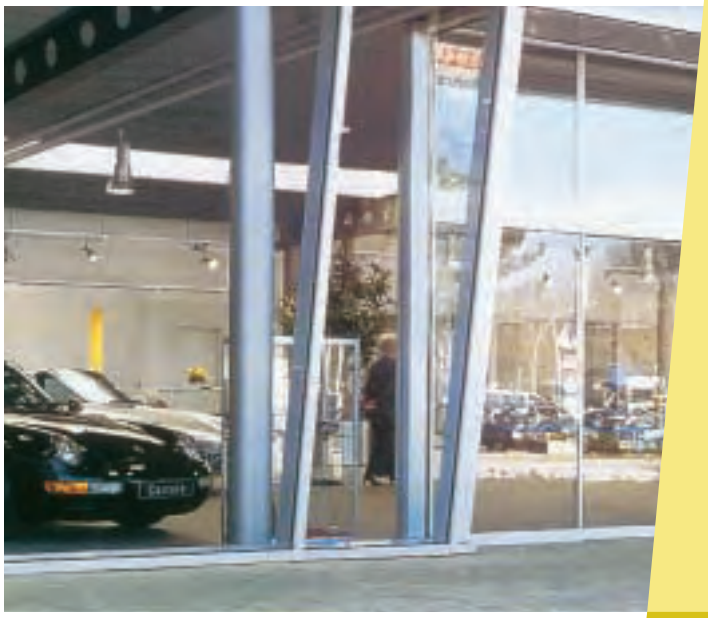
Non-reflective glass is available in thicknesses ranging from 2mm - 12mm (single glazed), or can be incorporated into laminated glass or Twin-Glaze units. The coating can be applied to tinted glass for increased solar control performance resulting in an effective, all-round shopfront glazing material.

9.7 Heat Resistant Glass

With poor tensile strength and a relatively high rate of expansion, float glass will crack very easily when subjected to temperatures of between 50 - 60°C. This occurs because the glass surface heats up disproportionately, causing tensile stresses to build up around the edges, eventually causing breakage.

Toughened Glass

Toughened glass has compressive stresses 'built-in' to the surface and can therefore tolerate a thermal gradient of 290°C on one side and ambient air temperature on the other.



Amiran application in shopfront. Note the difference to the right of the picture which has been glazed with ordinary glass.

However once the temperature exceeds this parameter, or the non-heated surface is rapidly reduced in temperature, toughened glass will disintegrate in the normal manner (See Section 4.3).

Standard toughened glass is generally used in oven doors, cook tops etc.

Glass Ceramics

Glass ceramics such as FireLite, Borosilicate, Borofloat and Robax are manufactured from a unique mix of raw materials, unlike that of ordinary soda/lime/silicate glass. This special composition results in glass products with dramatically reduced coefficients of linear expansion and therefore, a greater ability to tolerate thermal stresses (heat). Traditional applications for ceramic glass include space heaters, fire guards, furnaces and wood stoves, or where temperatures can reach 700 - 800˚C.

FireLite is a transparent, crystallised glass developed by Nippon Electric Glass Co. Ltd. (Japan). With an extremely unusual 'thermal expansion coefficient' of almost zero, FireLite will not crack even when heated to 800˚C and then doused with ice cold water. Available in sheet sizes up to 2438mm x 1220mm.

Borosilicate is manufactured with the inclusion of Boron using the sheet drawn process. Borosilicate has a lower rate of expansion and higher softening point when compared to ordinary float glass. It can also be toughened for improved heat resistance.

Borofloat has a very low coefficient of thermal expansion and therefore is capable of withstanding temperatures up to 500˚C. As the name implies, Borofloat is produced on a float line and consequently offers superior optical qualities and light transmittance. In addition the chemical resistance of Borofloat, even at temperatures above 100˚C, is better than most metals. This glass can be cut and worked as would float glass and be supplied toughened (not a Grade A safety glass) if required. Available in thicknesses from 3.3mm to 15mm with a standard sheet size of 850mm x 1150mm (larger sheet sizes are available on request).

Robax is a glass ceramic with a brownish colour capable of tolerating temperatures and thermal shock up to 700˚C. Robax can be cut and processed in the same way as ordinary annealed float. The standard sheet size is 840mm x 1580mm.

The thermal expansion coefficient of FireLite is almost 'zero' so it will not crack when heated to 800˚C and then hit with cold water. FireLite is manufactured by Nippon Electric Glass Co. Ltd. Japan

9.8 Fire Rated Glass

The heat radiating from a fire through glass can often inhibit escape and ignite materials on the unexposed side. Fire rated glass in its many forms provide a non-combustible, protective barrier in the event of fire. They form an important and integral component of a complete fire rated window or door system. Fire rated systems are graded and measured based on three distinct criteria:

Structural Adequacy relates to the system's ability to maintain structural stability and adequate load bearing capability as specified in AS 1530.4;

Integrity measures the system's ability to prevent the spread of flames and combustible gases as specified by AS 1530.4;

Insulation refers to the system's ability to restrict the rise in temperature of the glass surface not exposed to the fire, below the limits nominated in AS 1530.4.

All fire rated glazing systems must be tested and certified to meet the stringent criteria required for building and glazing as defined by the Building Code of Australia (BCA). In order to satisfy the BCA requirements, a fully fabricated, framed window assembly must achieve certain Fire Resistant Levels (FRL's). These FRL's correspond to the period of time (in minutes) the assembly can perform in relation to the specified test criteria defined in AS 1530.4. For example (and with reference to the above definitions), a nominated FRL of -/60/60 requires: no structural adequacy/60 minutes integrity/60 minutes insulation.

Table 9.8a: Fire Rated Products

System		Description	BCA - FRL
Reinforced	Georgian Wired	Wired Glass	60/60/NA
	Glass Blocks	190 x 190 x 100mm	60/60/NA
	NEG Glass Blocks	190 x 190 x 95mm	90/90/NA
Non-Reinforced	FireLite	Glass Ceramic	180/180/NA
	Pyroswiss	Calcium Silicate	90/90/NA
	Borofloat/Borosilicate	Glass Ceramic	120/120/NA
	Swissflam	Laminated	up to 120/120/NA
	Securiflam	Laminated	60/60/NA
	Promaclear	Coated Glass	60/60/NA
Insulating			
Intumescent	Pyrostop	Laminated	up to 120/120/120
	Swissflam	Laminated	60/60/30
	Pyrobel	Laminated	up to 120/120/120
	Promaglas	Laminated	up to 90/90/90
Gel	Contraflam	IG Unit	up to 120/120/120

NB: It must be stressed that all the above FRL classifications are based on tested framing and glazing systems.

There are three types of fire rated systems.

Reinforced systems contain either wired glass or glass block products where the glass will remain intact if broken thereby preventing the spread of flames.

Non-Reinforced systems incorporate the range of ceramic glass products and are installed as fire rated walls and openings. Their low expansion and high softening points allow such products as FireLite to achieve long integrity ratings of up to 180 minutes. FireLite is capable of withstanding a rapid rise in temperature, while maintaining visibility - an important attribute in fires.

A fire resistance test conducted in accordance with AS 1530.4 – 1990 (Test Report No.FR1376 – National Building Technology Centre (NSW)) on a panel of 5mm FireLite (2440mm x 880mm) was awarded a 180 minute fire rating classification.

Toughened laminated safety glass can only achieve a maximum 30 minute integrity rating. However multi-laminates containing a water based, alkali silicate interlayer achieves 60 minutes integrity.

Insulated systems are classified as those systems that satisfy both of the following:

- an integrity criteria for 'up to 120 minutes' and,
- an insulation requirement for '30 to 90 minutes'

Pyrostop shields against temperatures of over 1000˚C

Pyrostop glass samples before and after exposure to heat

There are two types of glazed systems that are classified as a fire rated insulated system.

The first is a multi-layered intumescent (expanding) laminate which can also be incorporated into an insulated glass unit for improved performance. The product is designed so the water within the special purpose interlayer evaporates and absorbs the energy from the fire. Simultaneously the interlayer expands, converting into a 'foam glass' and producing a tough, opaque shield against radiant and conducted heat. This system is so effective that while the exposed glass may be melting, the unexposed internal surface can be touched quite safely. Being a laminated product, any glass broken by the heat will remain intact within the frame maintaining a protective barrier.

