G. James is glass

HANDBOOK

G. James is glass

HANDBOOK

FIRST EDITION

Forward

The G.James Group is the most comprehensive and technologically advanced processor of glass in the Asia Pacific region. Significant investment in training, technology, equipment, business resources, infrastructure, and quality control systems ensure that all processes - including cutting, edging, laminating, toughening, double glazing, curving, coating, profiling and painting - are to world best standards.

Today, G.James operates the only vacuum-coating glass plant in Australia. The Group's impressive in-house capability has led to it being the preferred supplier on many national and international landmark projects.

With its worldwide reputation as an innovator of glass and associated products used in residential, commercial and high rise monumental buildings, G.James is at the forefront of developments within the glass industry.

Glass today is used to perform many functions other than its primary role of allowing light to enter a building. Its applications can be visual, mechanical, structural, decorative, thermal, architectural, artistic or a combination of any or all of these aspects. G.James provides a range of services including design assistance, specification guidelines, product development, testing and assessment to cover all of these elements.

This book has been compiled as a training and reference document for G.James employees, tutors, students, architects, engineers, builders, those within and those entering our industry.

Whatever your interest, we trust we can pass on a greater understanding of this amazing and versatile material - GLASS.

If you require further assistance or information on any of the material contained within this handbook, please contact the G.James Technical Advisory Service on 1800 452 637.

Joseph Saragossi

Mr Joseph Saragossi, AO
Chairman of Directors

The G.James Story

The origin of the G.James Group of Companies began when the late George James migrated from England in 1912. He established a glass merchandising business initially at West End, Brisbane and then from the early 1920's at 31 Bridge Street, Fortitude Valley, Brisbane.

The business was based on buying cases of glass from Australian and overseas sources and then selling to timber joiners. He commanded a large market covering Queensland, the northern part of New South Wales and as far south as Taree.

The business remained as such, with the addition of some cutting and processing, until the death of George James in 1958. His son-in-law Mr Joseph Saragossi, together with Joseph's wife Pearle and sister-in-law Gertie Baratin, founded a private company and purchased the G.James business. Joseph Saragossi had served as a Radio Officer in the American Armed Forces. He saw active duty in the South West Pacific and after the war established a successful electrical contracting business. He became the guiding force in building the business from five employees to its present size and diversification.

Market conditions were changing, post war glass quotas were lifted and major customers became major competitors. In addition, aluminium framed joinery was being introduced threatening the existence of the timber joiners, the most traditional and largest group of customers. These circumstances became the motivation in changing the direction from a glass merchant to a diversified wholesale, retail, contracting glass business as well as a manufacturer and installer of aluminium/glass window and door products for use in the building industry (residential, commercial, industrial and monumental).

During the 1960's aluminium largely replaced timber for framed joinery and the company relied heavily on imported extrusions and glass to fulfil its requirements. Economic growth during the late 60's and 70's led to the procurement of custom made extrusions from Australian producers thereby replacing previously imported windows and extrusions from the U.S.A.

As the product range gradually expanded, a small network of regional branches were established and fabrication facilities were increased. However with the limited availability of safety glass from within Australia and the constant reliance on local extruders for aluminium profiles, G.James recognised the need to become more autonomous. So began what would become a perpetual program of capital acquisitions and the establishment of strategically located glass processing and service facilities.

G.James premises at 31 Bridge Street, Fortitude Valley in 1940, the company's home for nearly fifty years.

1977: Glass Toughening Plant commissioned at Smithfield, Sydney
1986: Glass Laminating Facility opens at Narangba, Brisbane
1987: Glass Toughening Plant commissioned at Narangba, Brisbane
1989: Glass Toughening Plant opens at Campbellfield, Melbourne
1994: Glass Laminating Factory commenced in Senai, Malaysia
1996: Gas Convection Furnace (for Heat Processing) installed at Narangba, Brisbane
1998: Insulated Glass Unit Line opens at Eagle Farm, Brisbane
1998: Off-line, Vacuum Coating Glass Plant opens at Eagle Farm, Brisbane
1999: Insulated Glass Unit Line installed at Campbellfield, Melbourne
1999: Curved Toughened Glass Furnace commissioned at Smithfield, Sydney
1999: Glass Toughening Furnace commissioned at Senai, Malaysia

G.James now employs more than 2000 people involved in the manufacture, fabrication, processing and installation of a diverse range of glass and aluminium products.

G.James is today Australia's leading integrated glass and aluminium manufacturer and contractor.

Table of contents

Forward 2
The G.James Story 3

1.0 Getting to Know Glass 6
1.1 A Brief History 6
1.2 Glass Properties 8
1.3 Thickness Tolerances for Glass 10
1.4 Glass Surface Numbers 11
1.5 Identifying the Coated Surface 11
1.6 Glass Staining and Cleaning 11
1.7 Care and Storage 12
1.8 Glass Processing 13
1.9 Breakage Characteristics 16
1.10 Solar Spectrum 17
1.11 Thermal Breakage 19
1.12 Fade Control 21
1.13 Daylight and Colour Perception 23
1.14 Sound Insulation 23
1.15 Spandrel Design 26

2.0 Float Glass 28
2.1 Clear Float 28
2.2 Tinted Float 28
2.3 Supertints 29
2.4 Low Iron 29

3.0 Laminated Safety Glass 30
3.1 Introduction 30
3.2 Process 30
3.3 Benefits 31
3.4 Applications 32
3.5 Optilight 32
3.6 Cyclone Resistant Laminate 33
3.7 Anti-Bandit Glass 33
3.8 Characteristics 33

4.0 Heat Treated Glass 34
4.1 Introduction 34
4.2 Process 34
4.3 Properties 35
4.4 Available Sizes 35
4.5 Manufacturing Guidelines 36
4.6 Applications 36
4.7 Colourlite (Ceramic Painted Glass) 41
4.8 Characteristics 42
4.9 Heat Soak Testing 43

5.0 Curved Toughened Glass 44
5.1 Introduction 44
5.2 Terminology 44
5.3 Available Curves 46
5.4 Maximum Sizes 46
5.5 Measuring 46
5.6 Applications 46
5.7 Glazing 47
5.8 Acceptance Criteria 47
5.9 Standards 47

6.0 Reflective & Coated Glass 48
6.1 Introduction 48
6.2 On-Line Coatings 48
6.3 Solarplus (Off-line Coatings) 48
6.4 Handling Criteria 50
6.5 Low E (Low Emissivity) 50

7.0 Insulated Glass Units 52
7.1 Introduction 52
7.2 Process 52
7.3 Manufacturing Guidelines 53
7.4 Properties and Applications 53
7.5 Condensation 54
7.6 Characteristics 55

8.0 Safety and Security Glass 56

8.1 Introduction ... 56
8.2 ArmaClear – Bullet Resistant (BR) Glass ... 56
8.3 ArmaClear – Physical Attack (PA) Glass ... 58
8.4 ArmaClear – Prison Shield (PS) Glass ... 59
8.5 Train and Special Purpose Windows ... 59

9.0 Special Purpose Glass 60

9.1 Mirrors (Silver Glass) ... 60
9.2 One-Way Mirror ... 61
9.3 Convex Mirrors ... 62
9.4 Lead Glass ... 62
9.5 Diffused Reflection Glass (Picture Glass) ... 63
9.6 Non-Reflecting Glass ... 63
9.7 Heat Resistant Glass ... 63
9.8 Fire Rated Glass ... 64
9.9 Welding Glass ... 66
9.10 Glass Blocks ... 66
9.11 Aquatic Glazing ... 68
9.12 Electronic Security ... 68
9.13 Glass Floors and Stair Treads ... 70

10.0 Decorative Glass 72

10.1 Introduction ... 72
10.2 Figured Rolled Patterned Glass ... 72
10.3 Patternlite (Ceramic Painted Patterned Glass) ... 74

11.0 Glazing Techniques 76

11.1 Introduction ... 76
11.2 Dry Glazing ... 76
11.3 Wet Glazing ... 77
11.4 Glass Setting Blocks ... 79
11.5 General Glazing Applications ... 79
11.6 Considerations for Glazing ... 80
11.7 Mirror Installation ... 81

12.0 Standards and Testing 82

13.0 Stocklines 84

14.0 Units/Conversion Factors 86

15.0 Glossary 88

Appendix One ... 98
Appendix Two ... 100
Index ... 101

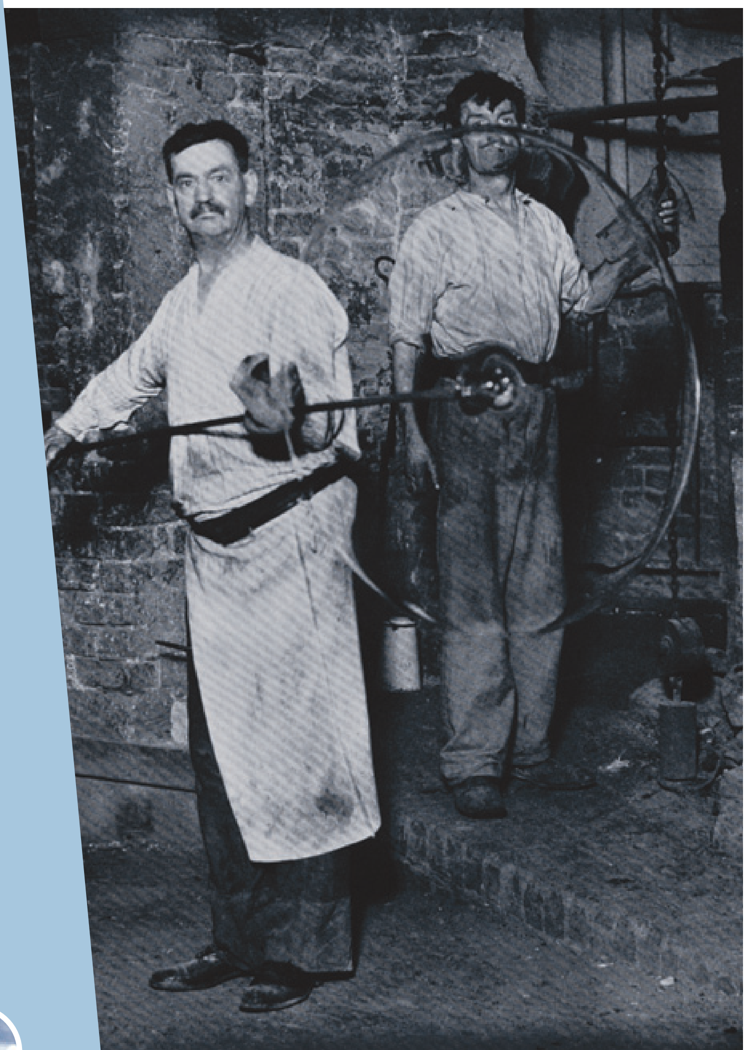
TABLE OF CONTENTS

1.0 Getting to know glass

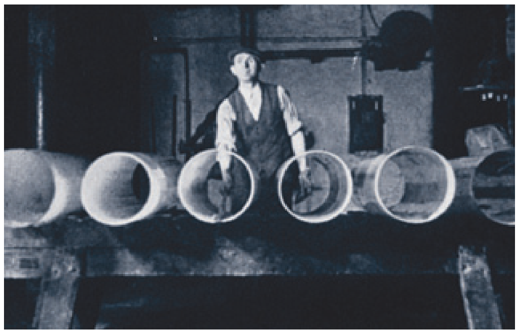
1.1 A Brief History

Where did it all start?

Glass was probably first discovered by Syrian copper founders between 5000 – 7000 years ago. The dross (or waste) produced by the ores could be described as vitreous pastes with colouring from various metallic oxides. It would of been very similar to obsidian, which is produced naturally through volcanic action. The substance was opaque and did not resemble glass as we know it today in its many forms.


The crown table spinning at the end of the punty

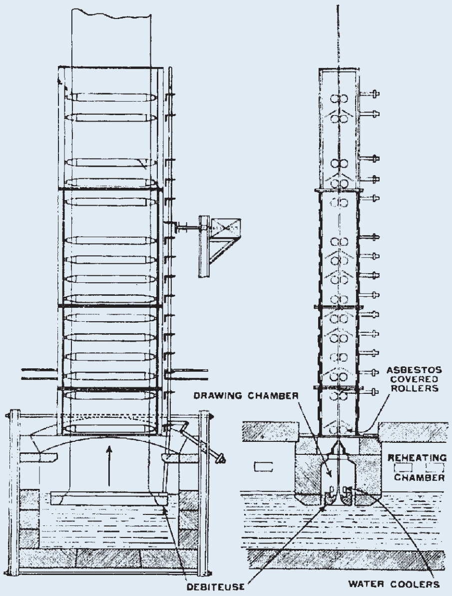

The old cylinder process


The old cylinder process

Pliny's well known story of the shipwrecked Phoenicians lighting a fire on the beach, using blocks of soda to support their pots and subsequently discovering glass the following morning - while being romantic, is not supported by historical facts.

Through conquest the art was taken to Egypt where the oldest relics are dated at 2000 B.C. It is also believed that Alexander the Great was buried in a glass coffin. From Egypt the technique was taken to Rome, from where it spread throughout Europe and continued to develop. Between the 7th and 13th centuries, the 'crown' method of spinning a gob of molten glass on a hollow rod or punty was used. This resulted in a bubble of glass being flattened into a disc approximately one metre in diameter, from which small pieces were cut from the outside, leaving the worst quality in the centre. The bulls-eye or bullion ironically is now the most sought after piece.

Figure 1.1a: Fourcault Process



The Fourcault process in action

Crowns were subsequently replaced by the cylinder blown and later the cylinder drawn process in 1903. In principle a long balloon of glass was blown or drawn; split and flattened and then allowed to cool slowly to avoid stress in the glass, however sizes were again limited.

It was in 1913 that continuous processes such as; the Fourcault process (Belgium); the Colburn - Libbey - Owens process (USA); and the most successful of all, the P.P.G. Pittsburgh process. All involved drawing the glass up vertically out of a tank of molten glass, the edges being held by knurled rollers to retain the ribbon width.

The sheet glass produced by these methods gave a good strong fire finish, but the very action of pulling upwards meant the product contained inherent bands of distortion which resulted in poor optical quality and terrible reflections.

Where true optical quality was required in mirrors or large shopfront windows, a plate glass was needed. The plate process involved sheet glass being ground and polished to achieve the desired quality. By 1938 the process had been developed to the stage where a continuous ribbon of cast glass was ground and polished on both surfaces simultaneously, first with sand then iron oxide. Apart from being extremely messy, the process line was longer than the ocean liner The Queen Mary, and was correspondingly, very costly.

The quantum leap came in late 1958 when Pilkington launched their Float Glass process, which has since been licensed to glassmakers throughout the world. This innovative process involved molten glass being floated on a shallow bath of molten tin, while being heated on the top surface. The resulting product is optically true and requires no further grinding or polishing. While manufacturing methods have changed dramatically over the last century, the basic ingredients used in glass making are still very much the same.

A typical float glass line

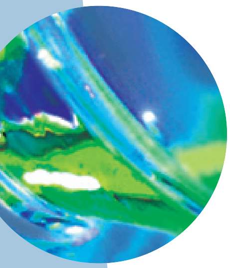
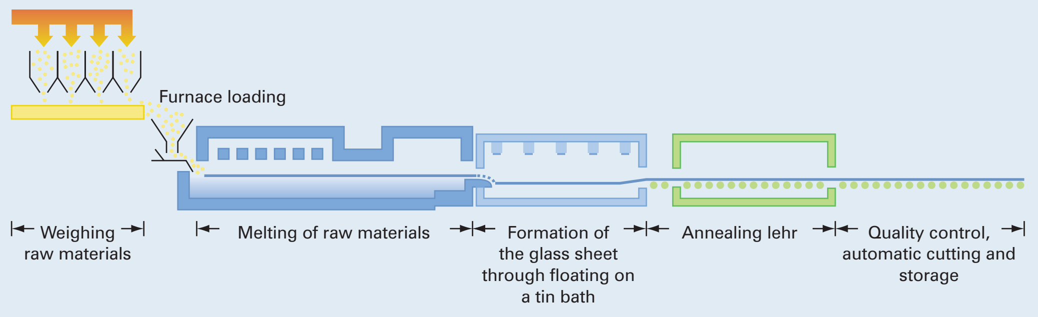


Figure 1.1b: Float Glass Process



A typical batch mix would consist of: 1000 parts silica (sand) + 310 parts soda ash + 295 parts limestone/dolomite + 60 parts feldspar and 400 parts cullet. Hence window glass is known as a soda/lime/silica. Glass may also be formed by mixing soda ash and silica. This product is referred to as 'water glass' because it is soluble in water. It is the limestone/dolomite that is required to stabilise the glass into a durable product.

1.2 Glass Properties

The general physical characteristics of soda/lime/silica glass for building purposes are:

Mass (kg): Area x Thickness(mm) x 2.6

Density: 2600 kg/m^3

Specific gravity: Approximately 2.60. Glass used for building purposes has a specific gravity comparable with that of aluminium which is approximately 2.70.

Coefficient of linear thermal expansion: 88 x 10^{-7}/°C. Glass has a much lower coefficient of linear thermal expansion than most metals.

Thermal conductivity: (K value) 1.05 W/m°C. The difference between various types of flat glass is small enough to be negligible.

Thermal endurance: 6mm glass heated to a higher temperature and plunged into water at 21°C will rupture at approximately 55°C differential.

Softening point: Approximately 730°C.

Modulus of elasticity: Young's modulus 70 GPa (70 x 10^9 Pa). The modulus of elasticity for glass is similar to that of aluminium.

Poisson's ratio: Float glass .22 to .23. Glass conforms to the elastic theory to the point of fracture.

Compressive strength: 25mm cube: 248MPa (248 x 10^6 Pa).

Tensile strength: For sustained loading 19.3 to 28.4 MPa. Determined as modulus of rupture.

Hardness scale: Moh's scale: diamond 10, sapphire 9, glass 6.5 – 5.5, gypsum 2.

Dielectric constant: 6mm glass at 21°C.

• 1,000,000,000 cycles per sec	6.0
• 10,000,000 cycles per sec	6.5
• 1,000 cycles per sec	7.4
• 10 cycles per sec	30.0

Refractive index: 1.52.
Refractive index varies for light of different wavelengths.

Reflection loss: Approximately 8 to 10% per panel (no absorption) normal incidence. Light is always reflected when it passes from a medium of one refractive index to a medium of another refractive index. The loss is a function of both the refractive indices of the medium and the angle of incidence of the light.

Thermal transmittance (U-value): 5.8 W/m^2°C for summer - 6.2 W/m^2°C for winter. This U-value is for a single panel of 6mm glass and is based on standard ASHRAE conditions. However, for most purposes a U-value of 6 is used.

Visible light transmittance: Sheet 85%, Plate/Float 87%, Rough Cast 80%, Wired Cast 75%, Translucent 70 - 85% dependent on pattern. These are approximate values for 6mm glass based on diffused (non-direct) light.

Infra-red transmittance: Ordinary glass has the property of being relatively transparent to short wave infra-red rays, but opaque to the longer wavelengths. This is the reason why horticultural glass houses accumulate heat from the sun's rays - radiation of short wavelength from the sun is passed through the glass, and is absorbed by the plants, benches, walls, etc, inside the house. These become hot and in turn re-radiate heat but of longer wavelength which cannot pass through the glass and is reflected back to the interior.

Ultra-violet transmittance: Ordinary glass transmits a very small proportion of the sun's ultra-violet rays. At 315nm less than 1%, at 340nm 41%.

Chemical resistance: Glass will resist most acids except hydrofluoric and at high temperature, phosphoric. Alkalis, however will attack the surface of glass. When glazed into concrete framing, alkalis released from the concrete by rain may be leached onto the glass causing staining, or etching of the glass surface. Weathering steels can deposit soluble sulphates, which may be difficult to remove from glass. Should this occur, any deposits should be removed as soon as possible.

Glass Strength

Glass in its pure form is an extremely strong, perfectly elastic non-crystalline brittle solid. In commercially available float products, its flexural or bending strength is limited by the surface tensile strength of the inevitable microscopic defects, flaws or cracks. These defects reduce the glass strength by a factor in excess of 100 compared to the strength of pure glass.

The property of pure elasticity with brittleness means that glass can not be permanently deformed by load as is the case for most solids such as metals and plastics, and that it fails without warning. Other phenomena affecting the surface flaws and thus the strength of the glass relate to the manufacturing process (with different strengths produced on the tin side and the air side), the duration of the load and presence of water which leads to static fatigue, the physical environment and cleaning processes used.

As annealed glass is quite variable in strength, a design safety factor of 2.5 is used for assessing the glass strength for structural performance. This still leads to an approximate expected failure rate of 8 in 1000 or nearly 1% which is much less than for other materials used in the engineering design processes in buildings.

Glass strength (not stiffness) can be altered by other processes including laminating, heat treating and/or using two pieces in a single hermetically sealed insulated glass unit.

The structural characteristics of these glass types are nominated in AS 1288 but they are summarised as follows:-

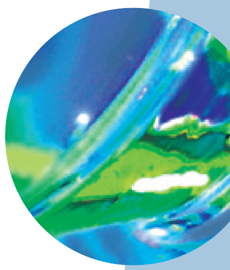
Laminated glass: This process does not significantly affect the strength of the glass but it does improve the safety of the glass as laminated glass typically remains intact and retains some strength even after fracture. For this reason, it is possible that future practice may allow higher stresses for such glass.

Heat treated glass: Both heat strengthened and fully toughened have a surface compression induced by a temperature increase and sudden quenching. The existence of the surface compression means that it must be overcome by load before any surface tensile stress is achieved. The magnitude of the surface compression is of the order of 3 to 6 times the typical stress values used in annealed glass design. This leads to a similar strength increase without any affect on the glass stiffness and deflections.

Insulated glass units: The hermetically sealed air or gas in the space between the glass units by virtue of Boyle's law ensures that the individual pieces of glass share the applied load approximately in proportion to their stiffnesses. Therefore for two pieces of equal thickness glass, the load is shared about 50:50.

Glass Strength Design

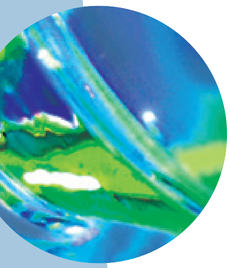
Refer to AS 1288 for specific design provisions. There has been significant improvement in the understanding of, and design methods for glass design since the 1980's. Glass (supported on all sides) under wind loading typically deflects more than its thickness and sometimes for the heat treated glass, many times more than their thickness. This large deflection behaviour introduces non-linearity i.e. The deflections are not directly proportional to the applied load. Because of the membrane stresses in the glass, it appears to stiffen with increased load and thus deflects less for each additional increase in load.



G. James
Technical Advisory Service

Phone: 1800 GJAMES (452637)

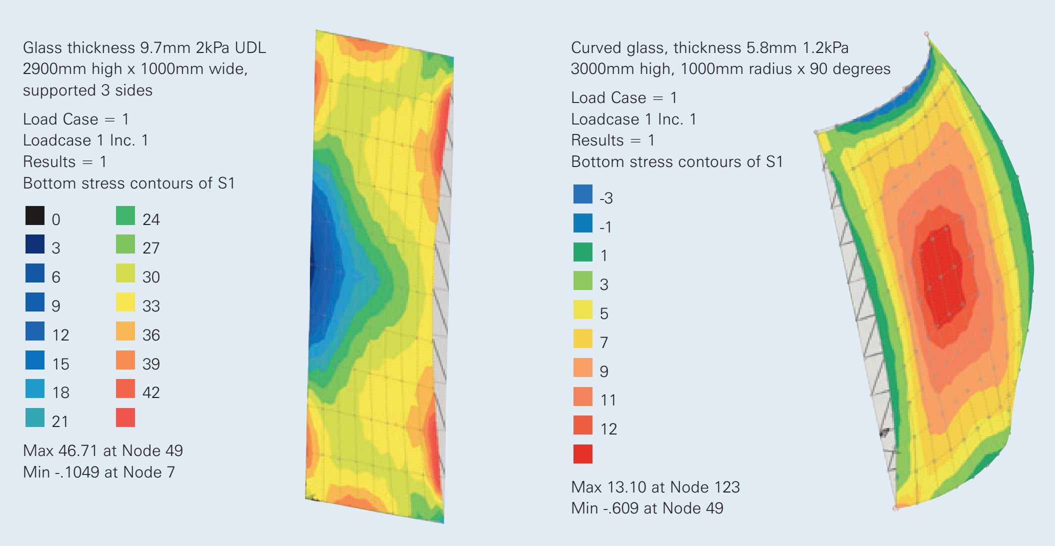
National Toll Free Number



Apart from the simple statically determinate case of simple span glass plates supported on 2 opposite sides, any analysis of glass under load must be carried out using a non-linear analysis method such as finite difference or finite element to determine the glass stresses and deflections. The correct application of a suitable failure prediction model is currently under debate. The extremely common case of a rectangular piece of glass with all four sides simply supported under uniform load has been well analysed and is the basis of the present glass design thickness recommendations of the ASTM and other bodies.