The second system is based on a toughened, insulated glass unit where the airspace is filled with layers of a special soft gel containing high concentrations of water. The thicker the gel, the higher the fire insulating qualities. On exposure to fire, the gel forms a crust which holds the glass together, while the evaporating water within the gel absorbs the heat energy. This process continues until the gel has burnt and expired - this will occur after the nominated fire rating time of the system.

It should be noted that both these insulated systems are prone to ultra-violet degradation and when used as external glazing it is recommended they should be combined with standard PVB interlayers.

9.9 Welding Glass

For the purpose of absorbing and reflecting harmful radiation emitted during welding and similar operations, G.James can supply Shade-12 welding glass. This product incorporates a special filter that reduces ultra-violet transmittance to around 0.0012% and infra-red transmittance to 0.007% ensuring excellent protection against welding flash.

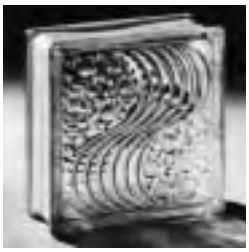
It should be noted that when using Shade-12, the reflective surface must face the light source.

9.10 Glass Blocks


Nubio-wolke *

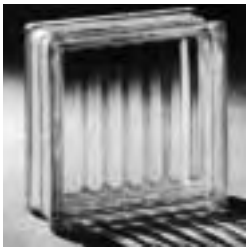

Cross ribbed (Also available in Broad cross ribbed)


Nobless *

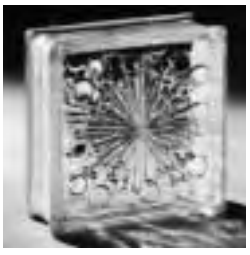

Welle


Helios *


Regent


Broad parallel ribbed (Also available in Parallel ribbed)


Clear view


Meteor *


Inka *


Maya


Metallik

* Patterns are also available in Goldtone.

For those wanting a unique decorative feature, glass blocks are an excellent alternative to ordinary glass. Glass blocks comprise of two separate sections which are sealed together at high temperatures to literally fuse the sections together.

The many benefits of glass blocks include:

- High light transmittance
- Excellent thermal performance
- Noise control
- Security
- Large range of patterns, colours and sizes
- Fire rating possible*

* Fire rated blocks must be 95mm or 100mm thick and installed in mortar into a tested steel perimeter frame.

Perfect for use in windows, entries and foyers, partition walls and other areas where light is required. G.James can supply, or supply and install glass blocks in curved, stepped or straight panels using either silicone or mortar systems.

Glass blocks used in bathroom application

Table 9.10a: Glass Blocks Patterns and Sizes

Names of designs	Available in sizes					
Nubio-wolke	1919	2424	2411	3030	1111	1919/10
Cross ribbed	1919	2424				1919/10
Broad cross ribbed	1919	2424		3030		1919/10
Parallel ribbed	1919	2424	2411			1919/10
Broad parallel ribbed	1919	2424				1919/10
Clear view	1919	2424	2411	3030		1919/10
Nobless	1919	2424				
Welle	1919					
Meteor	1919	2424				
Inka	1919	2424				
Helios	1919	2424				
Regent	1919	2424				
Maya		2424				
Metallik	1919	2424				
Aktis	1919					
Light diffusing	1919	2424				
Security block						1919/10

LEGEND

No	Dimension	Weight per unit	No. of blocks per m²
1919	190x190x80mm	2.4kg	25
2424	240x240x80mm	4.0kg	16
2411	240x115x80mm	2.0kg	32
3030	300x300x100mm	7.3kg	9
1111	115x115x80mm	1.0kg	64
1919/10	190x190x100mm	2.8kg	25

9.11 Aquatic Glazing

Water pressure in aquatic applications (such as view windows into swimming pools or aquariums) has a sustained pressure which is directly proportional to the depth of the water. At water level and above, this pressure is zero, but due to the exertion of triangular loads on the glass, even at a depth of 600mm (as would be the case in an average household fish tank) this would equate to 6 kPa of pressure. (See Figure 9.11a)

Glass Selection

AS 1288 requires reduced stress levels for sustained loads. Thick monolithic annealed or laminate (annealed or heat treated) is generally recommended for aquatic applications. The consequence of breakage must always be considered in any design.

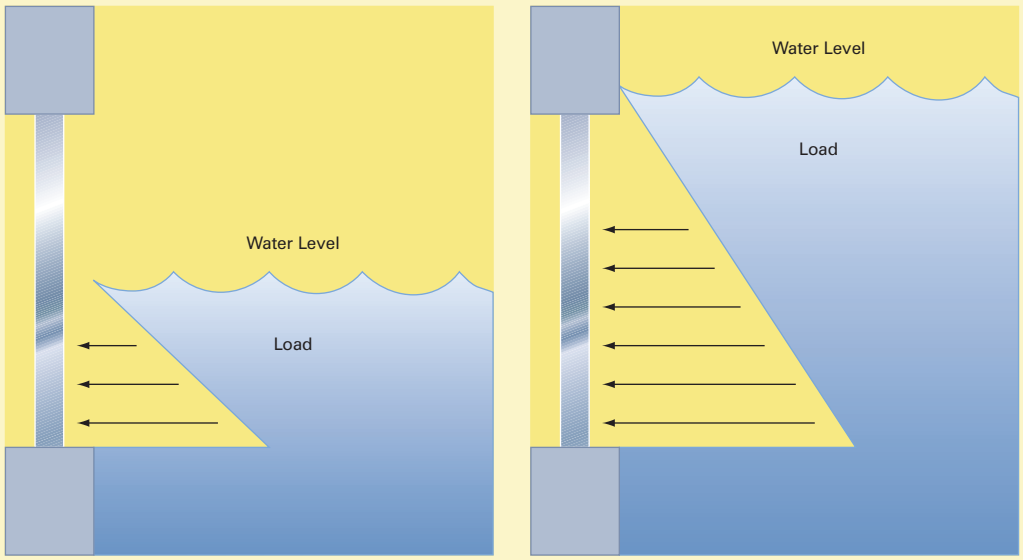
G.James' Technical Department can provide the necessary recommendations for your specific requirements.

9.12 Electronic Security

Electronic eavesdropping to obtain proprietary information, unwarranted interrogation of computers and interference or accidental loss of information by electronic noise (e.g. radar), can pose serious and costly problems in today's IT reliant age.

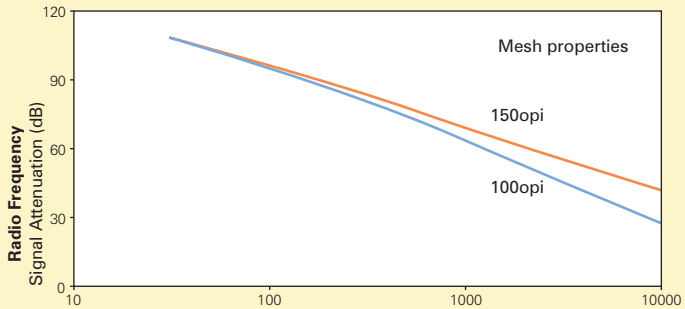
Protecting premises where such installations are housed can be achieved by employing Faradays cage principle thereby ensuring all the external surfaces (i.e. the floor, the ceiling, and all walls) are electrically conductive and then earthed. Consequently any radio frequencies omitted from equipment meets

Figure 9.11a: Triangular Loads of Water on Glass



Water has an approximate density of one tonne per cubic metre. This mass exerts significant pressures which increase linearly with the water depth.

Graph 9.12a: Performance of Electronic Security Glazing (Shielding Effectiveness)



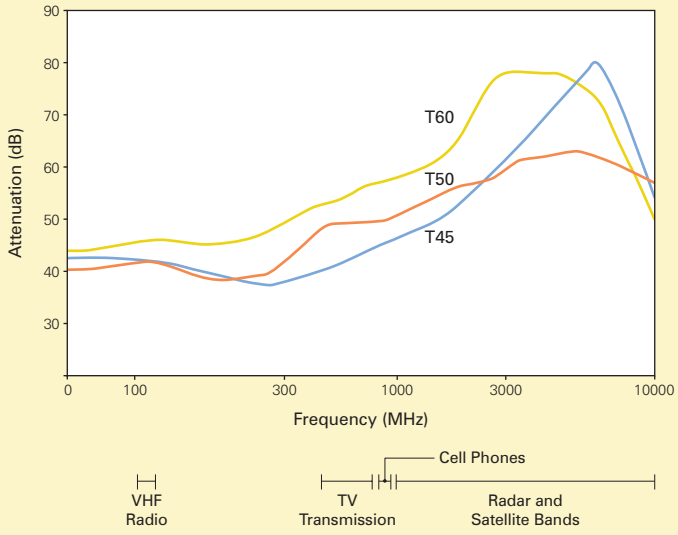
opi=openings per inch in interlayer mesh

the walls and simply travels to the ground. Similarly, any random external electronic interference is also diverted to ground.

As glazing systems are an integral part of most external walls they also need to be electrically conductive (See Figures 9.12a & 9.12b). G.James can supply a range of specialised laminate or Twin-Glaze products that effectively shield radio frequencies within the range of 100 - 10,000 MHz. (See Graphs 9.12b & 9.12c). For applications where protection is required in the lower bracket of 10 - 100 MHz, a metallised fabric mesh is incorporated within a laminated glass product (See Graph 9.12a). Data shielding systems are recommended for use in television and radio stations, security and computer installations and protecting operating personnel from harmful electromagnetic fields.

Data sensitive installation

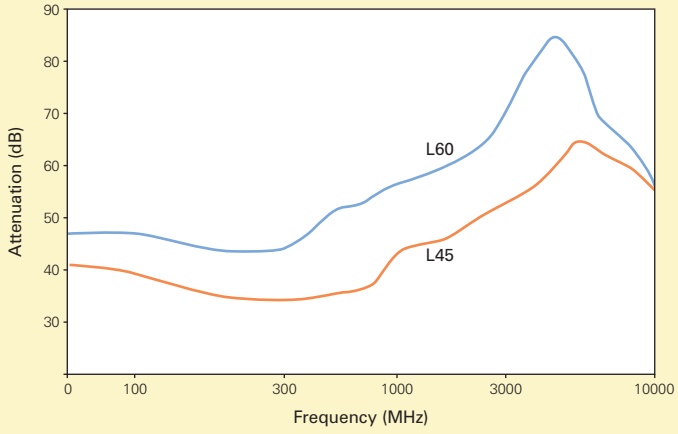
Graph 9.12b: Data Shielding Twin-Glaze Unit



Recommended for external glazing applications.

The various product codes (T45, T50 & T60) indicate the approximate attenuation of that product at 1000 MHz. For example, T50 indicates a data shielding Twin-Glaze unit with an approximate attenuation of 50 dB at 1000 MHz.

Graph 9.12c: Laminated Data Shielding Glass



Recommended for internal walls and partitions.

The various product codes (L45 & L60) indicate the approximate attenuation of that product at 1000 MHz. For example, L45 indicates a laminated data shielding glass with an approximate attenuation of 45 dB at 1000 MHz.

Figure 9.12a: Typical Drained Glazing System

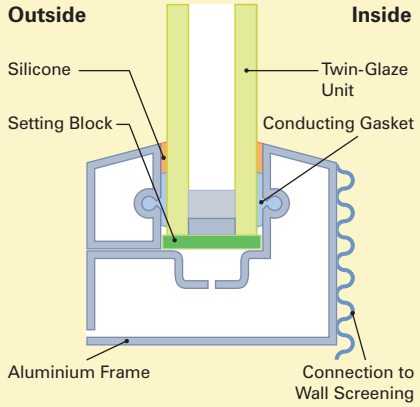
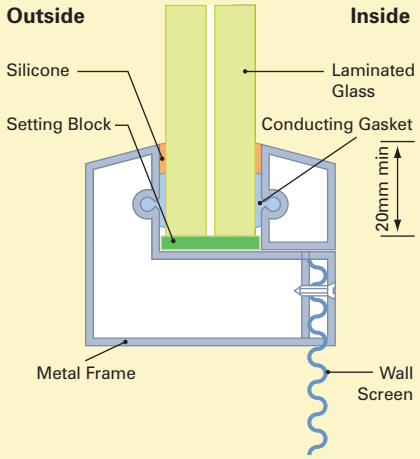


Figure 9.12b: Typical Internal Screening



(also suitable for secondary sash applications)

Main viewing ports, Auckland's Sky Tower

9.13 Glass Floors and Stair Treads

Glass is normally not considered a traditional flooring material, however with the obvious visual effects it can create, glass in such applications is gaining in popularity.

An interesting application of glass used in flooring is shown in the viewing panels set into the floor of the main observation deck of Auckland's landmark Sky Tower (NZ). The four main viewing ports were glazed with

Main viewing ports, Auckland's Sky Tower

laminated Starphire (low iron glass) providing safety, strength and excellent clarity.

In these types of applications, the glazing system should be supported on all sides with a substantial frame to ensure minimal deflection. It is recommended the glass panels be bedded and cushioned with a specified resilient material ensuring there is no direct glass to metal (or other hard object) contact. All materials considered, the rebate depth should be designed so the glass finishes flush with the floor.

Consideration should also be given to installing a sacrificial piece of low cost glass to the top surface. This would protect the more expensive glass underneath and can be easily and economically replaced when required.

Glass stair treads, incorporating thick annealed or laminated glass, can also produce a stunning visual effect as well as

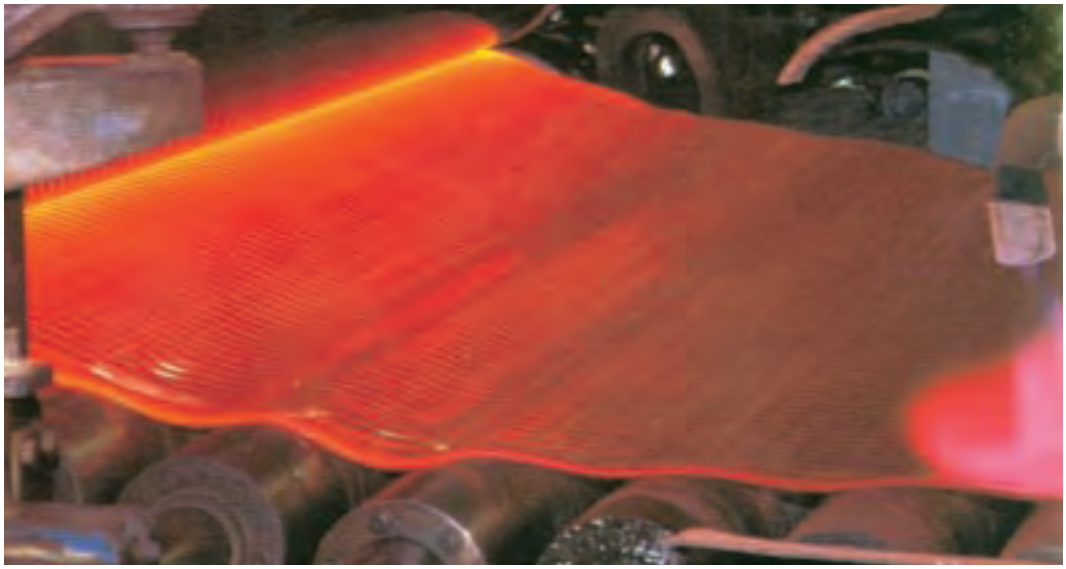
Star Casino – Sydney

complementing any surrounding glass features. In this instance, a sandblasted top glass should be considered to avoid highlighting scratches and scuff marks while also acting as a diffuser where under-floor lighting is used.

When used in floors, stair treads or similar applications where lighting is involved, the glass should be adequately ventilated to reduce the possibility of heat build-up and subsequent thermal stress.

Star Casino – Sydney

10.0 Decorative glass



Patterned glass manufacture

10.1 Introduction

Rolled plate glass was first produced by James Hartley (U.K.) in 1847, and later by the Chance Brothers (U.K.) who manufactured 'cathedral' and figured rolled between twin rollers in 1870. Wired glass was patented in 1855 however it failed to perform in service. In 1898 Pilkington's began producing wired glass on a commercial basis however the quality was still poor up until the 1930's when welded, square mesh wire was introduced.

G.James' range of decorative glasses encompass figured rolled patterned and decorative ceramic painted glass.

10.2 Figured Rolled Patterned Glass

Process

Patterned glass is manufactured by squeezing semi-molten glass between two rollers, one of which has a surface pattern and creates a continuous, permanent impression onto the glass ribbon. The pattern is printed onto one surface only while the other side remains smooth. The glass then travels through the annealing lehr where it is cooled before being cut to the required size.