The advances in computer technology with dramatic reductions in computer costs now allows for the analyses of more complex shapes, support conditions and load patterns to be economically achieved. Two examples of typical analyses are illustrated in Figure 1.2a.

Figure 1.2a: Finite Element Analysis



1.3 Thickness Tolerances for Glass

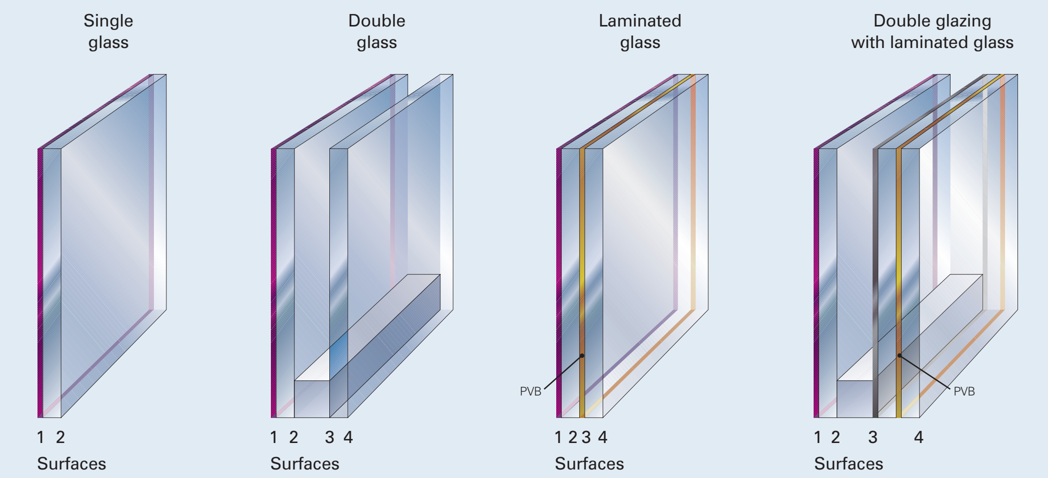
Table 1.3a: Thickness Tolerances

	Nominal Thickness	Tolerance	Range
Float	3mm	±0.2mm	2.8 - 3.2mm
	4mm	±0.2mm	3.8 - 4.2mm
	5mm	±0.2mm	4.8 - 5.2mm
	6mm	±0.2mm	5.8 - 6.2mm
	8mm	±0.3mm	7.7 - 8.3mm
	10mm	±0.3mm	9.7 - 10.3mm
	12mm	±0.3mm	11.7 - 12.3mm
	15mm	±0.5mm	14.5 - 15.5mm
	19mm	±1.0mm	18.0 - 20.0mm
	25mm	±1.5mm	23.5 - 26.5mm
Obscure/Figured Roll	3mm	+0.9mm, –0.5mm	2.5 - 3.9mm
	4mm	±0.5mm	3.5 - 4.5mm
	5mm	±0.5mm	4.5 - 5.5mm
	6mm	+1.0mm, –0.5mm	5.5 - 7.0mm
Wired	6mm	±1.0mm	5.0 - 7.0mm
PVB Laminate	5.38mm	–	4.95 - 5.81mm
	6.38mm	–	5.95 - 6.81mm
	8.38mm	–	7.95 - 8.81mm
	10.38mm	–	9.95 - 10.81mm
	12.38mm	–	11.95 - 12.81mm

NB: These figures are accepted Australian Industry Tolerances. Tolerance of non-standard thicknesses may fall outside the ranges stated above.

1.4 Glass Surface Numbers

Figure 1.4a: Glass Surface Identification



NB: Surface 1 = Exterior Surface

1.5 Identifying the Coated Surface

Figure 1.5a: Monolithic Reflective Glass

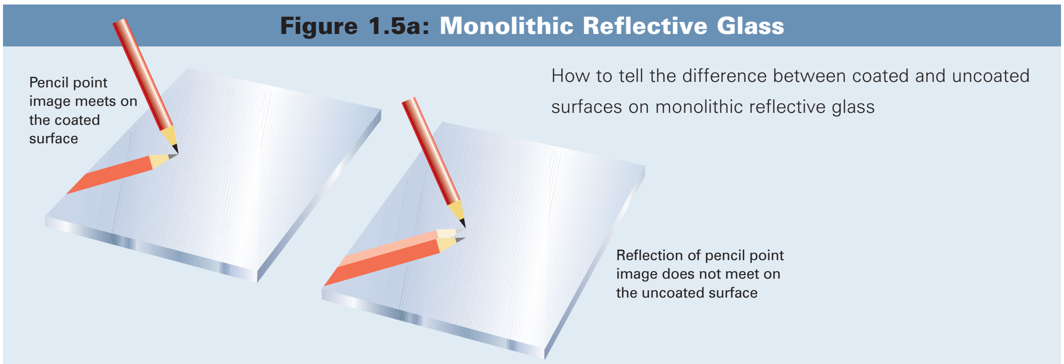
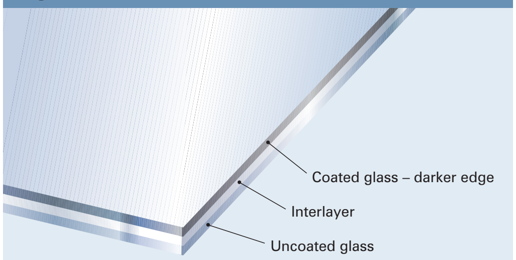


Figure 1.5b: Reflective Laminated Glass



How to tell the difference between glazing surfaces on reflective laminated glass.

Subject to certain exceptions, tinted PVB interlayered laminated glass (i.e. 6.38mm SS22 green laminated) has the reflective coating on surface position (3). The effect of the tinted PVB interlayer is to dampen the reflectivity and allow a building to exhibit a specific colour. This makes identification of 'outside' and 'inside' surfaces easier. However, with clear PVB interlayered laminated glass it may be difficult to determine the coated surface (i.e. 6.38mm TS21 clear laminated). The coated surface can usually be identified by the darker of the two glass edges (identification may be difficult after edge work e.g. flat grinding).

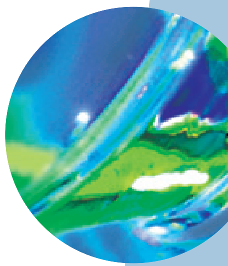
1.6 Glass Staining and Cleaning

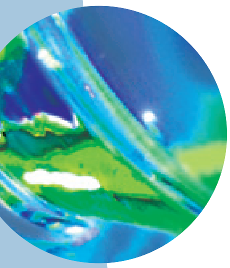
Staining

Glass is generally resistant to chemical attack and other degradation. It is inert to most acids, except hydrofluoric and phosphoric.

Typical glass problems on buildings would be:

- Alkalis leaching from concrete, mortar, plaster and gravel onto glass can cause staining and etching
- Hard water, high in calcium concentrates, which are allowed to continually run on the glass
- Deterioration of labels and protective films when left on the glass for prolonged periods
- Pitting of the glass, mainly due to weld splatter (in the form of black specs on the glass), improper sandblasting on site or wind blown debris





- Abrasions to the glass surface by using harsh, powder based cleaning products
- Scratches or spalling caused by the improper removal of plaster, paint, varnish or mortar splash
- A white staining effect which occurs when condensation repeatedly forms and dries on the glass, which in turn can cause surface decomposition
- Iridescence or the oil-stain image is a direct result of the wet-dry action of condensation or water on, or between the glass(es)

The only practical remedy for glass that is badly damaged by scratches, weld splatter, sandblasting, etching and even damaged edges is full replacement.

Cleaning

For cleaning purposes use a soft, clean grit-free cloth and water with a mild detergent. Thoroughly wash off any detergent residue with clean water. Do not under any circumstances use any form of abrasive cleaner as this may cause damage to the glass. Do not allow any metal or hard parts of squeegees or other cleaning equipment to contact the glass surface. Metal scrapers should not be used. Special care should be taken when cleaning coated reflective surfaces. For stubborn stains contact the G.James Technical Advisory Service on 1800 452 637.

1.7 Care and Storage

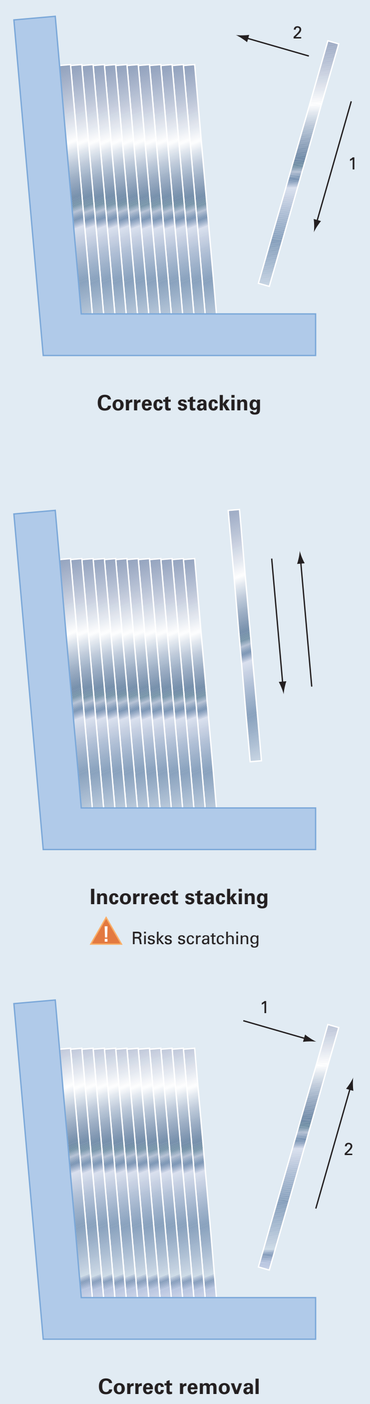
Glass quality can be maintained and risk of damage minimised by following some simple guidelines in storing and handling. Storage areas should be clean and dry with a good circulation of cool dry air, particularly after periods of high humidity to avoid wet-dry staining. Interleaving material should be used at all times, if possible with 'lucite' or 'colacryl', which contains adipic acid which acts as a stain inhibitor.

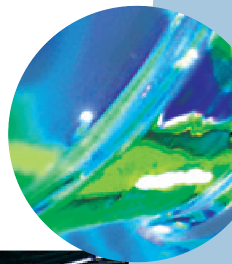
Store glass on even surfaces in areas not subject to heavy traffic or overhead debris. Where glass has been received in a wet condition, it should be unpacked, dried and re-stacked with separators that allow airflow between the panels.

Glass should always be stacked at an incline of 4 degrees from the vertical. Thick glass, tinted glass, insulated glass (IG) units and reflective glass should be stored out of direct sunlight to avoid any risk of thermal breakage. IG units must not be rotated or 'cartwheeled' over their corners.

Always use clean dry suction cups and do not use glass with severely vented or damaged edges.

Figure 1.7a: Handling and Storage





1.8 Glass Processing

G.James offers a wide variety of processing options with a comprehensive range of glass processing equipment, including five state-of-the-art Computer Numeric Control (CNC) machines. This equipment is capable of automatically probing and accurately processing edges, holes, cut-outs and shapes – the complexity of which would be impossible by hand. Discuss your special needs with our Technical Advisory Service on 1800 452 637.

Edgework

Clean Cut (C.C.)

- Edges are as cut with no further processing (15, 19 and 25mm may require processing)
- Edges are sharp

Rough Arris (R.A.)

- This edge is produced by a rough stone, wet belt or split-arris diamond wheel which leaves a white arrised edge. This is the typical edgework for toughened glass

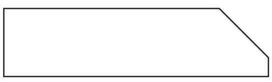
Smooth Arris (S.A.)

- This edge is produced by a wet stone or belt machine producing a smooth arris leaving the edge as cut. The result is a higher quality edge compared to a rough arris

Flat Grind (F.G.)/Flat Smooth (F.S.)

- This edge is produced on a straight line rectilinear machine with the polishing wheels retracted. It leaves a diamond smooth unpolished finish to the edge and arrises, and is the normal finish for silicone butt glazing

Mitre



- Rectilinear machines produce ground edges suitable for use in angled butt glazing
- Polished mitre edges are also available
- Mitres ranging from 22.5˚ to 89.5˚ are possible

Ordering mitred glass

- The nominated mitre is the angle of the glass edge remaining. To achieve a typical 135˚ angled butt-joint, a nominated mitre of 67.5˚ is therefore required
- Always give long point measurements
- Supply a drawing for out-of-square panels

One of G.James' Intermac CNC processing machines

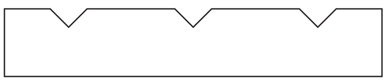
Flat Polish (F.P.)

- This is the standard edge produced by a straight line rectilinear machine and produces a fine polish to the edge and arrises. This edge is suitable for all furniture glass or wherever glass edges are exposed

Round and Polish (R&P)

- Using special purpose machinery, this edge is ground to a bullnose shape and then polished

Brilliant Cut



- This process cuts and polishes linear V shapes into the surface of the glass. It provides a classic elegant finish for decorative purposes

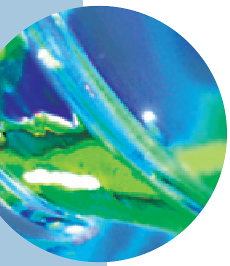
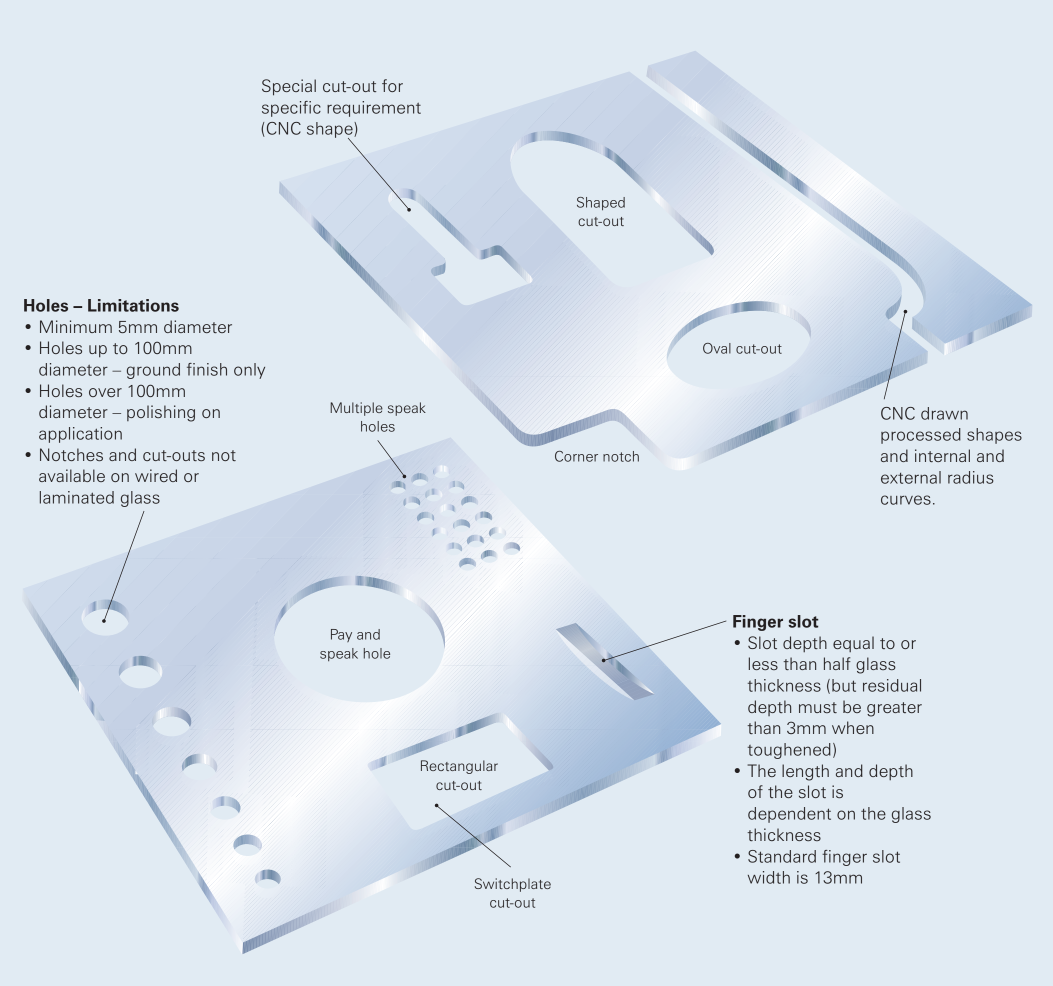
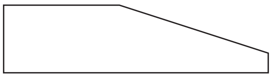


Figure 1.8a: Special Processing



Bevelling



With straight line and shaped bevelling machines, a beautiful and decorative touch can be added to mirrors, table tops and glass panels in doors. The bevel width is dependent upon glass thickness, and the required residual edge.

All bevelled glass has a clean cut edge as a standard finish, flat polishing is an optional extra.

NB: For toughened glass a 4mm minimum residual edge is mandatory. Bevelling limitations may apply.

Polished and Bevelled Cut-off Corners

- Minimum 200mm cut-off corners on 10mm/12mm glass, up to a maximum size of 2000mm x 1200mm
- Minimum 100mm cut-off corners on 10mm/12mm glass, up to a maximum size of 1500mm x 1000mm

Straight Line Bevelling

- Minimum size 100mm x 100mm
- Maximum size of 3200mm x 1500mm, up to maximum weight of 250kg. Consult our Technical Advisory Service for larger sizes

Table 1.8a: Straight Line Bevels

Thickness	Max. Bevel Width
4mm	25mm
5mm	30mm
6mm-19mm	35mm

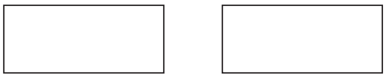
Shaped Bevelling

- Minimum 350mm diameter
- Minimum internal radius 70mm
- Maximum diameter 2100mm

Table 1.8b: Shaped Bevels

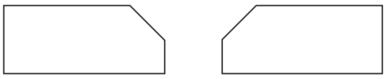
Thickness	Max. Bevel Width
4mm	20mm
5mm	30mm
6mm-19mm	35mm

Holes



- Holes can be drilled in all thicknesses of glass. For hole limitations see Figure 1.8a

Countersunk Hole



- Holes can be countersunk in toughened glass before toughening to accommodate mechanical fixings

Hole Sizes

The available holes are:
5mm, 6mm, 6.5mm, 7mm, 8mm, 9mm,10mm, 11mm, 12mm, 13mm, 14mm, 15mm, 16mm, 17mm, 18mm, 19mm, 20mm, 21mm, 22mm, 23mm, 25mm, 26mm, 28mm, 30mm, 32mm, 35mm, 40mm, 42mm, 45mm, 50mm, 58mm and 80mm. (Other hole sizes are available on request.)
Finger pull/thimble hole size = 21mm.

Cut-outs, Notches and Special Processing

See Figure 1.8a. For your specific requirements contact the G.James Technical Advisory Service on 1800 452 637.

Irregular Shapes

Defined as irregular shapes are:

- Shaped pieces of glass
- Glass cut to templates
- Circles or ovals
- Rakes with more than two corners not at right angles (90˚)
- Glass that requires a diagram because it cannot be expressed as a size on paper
- Squares and rectangles with notches

Not recognised as irregular shapes are:

- Squares and rectangles with radius or cut-off corners (charged as corners)

See Figure 1.8b for examples of irregular shapes.

Templates

In many instances templates provided on plywood or proper architectural drawings are requested. Detailed information required is as follows:

- Glass sizes
- Holes
- Edgework
- Cut-outs
- Stamp position (if applicable)

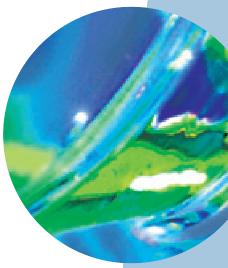
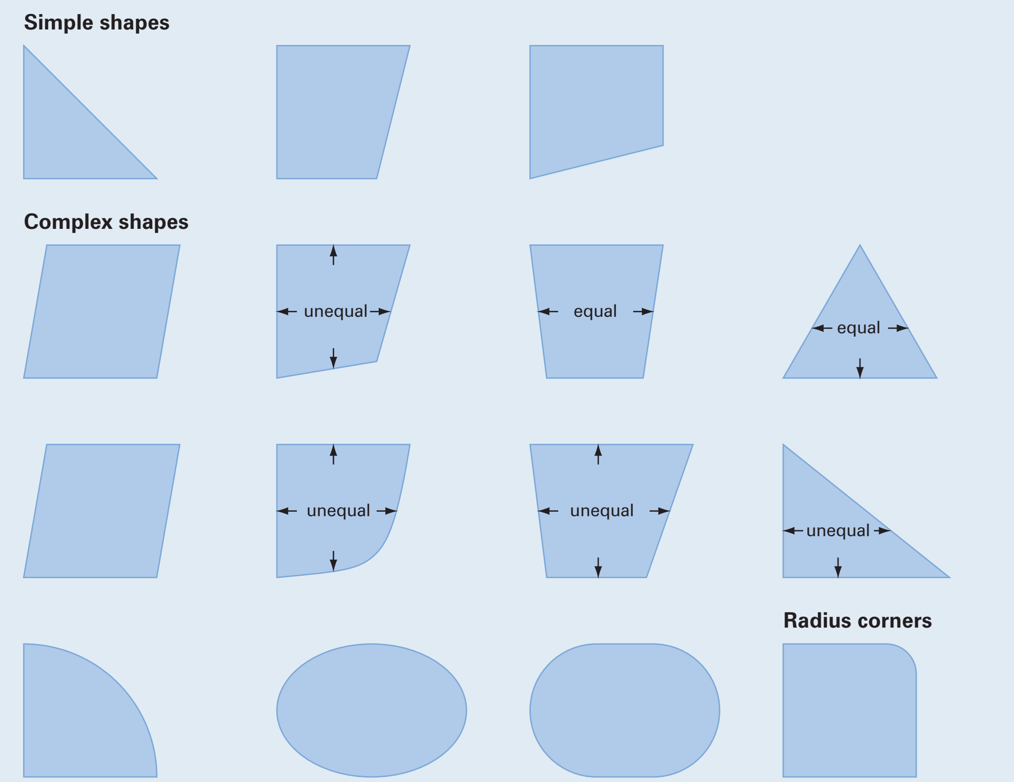
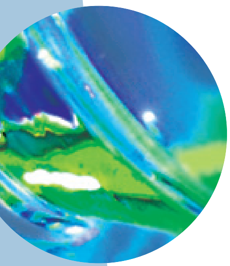


Figure 1.8b: Examples of Irregular Shapes





Ordinary float glass

Laminated safety glass

Toughened safety glass

Wired safety glass

1.9 Breakage Characteristics

Ordinary Float Glass

The familiar jagged edge pattern with lethal slivers of glass which, depending on the force of impact, either fly out or remain precariously intact. Often the removal of shattered pieces is difficult and dangerous.

Laminated Safety Glass

In the event of breakage, a web-like pattern is formed as a result of the bond between the glass and the vinyl interlayer. With a tendency to remain within the frame under impact, the severity of physical injury is significantly reduced. Broken laminated safety window glass will remain intact as a barrier against the weather while visibility is partially retained. Grade A laminated safety glass should be used anywhere there is a risk of human impact.

Toughened Safety Glass

Should toughened glass break, it shatters into small, relatively harmless particles compared with the sharp splinters resulting from the breakage of ordinary glass. Grade A toughened safety glass should be used where the possibility of human impact exists or in any situation requiring strength, safety or resistance to temperature fluctuations.

Wired Safety Glass

When wired glass is broken, the glass tends to remain attached to the wire enabling the panel to remain intact and in place. Safety applications are limited to Grade B safety glass applications.

Heat Strengthened Glass

Heat strengthened glass is about twice as strong as ordinary float glass and is used generally as a protection against thermal breakage. The breakage of heat strengthened glass is such that it fragments into large, non-jagged pieces which tend to remain in place within the frame. Heat strengthened glass is not considered a safety glass and therefore cannot be used where human impact requirements apply.

1.10 Solar Spectrum

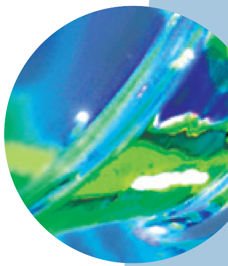
The sun radiates solar energy or sunlight by electromagnetic waves over a range of wavelengths known as the Solar Spectrum (290 – 2500 nanometres, where 1 nanometre = 1/1,000,000,000 of a metre).

The solar spectrum is divided into three bands, these are:

Ultra-violet light (UV)	290nm – 380nm
Visible light	380nm – 780nm
Infra-red	780nm – 2500nm

The energy distribution within the solar spectrum is approximately 2% UV, 47% visible and 51% infra-red. Only the visible light band is seen by the human eye.

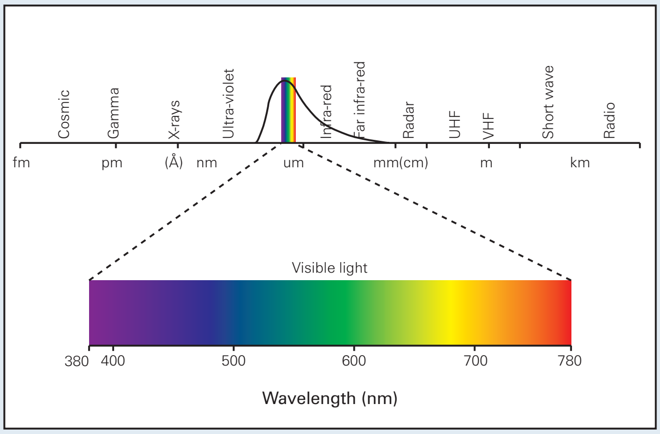
It is important to understand that the shorter the wavelength (i.e. the lower the nanometres), the higher is the energy associated with the radiation. This is highlighted by the fact that it is the shorter wavelength, high energy UV light which causes humans to sunburn, fabrics to fade and plastics to deteriorate. While the longer wavelength, low energy radiation produced by the visible light and infra-red bands are less damaging.



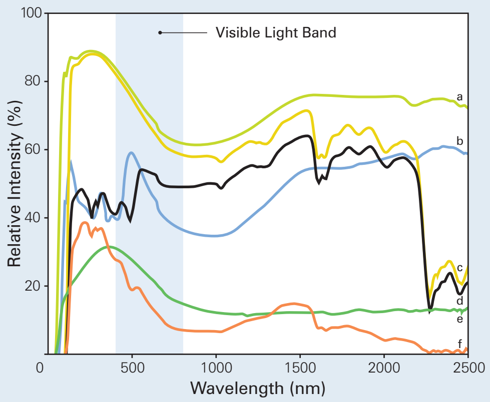
RAT Equation

When the combined UV, visible light and infra-red (solar energy) strikes glass it is reflected (R), absorbed (A) and transmitted (T) in different proportions, depending on the type of glass involved. This gives us the RAT Equation which accounts for 100% of solar energy. For example, 3mm clear float glass Reflects 8% of solar energy, Absorbs 9% and Transmits (directly) 83% (See Figure 1.10b).

Graph 1.10a: Electromagnetic Spectrum



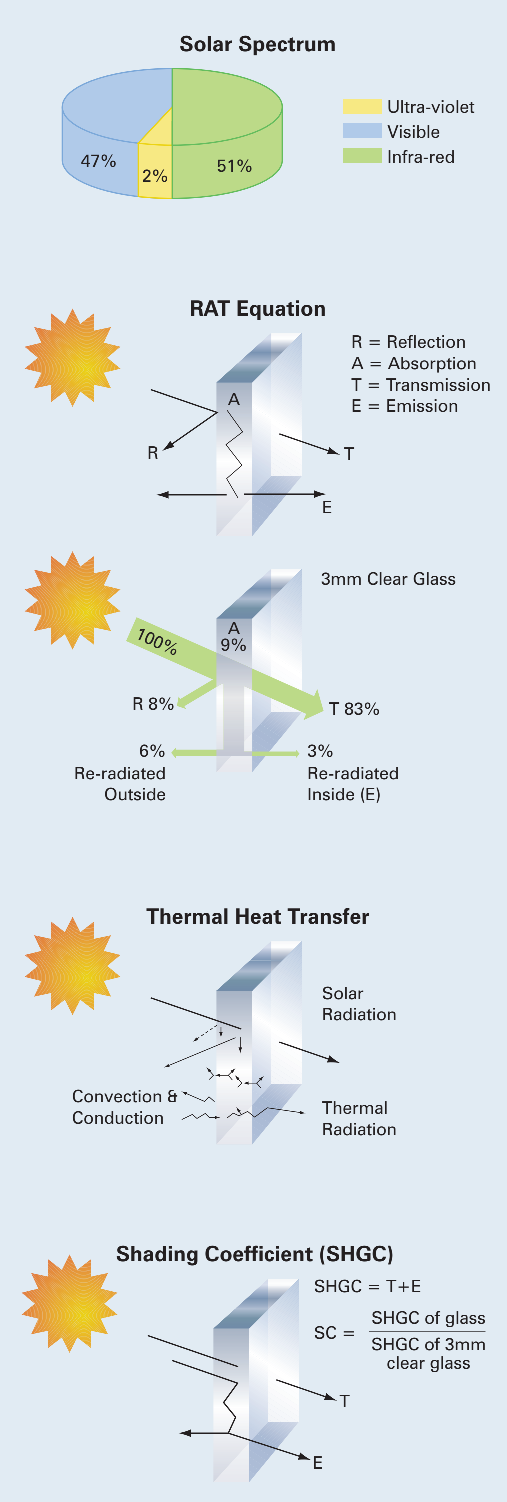
Graph 1.10b: UV Transmission



Spectrum of representative glass products showing UV transmission

- a - 6mm Clear
- b - 6mm Grey
- c - 6.38mm Clear Laminate
- d - 6.38mm Grey Laminate
- e - Solarplus TS30 on 6mm Clear
- f - Optilight HL229 Laminate

Figure 1.10b



G.James
Technical Advisory Service

Phone: 1800 GJAMES (452637)

National Toll Free Number

Thermal Heat Transfer

Heat is transferred either by convection (upward warm air currents), conduction (passing from one object to another) or radiation (where heat passes through space to an object where it is reflected, absorbed or transmitted). The absorbed portion of the energy is subsequently dissipated by re-radiation (or emission) to both the outside and inside, in varying proportions, dependent on the type of glass and external weather conditions.

Solar Control

As visible light and infra-red account for 98% of solar energy, they are extremely important considerations when selecting the glass. Solar control glasses are either body tinted and/or coated or surface modified to absorb or reflect the sun's energy and reduce the solar heat gain transmitted through the glass. (See Graph 1.10b)

Performance Terms

Visible Light Transmittance: Expressed as the percentage of visible light (380 - 780nm's) that is transmitted through a glass type.

Visible Light Reflectance: The percentage of visible light (380 - 780nm's) that is reflected from the glass surface(s).

Solar Energy Transmittance: The percentage of ultra-violet, visible and infra-red energy (290 - 2500nm's) that is directly transmitted through a glass type.

Solar Energy Reflectance: The percentage of solar energy that is reflected from the glass surface(s).

Solar Heat Gain Coefficient (SHGC) or Total Solar Energy Transmittance: The proportion of directly transmitted and absorbed solar energy that enters into the building's interior. The lower the number is, the better the glass is able to exclude solar radiation.

U-value (expressed in W/m^2K): The measure of air-to-air heat transfer (either loss or gain) due to thermal conductance and the difference between indoor and outdoor temperatures. The lower the number is, the better the insulating qualities of the glass.

Shading Coefficient (SC): The ratio of total solar radiation through a particular glass type, relative to the total solar radiation through 3mm clear float glass. The lower the number, the better the glass performs in reducing heat gain. (See Figure 1.10b)

Luminous Efficacy (or Coolness Factor): The ratio of visible light transmittance to the shading coefficient. This ratio is helpful in selecting glass in terms of those which transmit more light than heat. A glass with a luminous efficacy of 1 or greater is considered thermally efficient.

1.11 Thermal Breakage

Cause of Thermal Stress

Thermal stress is caused when the central area of the glass is heated (naturally or artificially) and expands, while the glass edges remain cool resisting expansion. (See Figure 1.11a)

Thermal breakage is a result of an excessive build-up of thermal stress in annealed glass. The amount of thermal stress depends upon the temperature difference between the hottest and coldest areas of the glass and also on the distribution of the temperature gradient across the glass.

Glass which has cracked as a result of thermal stress can be easily identified by the break pattern which is unique to a thermal fracture. The crack in the glass is initially at 90° to the edge and glass face for approximately 2cm-5cm and then branches out into one or more directions. The number of branches or secondary cracks is dependent on the amount of stress in the glass. (See Figure 1.11b)

Factors affecting Thermal Stress

Any factors that encourage an increase in the 'hot centre/cold edge' conditions tend to increase the thermal stress. These include:

Climate: The intensity of solar radiation on the glass which is determined by the geographical location of the building, the orientation of the building and the outside day and night temperatures.

Glass Types: Certain types of body tinted glass and coated glasses, inherently have a higher risk of thermal breakage due to their higher energy absorption. Similarly IG units or double-glazing are at greater risk as the outer glass is usually at a higher temperature due to the reduced heat transfer across the air space. (See Table 1.11a)

Figure 1.11a: Effects of Thermal Stress

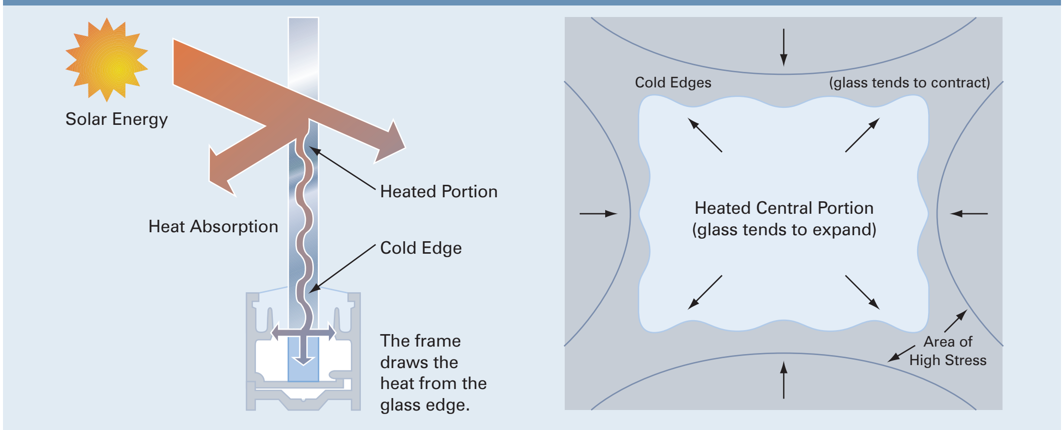
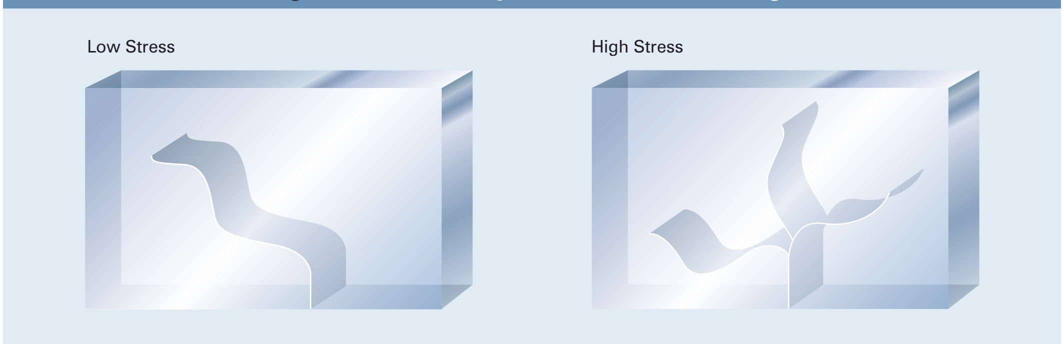


Figure 1.11b: Examples of Thermal Breakage



Edge Condition: The breaking stress of the glass is directly related to the position and size of any flaws in the edges. Good clean cut edges are considered the strongest edge for monolithic glass. With laminated glass good edges can be difficult to achieve, therefore flat ground edges are recommended on all high performance laminated products. (See Figure 1.11c)

Size and Thickness: The risk of thermal breakage increases as the size and thickness of the glass increases.

Glazing System: The thermal properties of the glazing system are an important consideration including:

- Framing materials (aluminium, steel, timber, and PVC)
- Colour of framing materials (light or dark)
- Type of glazing (fully captive, 2-sided captive or 4-sided structural)

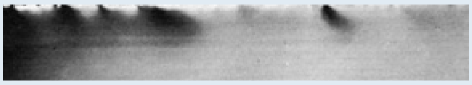
External Shading: Thermal stress will be increased if the glass is partially shaded by balconies, canopies, sun shades or deep mullions, transoms and columns.

Internal Shading: Internal blinds or curtains can reflect heat back into the glass increasing thermal stress. To reduce the risk of thermal breakage it is recommended that the confined space between the internal shading device and the glazing be ventilated. This can be achieved by allowing a minimum 38mm clearance to the top and bottom or side and bottom of the shading device and creating a minimum 50mm clearance between the glazing and shading device.

Internal Cooling/Heating Sources: Direct air streams from air conditioners, heaters, computers etc. onto the glass surface may increase the risk of thermal breakage. (See Figure 1.11e)

Figure 1.11c: Glass Edge Condition

Clean cut edge – acceptable



Good edge with little feather – acceptable

Severely feathered edge – just acceptable

Vented edge – not acceptable

Backup Material: Materials used behind glass in spandrel or suspended ceiling applications reduce the heat loss of the glass, therefore raising the glass temperature, increasing the thermal stress and the risk of thermal breakage. The colour of the backup material is important, as a light coloured surface will reflect heat back towards the glass while a dark coloured surface will absorb heat.

Where thermal breakage is a concern, heat strengthened glass should be specified as it has higher compressive stresses which resist thermal breakage. If in doubt, a thermal safety assessment should be conducted to determine if heat strengthened glass is required (See Appendix One for a Thermal Safety Assessment Request form).

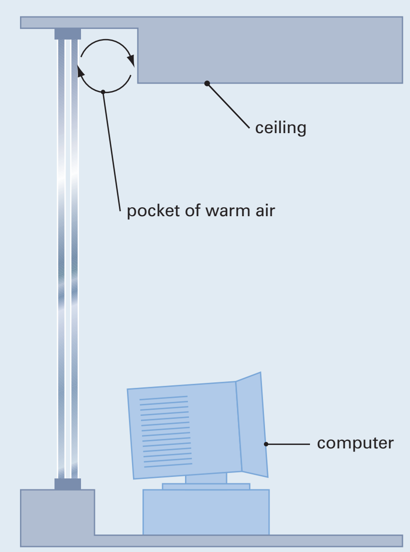
Table 1.11a: Risk of Thermal Breakage

Glass Type	Solar Absorption %	Risk of Thermal Breakage
Clear	18	Low
Tinted	30 - 40	Medium
Supertints	45 - 65	Medium - High
Reflective coating on clear	60 - 70	High
Reflective coating on tinted	80 - 85	Very High

1.0 GETTING TO KNOW GLASS

Figure 1.11d: Factors affecting Thermal Safety

Figure 1.11e: Air Pockets



Avoid pockets of warm air

1.12 Fade Control

It is well recognised that carpets, curtains and furnishings exposed to direct sunlight for continual periods of time will experience the effects of fading and yellowing. While the solution is usually to close off the room with curtains and blinds, this darkens the room and shuts out any view of, or relationship with the outside. However by selecting an appropriate glass type, it is possible to allow natural light to enter a room yet significantly reduce the rate at which fading occurs. Before we consider glass in this respect, the process of fading should firstly be explained.

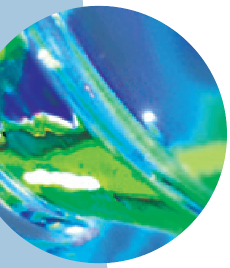


Table 1.12a: Damaged Weighted Transmission

Glass Type	Tdw
3mm Clear Float	0.72
6mm Clear Float	0.65
6.38mm Clear Laminate	0.34
6.38mm Green Laminate	0.26
6mm Solarplus TS30 on Clear	0.15
6.38mm Solarplus SL22 Laminate	0.12
6.38mm Optilight HL229 Laminate	0.12

NB: Solarplus (refer to Section 6.2)/Optilight (refer to Section 3.5)

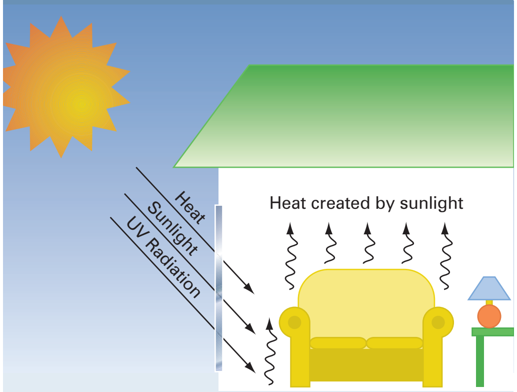
Research has confirmed that one of the major causes of fading is solar radiation (or sunlight), which comprises of three specific energy bands: ultra-violet radiation (UV), visible light and infra-red radiation. Pollutants, moisture and oxygen are, to a lesser extent, other contributing factors.

As solar radiation enters the room, it is absorbed by the exposed fabric causing the temperature to rise. This continual heating of the fabric by the visible light and infra-red radiation, and the more damaging effects of the UV rays, combine to deteriorate and break-down the dye and fabric structure of the furnishings, eventually leading to the discolouration that is associated with fading.

From a glass perspective, the objective is therefore to select a product that has high absorption or reflection of UV, visible light and infra-red radiation. In the instance of reducing the damaging effects of UV radiation, it is important to know the clear polyvinyl butyral interlayer in laminated glass effectively absorbs up to 99% of the UV. By incorporating a reflective or tinted solar control glass into a laminated product will reduce both the amount of visible light and total solar energy that passes through the glass.

In order to compare the relative fading reduction offered by different glass types and configurations, a measurement called the Damage Weighted Transmittance (Tdw) is employed. This measure is 'weighted' to include the fact that fading damage decreases as the energy wavelength increases. In addition, clear 3mm float is designated as the benchmark against which the fading reduction qualities of all other glass types are measured. For this purpose 3mm float has a Tdw of 0.72, while complete exposure is stated as 1.0Tdw. Consequently the lower the Tdw of a glass, the better the fade reduction.

Figure 1.12a: Fading your Furnishings



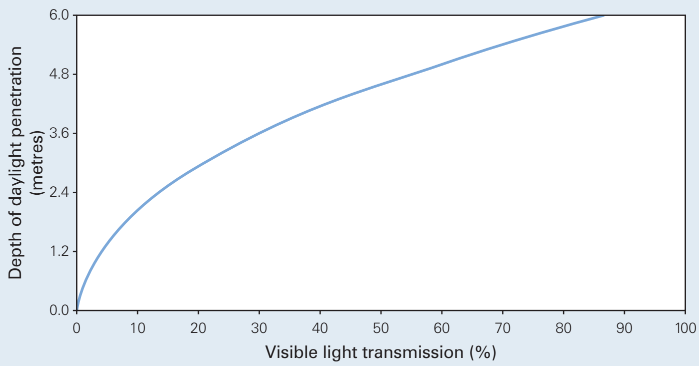
How sun fades your furnishings

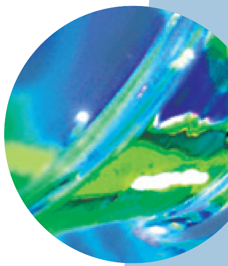
Fading is caused by a combination of UV radiation, sunlight and heat.

UV radiation is the greatest contributing factor to fading and its effect is increased by heat.

The right glass can eliminate up to 99% of UV radiation and significantly cut sunlight and heat.

Graph 1.13a: Glass Transmission





1.13 Daylighting and Colour Perception

Daylighting

As building occupants we have traditionally required daylight to work, enhance the appearance of interiors and save energy by reducing the need for artificial lighting. The more daylight, the higher the amount of solar energy and heat that enters the interior hence cooling costs become a major concern. The question here then is to ascertain what transmittance is required to achieve a specific penetration of daylight, or given a transmittance %, what depth of daylight can be expected.

As an indicator, the relationship between the depth of daylight and the visible light transmittance (VLT) of glass has been mapped (See Graph 1.13a). For a reference point, it has been determined that 6mm clear float with a VLT of 87%, can supply adequate daylight to a depth of approximately six metres. Because of the clarity of clear float, six metres has therefore been nominated as the maximum depth possible and hence the curve peaks at 87% transmission.

If we consider 6mm grey tinted float with a VLT of 43%, approximately one-half that of 6mm clear, the curve reveals a daylight depth of 4.50 metres. As the curve is non-linear, it should be noted that a one-half reduction in VLT does not translate to a one-half reduction in daylight depth. In essence there is no correlation between the percentage decrease in VLT (when compared to 6mm clear float) and the daylight depth.

NB: Refer to Section 15 for the visible transmittance properties for various glass types.

Colour Perception

Transmitted colour is produced from either tints in the body of glass, tinted interlayer (laminated glass) and/or applied coatings. Studies have shown that the psychological considerations of the brain and eye influence the way we perceive colour. Where the view out is exclusively through a tinted glass (with no reference to normal daylight), the human eye adapts to, and compensates for the colour of the light received through the glass. For example, snow will still look white through grey glass. However if an adjacent window is glazed with clear glass or open, the snow will appear purple/blue (when viewed through the grey glass) as the eye attempts to balance the white of daylight and the colour of the tint. In summary, the view outside will appear normal through tinted or coated glass unless there is a reference to natural, white light.

1.14 Sound Insulation

Sound is created when a source or object produces vibrations. The vibrations result in small changes in the surrounding air pressure producing spherical, three dimensional sound waves. If they were visible, these vibrations would resemble a series of concentric circles that spread out in all directions from the point source, similar to when a stone is dropped

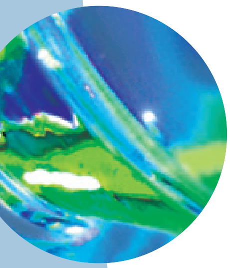
Table1.14a: Perceived Loudness

Change in sound pressure level (dB)	±3	±5	±10
Apparent loudness change	Just perceptible	Clearly noticeable	Twice (or half) as loud

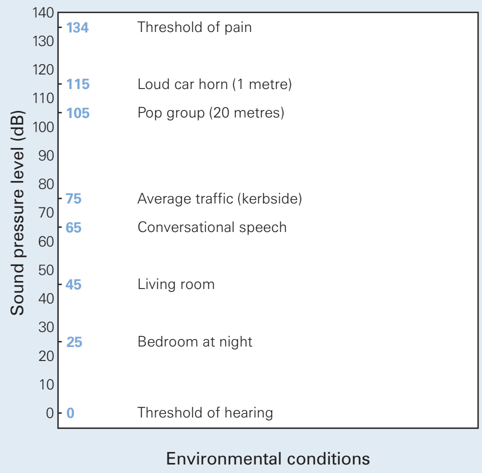
Table1.14b: Recommended Design Sound Levels

Environment	Satisfactory	Maximum
Classrooms	35 dB(A)	40 dB(A)
Conference rooms	30 dB(A)	35 dB(A)
Hotel/motel sleeping areas	30 dB(A)	35 dB(A)
Residential		
Recreation areas	30 dB(A)	40 dB(A)
Sleeping areas	30 dB(A)	35 dB(A)
Work areas	35 dB(A)	40 dB(A)

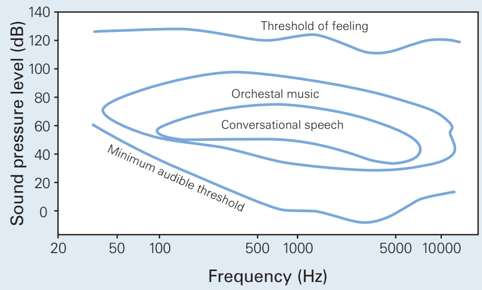
NB: (A) refers to a weighted measure which has been included to correlate subjective results with measured results.



Graph 1.14a: Acoustic Spectrum



Graph 1.14b: Acoustic Spectrum



into water. The vibrations travel at a constant speed of 344 metres per second at 20˚C (i.e. the speed of sound) but faster if the temperature is higher. The more the air pressure is disturbed, the louder the sound.

As the distance from the source increases, there is a gradual decrease in the energy associated with the sound waves and the sound decays or attenuates.

All sound waves have a frequency which is measured in Hertz (Hz). A sound wave with a frequency of 800 Hz implies there are 800 vibrations per second generating from the source. The human ear is able to detect frequencies ranging from 20 Hz to 20,000 Hz however it is most sensitive to sound within a range of 500 Hz to 8,000 Hz.

Sound Intensity

Sound intensity is the amount of acoustical energy associated with a sound wave and is directly proportional to the Sound Pressure Level (SPL). For instance, the SPL of a jet plane's engines at 10 metres would be significantly reduced at a distance of 1 kilometre. The resulting sound pressure intensity may be similar to a domestic vacuum cleaner at 3 metres. This example clearly illustrates how the sound pressure intensity relates to the sound power of the source and the distance from the source.