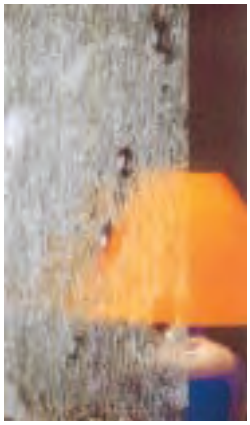
For the production of wired glass, square steel wire mesh is sandwiched between two separate ribbons of glass which is then pressed through a further pair of patterned rollers to imprint the selected design.

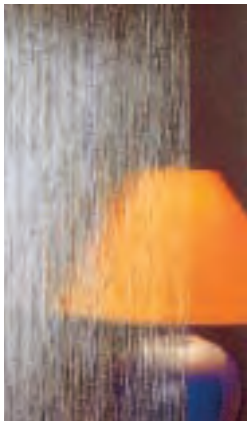
Types

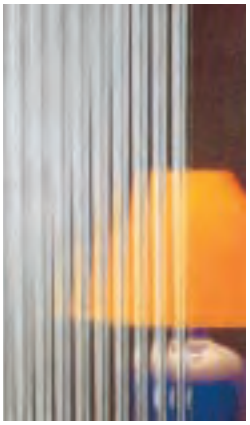
With 16 different designs, three of which are wired (See Figure 10.2a), G.James offers patterned glass in a variety of colours, textures and degrees of opacity with the majority capable of being toughened while a small number can be laminated (See Table 10.2a).

Georgian Polished Wired is a clear, totally transparent wired glass. Produced as a cast glass, and subsequently ground and polished on both sides using the old plate glass method, this product is optically true and the preferred glass for use in fire doors where small vision panels are installed. Note that polished wired glass is a Grade B safety glazing material.

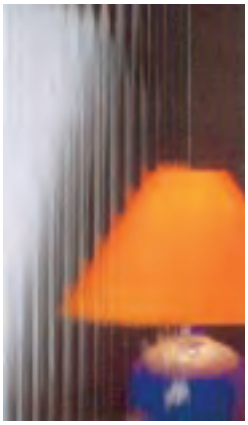
Table 10.2a: Figured Rolled Patterned Glass

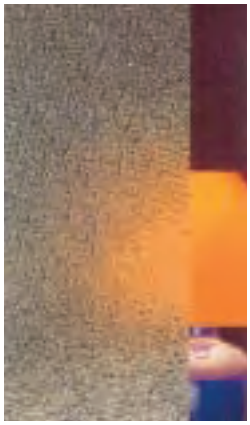

Tandarra


Seadrift

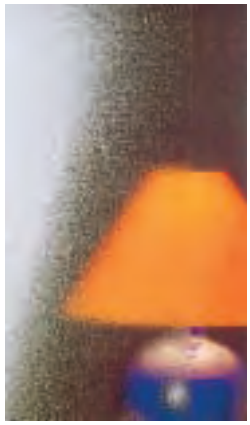

Broadline

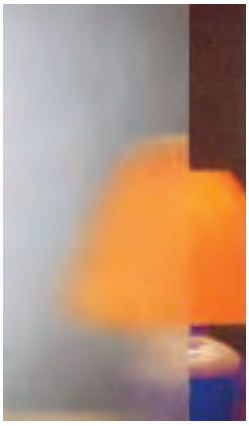

Narrow Reeded


Strata


Sparkle


Kosciusko

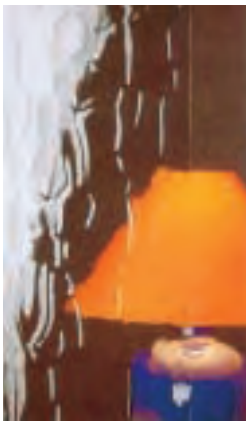

Roughcast

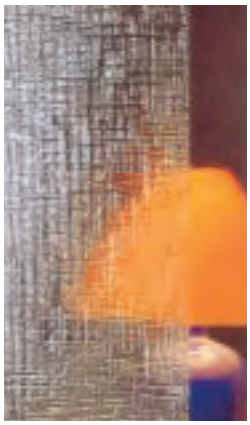

Satinlite

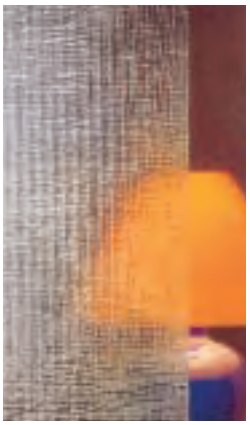

Spotswood

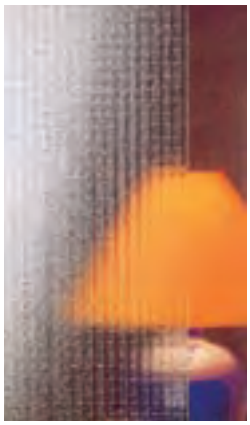

Glue Chip


New Cathedral


Flemish


Scintilla


Obscura


Squarelite

NB: Polished Wired not illustrated

Applications

Patterned glass has many applications including use in partitioning, showerscreens, doors and sidelights, furniture, shelving, leadlighting, balustrading and other areas where a decorative effect or visual obscurity is desired.

Although figured rolled glass is obvious by its presence, in certain specific situations consultation with the relevant section of AS 1288 should be consulted to determine whether a laminated, toughened or safety wired product is required.

While the use of wired glass is common in fire rated products, it should be noted that wired glass alone does not have a fire rating. To achieve any fire rating it must be part of a complete glass window/door assembly (See Section 9.8).

Characteristics

Wired glass absorbs solar radiation and may be subject to thermal stress. It is preferable not to expose wired glass to severe direct sunlight. Similarly, blasts of very hot water placed directly onto wired glass may result in thermal cracking and should be avoided. Tinted patterned glass may be susceptible to thermal breakage when glazed externally. Further information can be obtained from the G.James Technical Advisory Service on 1800 452 637.

10.3 Patternlite (Ceramic Painted Patterned Glass)

The application of fused, coloured ceramic paint to glass provides architects and designers with a new dimension in the use of patterned glass by offering a cost effective and unobtrusive means of minimising exposure and/or controlling the amount of light transmission.

The coloured ceramic paint used in the process of manufacture consists of glassflux (70 - 95%) and ceramic pigment (5 - 30%).

Table 10.2a: Figure Rolled Patterned Glass Selection Chart

	Type					Colour/Thickness					Safety Form				
	Text	Print	W3	W4	W5	W6	B5	B6	G5	G6	Lam	Tou	Wir	Non-dir	Dir
Tandarra	•				•		•					•			•
Seadrift	•		•		•		•					•			•
Broadline	•		•												•
Narrow Reeded	•		•												•
Strata	•		•		•						•	•			•
Glacier/Sparkle	•		•											•	
Kosciusko	•		•											•	
Roughcast	•		•		•							•		•	
Satinlite	•		•	•	•	•					•	•		•	
Spotswood	•		•	•	•		•	•	•	•	•	•		•	
Glue Chip	•		•	•	•						•	•		•	
New Cathedral	•		•	•	•		•		•		•	•			•
Flemish	•			•								•			•
Scintilla	•					•		•					•	•	
Obscura	•					•							•	•	
Squarelite	•					•							•	•	
Polished Wire						•							•	•	

Legend: Text – Textured; Print – Printed; W3 – White 3mm; W4 – White 4mm; W5 – White 5mm; W6 – White 6mm; B5 – Bronze 5mm; B6 – Bronze 6mm; G5 – Grey 5mm; G6 – Grey 6mm; Lam – Laminated; Tou – Toughened; Wir – Wired; Non-dir – Non-directional; Dir – Directional.

Process

This type of patterned, decorative glass is created by silk-screening the selected colour and pattern onto one surface of the glass. Once the pattern has been applied, the glass is then either toughened or heat strengthened, with the heat generated within the furnace sufficient to melt the ceramic paint permanently fusing the pattern onto the glass substrate.

Patternlite can be applied to surface 2, 3 or 4 depending on the glass configuration and desired effect.

In essence Patternlite is used for light diffusing purposes, with the reduction in light transmittance equal to the glass area covered by the applied pattern (See Table 10.3a).

Table 10.3a: Light Transmission

Cover (%)	40	50	60
Transmission (%)	63	56	49

Figures based on 6mm clear float with printed coverage to Surface #2.

Types

G.James offers Patternlite in four standard designs (See Figure 10.3a) in eight standard colours (See Figure 4.7a) however custom designed patterns and colours for specific project requirements are available.