The SPL is measured in Decibels (dB), and employs a non-linear, logarithmic scale to evaluate sound intensity. This logarithmic or compressed scale is such that it cannot be used to compare the loudness of particular sounds in a simple linear fashion. For example an 80 dB sound is not twice as loud as a 40 dB sound. To the contrary, any change in the sound intensity multiplies (or divides) tenfold for every 10 dB increment change. In this instance the noise has 10,000 times more sound power.

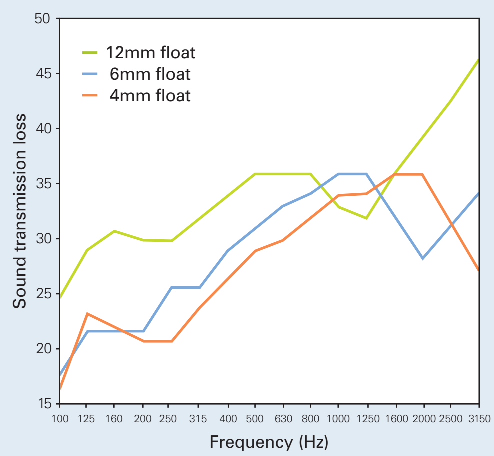
Perceived loudness on the other hand relates to the human ears ability to detect changes in the sound pressure level and doubles every 10 dB change in measured SPL (See Table 1.14a).

Graphs 1.14a & b provide an indication of the various SPL's experienced in our daily lives and the frequency range over which certain sounds occur. Note that as a normal human ear can only detect sound at 0 dB, this is used as a reference point for such acoustic scales - it does not mean there is no sound.

Sound Insulation Measures

As all glass allows the transmission of sound, in varying degrees, it is important to be aware of

Graph 1.14c: Coincidence Dip



Frequency spectra for 4mm, 6mm and 12mm Float Glass showing how the coincidence dip occurs at different frequencies for each glass thickness.

the various rating systems that may be referred to when considering the acoustic performance of glass in the construction industry.

Sound Transmission Loss (STL)

The STL measures (in decibels) the insulation effectiveness of a particular glass as a barrier in reducing exterior noise, i.e. the amount of sound diffused or lost as the noise travels through the glass. The parameters used in determining this figure only considers the frequency range between 125 Hz - 4000 Hz, with the higher the STL (dB), the better the acoustic performance of the glass.

Sound Transmission Class (STC)

STC utilises a single-number rating system to categorise the acoustic reducing qualities of glass when used for interior applications such as partitions, ceilings and walls. While not intended for use in selecting glass for exterior wall applications, STC ratings are often specified for such purposes. G.James can provide a comprehensive range of openable windows and doors, and fixed glass systems that have been STC rated and tested at the National Acoustic Laboratories.

Traffic Noise Reduction (Rtra)

This measure incorporates a weighted factor for typical town and city road traffic noise over a range of frequencies. Combining this factor with the basic sound insulation of the window, provides a more meaningful guide to the actual acoustic performance of a glazed area.

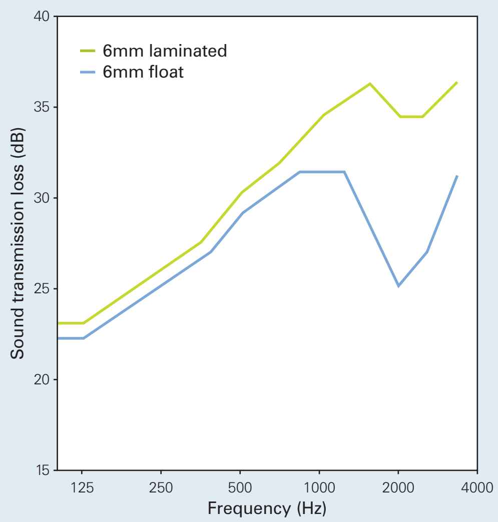
Coincidence Dip

This term refers to the dip or loss in insulating properties of glass which occurs when the glass is vibrating at the same frequency as the sound being transmitted. The frequency at which this occurs is largely dependent on the thickness of the glass (See Graph 1.14c).

Glass Performance

Unwanted sound is considered noise when it intrudes on our daily lives. To minimise this intrusion all aspects of the building construction need to be evaluated, however in this instance we will only analyse the acoustic qualities of glass. The first step in this analysis is to determine the source of the unwanted noise. This is a critical step, as the noise source can vary from low frequency traffic noise to high frequency aircraft noise.

Graph 1.14d: Laminated Glass Insulation



The effect of lamination on the sound insulation of glass. Note the coincidence dip for solid glass is virtually non-existent for laminated glass.

To proceed in this regard, the sound insulation qualities of the various glass configurations are as follows:

Monolithic Glass

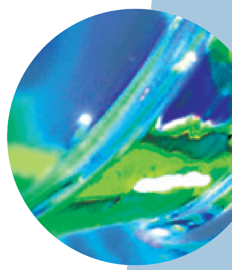
Glass generally follows the Mass Law, i.e. the thicker the glass, the better the sound insulation properties. Graph 1.14c illustrates this principle by portraying 12mm monolithic float as superior to 4mm or 6mm float over the lower frequency range, which is generally associated with unwanted traffic noise.

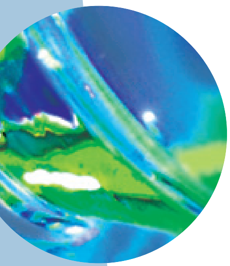
Laminated Glass

The polyvinyl butyral interlayer (0.38mm to 1.52mm) used in laminated glass provides a dampening effect which reduces the loss of insulation at the coincidence frequency. Graph 1.14d shows the coincidence dip for laminated glass is significantly reduced when compared to float glass of equal thickness. Laminated glass also has superior sound insulation qualities in the higher frequency range where the noise from sources such as aircraft are a problem. Increasing the interlayer thickness will only have a marginal effect on improving the sound insulation performance of laminated glass.

Double Glazing

A common misconception is that a standard hermetically sealed double glazed unit with an airspace (up to 12mm) will provide effective sound insulation, this is not the case. For double glazing to be effective an airspace





between 100mm to 200mm would be required. An additional benefit can be obtained by incorporating glasses of different thickness (at least 30% difference) or using laminated glass in one or both of the panels.

Where double glazing is not feasible, the most cost-effective method of reducing sound is achieved by installing a thick monolithic or laminated glass.

Areas around windows

It is important to note that no matter how good the noise insulation qualities of the window are, there should be no gaps or cracks around the window frame. A gap of no more than 1% of the total window area will result in a 10 dB loss in sound insulation.

1.15 Spandrel Design

As curtain wall design became more popular, the question of what glass to use in the spandrel area became more of an issue for architects and designers.

In the spandrel cavity, temperatures can exceed 100˚C along with extreme humidity. It is therefore critical for architects and designers to ensure the building and glazing materials specified in the spandrel design are temperature stable and chemically compatible.

The spandrel glass options are as follows:

Ceramic Painted Glass

Ceramic painted glass offers a well proven, time-tested product available in a comprehensive range of colours. This allows architects either the choice of a relatively similar match to the vision glass or a complete contrast.

The process of manufacturing ceramic painted glass involves paint being fused into the glass surface through the heat treatment process. The resulting product is both mechanically and thermally stable, with a colouring that will not fade or peel.

A minimum gap of 50mm should be maintained between the spandrel glass and other building components. In addition, ceramic painted glass should not be used in applications where the painted surface is viewed or where backlighting may occur.

Organic Opacifier

As reflective glass became more popular, it was increasingly difficult to match the spandrel panels to the vision glass. Today reflective glass is being specified for spandrel as well as vision panels providing the facade with an overall uniform appearance.

To mask the vision into the spandrel area, an organic (polyester) opacifier film is bonded to the coated (second) surface of monolithic panels. It is essential the glass in these applications be heat strengthened to withstand thermal stress. Should breakage, either mechanical or thermal occur, the opacifier will tend to hold the glass in place until the panel can be replaced.

G.James does not recommend the use of opacifier on glass which has a visible light transmission greater than 25%, as it highlights any imperfections in the film application. It should also be noted, that panels used in structural glazing applications are to be ordered with the necessary cutback to the opacifer to ensure good adhesion of the silicone to the glass substrate.

Under certain lighting conditions a banding effect may be noticeable between the vision and spandrel glass. If this is unacceptable, insulated glass units should be specified. As with all spandrel glass, a minimum 50mm gap should be maintained between the opacified glass and any backup material.

Insulated Glass Units

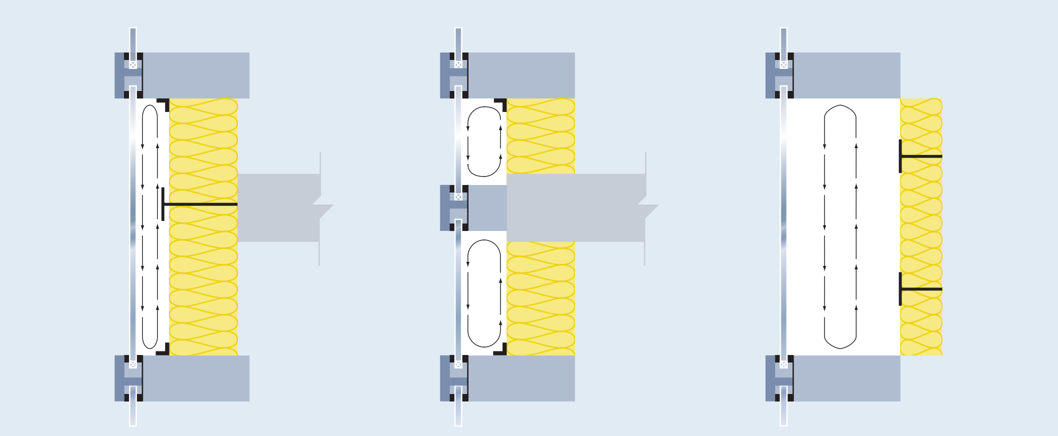
To minimise the banding effect and achieve greater uniformity between the vision and spandrel glass, new glass combinations were required. This saw the development and introduction of IG units into spandrel applications. A unit that incorporates the vision glass as the outer lite and a ceramic painted (dark grey) panel as the inner lite is now considered the ultimate spandrel glass. This spandrel make-up provides an ideal match for vision areas regardless of whether reflective, Low E or tinted glass is installed. Many monumental projects use IG units in the spandrel applications.

Shadow Boxes

Some designers prefer to address the 'read through' of reflective, unopacified glass by

1.0 GETTING TO KNOW GLASS

Figure 1.15a: Spandrel Design Types



using a simple shadow box design. A situation arises when the temperature and humidity conditions in this cavity become extreme causing out-gassing from the backup materials, depositing a visible film on the glass. Consequently G.James does not recommend the use of shadow boxes with unopacified Solarplus products or transparent glasses.

Glass – The versatile building material (Rialto Hotel, Melbourne)

2.0 Float glass

Crown Towers, Surfers Paradise

2.1 Clear Float

Production of float glass involves the pouring of molten glass from a furnace onto a large, shallow bath of molten tin. The glass floats on the molten tin, spreading out and forming level parallel surfaces, with the thickness controlled by the speed at which the solidifying glass is drawn off the tin bath.

The glass then travels through an annealing lehr where the cooling process continues under controlled conditions and emerges in one long continuous ribbon, where it is then cut to suit customer requirements.

Clear float glass is colourless and transparent thereby providing a high degree of visible light transmittance.

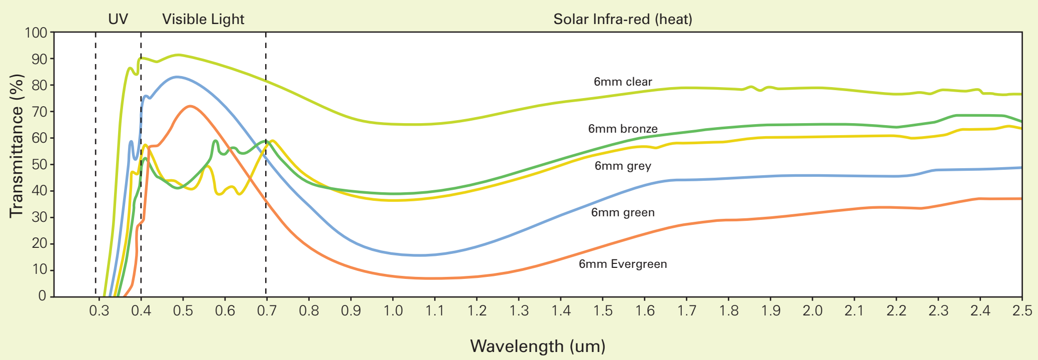
2.2 Tinted Float

Body tinted or heat absorbing glasses are produced on the float process with the addition of small quantities of metal oxides to the normal clear glass mix.

The standard range of colours are Green, Grey, Blue and Bronze. Addition of colour does not affect the basic properties of the glass although visible light reflectance will be slightly lower than clear glass. The colour density will increase with thickness while the visible light transmittance will decrease correspondingly as the thickness increases.

Tinted glasses reduce solar transmittance by absorbing a large proportion of the solar energy, the majority of which is subsequently dissipated to the outside by re-radiation and convection. It is for this reason that extra care needs to be given to edge condition and the fact that heat strengthening may be required, particularly with the thicker glasses, to avoid the risk of thermal breakage.

Graph 2.2a: Transmitted Energy Wavelength



2.3 Supertints

The supertints are a further extension of the family of tinted glass products. Products such as Evergreen/Solargreen, Azurlite and Arctic Blue provide excellent light transmittance while still maintaining effective solar control properties. These products are often termed 'spectrally selective' as they effectively select the visible light band from the solar spectrum (resulting in a higher light transmission) and filter out the UV and infra-red bands when compared to standard tints. In contrast, Supergrey and Optigray have been designed to reduce light transmittance and solar heat gain to achieve desirable shading coefficients.

As supertints have higher absorption properties than standard tinted glass, a thermal safety assessment is recommended to determine if heat treatment is required.

Evergreen: Is one of the supertints specifically designed to provide high light transmittance along with excellent solar control properties. At the same time it reduces glare and UV transmittance. With a 66% light transmittance, this compares to 43% for standard grey, 51% for standard bronze and 78% for standard green. An additional benefit of Evergreen is that it offers approximately 20% better solar performance than body tinted glass with a shading coefficient of 0.58 compared to 0.69 - 0.71 for the standard tints. Its overall solar performance ratio or luminous efficacy is exceptional with a ratio of 1.13 (the higher the figure the better) which compares to standard grey or bronze with 0.62 and 0.72 respectively. Evergreen is an ideal choice for reducing both air-conditioning and lighting costs.

Azurlite: Has a pleasing azure blue appearance, and combines a high light transmittance with an effective, relatively low shading coefficient. At 71% light transmittance, the total solar energy transmitted is only 50% giving a shading coefficient of 0.58 and a luminous efficacy 1.22.

Optigray: Optigray 23 is designed to offer a much lower light transmittance of only 23%. While at the same time, the total heat transmittance is reduced to 41% and achieving an effective shading coefficient of 0.47 and a luminous efficacy of 0.49. The reduction of the light transmittance has the added advantage of cutting reflection down to 5% while simultaneously allowing only 8% ultra-violet transmittance. It is therefore very beneficial in providing protection against fading.

Supergrey: Provides the lowest visible light transmittance (8%) of any body tinted glass. However, it gives exceptional solar control with the lowest shading coefficient (0.39) of any uncoated glass and, in some instances, better than that of certain reflective glasses. In addition it has very low indoor and outdoor reflectance of only 4% and is extremely effective in reducing glare and the need for internal blinds. Its deep grey toned colour enables it to be used in matching spandrel panels with no read through. Further, Supergrey blocks 99% of ultra-violet radiation reducing the degradation of carpets and fabrics.

2.4 Low Iron

Standard everyday clear glass has an inherent green tinge, which is more apparent when viewing the edge of the glass or in a composite stack of many panels.

The colour is due to the iron content in the sand (silica) whereas the low iron glasses contain approximately one tenth of the iron content of standard clear glass. Products such as Starphire and Diamant are ultraclear glasses that are amazingly white. In monolithic form, these are ideal in decorative and furniture applications while it can be toughened or laminated for use in showcases, shopfronts and toughened glass entries.

Increasingly, architects are looking for a white glass because of its high fidelity colour transmittance and the clarity of the edges make it ideal for atriums or indeed entire facades where solar control is not a factor.

3.0 Laminated safety glass

Clean room, G.James Malaysia

3.1 Introduction

In 1903 French chemist Edward Benedictus accidentally broke a bottle of cellulose acetate in his laboratory. As a result, he discovered that the cellulose, on hardening, held the fragments of glass together. This subsequently led to the use of cellulose as the binding agent in the glass laminating process. A Saint-Gobain patent of the process followed in 1910. Further development by Dupont and Monsanto led to the use of laminated windscreens in cars after the Second World War.

Autoclaving glass, Brisbane

Vinyls have long since replaced the earlier use of celluloid, which tended to turn brown with age and become brittle. Polyvinyl Butyral (PVB) is now the most common interlayer material used around the world for laminating purposes.

3.2 Process

The manufacture of laminated glass commences with the glass being thoroughly washed and dried before passing into an air-conditioned 'clean room'. Here the humidity and temperature are strictly controlled, with operators wearing special lint-free headgear and clothing, to ensure the atmosphere is free of dust, moisture and debris of any description.

A PVB interlayer, initially translucent in appearance, is sandwiched between the glass(es) which then pass through pressurised rollers and heating ovens. This pre-nip, de-airing process removes air trapped between the glass and the interlayer(s) as well as softening the PVB to give initial adhesion or pre-tacking.

The glass is then autoclaved where it is again heated and subjected to extreme pressure (between 8 and 12 BAR) permanently bonding the glass and the interlayer. It is during this final process that the glass becomes completely transparent.

G.James produce laminated glass covering the full spectrum from basic 2 ply clear laminates, through tinted, reflective to multi-ply, bandit and bullet resistant, and very high impact performance products.

Table 3.2a: Manufacturing Capabilities

	Minimum	Maximum
Thickness	5.38mm	50mm
Size	100mm x 100mm	2440mm x 3660mm

Brisbane Convention Centre

3.3 Benefits

G.James laminated glass is a durable, versatile, high performance glazing material that offers a range of benefits:

Safety

When subjected to accidental human impact, the bond between the glass and interlayer combine to absorb the force of the impact, resisting penetration of the laminate. Should the impact be sufficient to break the glass, the resulting fragments typically remain intact, firmly adhered to the PVB interlayer. This important characteristic significantly reduces the likelihood of serious injury qualifying laminated glass as a Grade A safety glass.

Security

Laminated glass offers greater protection for people and property by providing an effective barrier when under attack. Although the glass will break if hit with a hammer, brick or similar object, the interlayer will resist penetration ensuring any attempt to enter the premises will be slow and noisy. Also, if attacked the glass will tend to remain in the opening, keeping wind and rain out of the building until it can be replaced at a convenient time.

Sound Reduction

In many instances laminated glass is often overlooked as an acoustic glass. For most applications, laminated glass provides an effective, low cost method of reducing the transmission of noise through the glass. This is achieved through the ‘viscoelastic’ properties of the PVB interlayer which dampens the coincidence dip (See Section 1.14) in the mid to high frequency range (1000 - 2000 Hz). Coincidence impairs the overall acoustic performance of glazing systems, as general environmental noise sources such as traffic and aircraft have significant amounts of sound energy in this frequency range.

Heat and Glare Control

While it is desirable to allow more natural light into our homes and buildings, more light often means more heat entering the interior. Laminated glass with a tinted interlayer, can reduce heat gain by absorbing this radiated heat while simultaneously cutting down the amount of glare that occurs with high levels of natural light. The underlying benefit is lower costs associated with cooling the interior.

For optimum heat and glare control, G.James’ range of Optilight products (See Section 3.5) or laminated glass incorporating a Solarplus reflective coating (See Section 6.2) are recommended.

Laminated glass application

UV Elimination

G.James laminated glass products protect expensive curtains, furnishings and carpets from the damaging effects of short-wave ultra-violet radiation. The PVB interlayer filters the sun eliminating up to 99% of UV rays while allowing the important visible light to pass through.

Low Visible Distortion

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.

NB: These benefits are dependent on the nature of the final processed product.

With glass laminating facilities in Australia and Malaysia, G.James has the capability to manufacture the complete range of architectural glass products to satisfy specific design requirements for colour, thermal and mechanical performance.

3.4 Applications

The many features and possible configurations of laminated glass combine to provide a product that has a wide and varied range of applications:

- Overhead glazing, skylights and rooflights
- Glazed areas surrounding gymnasiums and swimming pools
- Glass balustrading and lift wells
- Showerscreens, mirrors, sliding doors and sidelights
- Shopping centres, offices and banks
- Hospitals, schools and libraries
- Aquariums and zoos
- Jails, embassies and security vehicles
- Blast resistant glazing

3.5 Optilight

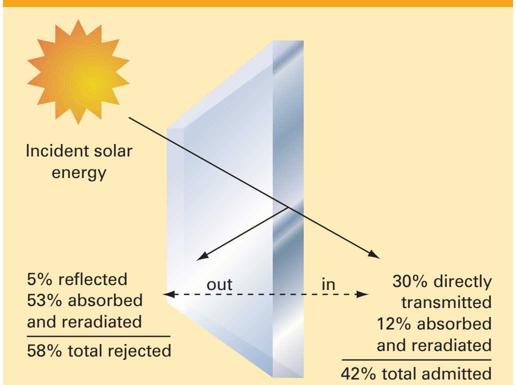
Optilight is G.James' range of spectrally selective, high performance laminated glass products that offer optimum light transmission, reduced solar heat gain/loss and minimum reflectance while maintaining the natural toning of the glass.

By combining readily available raw glass and interlayer, and the latest hard-coating technology, Optilight provides a cost-effective product with proven durability, reliability and serviceability. The neutral coloured coating incorporated within this glass ensures minimal reflection and is therefore ideal in commercial applications where the original clear or tinted appearance of glass is desired.

Capable of being supplied as either a laminated product or incorporated into an IG unit, Optilight products are suitable for vision and overhead glazing applications.

As with all high performance solar control products, a thermal safety assessment is recommended to assess the need for heat processing to avoid thermal fracture of the glass. (See Appendix One for a Thermal Safety Assessment Form.)

Figure 3.5a: Optilight HL719



Solar performance analysis based on 12.76mm Optilight HL719

3.6 Cyclone Resistant Laminate

By incorporating a thicker combination of interlayers, Cyclone Resistant laminate is designed to resist penetration of flying debris and maintain clear vision (dependent on glass configuration) in the event of breakage. Also designed to satisfy the criteria for protection in openings, as defined in the Australian Standards AS 1170.2, this product resembles an ordinary panel of glass when glazed.

It is essential that cyclone resistant glass is held captive in a suitable framing system to prevent the glass from evacuating the building when subjected to severe storm and cyclone conditions.

G.James cyclone resistant, laminated safety glass can be manufactured to incorporate solar control products.

Tests have shown that cyclone resistant glass meets the requirement of resisting penetration from impact of a 4kg, 50mm x 100mm timber plank on end, travelling at 15mtrs/sec. This is equivalent to an impact energy of 450J.

3.7 Anti-bandit Glass

G.James Anti-bandit glass is a laminated product incorporating a 1.52mm PVB interlayer. It is this increased thickness of interlayer which foils attacks from such items as bricks, hammers and axes.

It is essential that anti-bandit glass is held captive in a suitable framing system to prevent the glass evacuating the building when subjected to an attack.

3.8 Characteristics

Edge Delamination

Delamination to the edge of laminated glass is an inherent characteristic of this product. More noticeable where the glass edges are exposed, delamination is the result of a breakdown in the bond between the polyvinyl butyral interlayer and the glass. The extent of the breakdown will depend on the glazing application and location but generally will not extend any further than 10mm in from the glass edge. It should be noted delamination is not detrimental to the strength or performance of the glass. If delamination is a concern, it is recommended that the glass be glazed fully captive in a frame.

Lloyds of London

4.0 Heat Treated glass

G.James Toughening Furnace, Brisbane

4.1 Introduction

In the Mappae Clavicula (a 9th century book) there is a description of 'unbreakable glass'. It was understood at this early stage that glass could be toughened and made stronger by quenching in hot oil. Similarly 'Prince Rupert's Drops' were produced by dropping molten gobs of glass into water. The result is a teardrop shaped piece of glass, the head of which is strong enough to withstand heavy blows with a hammer. However if the fine tail is snapped off, the complete teardrop explodes with a surprising amount of energy. This phenomenon occurs due to the outer 'skin' of the drop immediately solidifying on contact with the water while the centre cools at a slower rate. Consequently, the centre of the drop is put into tension and pulls inwards on the already hardened outer surface, which is now in compression. Breaking the tail releases the tension, which dissipates through the compressed outer surface. This is a classic demonstration of the principles involved in the toughening process.

In 1879 De La Bastie took this principle further by quenching the glass in a bath of linseed oil and tallow. The resulting product however was closer to what is today termed 'heat strengthened', rather than fully toughened. Both these methods had severe bowing problems which Siemens tried to overcome by quenching the glass between two cast iron blocks. It was not until 1928 that Reunies des Glaces in France invented the vertical electric furnace where large sheets of glass could be processed with minimal bowing. Pilkington (U.K.) followed quickly with their process of quenching by blowing air on both sides of the glass simultaneously.

In essence the process remains the same today and although vertical furnaces are still used, almost all architectural glass is produced on horizontal furnaces.

4.2 Process

Toughened Glass

The cut-to-size glass sheets are fed from the loading conveyer into the furnace where it oscillates back and forth on ceramic rollers until it reaches approximately 620°C.

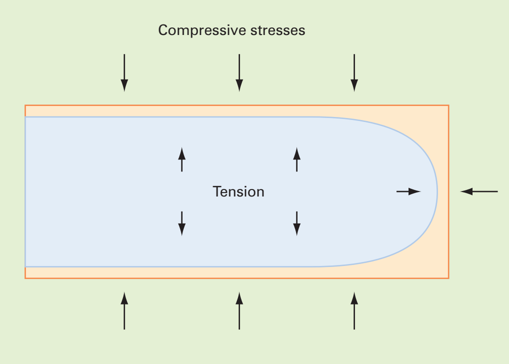
Progressing from the furnace, the glass moves into the quench where it is rapidly cooled by blasting both sides with air.

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 that of annealed glass of equal thickness.

Heat Strengthened

The process is similar to that of toughening, however in this instance the glass is quenched

Figure 4.2a: Stresses in Heat Treated Glass



at a slower rate. The result is lower compressive stress, increasing the strength to only twice that of annealed glass of equal thickness.

The latest development in technology has been the introduction of gas-fired, forced convection heat processing which has resulted in improvements in the speed of manufacture and quality of heat treated glass.

G.James operates the following heat processing facilities:

Brisbane: Two horizontal furnaces, the largest of which is gas-fired.

Sydney: Three horizontal furnaces (one of which manufactures both flat and curved toughened glass) and one vertical tong furnace for specialty glass.

Melbourne: One horizontal furnace.

Malaysia: One horizontal furnace.

4.3 Properties

Toughened Safety Glass

- Up to five times stronger than annealed glass of the same thickness
- Designated Grade A safety glass as per AS/NZS 2208
- In the event of breakage, the panel will fracture into relatively small harmless particles
- Greater resistance to thermal stress when compared to annealed glass (can be subjected to temperatures ranging from 70˚C to 290˚C)

Because of its mechanical strength it is ideal for creating a 'total vision' concept in all glass assemblies, foyers and entrance ways. It is

The small and relatively harmless fragments of toughened glass

recommended for doors, side panels and low lites, glass balustrades, shower and bath screens, pool fences and glass walled squash courts. It is also used in automotive, marine, rail and land transport as well as furniture applications.

Heat Strengthened

- Twice as strong as annealed glass of equal thickness
- Not designated as a safety glass
- Greater resistance to thermal stress when compared to annealed glass
- Typically breaks into large pieces, which tend to remain in the opening

4.4 Available Sizes

G.James Safety Glass can offer an extensive range of toughened and heat strengthened products and manufacture to the following size specifications:

Brisbane:

- 2100mm x 4500mm @ 3mm - 19mm thick
- 1500mm x 5100mm @ 5mm - 25mm thick

Sydney:

- 2100mm x 4000mm @ 4mm - 25mm thick
- 1500mm x 2400mm @ 4mm - 25mm thick
- 2100mm x 3600mm @ 5mm - 19mm thick
- 20mm diameter min. (vertical)

Melbourne:

- 2100mm x 5000mm @ 4mm - 25mm thick

Malaysia:

- 2440mm x 4200mm @ 4mm - 19mm thick

Height to width ratio limitation on all furnaces is 15:1, while the minimum size on all horizontal furnaces is 350mm x 350mm.

NB: Should your glass requirements approach these maximum or minimum sizes, please consult our technical advisory service.

4.5 Manufacturing Guidelines

As heat treated glass cannot be cut, drilled or edgeworked in any way, it is therefore important to ensure the sizes ordered are correct. If a template is required, it should be full size and of a rigid material such as plywood.

If applicable, and in particular with reflective glasses, the direction of roller-wave should be specified (See Section 4.8). It is recommended the roller-wave run horizontal provided the sizes are within the constraint of the furnace width.

Again due to the heat process involved, toughened glass will contain localised warp or bow which will vary with thickness and colour, particularly reflective glasses including Low E, ceramic painted, sandblasted or figured rolled glass.

Holes

Hole sizes

The following hole sizes are available:
5mm, 6mm, 6.5mm, 7mm, 8mm, 9mm, 10mm, 12mm, 13mm, 14mm, 15mm, 16mm, 17mm, 18mm, 19mm, 20mm, 21mm, 22mm, 23mm, 25mm, 26mm, 28mm, 30mm, 32mm, 35mm, 40mm, 42mm, 45mm, 50mm, 58mm and 80mm.

Due to the dimensional precision required for the various applications of heat processed glass, accurate and detailed diagrams are essential.

To avoid confusion, manufacturing delays and costly replacements, diagrams must comply with the following guidelines:

Diagram Guidelines

- Each item should be drawn separately on A4 size paper
- Each item must be clearly dimensioned with clearly indicated measurements from reference points
- Cut-out or notch positions and sizes must be clearly dimensioned with the measurement preferably to the edge of the cut-out or notch
- Hole sizes indicated and hole positions clearly dimensioned from the edge to the hole centre
- Glass thickness and type indicated
- Edgework requirements indicated to all individual edges
- Stamp position and type indicated
- Square corners indicated on rakes or irregular shapes
- Radii clearly indicated

4.6 Applications

Balustrades

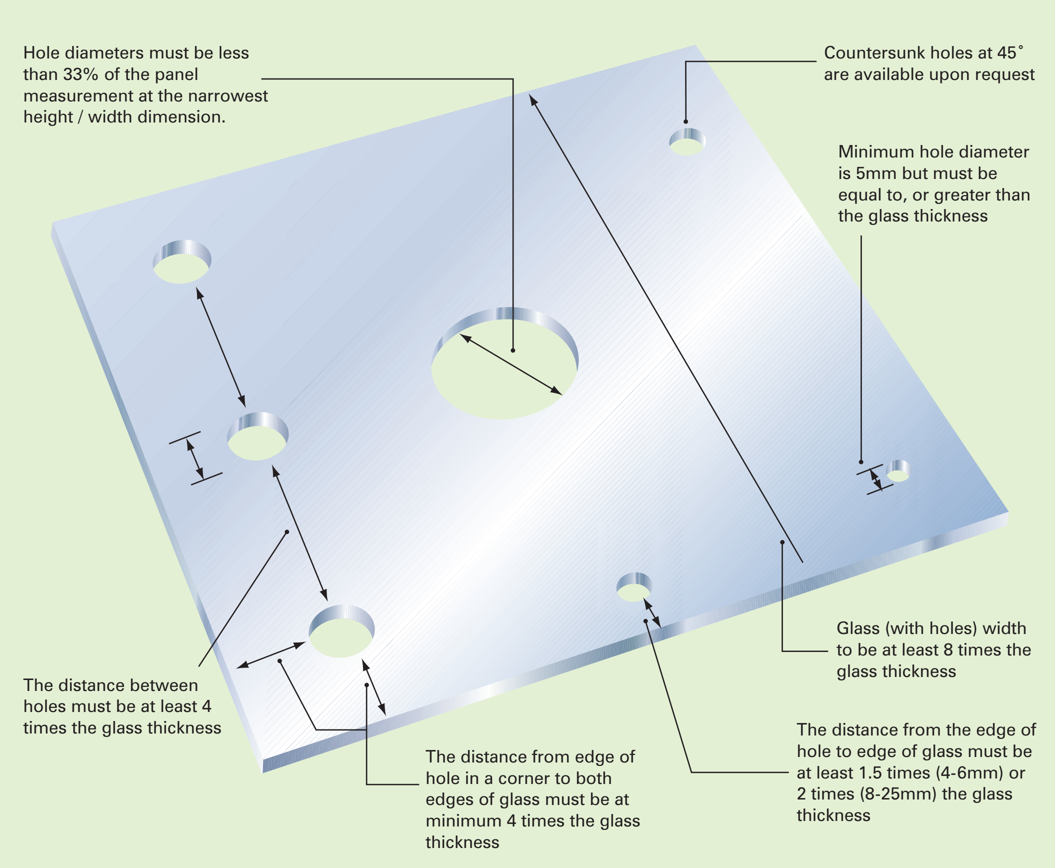
Framed and structural self-supporting balustrades are ideal for use in pool fencing, balcony, staircase and other applications where the ultimate in unobstructed views is desired. Suitable for both commercial and residential situations, these systems provide a low maintenance, stylish and unique balustrade alternative.

G.James offer a selection of powder coated aluminium framed balustrade or structural self-supporting systems glazed with Grade A safety glass (clear, tinted or decorative).

The glass thickness used for such purposes is dependent upon the application with strict compliance to the relevant regulations, codes and standards.

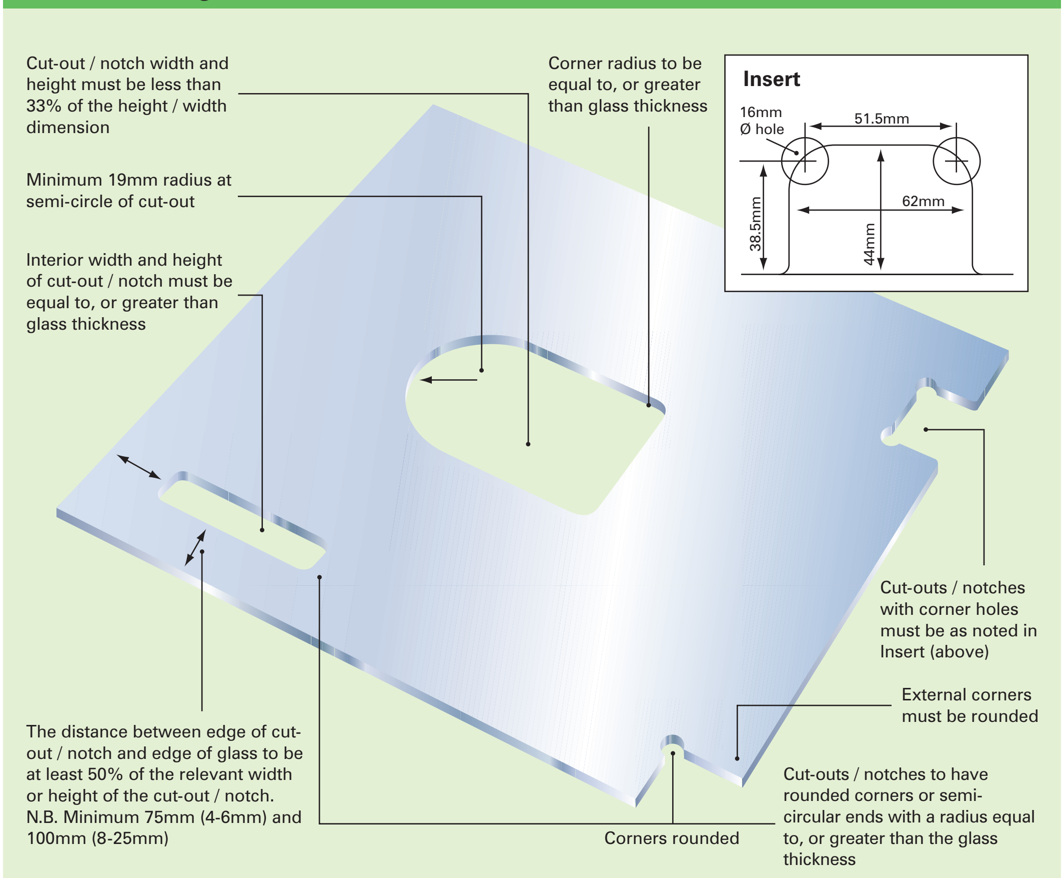
4.0 HEAT TREATED GLASS

Figure 4.5a: Process Limitations – Holes



NB: Holes will have a ground finish with arris unless otherwise specified.

Figure 4.5b: Process Limitations – Cut-outs and Notches



NB: Cut-outs and notches will have a ground finish with arris. Polished cut-outs and notches are available on request.

Frameless toughened glass showerscreen

Consult the following to ensure compliance:

- AS 1170: Wind Load requirements
- AS 1288: Use of Glass in Buildings
- The Building Code of Australia
- Local Authority requirements
- AS 1926: Fences for Swimming Pools
- AS 2820: Gate Units for Private Swimming Pools

NB: G.James does not recommend monolithic toughened glass be used on the exterior sheer face in elevated locations above trafficable areas.

Frameless Showerscreens

Frameless toughened safety glass showerscreens offer a unique and stylish alternative to aluminium framed screens by creating the illusion of space and a distinct feature in bathrooms and ensuites.

With configurations limited only by the imagination, each screen is custom designed and measured to suit the particular site to ensure structural stability and functionality.

A wide selection of handles (or knobs) and hinges are available in powder coated, chrome or gold plated finishes.

Glass Assemblies

Suspended glass assemblies allow designers to create an impressive feature without the interference of framing, providing greater light and a feel of open space with minimal visual barriers. In principle, the system involves toughened glass panels bolted together at the edges/ends with specially designed fittings and hung from the building structure hence the term 'suspended' glass assemblies.

Toughened glass fins are used at each vertical joint to act as stabilisers and provide stiffness against high wind loads. The panel to panel joints are sealed with silicone and the entire assembly is suspended on adjustable hangers and retained at the bottom and sides in a peripheral channel. This channel, designed with deep glazing pockets, can accommodate a certain amount of movement within the floating facade. An exciting new development in frameless glass assemblies is the use of structural trusses eliminating the need for patch fittings.

Types

Toughened glass assemblies can be designed to incorporate the following systems:

- 'Spider' fittings with cable/bow trusses
- Patch plate fittings
- Countersunk, flush faced patch fittings
- Structural trusses (without the need for holes)

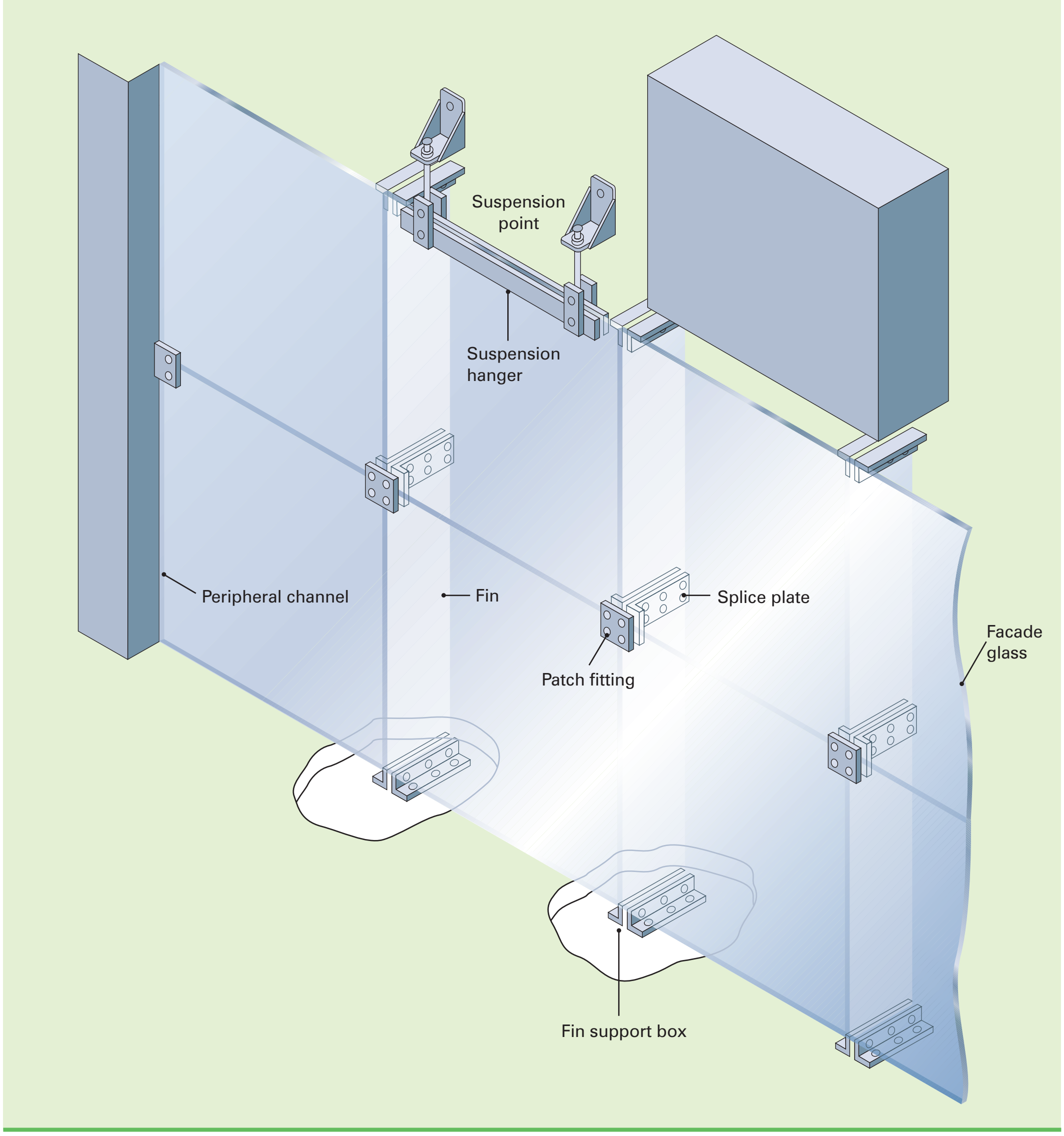
G.James can design assemblies to suit a wide range of applications incorporating either flat or curved toughened glass.

NB: It is recommended that glass used in suspended glass assemblies be heat soak tested.

Toughened glass assembly

Toughened glass assembly incorporating spider fittings

Figure 4.6a: Toughened Glass Assemblies



Frameless toughened glass entry

Frameless Entries

For building entrances and shopfront applications, frameless toughened glass entries provide impressive, unobstructed views with design flexibility and functionality.

Types:

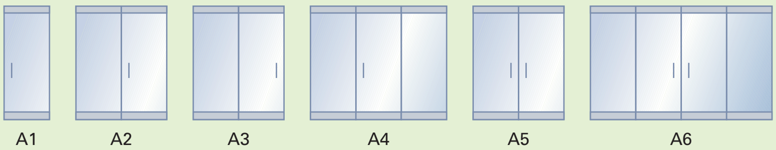
- Heavy-duty floor springs in single or double action with hold open or non-hold open functions
- Automatic pivot systems
- Concealed overhead closers
- Automatic, overhead operators with electric locks, card readers or panic bars

Hardware Options:

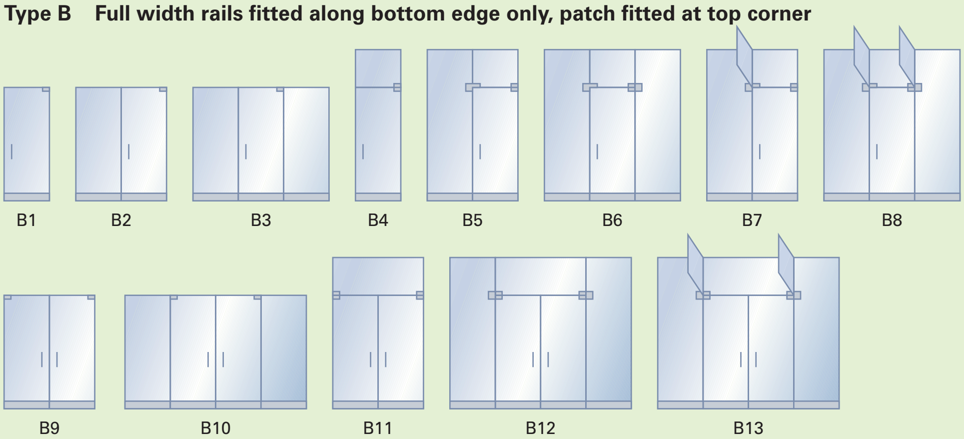
- Locks fitted to the top and/or bottom rails, or at the handle position

Figure 4.6b: Frameless Glass Door Options

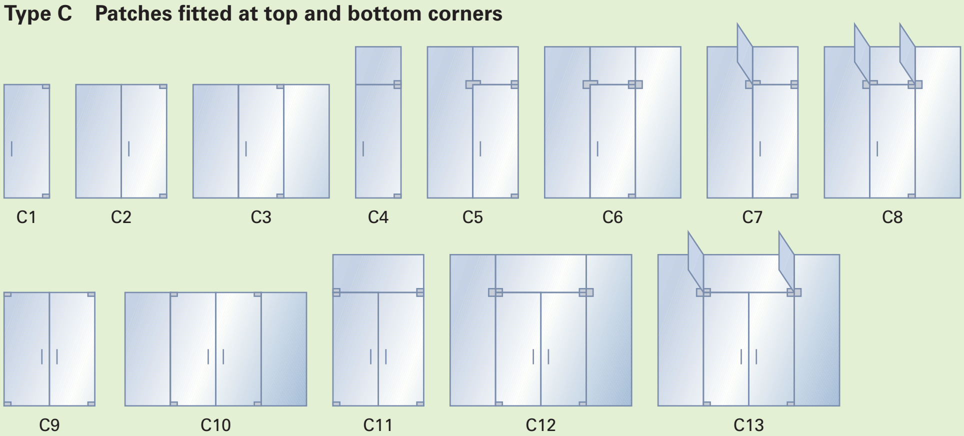
Type A **Full width rails fitted along top and bottom edges**



Type B **Full width rails fitted along bottom edge only, patch fitted at top corner**



Type C **Patches fitted at top and bottom corners**



• Handles in a selection of designs and sizes

All above are available in either brass, polished or satin stainless steel, powder coated or anodised finishes.

Bi-folding and Stacking Doors

Utilising the latest hardware componentry with the features of toughened glass, bi-folding and stacking doors offer a moveable wall system which allows the glass panels to travel in a concertina style folding action. The glass panels can be either framed or frameless and, once completely opened, be totally hidden from public view. This facility allows any commercial operation to have maximum business exposure and full use of all available space making it perfect for cafes, coffee shops etc.

Multi-stacking configurations can be designed to suit residential applications to provide unobstructed views of the city, surrounding countryside or pool area. In addition, bi-folding and stacking systems are capable of incorporating sliding or pivot doors.

NB: Weatherproofing issues need to be considered.

4.7 Colourlite (Ceramic Painted Glass)

The application of fused colour to glass provides architects with the ability to complement or contrast the vision glass used in today's modern buildings. The coloured frit used in this process consists of glassflux (70 - 95%) and ceramic pigment (5 - 30%).

Frameless toughened glass stacking door system

Figure 4.7a: Colourlite Standard Colours

NB: Colours are for illustrative purposes only

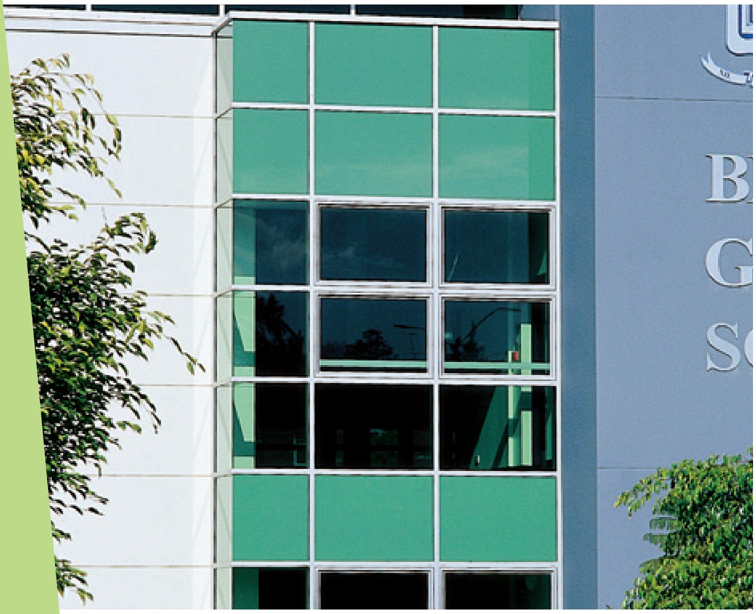
Process

The manufacture of Colourlite involves 'screening' the selected coloured ceramic paint onto one side of the glass. This method of application ensures total and complete coverage of the glass surface. Once the colour has been applied, the glass is then heat treated with the heat generated within the furnace sufficient to melt the frit into the glass substrate.