Patternlite can be applied to clear or tinted glass substrates, laminated glass, or incorporated into a Twin-Glaze unit. Further, combining Patternlite with a reflective coated glass will significantly reduce glare and decrease solar transmission.

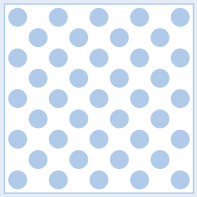
Properties and Applications

The manufacture process of Patternlite bonds the pattern to the glass providing a permanent non-porous surface with excellent scratch resistance (removal of the pattern is not possible without damage to the glass substrate). G.James Patternlite is impervious to weathering and fade resistant.

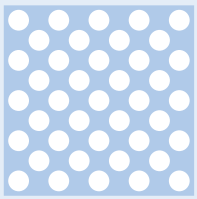
When specifying the pattern colour, be aware that lighter colours will act as a daylight diffuser. Further, light colours will naturally reflect solar energy while darker colours will absorb such energy.

Overhead canopies and skylights are the primary uses of Patternlite while the application of custom or corporate door motifs on toughened glass entry doors are also possible.

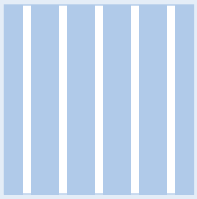
Figure 10.3a: Standard Designs



3mm dots, 40% cover

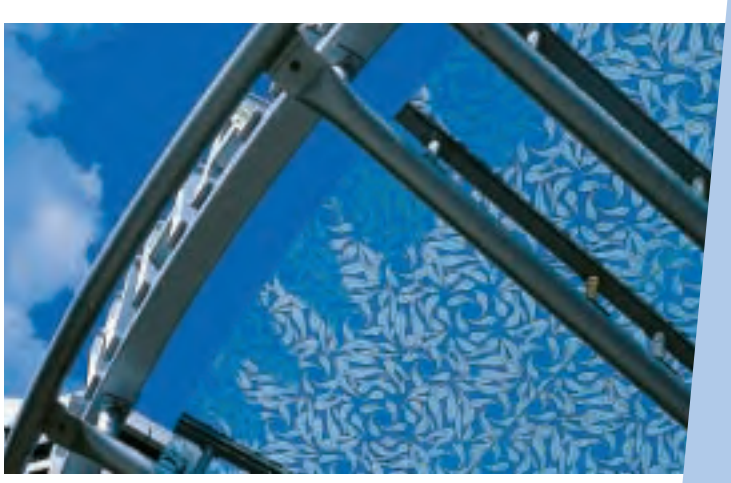


3mm reverse dots, 60% cover



3mm strip, 50% cover

Gum leaf design



Patternlite – Gum leaf design

11.0 Glazing techniques

11.1 Introduction

Architects and designers are continually looking for better and more complex ways to use glass in buildings. Large picture windows, glass awnings, balustrades and expansive use of glass in shopfronts, foyers and ground floor entries are today common sights.

While many factors are considered in selecting the glass, the glazing techniques used in the installation process are equally as important. In essence this involves choosing the correct materials and their proper installation and use to ensure long term performance of any glazing.

The framing system should be adequately designed to support and retain the glass under the design load conditions and also provide an effective weather-tight seal while the glass remains free floating and non-load bearing.

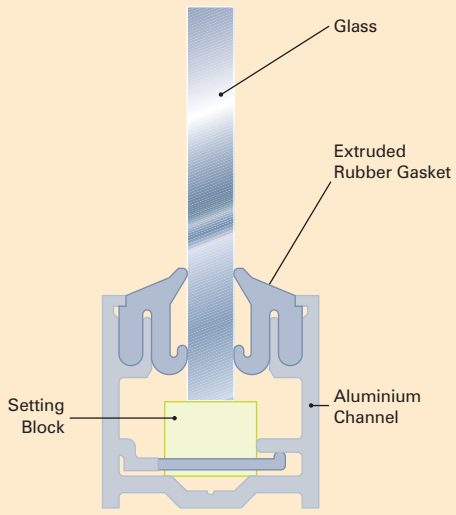
As this section is a guide only, reference to Australian Standard AS 1288, Glass in Buildings - Selection and Installation is recommended.

11.2 Dry Glazing

Dry glazing is the common description for systems utilising extruded rubber gaskets manufactured from either PVC, EPDM, neoprene and Santoprene to one or both sides of the glass to provide a tight weather seal.

Installation of the gasket commences in one corner of the frame with the gasket pressed into the glazing pocket in 100mm to 200mm sections until completed. It is important the gaskets are cut slightly oversize and continually worked towards the starting point to minimise the chance of shrinkage. To assist

Figure 11.2a: Example of Dry Glazing



with installation, lubricate and soften the gasket by placing it in a container of hot, mildly soapy water.

Internal applications such as partitions, doors and viewing windows generally have no air or weather sealing requirements. Framing in this instance can comprise aluminium channels or timber beads.

External glazing systems are designed to be pressure equalised and self-draining, with extruded gaskets used to achieve air and weather sealing. PVC gaskets are suitable for use in the glazing of shopfronts, residential and commercial buildings under 10 metres high. For buildings over 10 meters high, the use of Santoprene or neoprene gaskets should be considered. It is essential the correct thickness of gasket is used to ensure compression on the internal gasket is achieved to prevent air and water ingress.

11.3 Wet Glazing

Wet glazing materials can be classified into one of three main types:

- Putty based compound
- Butyl tapes
- Elastomeric Sealants

Putty Based Compounds

The use of putty based compounds as a glazing material has declined with the introduction of more versatile materials and techniques, and is now only used in the glass replacement market on older homes and buildings. Oil-based putty is not compatible with glazing materials such as silicone or neoprene and CANNOT be used in the glazing of laminated glass or Twin-Glaze units.

Butyl Tapes

Butyl tapes are an elastomeric material extruded into a ribbon and available in various widths and thicknesses. This tape is extremely durable and has excellent adhesion to both glass and metal surfaces when continuous pressure is applied. A shim can be incorporated into the tape to reduce the butyl compound being 'pumped out' of the glazing channel as a result of the combined actions of heat and wind.

Over the last decade the use of butyl tapes has declined in favour of other glazing materials.

Elastomeric Sealants

Silicones, polyurethanes, acrylics and butyl sealants are the main types of elastromeric sealants used throughout the glazing industry.

Sealant Selection

When selecting an appropriate sealant for a specific glazing installation, it is important to consider the properties of the various sealant types in order to avoid any long term problems. Gunable silicone and polyurethane are the most commonly used elastromeric sealants and cure by way of chemical reaction assisted by temperature and humidity or by solvent release.

Silicone

Silicone is the most widely used sealant with many benefits including, longevity, flexibility and good adhesion to glazing substrates. In addition silicone is less affected by ultra-violet radiation providing excellent long-term weatherability, making it an ideal material for use in external applications such as structural, weatherseal and butt-joint glazing. However each silicone type has some drawbacks which may be detrimental to the application.

Table 11.3a: Silicone Applications

Type	Application	Details	Colour	Site Applied	Factory Applied
Structural	Glass to aluminium	Neutral cure ONLY	Black	1 part	1 part or 2 part
Structural	Monolithic glass to glass	Acetic structural or Neutral cure	Black and translucent	1 part	1 part
Structural	Laminated glass to glass	Neutral cure ONLY	Black	1 part	1 part
Weatherseal	Laminated glass to glass	Neutral cure ONLY	Black and translucent	1 part	1 part

NB: The use of black silicone is recommended in all applications.

A range of glazing material and tools

There are two main categories of silicone: acetic cure and neutral cure. Recognised by their pungent odour, acetic cure silicones contain chemical compounds that produce acetic acid as a by-product of the curing (hardening) process. Alternatively certain types of neutral cure silicones release alcohol as a by-product of the curing process. Table 11.3a details the specific type/s of silicone suitable for various glass applications. Silicone is available in either high or low modulus (i.e. movement capability and tear resistance) and/or in a choice of one-part or two-part products.

Adhesion, Compatibility and Stain Testing

Due to the wide variety of painted and other surface types currently available for construction purposes, simple adhesion, compatibility and stain testing should be carried out prior to the commencement of any sealant application. If required, samples of all intended materials can be supplied to the relevant sealant manufacturer for testing.