Minimum size: 350mm x 350mm
Maximum size: 1500mm x 2700mm

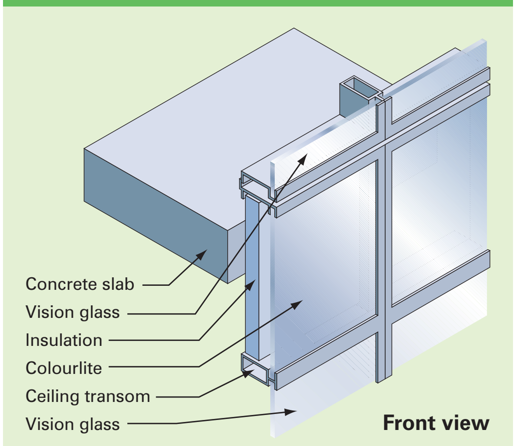
Properties and Applications

The application of Colourlite bonds the colour to the glass, supplying a permanent non-porous surface with excellent scratch resistance (removal of the colour is not possible without damage to the glass substrate). G.James Colourlite is impervious to weathering and fade resistant.



Colourlite spandrel application

Figure 4.7b: Colourlite Spandrel Application



Variation in perceived colour may occur with any ceramic frit. Such variations however will be more apparent with white or light colours because of unavoidable light transmittance. Further due to inherent variations in the ceramic frit thickness, lighter colours are more influenced by the colours of materials installed behind the glass. Therefore, if white Colourlite is specified, the area behind the glass must be of a uniform light colour to avoid any shadowing effect. It is recommended that full-sized prototypes (incorporating all specified spandrel materials, in particular insulation) are viewed on-site and approved by the client to avoid any oversight in this regard.

Viewing should always be from the glass side and never the painted surface, nor should Colourlite be used in applications where backlighting may occur.

Colourlite's excellent colour stability and aesthetic features means this product is perfect for spandrel panels in high rise/apartment buildings. Choose from the eight standards colours (See Figure 4.7a) or select your own customised colour.

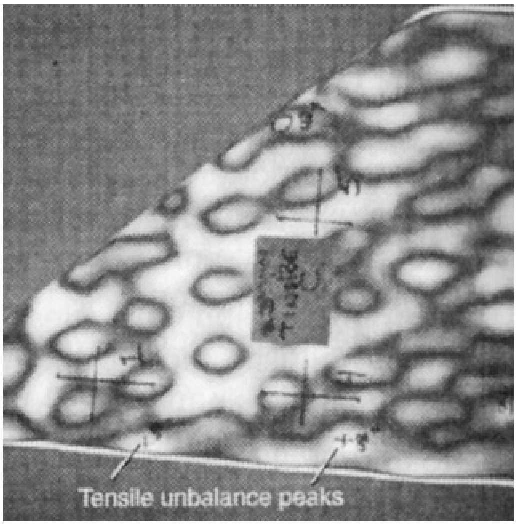
4.8 Characteristics

Roller-wave

An inherent consequence of the heat treatment process is roller-wave which is caused by the heated, slightly softened glass being in continual contact with the oscillating ceramic rollers. This distortion is more noticeable in reflective or dark tinted glasses and if applicable, the direction of roller-wave should be specified. It is recommended the roller-wave run horizontal provided the sizes are within the manufacturing constraints of the furnace.

Quench Pattern

During the quenching phase of the heat treatment 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 these areas of high compressive stresses is the occasional appearance of a strain pattern of iridescent spots or darkish shadows. This effect is referred to as the 'quench pattern' as it occurs in the furnace quench.



An example of a quench pattern viewed under polarised light

Typically, the pattern is only visible at times of polarised light or by viewing the glass from the inside at acute angles. Similarly, the thicker and more reflective the glass, the more obvious the quench pattern will be.

Nickel Sulphide Inclusion

Toughened glass can on rare occasions shatter for what appears to be no apparent reason. This is sometimes referred to as a 'spontaneous breakage'.

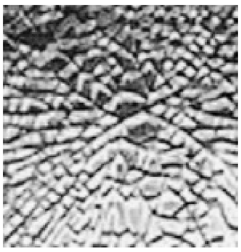
In the early 1960's, the I.C.I. building in Melbourne had extensive breakage in the spandrel panels. Mr Ron Ballantine of the CSIRO investigated the case and discovered the cause was nickel sulphide (NiS) inclusions, a substance that possesses both an Alpha and a Beta phase. Once subjected to heat, as would occur during the toughening process, this phase alters to the more unstable Beta phase. Since the quenching process is very rapid, the structure of NiS does not have time to transform back to the stable Alpha phase. This phase transformation will continue to occur over periods of time ranging from a few minutes to years after glazing.

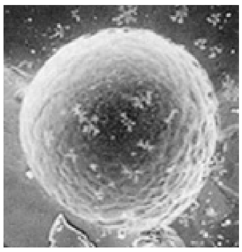
The cause of spontaneous breakage is not limited to NiS but any foreign particle, even silica stones, which may enter the raw glass mix or float glass manufacturing process. However while other such particles can be found using electronic scanners, to date NiS stones go undetected, only being identified after breakage. Identification is possible by following the fracture radii to the centre point of origin. If there appears two larger fragments shaped like 'butterfly wings', this would typically indicate the presence of NiS. Microscopic examination may reveal a minute black speck or NiS stone in the centre of the glass. Stones of concern are always situated in the central or tensile zone and vary in size upwards from 0.04um in diameter.

While glass manufacturers are extremely careful to ensure that no nickel enters the glass tank, it should be noted that it takes only 0.1 gram of nickel in a 500 tonne tank to produce 50,000 NiS stones.

4.9 Heat Soak Testing

G.James Safety Glass can conduct heat soak testing (HST) on toughened glass if required. Heat soaking is a destructive test which heats the glass for several hours at 280˚C to speed up the Alpha to Beta transformation of any nickel sulphide (NiS) should it be present. This accelerated testing process reduces the likelihood of breakage by a factor of 20 with a 95% conversion rate of potentially damaging nickel sulphide inclusions. Obviously identifying NiS inclusion prior to on-site installation has distinctive cost, safety and security benefits and is therefore strongly recommended for toughened glass assemblies or where the consequence of breakage could result in injury.





Left: Typical failure pattern (butterfly wings) observed after spontaneous breakages of toughened glass due to NiS inclusions

Right: Scanning Electron Micrograph of a typical NiS inclusion observed after the spontaneous failure of toughened glass (about 0.2mm diameter). One can note the rough aspect of the surface, as always seen on dangerous NiS stones

5.0 Curved toughened glass

A range of possible curves

5.1 Introduction

In another first G.James combines the strength of toughening with the latest in curved safety glass technology to offer architects, specifiers and interior designers a range of innovative and exciting design options.

The continuous manufacturing process involves heating, then curving the glass to the required shape before finally toughening. By employing movable platens in the quenching process, the need for expensive press moulds has been eliminated. This technology allows each shape to be precisely moulded to customer specifications providing cost effective building solutions.

5.2 Terminology

To assist designers and clients when seeking quotations or placing orders the following terminology should be used:

Height: The straight edge length of the glass.

Depth: The distance between two parallel lines which enclose the curved glass.

Radius: The distance from the centre of the circle to the circumference of the circle.

Degree: The angle of a segment in a circle expressed in degrees.

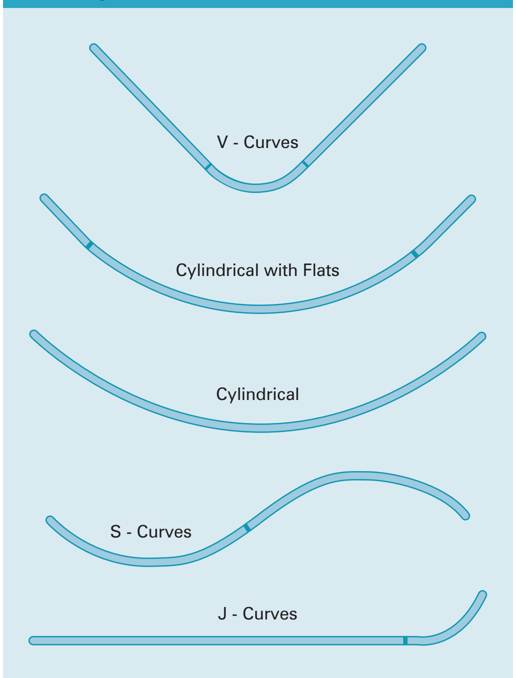
Tangent: A straight line extending from the arc of the curve.

Chord: The straight distance between the edges of the curve.

Girth: The distance around the surface of the curve.

(See Figures 5.2a & 5.2b)

Figure 5.3a: Available Curves



5.0 CURVED TOUGHENED GLASS

Figure 5.2a: Dimensional Specification No.1

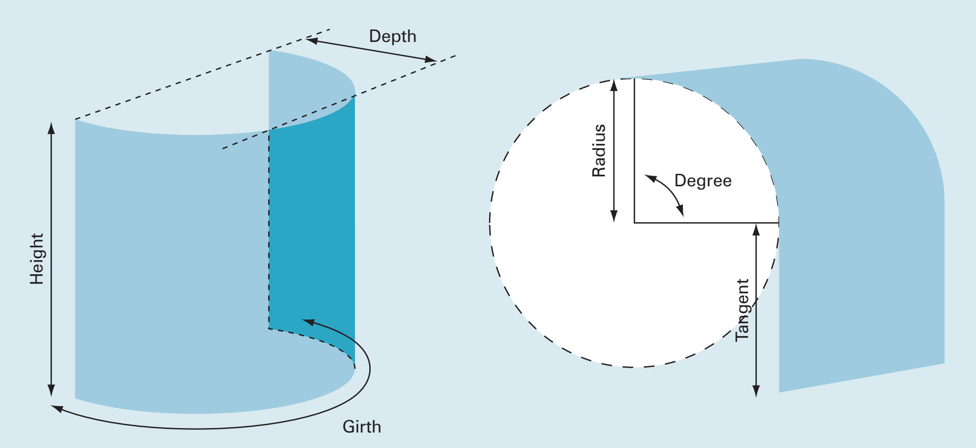


Figure 5.2b: Dimensional Specification No.2

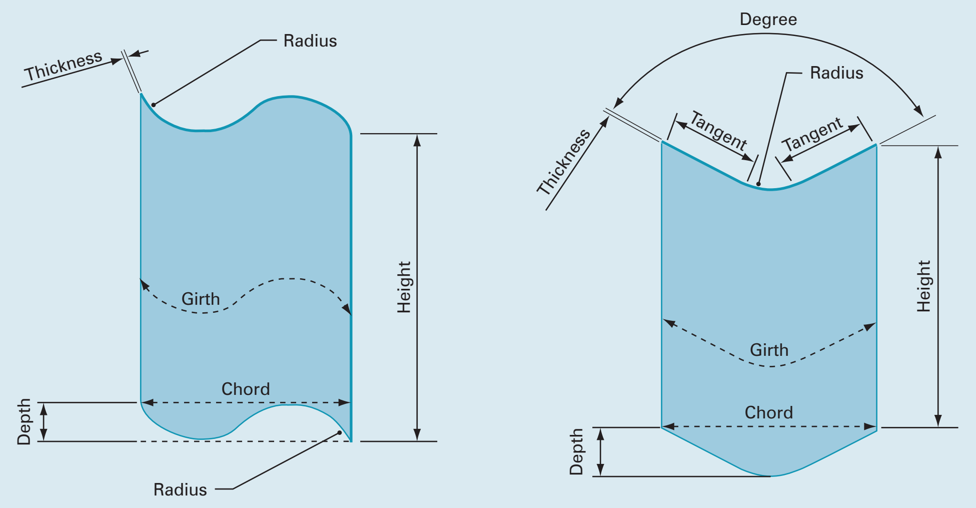


Table 5.4a: Maximum Sizes

Thickness	Glass type	Girth	Height	Minium radius
3mm	Heat Strengthened	2140mm	2500mm	635mm
4mm	Heat Strengthened	2140mm	2500mm	635mm
5mm	Toughened	2140mm	2500mm	635mm
6mm	Toughened	2140mm	3000mm	635mm
8mm	Toughened	2140mm	3000mm	762mm
10mm	Toughened	2140mm	3000mm	762mm
10mm	Toughened	2140mm	3660mm	1525mm
12mm	Toughened	2140mm	3000mm	889mm
12mm	Toughened	2140mm	3660mm	1525mm
15mm	Toughened	1830mm	1830mm	2550mm
19mm	Toughened	1830mm	1830mm	2700mm

G.James' flat and curved glass toughening furnace, Sydney

5.3 Available Curves

(See Figure 5.3a)

It should be noted that the maximum bending angle is 90˚, therefore a full circle (360˚) can only be achieved using four pieces of glass.

5.4 Maximum Sizes

As height increases, the glass becomes more difficult to curve and therefore the minimum radius must be increased. Similarly as the glass weight and thickness increases, the maximum height must be decreased and the minimum radius increased (See Table 5.4a).

5.5 Measuring

Providing accurate dimensions for the purpose of manufacturing curved toughened is crucial to the whole process. In particular, the radius and girth dimension must be clearly stated as being measured from either:

a) the inside edge of the glass,

b) the centre of the glass, or

c) the outside of the glass.

The preferred dimension is the radius from the inside edge of the glass, particularly for cylindrical shapes.

Where the chord and depth dimensions can be supplied, a computer program will be used to print out all necessary dimensions for clients checking and sign off.

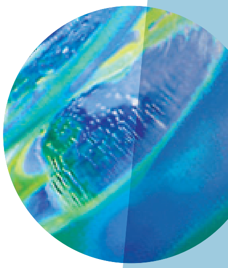
Templates would be preferred for cylindrical shapes but are a must for cylindrical shapes with flats. All templates must be of a hard material such as plywood and remember the minimum possible radii as previously listed in Table 5.4a.

5.6 Applications

G.James curved toughened safety glass has many and varied applications including:

- Shopfronts and Internal Partitions
- Balconies, Balustrades and Pool Fencing
- Revolving Doors
- Elevators and Lifts
- Skylights and Covered Walkways
- Bay Windows
- Showerscreens
- Display Cases, Deli bends and Food Cabinets
- Glass Furniture
- Windscreens

5.0 CURVED TOUGHENED GLASS



It is also possible to incorporate Colourlite onto the surface of curved toughened glass panels.

5.7 Glazing

Please refer Section 11.

G.James can also supply, curved aluminium channels for head and sills if required.

5.8 Acceptance Criteria

Limitations

Curved toughened glass can only be curved in one plane (dimension).

The manufacturing limitations are as follows:

- Maximum girth or curved dimension
  – 2140mm (5mm – 12mm)
- Maximum height
  – 3000mm (6mm/8mm)
  – 3660mm (10mm/12mm)
  For other thicknesses see Table 5.4a
- Minimum height 400mm

Edgework: As per flat toughened glass

Cut-outs: As per flat toughened glass

Holes / Spacings: As per flat toughened glass

Tolerances

Curve: To fit within ± 3mm of the specified shape or 6mm more than the glass thickness.

Local Warpage: At the curved edge: 1.5mm for glass up to 6mm thick and 3mm for glass over 6mm.

5.9 Standards

The appropriate standard for Architectural curved toughened glass covering the thickness range of 5mm – 12mm is AS/NZS 2208. For automotive glasses 5mm – 12mm thick, the appropriate standard is AS 2080.

As 3mm and 4mm are only available in heat strengthened and not fully toughened, such panels are not covered by the above standards as heat strengthened is not classified as a Grade A safety material.

G.James Technical Advisory Service

Phone: 1800 GJAMES (452637)

National Toll Free Number

Applications for curved toughened glass

6.0 Reflective & Coated glass

Royal Sun Alliance Building, Auckland

6.1 Introduction

As demand for better performing glass products increased, technology evolved that allowed metallic coatings to be applied to the glass surface. The result was a range of glass products that offer the following benefits:

- A wide choice of external appearances with varying degrees of reflectance
- Superior, all-round performance levels when compared to those of body tinted glass
- A multitude of combinations to satisfy specific aesthetic and performance requirements

6.2 On-line Coatings

On-line coated (or pyrolytic) glass is produced by depositing a metallic oxide onto the glass surface during the float manufacturing process. The result is a series of reflective coatings that are extremely hard and durable, to the extent that they can be heat treated and curved if required. The application process does however limit the range of available colours when compared to off-line coatings.

On-line coated products include Stopsol, Solarcool and Eclipse in addition to Low E types Energy Advantage, K Glass and Sungate 500.

6.3 Solarplus (Off-line Coatings)

Solarplus is G.James' range of Airco (off-line) processed, reflective and Low E solar control glass products.

In this state-of-the-art technology, the material to be sputtered is the cathode in a high voltage electrical circuit. Process gas is fed into a vacuum chamber where a glow discharge (plasma) forms. Electrons are taken from the gas and leave positively charged ions. The ions are attracted to, and collide with the target cathode (the material to be sputtered). This process takes place at very high speed and atoms of the target material are ejected and then recondense on the glass below.

By fine-tuning, the process is capable of uniform coatings on sheets of glass up to 2140mm x 3660mm or as small as 300mm x

G.James coating line

6.0 REFLECTIVE AND COATED GLASS

900mm. Almost any non-magnetic alloy or metal can be sputtered, the more common ones being stainless steel, silver and titanium. With argon present in the chamber, a metallic coating is produced. With oxygen or nitrogen either a metallic oxide or metallic nitride layer is produced.

Light transmittance and colour, depend on the coating material and the density of the deposit. G.James Safety Glass has the only architectural glass coating facility in Australia.

Solarplus products are available in either annealed monolithic form (clear and tinted), heat treated or laminated glass or incorporated into a Twin-Glazed unit, depending on the selected coating.

Coating Definitions

The coating description comprises two letters and two numbers, for example TS21. The two letters identify the type of coating and the two numbers indicate the visible light transmittance on 6mm clear glass. The higher the number, the greater the visible light transmittance, conversely the lower the number the better the glass performs in reducing heat transfer. Off-line coatings applied to tinted glass or incorporated into a laminated glass with a tinted interlayer further reduces the visible light transmittance. In these instances the number reference serves as a guide only to the visible light transmittance and may assist in comparing types of glass.

Figure 6.3a: 3 Chamber Off-line Coating System

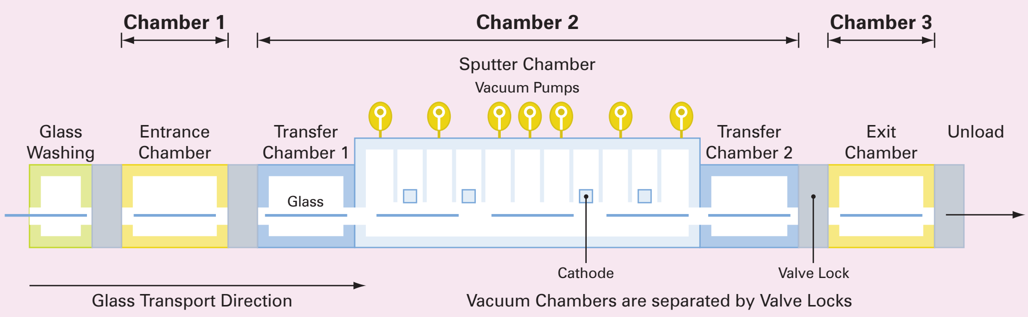
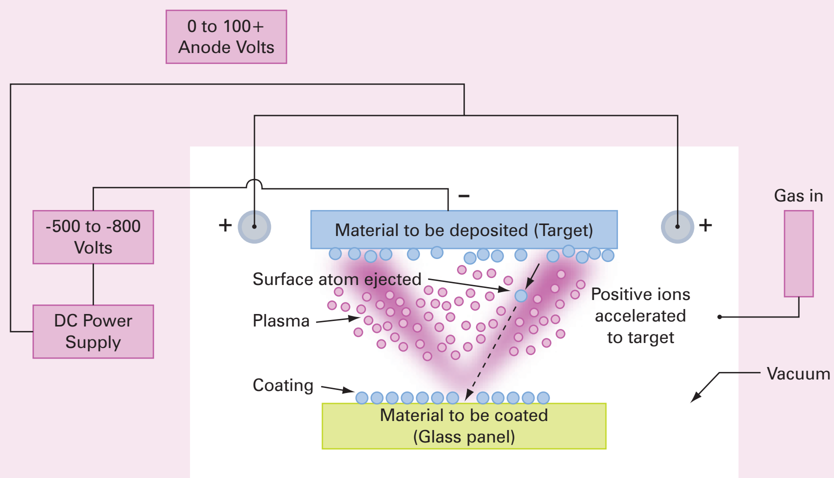
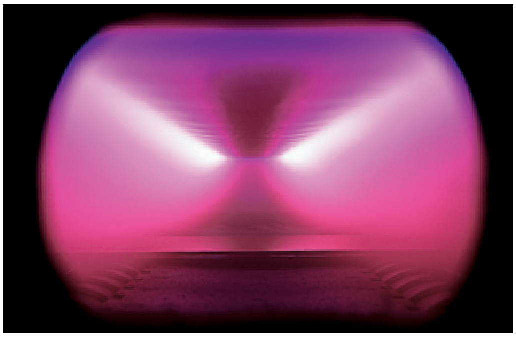


Figure 6.3b: The Sputtering Process



How glass is coated? The Sputtering Process

Glass is conveyed into a vacuum chamber which houses a proprietary AIRCO cathode and a 'target' (bar of the material to be deposited onto the glass). A controlled amount of gas is fed into the chamber, and a negative charge is applied to the cathode, resulting in a glow discharge (plasma) within the magnetic field created by permanent magnets in place behind the target.This plasma creates positive ions which are attracted to the negatively charged target, bombarding the target with such force that atoms of the target are ejected and deposited, atom by atom, onto the glass panel being coated. This cathode technique, developed by AIRCO scientists, is 10 – 100 times more efficient than previous sputtering processes.



Plasma glow during the sputtering process

Solarplus Coatings

TS Series
External Appearance*: Silver Blue to Deep Blue
Product Code: TS21, TS30, TS35***, TS40 and TS50***

TE Series
External Appearance*: Earth
Product Code: TE10

SS Series
External Appearance*: Neutral Silver
Product Code: SS08, SS14*** and SS22

SC Series
External Appearance*: Pewter (Antique Silver)
Product Code: SC22**, SC30*** and SC40***

SL Series (Laminated glass only)
External Appearance**: Silver
Product Code: SL10***, SL20 and SL30***

Notes:
*External appearance based on clear glass.
**External appearance based on clear glass with clear PVB.
***Non Standard coating (surcharge may apply).

As with all solar control glass products, a thermal safety assessment is recommended to determine if heat treatment is required to avoid thermal breakage.

6.4 Handling Criteria

Delivery & Storage

Do

- Make sure the glass is always supported
- Protect from knocks, abrasions and excessive pressure - especially on edges
- Keep surfaces dry, clean and interleaved with polyfoam

Don't

- Bend
- Store in direct sunlight or unventilated spaces

Handling

Do

- Handle glass manually, or with clean, oil-free vacuum pads

Don't

- Use gloves or vacuum pads which are dirty or contaminated

Installation

Do

- Take care not to damage the coating when fitting into the frame, or with glazing tools, sealant guns etc., or by leaning materials against the coated surface
- Glaze with coated surface to the INSIDE of the building (monolithic form only)
- Remove excess lubricants immediately and check regularly for any reappearance
- Clean up splashes from plaster, mortar or concrete before they harden
- Minimise damage by hanging protective plastic drapes over (but not touching) glazed panels once completed

Don't

- Glaze sheets with damaged edges
- Use glass with vented or severely feathered edges
- Glaze with coating exposed to weather

Cleaning

Do

- Clean panels as soon as possible after installation, especially if there is a risk of leaching, run-off or spattering from other materials
- Use ammonia and water or well-diluted mild detergent for routine cleaning

Don't

- Use abrasive cleaners

General

Don't

- Apply protective films to any coated surface
- Mark or label the coated surface

6.5 Low E (Low Emissivity)

All materials lose heat, but some more quickly than others. The rate of heat loss depends on the surface emissivity of the material. For example, a silver teapot will retain the fluid temperature far longer than a glass teapot because the surface of silver has a much lower 'emissivity'. Emissivity is defined as the rate of emitting (radiating) absorbed energy.

The radiant energy is long wave infra-red, which is in effect re-radiated back towards the heat source.

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 from the surface. When Low E coatings are applied to the glass, the surface emissivity is reduced to less than 0.20. Therefore the lower the surface emissivity, the better the glass reduces heat gain or heat loss. For assessment purposes, heat gain or loss is measured in U-value (W/m²K) with the lower the number, the better the performance of the glass.