Surface and Joint Preparation

Glass and polycarbonate surfaces should be subjected to a two stage cleaning process as recommended in sealant suppliers' literature. This procedure is as follows:

- Thoroughly clean the surface with either methylated spirits or isopropyl alcohol (only) on clean cloths or lint free paper
- Before the solvent completely evaporates, wipe the surface dry with a second, clean lint-free cloth to remove all contaminants

NB: It is important that cleaning solvents containing chemicals such as ammonia, xylene (i.e. white spirits) are not used with polycarbonate materials as it will cause crazing of the material. This also applies to glazing products that release solvents or ammonia during curing. Specific glazing products and methods must be used when glazing polycarbonate products.

Masonry surfaces should have loose dust, dirt and debris removed by a brush.

Aluminium surfaces should be cleaned with white spirit using clean cloths or lint free paper and employ the two stage cleaning process described above.

NB: It is important to use white spirits as the cleaning solvent to properly remove waxes and other contaminates from painted aluminium surfaces. Alcohol based cleaners like methylated spirits may not be sufficient to obtain optimum adhesion on all surfaces.

Priming may be required if adhesion tests show cleaning only, provides inadequate adhesion. Should this occur the manufacturer's recommendations must be followed.

NB: Suitable protective clothing, eyewear and gloves should be worn when using solvents or primers.

Sealant Application and Tooling

After preparing the surface (and the primer, if required, has dried), it is critical the sealant is immediately applied. Delays will allow dust etc. to collect on the various surfaces and contaminate the frames. Apply the sealant by pushing a bead of sealant forward into the joint cavity. Do not pull the applicator gun as the sealant will tend to lay over the joint rather than be pushed into the cavity as is required to achieve a proper seal. Pushing the sealant also helps wet all the contact surfaces. Care must be taken to ensure joints are filled without voids, air pockets or bubbles.

Under no circumstances should uncured sealant be tooled off with solvents. Tooling fluids are not recommended as they can cause possible joint contamination and inhibit sealant cure.

11.4 Glass Setting Blocks

Glass setting blocks can take the form of neoprene, EPDM, silicone or PVC materials which generally have a 80 Durometer Shore hardness.

Setting blocks are used in the glazing of monolithic, laminated and Twin-Glaze units to:

- Provide a cushion for the glass
- Maintain the proper location of the glass
- Ensure correct edge clearance and frame retention

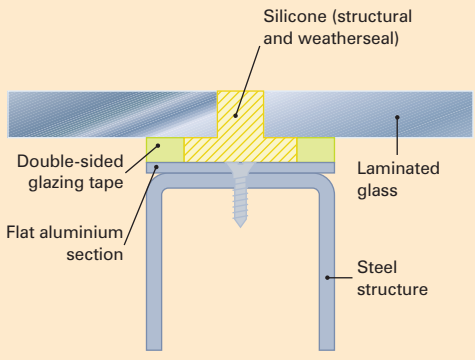
For correct size and position of setting blocks consult AS 1288.

11.5 General Glazing Applications

Structural Glazing (1 or 2 part silicone)

Structural glazing, either 4-sided or 2-sided, utilises structural silicone to adhere and seal glass or cladding materials to the aluminium substrates. In all structurally glazed applications, a calculation is required to determine the thickness and width of the silicone (structural) bite in order to satisfy load requirements on the framing and glass. The nominated bite size is attained by correctly positioning and selecting an appropriate double-sided, structural tape which is available in varying thicknesses and widths. During installation glaziers must ensure the structural silicone being pumped into the joint totally wets both substrates being glued, filling the aluminium to glass void. Temporary retainers may be required to secure the glass in place while the silicone is curing. One-part silicones may require 21 days to reach full strength after which time temporary retainers can be removed.

Figure 11.5a: Example of Structural Glazing

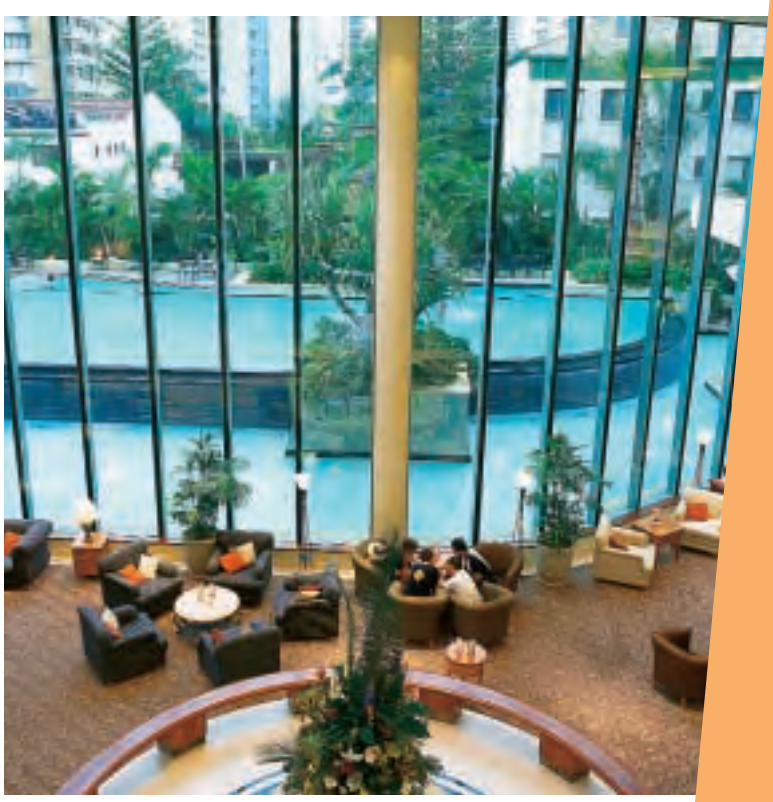


Prior to installation, correct cleaning (and possibly priming) of the aluminium frames and glass is paramount to ensure good adhesion.

4-sided Structural Glazing involves adhering the glass or cladding to aluminium on all four sides achieving a totally flush, frameless, external appearance.

2-sided Structural Glazing involves adhering the glass or cladding to aluminium on opposite sides, either vertically or horizontally, with the other two edges held captive with an aluminium bead or cover strip.

For sloped overhead glazing, either 4-sided or 2-sided structural glazing can be used to ensure a weather tight system is achieved.



Legends Hotel, Surfers Paradise

Butt-Joint Glazing

2-edge Support

2-edge butt-joint glazing involves the glass being retained horizontally in an aluminium channel glazed with a gasket while the vertical joints are sealed with silicone. This type of glazing is used in office partitions and internal shopfronts (subject to the requirements of AS 1288).

NB: In certain instances glass fins may be required for structural support.

Cathedral Place, Brisbane

4-edge Support

4-edge butt-joint glazing incorporates a glass fin at the silicone joint which provides structural support for the glass panels. The size of the glass fin and how it is retained at the head and sill are important considerations to ensure adequate structural support is achieved.

90° Butt Corner

With 90° butt corner joints, the glass is considered to be structurally supported by the adjacent panel, i.e. the glass panels support one another in a similar method to that of a glass fin providing sufficient structural bite is available. This may also apply to internal angles up to 135°. It is necessary to check that the glass thickness is sufficient to provide the required silicone bite.

Weatherseal Glazing - Non-structural

Weatherseals have many different forms and include glass to glass butt-joints, glass to aluminium seals or aluminium to aluminium seals for cladding joints. It is important that silicone weatherseals have the correct joint design to accommodate building movement, expansion and contraction due to heating and cooling.

11.6 Considerations for Glazing

Annealed and Heat Treated Glass

Annealed and heat treated glass with any surface or edge damage must not be glazed as this weakens the glass causing possible thermal or spontaneous breakage.

Laminated Glass

Glazing systems incorporating laminated glass should include weep (drain) holes as it is essential that the edges remain dry as prolonged exposure to moisture will cause delamination around the edges. This may even occur when laminated glass is glazed in unframed applications such as balustrade in-fill panels. All types of silicones may cause slight delamination, with acetic cure silicone being the most detrimental. If silicone is to be used a neutral cure type is recommended. It should be noted that delamination does not effect the structural integrity of the glass or joint.

Twin-Glaze Units

All systems glazed with Twin-Glaze units must incorporate weep (drain) holes as any long term exposure to moisture WILL result in unit

failure. Weep holes must be equivalent to three (3) 10mm holes per sill. All Twin-Glaze units have silicone secondary seals and therefore do not require additional protection against UV radiation.

Curved Glass

For the glazing of curved glass an extra setting block is required in the centre of the curve. Due to the glass and aluminium bending tolerances, it is recommended a silicone cap-seal is employed to alleviate any pressure points in the glass curve that may be caused by dry glazing with PVC gaskets.