Solarplus Low E

In terms of visible light transmission and thermal insulation, Solarplus Low E is the optimum glass product. These off-line sputtered coatings are transparent layers of silver and metal oxide deposited onto the glass surface. The metal oxides, which surround the silver, protects and suppresses the visible reflectance of the silver. This range of coatings can only be supplied on glass that will form part of a Twin-Glaze unit (edge deletion required).

G.James produce two off-line Low E coatings, namely LE80 and LE54 as part of the Solarplus Low E range.

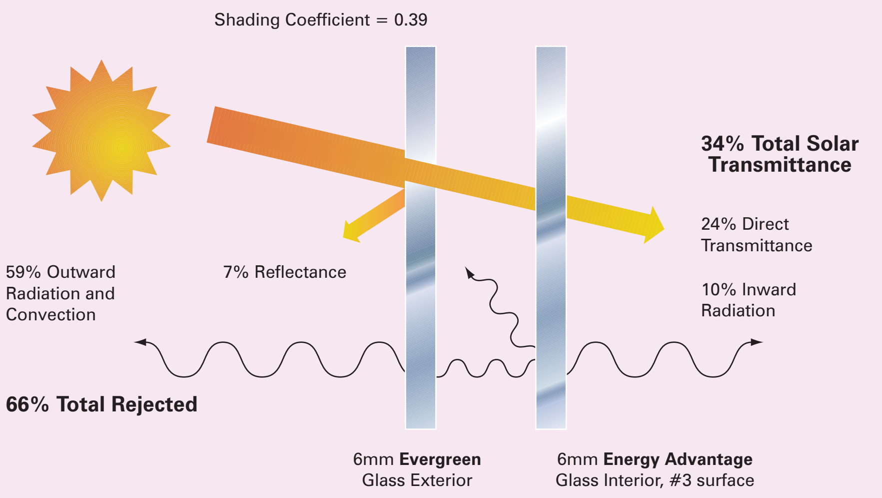
Solarplus Low E LE80 has a neutral colour in both reflection and transmission. This is accompanied by very high light transmission which, when combined with a high performance reflective or body tinted glass and incorporated into a Twin-Glaze unit, results in a thermally efficient window with both a low shading coefficient and U-value.

Solarplus Low E LE54 is a tinted coating which is ideal for use in warm climates, as it offers a balance between light transmission and solar energy control. By combining this coating with a body tinted glass in a Twin-Glaze unit, a desirable shading coefficient is achieved while maintaining good light transmittance, minimal external reflectance and low U-value.

G.James also stock a range of on-line coated Low E glass which can be cut, toughened, laminated or curved in the same way as ordinary annealed glass and requires no edge deletion for fabrication. This range of coated products has very high light transmission, low reflectance and is only available on clear glass. When incorporated with a solar control glass in a laminate (Optilight) or a Twin-Glaze unit, a desirable shading coefficient and a reduction in U-value can be achieved.

NB: Please refer to Section 15 for performance figures

Figure 6.5a: Low E Glass



7.0 Insulated glass units


Russell Offices, Canberra

7.1 Introduction

By nature, a single piece of glass has little resistance to either heat gain or loss, primarily because it is a good conductor and a very poor insulator. Recognising this problem, T.D. Stetson (USA) registered the patent for insulated glass in 1865. Stetson discovered that by adding a second panel of glass separated by still, dry air the insulating properties of glass could be improved. The improved performance of this insulated glass is attributed to the low thermal conductivity of the air pocket. It was not until after World War One that commercial production of the 'bonded units' commenced, with manufacturing techniques improving throughout the 1950's in Europe and the USA.

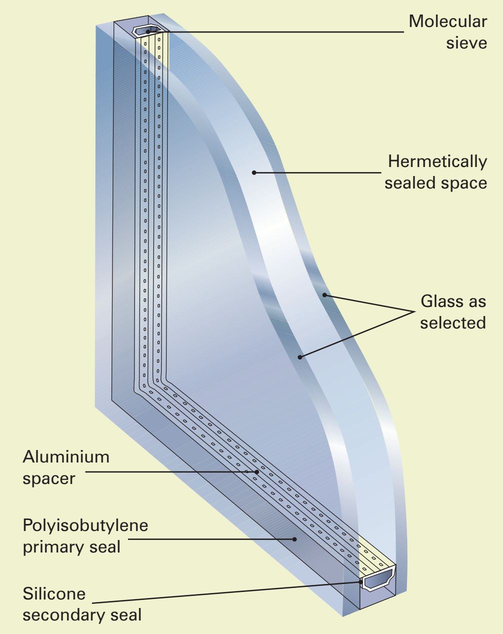
Methods used to seal the unit have progressed over time from the original metal to metal, to metal soldered, then glass fused and finally, to the current day, double sealed system.

G.James began manufacturing IG units in 1991 and registered the name 'Twin-Glaze' under which it markets this product.

7.2 Process

Cut-to-size glass is moved vertically along a conveyor through a washing and inspection process which ensures the glass is thoroughly clean and free of defects. The hollow aluminium spacer is then shaped to suit with a strip of Polyisobutylene applied to both sides providing the primary seal and an excellent vapour barrier. The spacer, which is filled with molecular sieve (desiccant) to prevent condensation from forming after sealing, is positioned between the two panels of glass

Figure 7.2a: Typical Twin-Glaze Unit




G.James Twin-Glaze Line

and then pressed together. Finally the silicone secondary seal is applied to the perimeter void around the unit.

Application of the secondary seal provides the following benefits:

- Good tensile strength to the glass to glass edge
- Low vapour and gas diffusion
- Excellent adhesion between the glass and the metal spacer with short curing times
- Superior structural bonding for the total unit

Today's automated systems such as the Lisec machines operated by G.James provide computerised washing, spacer bending, pressing and sealing with state-of-the-art robotic equipment. G.James is an accredited member of the Insulated Glass Manufacturers Association (IGMA) and complies with BS5713:1979 and CAN/CGSB - 12.8-M90.

7.3 Manufacturing Guidelines

Spacer Widths Available: 6mm, 8mm, 9mm, 10mm, 12mm, 14mm, 15mm, 16mm, 18mm, 19mm, 20mm, 22mm and 24mm.

7.4 Properties and Applications

The principle function of a Twin-Glaze unit is to improve the building occupant's comfort and reduced heating and cooling costs by minimising the flow of heat from the inside to the outside, or outside to inside - depending on the season. This is achieved by the airspace diffusing the transfer of heat creating insulation properties almost twice that of a single panel of glass.

The insulation value (U-value) is dependent on the unit configuration this includes the glass type/s, glass thickness and spacer width. Twin-Glaze units incorporating solar control

Table 7.3a: Size Limitations

Twin-Glaze units incorporating	Available Thickness	Minimum Sizes	Maximum Sizes
Annealed glass	Various	400mm x 400mm	2400mm x 3500mm
Heat Strengthened glass	Various	400mm x 400mm	2100mm x 3500mm
Toughened glass	Various	400mm x 400mm	2100mm x 3500mm
Laminated glass	Various	400mm x 400mm	2400mm x 3500mm

NB: Minimum/maximum sizes will be dependent on human impact/wind loading requirements. Maximum size will be dependent on weight (max. 225kg) and unit configuration.

products such as Solarplus significantly reduce solar heat gain, while certain combinations can provide superior solar and glare control, reduced air conditioning costs, improved noise reduction, greater fire resistance and increased security.

In colder climates where solar energy transmittance is encouraged, a combination of clear glass and Low E (inner) will ensure high light and energy transmittance while the Low E ensures it stays 'trapped' inside. In warmer, tropical climates this same combination helps reflect and prevent the near infra-red (heat) from transferring through to the interior.

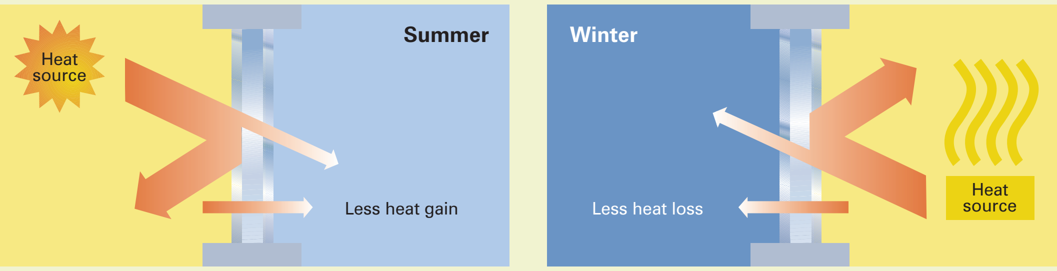
Twin-Glaze units can incorporate combinations of processed clear, tinted, reflective, low emittance (Low E) or Colourlite glass.

A thermal stress analysis is strongly recommended where solar control glass is involved - in particular Low E and high performance glass.

7.5 Condensation

Air comprises a mixture of gases including water vapour. At any given temperature, air reaches a 'saturation point' where it cannot hold any more water. Should air with excess

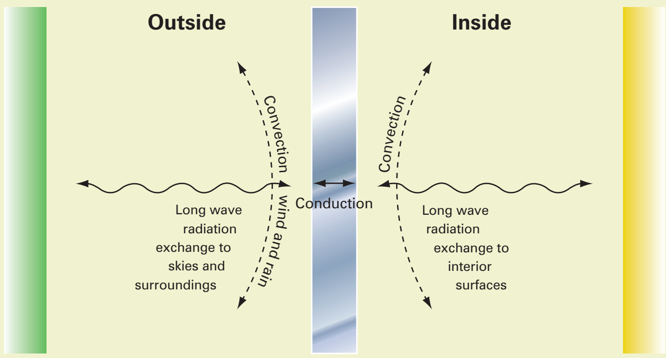
Figure 7.4a: Solar Control



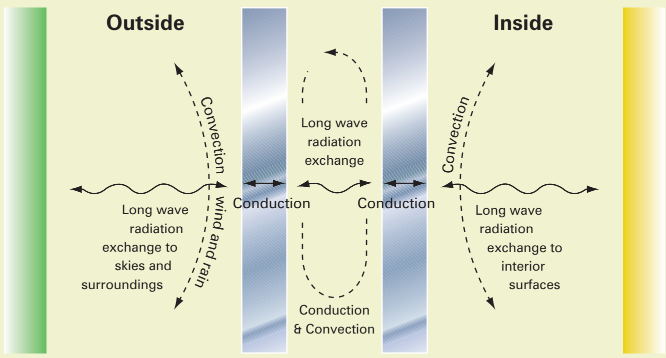
Low E glass helps prevent heat from entering in the summer

Low E glass helps prevent heat from escaping in the winter

Figure 7.4b: Heat Gain/Loss – Single Glass vs Twin-Glaze Unit



As single glass is a poor insulator and easily conducts heat, there is minimal resistance to heat gain/loss.



An air space between two panels of glass significantly improves insulation due to the low thermal conductivity of air (compared to glass). The second panel further assists with thermal resistance.

water vapour come into contact with a colder surface, condensation will form on this surface. The temperature at which condensation occurs is known as the 'dew point'.

In colder climates, condensation can develop on the inside of windows when the outside temperature is significantly lower than the inside temperature thereby reducing the surface temperature of the glass. To overcome this temperature variation, Twin-Glaze units should be selected to provide a thermal barrier between the inside and the outside, thereby minimising the occurrence of condensation.

7.6 Characteristics

There are three main optical effects that can occur with Twin-Glaze units:

Distortion and Reflection

All buildings are subject to constant interior and exterior changes in temperature and pressure. These naturally occurring changes although quite small at times, are sufficient to cause the glass to deflect or bow, resulting in a distorted, reflected image. This distortion known as 'pillowing' is visible mainly in the corners of the unit when viewed from a distance and can be either convex (where the glass bows outwards) or concave (inward bowing). This unavoidable effect is more noticeable with reflective type glasses.

Newtons Rings

With changes in atmospheric pressure, the glass in large Twin-Glaze units may deflect to the extreme where they touch in the centre of the unit, creating irregular, coloured circles similar to an oil stain effect. If either panel is pushed, the rings will move and change shape. Once the unit has pressure equalised, the effect of Newton Rings will disappear however it can be avoided by limiting the size of the unit and/or using thicker glass.

G.James
Technical Advisory Service

Phone: 1800 GJAMES (452637)

National Toll Free Number

Sky Tower, Auckland

Brewsters Fringes

Only possible with very high quality float glass, this rare and temporary occurrence is a consequence of using two glasses of exactly the same thickness with precise parallel surfaces. The reflected light within one glass blends with the reflection within the other glass to form faint coloured streaks. Brewsters Fringes can appear anywhere over the glass surface and can be avoided by using different glass thicknesses.

8.0 Safety and Security glass

Bullet resistant glass under attack

8.1 Introduction

With safety and security becoming an increasingly important feature in modern building design, G.James has developed the ArmaClear range of specialty glass products to ensure optimum protection should the need arise.

These high impact products are visually similar to ordinary glass (of the same thickness) providing an unobtrusive barrier against most forms of attack. ArmaClear has been installed in a variety of safety and security sensitive applications throughout Australia and overseas, having proved their effectiveness after extensive testing and in-situ service.

8.2 ArmaClear – Bullet Resistant (BR) Glass

The Process

ArmaClear Bullet Resistant (BR) glass is manufactured employing G.James' laminating process where multiple layers of glass and polycarbonate are subjected to tremendous heat and pressure, permanently bonding the individual components into one complete panel. Bullet resistant glass construction can be customised to include tinted glass, tinted or obscure interlayers, reflective coatings and one-way mirror, with certain curved configurations also possible.

Holes, cut-outs and shapes are available but may involve some limitations.

G.James has the manufacturing capabilities and technological experience to satisfy a wide range of specifications, from small hand guns to high-powered rifles and shotguns. The G.James Technical Advisory Service is available to assist with reliable and confidential advice.

Properties and Applications

ArmaClear BR products are multi-ply laminates ranging in thickness from 32mm to 45mm and may consist of an all glass construction or incorporate a combination of glass and polycarbonate. The multiple layers of glass used on the attack side deform and slow the bullet, while the polycarbonate absorbs the force of impact. The actual product thickness and configuration is totally dependent upon

Range of weapons

Table 8.2a: ArmaClear Bullet Resistant Products

Level	Weapon and calibre	Ammunition	Range	Number of strikes	Thickness (mm)	Weight (kg/m²)
G0	Handgun 9mm military	Mk 2Z standard 9mm 7.4 metal case bullet	3m	3	35	82
G1	Handgun 357 magnum	10.2g soft point semi-jacketed, flat nose	3m	3	32	70
G2	Handgun 44 magnum	15.6 soft point semi-jacketed, flat nose	3m	3	34	73
S0	Shotgun 12 gauge	12 gauge 70mm, high velocity magnum 32g SG shot	3m	2	34	73
S1	Shotgun 12 gauge	12 gauge 70mm 28.35g single slug	3m	2	38	86
R1	Rifle 5.56mm	M 193 5.56mm 3.6 full metal case	10m	3	38	86
R2	Rifle 7.62mm	NATO standard 7.62mm 9.3g full metal case	10m	3	45	98

the nominated calibre of weapon correlating to a specific level of protection (See Table 8.2a).

The components used in the manufacture of ArmaClear BR ensure normal vision is maintained. The final product is resistant to abrasion while also providing superior sound insulation. The strength and appearance of this product is unaffected by exposure to sunlight however a thermal safety assessment is recommended where tinted or reflective components are incorporated. Care must be taken to avoid edge damage.

In the event of an attack, ArmaClear will maintain a protective barrier and degree of visibility, except around the area of bullet impact. It is ideal for installation in banks, prisons, armoured vehicles, embassies, payroll offices, police stations, airports, public buildings, government offices and special defence vehicles.

Framing and Accessories

It should be emphasised that the surrounding frame and support structure are equally important as the glass, and must be of a strong construction and capable of providing the same level of protection to that of the bullet resistant glass.

For this reason, G.James has developed framing systems to complement all ArmaClear BR products, including the supply of document trays and voice transfer louvres. Installation can also be provided if required.

ArmaClear bullet resistant glass, framing and accessories

Performance

Standards Australia issued AS 2343 to ensure high standards of performance and detail strict guidelines for bullet resistant glazing.

The Standard defines three broad attack categories:

- 'G' - Resistant to hand gun attack
- 'S' - Resistant to shotgun attack
- 'R' - Resistant to rifle attack

ArmaClear BR products have been tested and certified by an independent, accredited NATA laboratory to ensure compliance with the various parameters outlined in Table 8.2a. Test certificates can be supplied upon request.

NB: NATA - National Association of Testing Authorities.

8.3 ArmaClear – Physical Attack (PA) Glass

G.James' ArmaClear Physical Attack (PA) glass has a remarkable resistance to human attack and penetration.

The Process

ArmaClear PA is manufactured using modern laminating processes where the multiple layers of glass and polycarbonate are subjected to tremendous heat and pressure, permanently bonding the multiple layers of material into one complete pane. Physical Attack glass construction can be customised to include tinted glass, tinted or obscure interlayers, reflective coatings and one-way mirror with certain curved configurations also possible.

ArmaClear PA glass is made-to-order with holes, cut-outs and shapes available if required, however due to the product configuration processing limitations do apply.

G.James has the manufacturing capabilities and expertise to meet the various criteria for intruder resistance and levels of attack. The G.James Technical Advisory Service is available to assist with reliable and confidential advice.

Properties and Applications

ArmaClear PA products comprise an all glass construction or incorporate a combination of glass and polycarbonate with the multi-ply construction resisting penetration even after the glasses within the composite are broken. The multiple glass layers used on the attack side absorb the force inflicted by various hand held implements, making the progress of penetration slow with the attacker quickly tiring and eventually ceasing the attack.

The components used in the manufacture of ArmaClear PA are resistant to abrasion and also provide excellent sound insulation. The strength and appearance of this product is unaffected by exposure to sunlight however a thermal safety assessment is recommended where tinted or reflective components are incorporated. Care must be taken to avoid edge damage.

In the event of an attack, ArmaClear PA will maintain a protective barrier and degree of visibility, except around the area of impact.
It is ideal for use in prisons, detention centres, mental health facilities, police stations, shopfronts (jewellery stores etc.), computer installations and other associated establishments.

Table 8.3a: ArmaClear PA Products

Product	Thickness	Minimum Size (mm)	Maximum Size (mm)
PA4H3P4H	12.26mm	100 x 400	1100 x 2200
PA6H4P6H	17.76mm	100 x 400	1100 x 2200
PA6H6P6H	19.26mm	100 x 400	1100 x 2200
PA6H9P6H	22.76mm	100 x 400	1100 x 2200

ArmaClear physical attack glass – Mental health facility

8.0 SAFETY AND SECURITY GLASS

Framing

It should be noted that the surrounding frame and support structure are of equal importance and must be of a strong construction and capable of providing a level of protection similar to that of the PA glass.

To complement the range of ArmaClear PA glass, G.James offer associated framing systems which can be supplied knock-down condition (KDC) or fully installed.

Performance

Standards Australia issued AS 3555 to maintain high levels of performance and outline the guidelines for physical attack glazing.

Extensive testing of ArmaClear PA products subjected to attacks from sledgehammers, jemmy bars, bricks and axes have far exceeded industry standards and expectations. For security reasons, test performance figures are not published but are available on request against a specific project enquiry.

8.4 ArmaClear – Prison Shield (PS) Glass

G.James ArmaClear Prison Shield (PS) is a range of thin, lightweight anti-intruder laminated glass products which has been specifically introduced for low security applications where intrusion is of concern.

ArmaClear PS is constructed using a combination of toughened safety glass, heat - strengthened glass and polyvinyl butyral interlayer between the two glasses. This configuration provides initial strength in addition to continued strength even after one or both of the glass skins have been broken, making it well suited for watch houses, lock-ups, detention centres and police stations. Customised to suit individual requirements, ArmaClear Prison Shield can be manufactured to incorporate tinted glass, tinted or obscure interlayer, reflective coating or one-way mirror.

Table 8.4a: ArmaClear PS Products

Product	Thickness	Minimum Size (mm)	Maximum Size (mm)
PS6H26H	14.28mm	100 x 400	2100 x 3660
PS10H310T	23.04mm	100 x 400	2100 x 3660
PS5H25H	12.28mm	100 x 400	2100 x 3660

G.James is the chosen supplier to QR tilt trains

8.5 Train and Special Purpose Windows

The development of G.James' security products has been extended to include a range of dedicated window products for the transport and railway industries. With extensive in-house design and manufacturing capabilities, G.James can supply fully fabricated, special purpose windows incorporating high impact laminated glass and aluminium perimeter frames.

Of particular mention is the range of railway window systems which includes forward facing windscreens, driver's cab side windows, saloon side windows. These systems have undergone extensive testing and comply with British Standard BRB 566 and the Federal Railroad Administration (FRA) Standards.

9.0 Special purpose glass

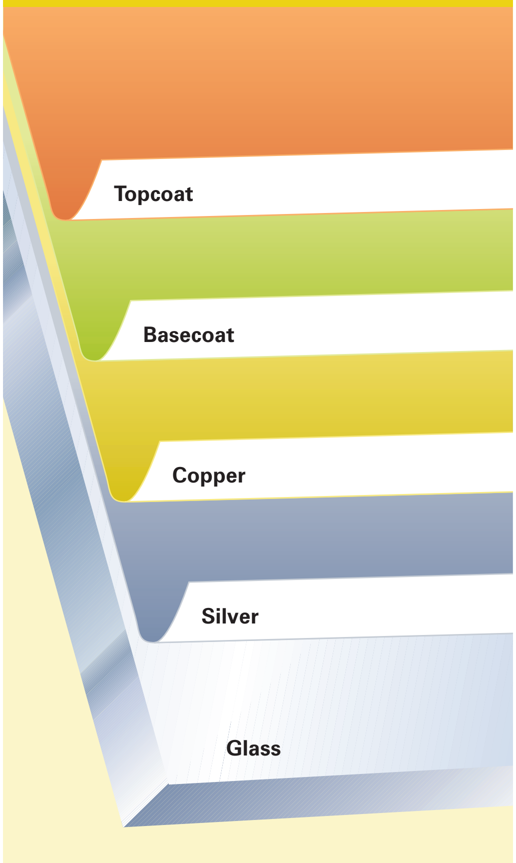
9.1 Mirrors (Silver Glass)

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)

Figure 9.1a: Silvering Process



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.

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

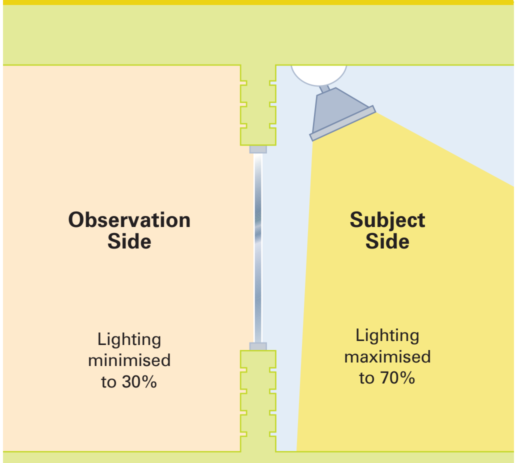
9.2 One-Way Mirror

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

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.

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.

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.

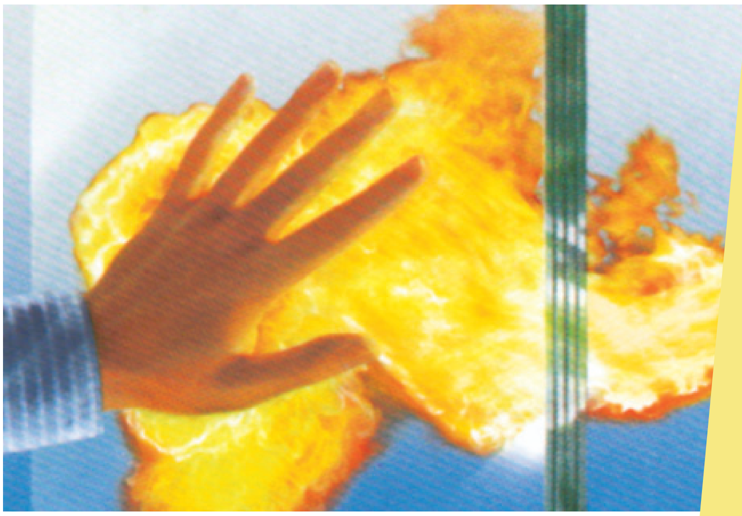
Non-Reinforced systems incorporate the range of ceramic glass products and are installed as fire rated walls and openings. Their low expansion and high softening points allow such products as FireLite to achieve long integrity ratings of up to 180 minutes. FireLite is capable of withstanding a rapid 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.

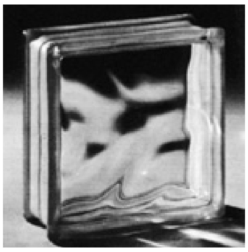
It should be noted that both these insulated systems are prone to ultra-violet degradation and when used as external glazing it is recommended they should be combined with standard PVB interlayers.