Bullet Resistant and Physical Attack Glass

With glass polycarbonate composite panels it is important that cleaning solvents containing chemicals such as ammonia and xylene (e.g. white spirits) are not used as they induce stress into the polycarbonate edges resulting in crazing. This can also occur with some glazing products which release solvents during curing. To avoid any problems the glass should be cleaned with a mild solution of soap or detergent and luke warm water.

11.7 Mirror Installation

Mirrors should be mounted plumb and flat to avoid distortion and installed in a manner which permits air circulation between the wall and mirror back minimising condensation. This is especially important in bathrooms, ensuites or rooms with high humidity.

Mirrors should never be fixed directly to unpainted concrete, brick, plaster or timber, as there is always the potential of chemical attack from these unsealed surfaces.

Fixings - Screws, Domes or Rosettes

The most widely used method of fixing frameless mirrors is by using screws and domes or rosettes fixed through holes in the four corners of the mirror.

For mirrors over 3m², holes should be at 900mm centres and a minimum 50mm from the edge.

Screws must not be over-tightened as breakage will occur.

Double-sided Tape

Such tape must be capable of permanently bonding to the wall and at least 2- 3mm thick. Vertical strips are recommended to reduce the possibility of moisture and other contaminants being trapped behind the mirror. Supporting the bottom edge should also be considered for safety purposes.

Silicone/Adhesive Fixing

The use of silicone or structural adhesive is useful on uneven surfaces or where concealed fixings are required. Silicone or adhesive should be applied in vertical strips and never in 'blobs'. Double-sided tape is used to hold the mirror in place while the silicone or adhesive cures. For vinyl backed mirrors, the vinyl should be removed in areas where the silicone or adhesive is to be applied to ensure sufficient bonding between the mirror and the wall.

For compatible silicones and adhesives consult with G.James Technical Advisory Service.

Batten Fixing

The suggested way of achieving a plumb installation, particularly for large areas, is to use vertical batten fixing. The vertical battens (50mm x 25mm) should be primed, before fixing to ensure no chemical reactions between the resins and mirror back.

Either double-sided tape, silicone, adhesives or rosettes can then be used to install mirrors to the battens.

12.0 Standards and testing

12.1 Standards

Australian Standards (AS):

AS 1170.2
Minimum design loads on structures - Wind loads.

AS 1288
Glass in buildings - Selection and installation.

AS 1530
Methods for fire tests on building materials, components and structures.

AS 1926
Swimming pool safety.

AS/NZS 2080
Safety glass for land vehicles.

AS 2107
Acoustics - Recommended design sound levels and reverberation times for building interiors.

AS/NZS 2208
Safety glass materials in buildings.

AS/NZS 2343
Bullet-resistant panels and elements.

AS 2820
Gate units for private swimming pools.

AS 3555
Building elements - Testing and rating for intruder resistance.

AS 3959
Construction of buildings in bushfire-prone areas.

AS/NZS ISO 9000 Series
Quality Management System Standards.

Other Industry Standards and Publications:

ASHRAE
American Society of Heating, Refrigerating and Air-conditioning Engineers.

ASTM
American Society for Testing and Materials.

ASTM 1036
Specification for flat glass.

ASTM 1048
Specification for heat treated glass.

BCA
Building Code of Australia.

BS 5713
British Standard - Hermetically sealed IG units.

BS 5821
British Standard - Rating sound insulation.

BRB 566
British Rail Board - Railway transport/safety glazing.

CAN/CGSB - 12.8 - M90
Canadian insulating glass units national standard.

FRA I & FRA II
Federal Railroads Administration (USA) - Rail transport/safety glazing.

12.2 Product Standards

AS/NZS 2208 (Safety glazing materials in buildings)

- G.James Safety Glass (Qld) Pty Ltd - Laminating Lic. No. 809.
- G.James Safety Glass (Qld) Pty Ltd - Toughening Lic. No. 809.
- G.James Safety Glass Pty Ltd (NSW) - Toughening Lic. No. 592.
- G.James Safety Glass Pty Ltd (Vic) - Toughening Lic. No. 951.
- G.James Industries (Malaysia) Sdn. Bhd.- Laminating Lic. No. 1441.
- G.James Industries (Malaysia) Sdn. Bhd. - Toughening Lic. No. 1441.

AS/NZS 2080 (Safety glass for land vehicles)

- G.James Safety Glass (Qld) Pty Ltd - Laminating Lic. No. 821.
- G.James Safety Glass (Qld) Pty Ltd - Toughening Lic. No. 821.
- G.James Safety Glass Pty Ltd (NSW) - Toughening Lic. No. 471.
- G.James Safety Glass Pty Ltd (Vic) - Toughening Lic. No. 949.
- G.James Safety Glass Pty Ltd (Vic) - Laminating Lic. No. P302.

AS/NZS 2343 (Bullet resistant panels and elements)

- G.James Safety Glass (Qld) Pty Ltd - Security Products Lic. No. 1499.

12.3 Quality Management Systems Certification to ISO 9000 Series

G.James Safety Glass Pty Ltd
- Certificate No. QEC 7280.

G.James Glass & Aluminium Pty Ltd
- Certificate No. QEC 2153.

G.James Extrusion Co Pty Ltd
- Certificate No. QEC 079.

12.4 Test Facilities

The following are test facilities used by G.James:

ASIO
Australian Security Intelligence Organisation (T4 Protective Security): Forcible Attack Testing.

Ballistic Edge
Bullet resistant glass testing.

BHP - Sydney
Cyclone test facility.

BRANZ
Building Research Australia and New Zealand: IG unit testing.

CSIRO
Commonwealth Science Industry Research Organisation: Acoustic testing.

G.James Engineering Services Pty Ltd

- Physical attack testing
- BRB 566 and FRA testing
- Optical and thermal measurements
- Accelerated life testing of products

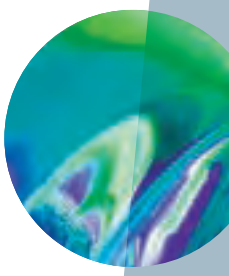
G.James Testing Laboratory
NATA Registered Laboratory No.3630 (within the field of mechanical testing).

James Cook University - Townsville
Cyclone resistant glazing.

National Acoustic Laboratories
Acoustic testing.

Queensland University of Technology - Brisbane
Photometric Laboratory: UV transmittance/ laminated glass and luminous transmittance through laminated glass.

Faculty of Building Environment and Engineering: Forcible attack testing.



13.0 Stocklines

13.1 Clear Float

1.2mm, 2mm, 2.5mm, 3mm, 4mm, 5mm, 6mm, 8mm, 10mm, 12mm, 15mm, 19mm & 25mm

13.2 Tinted Float

Grey: 4mm, 5mm, 6mm, 8mm, 10mm & 12mm

Bronze: 4mm, 5mm, 6mm, 10mm & 12mm

Green: 4mm, 5mm, 6mm, & 10mm

13.3 Super Tints/Performance Glass

Evergreen: 3mm, 4mm, 5mm & 6mm

Arctic Blue: 4mm, 6mm & 10mm

Azurlite: 4mm, 6mm & 10mm

Panasap (Dark) Blue: 5mm & 6mm

Optigray 23: 6mm

Supergrey: 4mm & 6mm

Low Iron Glass

Starphire: 6mm,10mm & 12mm

Diamant: 6mm,10mm & 12mm

On-line Reflective

Solarcool Grey: 4mm & 6mm

Solarcool Bronze: 4mm & 6mm

Solarcool Azurlite: 4mm & 6mm

Eclipse Grey: 6mm

Eclipse Blue Green: 6mm

Eclipse Evergreen: 6mm

Eclipse Arctic Blue: 6mm

Stopsol Classic Dark Blue: 6mm

Stopsol SuperSilver Dark Blue: 6mm

Reflectafloat: 6mm

Solarplus

TS21: 3mm & 6mm

TS30: 3mm & 6mm

SS08: 3mm & 6mm

SS22: 3mm & 6mm

SL10*: 3mm & 6mm

SL20*: 3mm & 6mm

NB: Other coatings available upon request.
* Only available in laminated.

Low E

Energy Advantage: 3mm, 4mm & 6mm

Sungate 500: 4mm & 6mm

K Glass: 4mm & 6mm

13.4 Figured Rolled Patterned

Non-reflective: 2mm

White

Broadline: 4mm

Cathedral: 3mm, 4mm & 5mm

Flemish: 4mm

Glue Chip: 5mm

Kosciusko: 3mm

Narrow Reeded: 4mm

Roughcast: 3mm & 5mm

Satinlite: 3mm

Seadrift: 5mm

Glacier/Sparkle: 3mm

Spotswood: 3mm, 4mm & 5mm

Strata: 3mm & 5mm

Tandarra: 5mm

Tinted

Grey (Cathedral): 5mm

Grey (Spotswood): 5mm & 6mm

Bronze (Cathedral): 5mm

Bronze (Seadrift): 5mm

Bronze (Spotswood): 5mm & 6mm

Bronze (Tandarra): 5mm

NB: Some discontinued patterned glass also available ex-stock

13.5 Wired Glass

Clear

Georgian Polished: 6mm

White

Obscura: 6mm

Scintilla: 6mm

Squarelite: 6mm

Tinted

Bronze (Scintilla): 6mm

Qualage

Tudor Clear: 4mm & 5mm

Colonial Clear: 4mm & 5mm

Colonial Cathedral: 4mm & 5mm

13.6 Laminated

Clear

5.38mm, 6.38mm, 6.52mm, 6.76mm, 8.38mm, 10.38mm, 10.76mm, 11.52mm & 12.38mm

Grey

5.38mm, 6.38mm, 6.52mm, 6.76mm, 8.38mm, 10.38mm, 11.52mm & 12.38mm

Bronze

5.38mm, 6.38mm, 6.76mm, 8.38mm, 10.38mm & 11.52mm

Green

5.38mm, 6.38mm, 8.38mm, 10.38mm, 11.52mm & 12.38mm

Evergreen

6.38mm, 6.76mm, 8.38mm, 10.38mm, 11.52mm & 12.38mm

Opticolor

Various colours and glass thicknesses available

Automotive

Clear: 5.38mm, 5.76 W.H.P., 6.38mm & 6.76 W.H.P

Grey: 5.38mm & 6.38mm

Bronze: 5.38mm & 6.38mm

Green: 5.38mm, 5.76 W.H.P., 6.38mm & 6.76 W.H.P.

Dark (Brown) Neutral: 6.76mm

Figured Patterned Laminated

Translucent: 6.38mm, 8.38mm, 10.38mm & 12.38mm

Clear Showertex (Cathedral): 6.76mm

Grey Showertex (Cathedral): 6.76mm

Bronze Showertex (Cathedral): 6.76mm

NB: Other patterns available on request

13.7 Mirrors

Clear

3mm, 4mm & 6mm

Tinted

Grey: 4mm & 6mm

Bronze: 4mm & 6mm

Venetian Strip

Clear: 6mm

Vinyl Back Mirror

Grade A & B: 4mm

Grade B: 6mm

One Way Mirror

Solarplus SS08 Grey Laminated: 6.38mm

13.8 Glass Blocks

A large range of clear, patterned glass blocks

13.9 Special Purpose Glass

Heat Resistant Glass

FireLite: 5mm

Robax: 5mm

Borofloat: 5.5mm

Radiation Shielding Glass

Lead Glass: Various thicknesses

Prior to selection/ordering any of the above stocklines verify available sheet size with your G.James representative.

NB: Some items maybe temporarily out of stock or only available on request.

14.0 Units/Conversion factors

Units

Length:	metres (m)
Mass:	kilograms (kg)
Time:	seconds (s)
Temperature:	Kelvin (K)
Energy:	joule (J)
Force:	newton (N)
Power:	watt (W)
Pressure:	pascal (Pa)

Length

Metric to Metric

1 millimetre	= 1000 micrometres
1 centimetre	= 10 millimetres
1 metre	= 1000 millimetres = 100 centimetres
1 kilometre	= 1000 metres

Imperial to Metric

1 inch	= 25.4 millimetres
1 foot	= 0.305 metre = 30.48 centimetres
1 yard	= 0.914 metre
1 mile	= 1.609 kilometres
1 fathom	= 1.829 metres

Metric to Imperial

1 centimetre	= 0.394 inch
1 metre	= 39.37 inches = 3.28 feet = 1.094 yards
1 kilometre	= 0.621 mile

Area

Metric to Metric

1 sq. metre	= 10 000 sq. centimetres
1 hectare	= 10 000 sq. metres
1 sq. kilometre	= 100 000 sq. metres = 100 hectares

Imperial to Metric

1 sq. inch	= 645.16 sq. millimetres
1 sq. foot	= 0.093 sq. metre
1 sq. yard	= 0.836 sq. metre
1 perch	= 25.293 sq. metres
1 acre	= 0.405 hectare
1 sq. mile	= 2.59 sq. kilometres

Metric to Imperial

1 sq. metre	= 10.764 sq. feet = 1.196 sq. yards
1 sq. kilometre	= 0.386 sq. mile
1 hectare	= 2.471 acres

Mass

Metric to Metric

1 gram	= 1000 milligrams
1 kilogram	= 1000 grams
1 tonne	= 1000 kilograms = 1 cubic metre (fluid)

Imperial to Metric

1 ounce	= 28.35 grams
1 pound	= 0.454 kilogram
1 stone	= 6.35 kilograms
1 ton	= 1.016 tonnes

Metric to Imperial

1 gram	= 0.035 ounce
1 kilogram	= 2.205 pounds
1 tonne	= 0.984 ton

Volume & Capacity

Metric to Metric

1 cubic centimetre	= 1000 cubic millimetres
1 cubic metre	= 1 000 000 cubic centimetres = 1000 litres = 1000 kilograms (fluid)
1 litre	= 1000 millilitres

Imperial to Metric

1 cubic inch	= 16.387 cubic centimetres
1 cubic foot	= 0.028 cubic metre
1 UK gallon	= 4.546 litres
1 US gallon	= 3.785 litres

Metric to Imperial

1 cubic centimetre	= 0.061 cubic inch
1 cubic metre	= 35.315 cubic feet
1 litre	= 0.22 UK gallon = 0.264 US gallon

Power & Force

Metric to Metric

1 watt	= 1000 milliwatts = 1 joule/second
1 kilowatt	= 1000 watts
1 megawatt	= 1000 kilowatts

Imperial to Metric

1 horsepower	= 0.746 kilowatt
1 British Thermal Unit (Btu)/hour	= 0.293 watt
1 pound force	= 4.448 newtons

Metric to Imperial

1 watt	= 3.412 Btu/hour = 0.738 feet pound force/second
1 kilowatt	= 1.341 horsepower
1 newton	= 0.225 pound force

Energy

Metric to Metric

1 joule	= 1000 millijoules = 1 newton metre
1 kilojoule	= 1000 joules
1 megajoule	= 1000 kilojoules
1 kilowatt hour	= 3.6 megajoules

Imperial to Metric

1 foot pound force	= 1.356 joules
1 Btu	= 1.055 kilojoules

Metric to Imperial

1 joule	= 0.738 foot pound force
1 kilojoule	= 0.948 Btu

Thermal Values

R-value	= 1 ÷ U-value
U-value	= 1 ÷ R-value
Btu/ft².h.°F	= W/m².K ÷ 5.68
W/m².K	= Btu/ft².h.°F x 5.68

Pressure

Metric to Metric

1 pascal	= 1 newton/sq. metre
1 kilopascal	= 1000 pascals

Imperial to Metric

1 pound force/ sq. inch	= 6.895 kilopascals
1 pound force/ sq. foot	= 47.88 pascals

Metric to Imperial

1 kilopascal	= 0.145 pound force/sq. inch

Speed

Metric to Metric

1 metre/second	= 3.6 kilometres/hour
1 kilometre/hour	= 0.277 metre/second
1 knot	= 1.852 kilometres/hour = 0.514 metre/second

Imperial to Metric

1 foot/second	= 0.305 metre/second
1 mile/hour	= 1.609 kilometres/hour = 0.447 metre/second

Metric to Imperial

1 metre/second	= 3.281 feet/second
1 kilometre/hour	= 0.621 mile/hour

Speed of Sound

1193.25 kph

741.45 mph

Area of Circle

Area = πr^2 (3.14159 x radius²)

Circumference of Circle

Circumference = $2\pi r$ (2 x 3.14159 x radius)
= πd (3.14159 x diameter)

Temperature Conversions

°Celsius	= (°Fahrenheit - 32) x $^5/_9$ = Kelvin - 273.15
Kelvin	= °Celsius + 273.15
° Fahrenheit	= ($^9/_5$ x °Celsius) + 32