9.9 Welding Glass

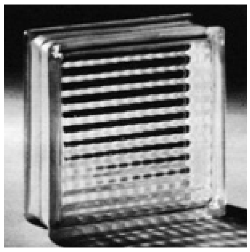
For the purpose of absorbing and reflecting harmful radiation emitted during welding and similar operations, G.James can supply Shade-12 welding glass. This product incorporates a special filter that reduces ultra-violet transmittance to around 0.0012% and infra-red transmittance to 0.007% ensuring excellent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

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

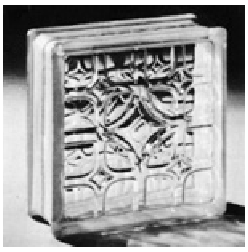
9.10 Glass Blocks



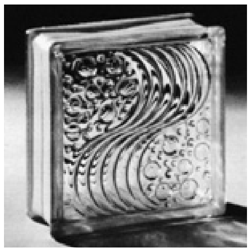
Nubio-wolke *



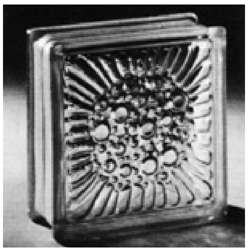
Cross ribbed (Also available in Broad cross ribbed)



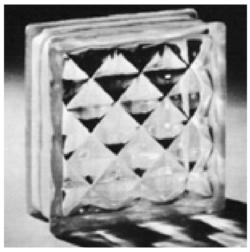
Nobless *



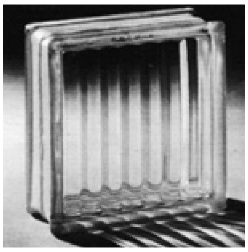
Welle



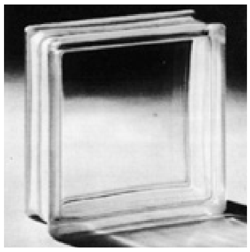
Helios *



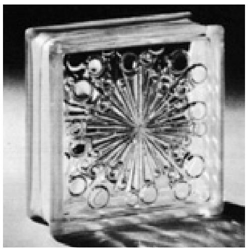
Regent



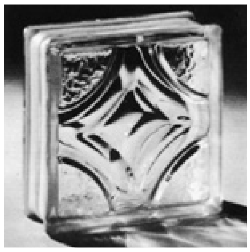
Broad parallel ribbed (Also available in Parallel ribbed)



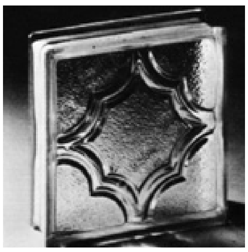
Clear view



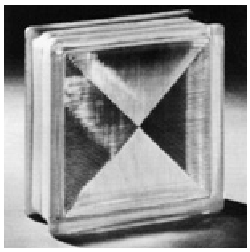
Meteor *



Inka *



Maya



Metallik

* Patterns are also available in Goldtone.

9.0 SPECIAL PURPOSE GLASS

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.

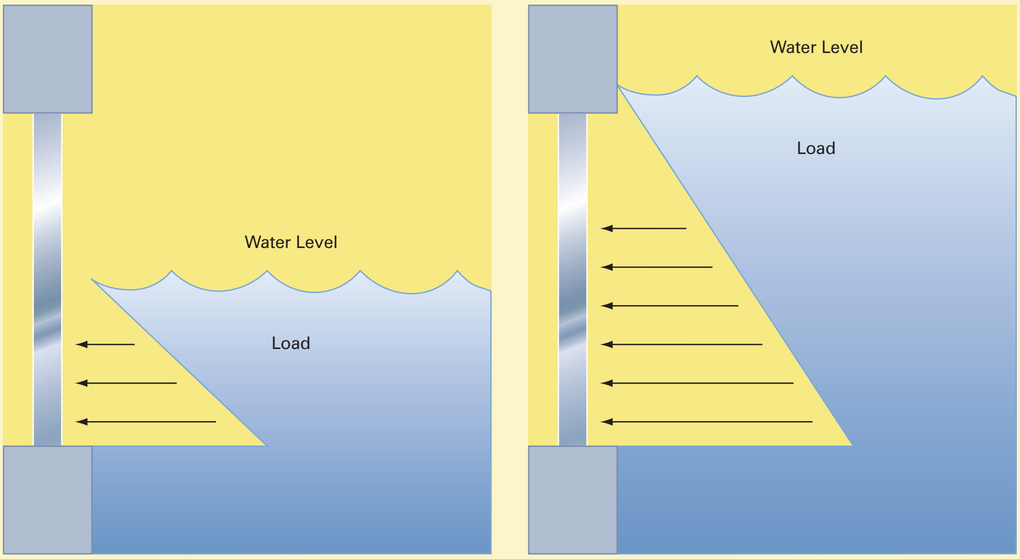
G.James' Technical Department can provide the necessary recommendations for your specific requirements.

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.

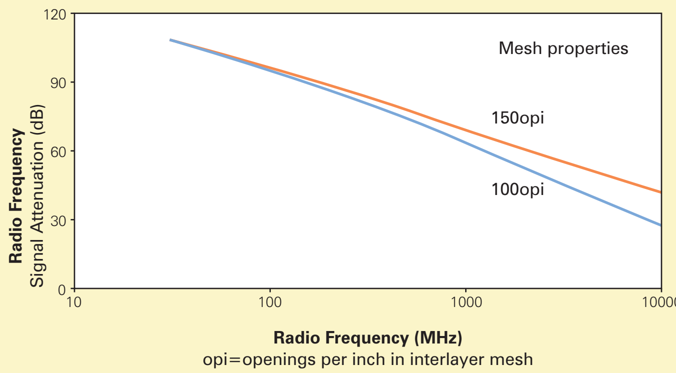
Protecting premises where such installations are housed can be achieved by employing Faradays cage principle thereby ensuring all the external surfaces (i.e. the floor, the ceiling, and all walls) are electrically conductive and then earthed. Consequently any radio frequencies omitted from equipment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

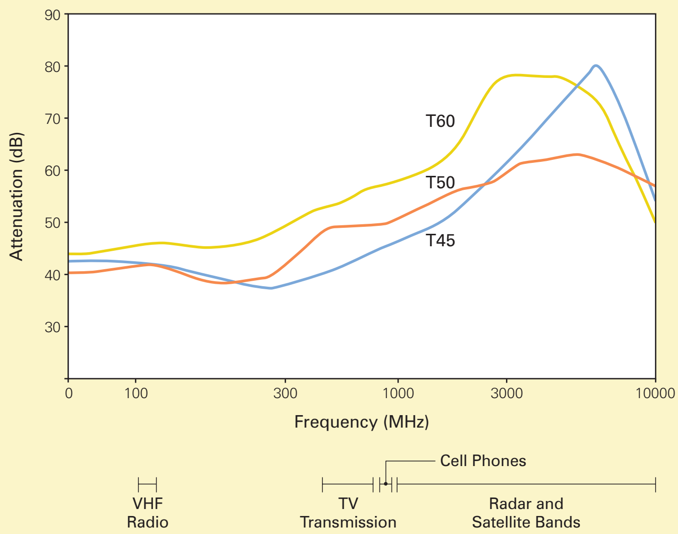


the walls and simply travels to the ground. Similarly, any random external electronic interference is also diverted to ground.

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

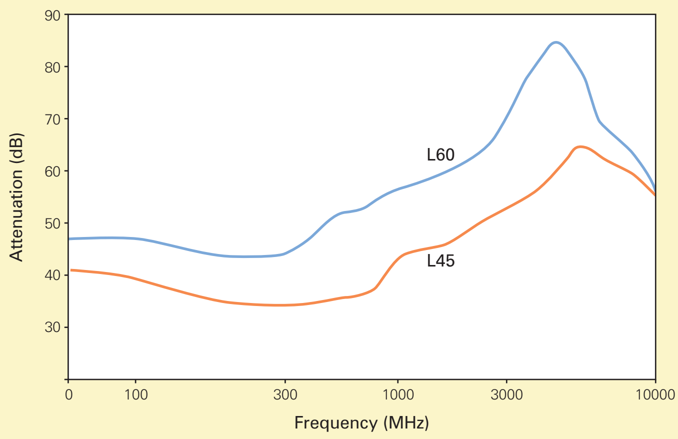
Graph 9.12b: Data Shielding Twin-Glaze Unit



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

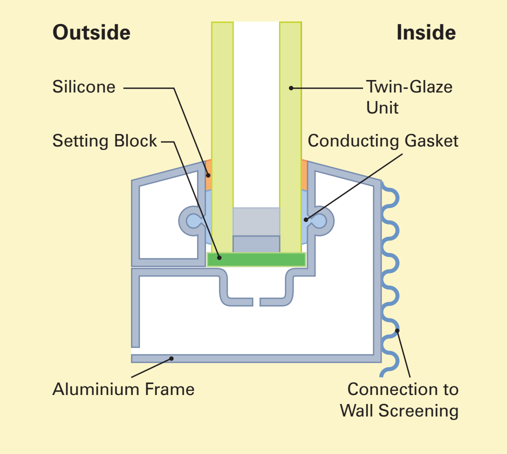
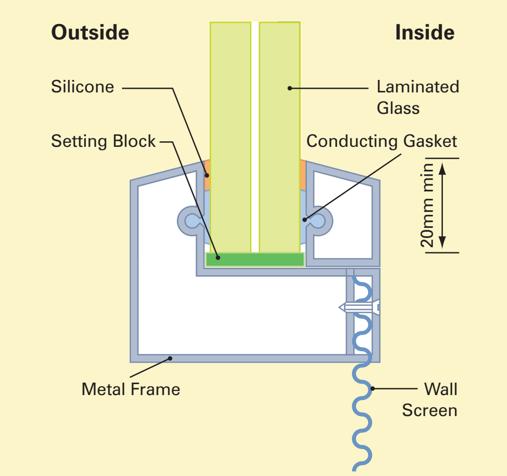


Figure 9.12b: Typical Internal Screening



(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.

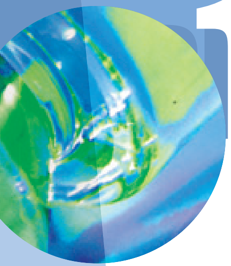
Glass stair treads, incorporating thick annealed or laminated glass, can also produce a stunning visual effect as well as


Star Casino – Sydney

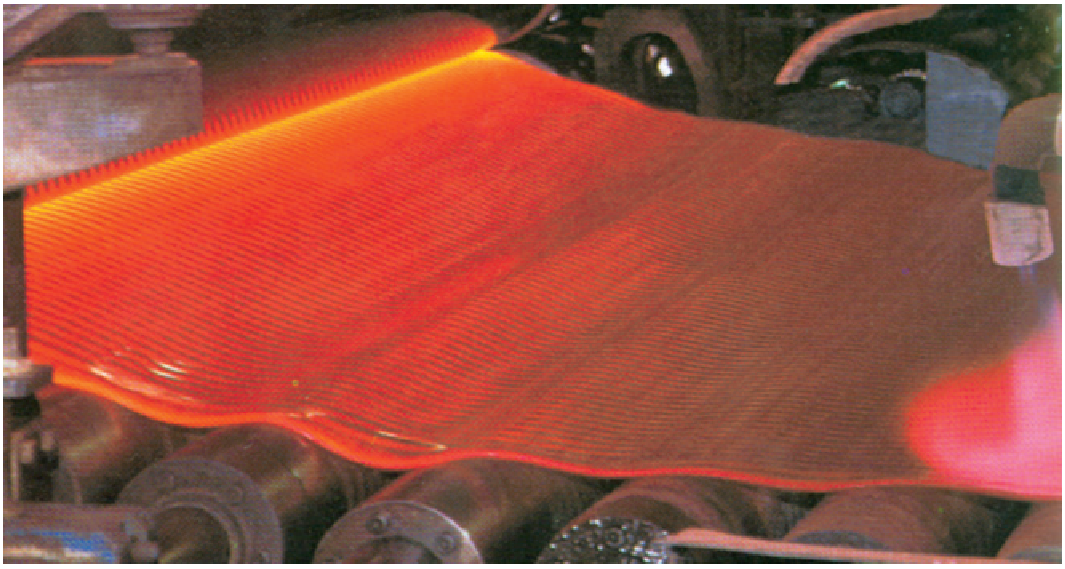
complementing any surrounding glass features. In this instance, a sandblasted top glass should be considered to avoid highlighting scratches and scuff marks while also acting as a diffuser where under-floor lighting is used.

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.

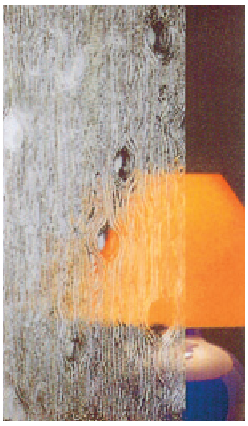
For the production of wired glass, square steel wire mesh is sandwiched between two separate ribbons of glass which is then pressed through a further pair of patterned rollers to imprint the selected design.

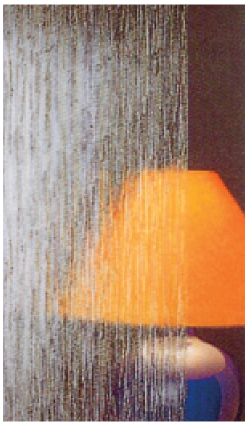
Types

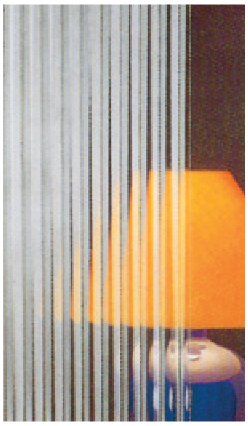
With 16 different designs, three of which are wired (See Figure 10.2a), G.James offers patterned glass in a variety of colours, textures and degrees of opacity with the majority capable of being toughened while a small number can be laminated (See Table 10.2a).

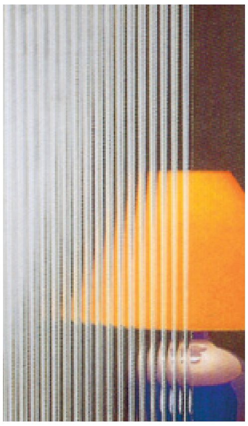
Georgian Polished Wired is a clear, totally transparent wired glass. Produced as a cast glass, and subsequently ground and polished on both sides using the old plate glass method, this product is optically true and the preferred glass for use in fire doors where small vision panels are installed. Note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

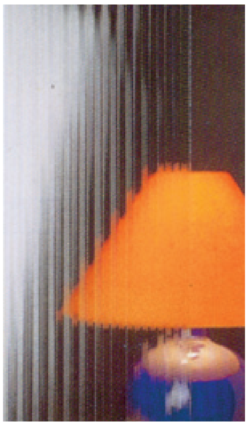
Table 10.2a: Figured Rolled Patterned Glass

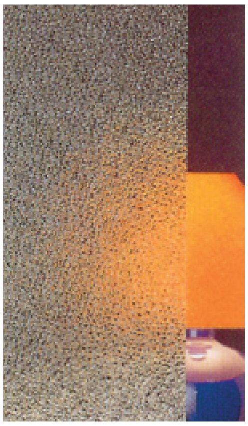

Tandarra

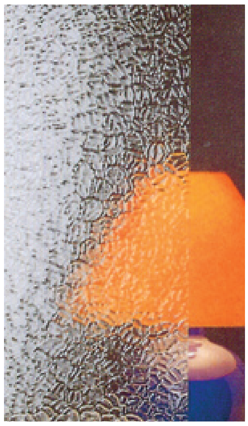

Seadrift

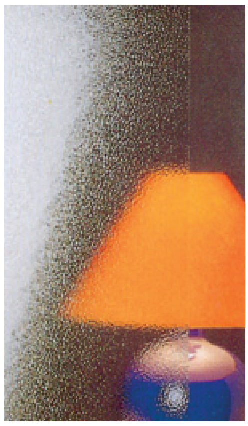

Broadline

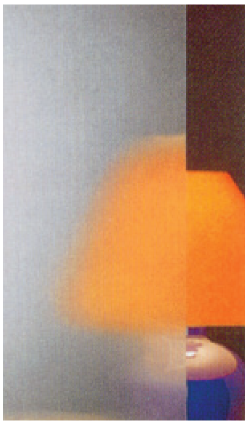

Narrow Reeded

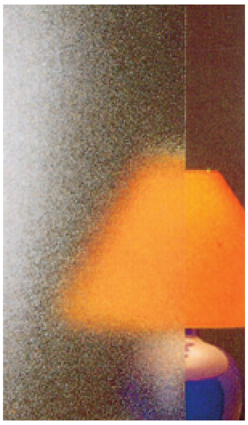

Strata


Sparkle


Kosciusko


Roughcast

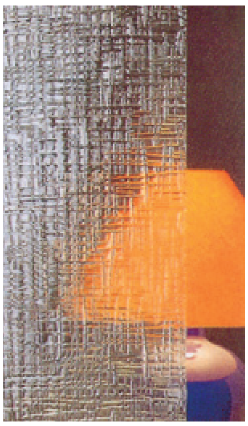

Satinlite

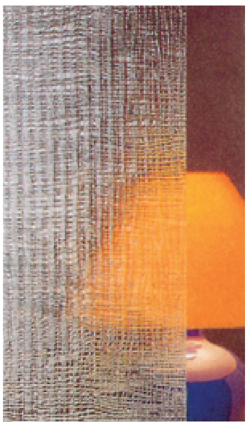

Spotswood

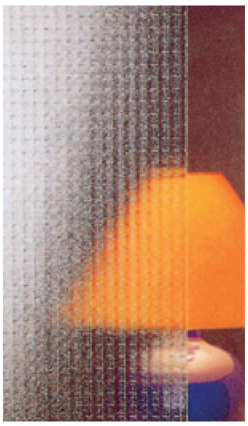

Glue Chip


New Cathedral

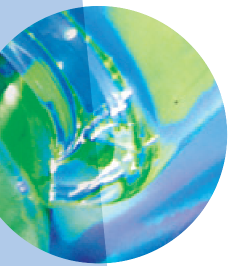

Flemish


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)

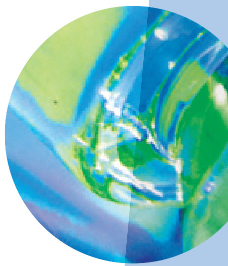
The application of fused, coloured ceramic paint to glass provides architects and designers with a new dimension in the use of patterned glass by offering a cost effective and unobtrusive means of minimising exposure and/or controlling the amount of light transmission.

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.

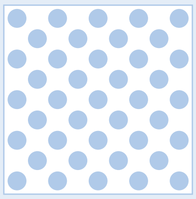
Properties and Applications

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.

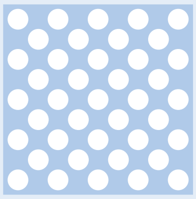
When specifying the pattern colour, be aware that lighter colours will act as a daylight diffuser. Further, light colours will naturally reflect solar energy while darker colours will absorb such energy.

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.

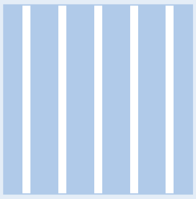
Figure 10.3a: Standard Designs



3mm dots, 40% cover



3mm reverse dots, 60% cover



3mm strip, 50% cover

Gum leaf design

Patternlite – Gum leaf design

11.0 Glazing techniques

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.

11.1 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.

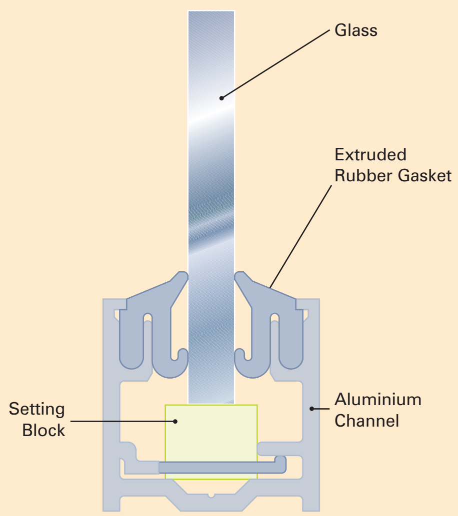
While many factors are considered in selecting the glass, the glazing techniques used in the installation process are equally as important. In essence this involves choosing the correct materials and their proper installation and use to ensure long term performance of any glazing.

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

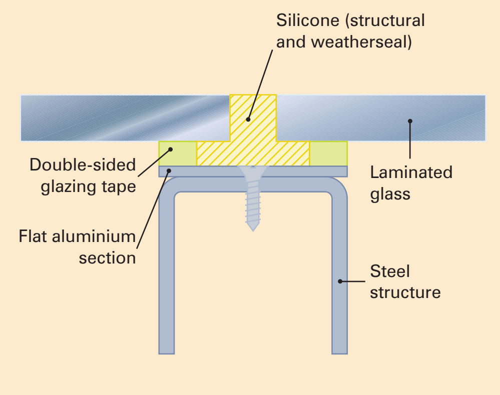
For correct size and position of setting blocks consult AS 1288.

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

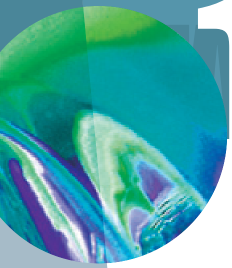
The suggested way of achieving a plumb installation, particularly for large areas, is to use vertical batten fixing. The vertical battens (50mm x 25mm) should be primed, before fixing to ensure no chemical reactions between the resins and mirror back.

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

G.James
Technical Advisory Service

Phone: 1800 GJAMES (452637)

National Toll Free Number



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.

12.0 STANDARDS AND TESTING

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

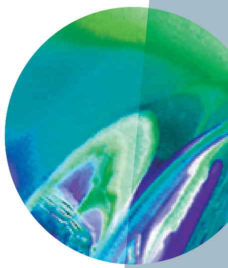
G.James Testing Laboratory
NATA Registered Laboratory No.3630 (within the field of mechanical testing).

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

14.0 UNITS/CONVERSION FACTORS

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/ft^2.h.°F = W/m^2.K ÷ 5.68

W/m^2.K = Btu/ft^2.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 radius^2)

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

15.0 Glossary

16.1 Glossary

Absorption
That portion of total incident radiation that is absorbed by the glass and subsequently re-radiated either outside or inside.

Acoustics
The science of sound, and sound control.

Adipic Acid
A weak organic acid whose function is to neutralise any bases produced by the prolonged contact of moisture with the glass surface.

Ambient Temperature
Temperature of the surrounding air (˚C).

Annealing
In the manufacturing of float glass, it is the process of controlled cooling done in a lehr to prevent residual stresses in the glass. Re-annealing is the process of removing objectionable stresses in glass by re-heating to a suitable temperature followed by controlled cooling.

Annealing Lehr
An on-line, controlled heating/cooling apparatus located after the tin bath and before the cooling conveyor of a float glass production line. Its purpose is to relieve induced stress from the flat glass product to allow normal cold end processing.

Anodise
To apply a hard corrosion resistant oxide film onto the surface of aluminium using electrolysis.

Arriss
A small bevel at an angle of approximately 45 degrees to the surface of the glass applied usually with a wet or dry belt, stone or machine.

Aspect Ratio
The quotient of the long side of a glazing panel over the short side of that panel.

Attenuation
The reduction of sound intensity (or signal strength) with distance. Attenuation is the opposite of amplification, and is measured in decibels.

Autoclave
A vessel that employs high pressure and heat to produce a bond between glass and PVB or urethane sheet, creating a laminated glass product.

Backer Rod
A polyethylene or polyurethane foam material installed under compression and used to control sealant joint depth, provide a surface for sealant tooling, serve as a bond breaker to prevent three-sided adhesion, and provide an hour glass contour of the finished sealant bead.

Bead
A strip of timber, aluminium or other suitable material secured to the rebate to retain the glass in place (sometimes referred to as glazing bead).

Bent Glass
(See Curved Glass.)

Bevelling
The process of edge finishing flat glass to a bevel angle.

Bite
Also referred to as structural bite, is the width of silicone sealant that is applied to the panel of glass to adhere it to the frame.

Blisters
A profusion of bubbles or gaseous inclusions in the glass. Small bubbles less than 2mm diameter referred to as seeds.

Bloom
A surface film on the glass resulting from atmospheric attack or deposition by smoke or other vapours.

Body Tinted Glass
(See Tinted Glass.)

Bow (and Warp)
A curve, bend or other deviation from flatness in glass.

Breather (Tube) Units
An insulating glass unit with a tube factory-placed into the unit's spacer to accommodate pressure differences encountered in shipping due to change in elevation. These tubes are to be sealed on the job site prior to unit installation. (See also Capillary Tubes.)

Brilliant Cut
Decorative process in which designs are cut into the glass with abrasive and polishing wheels.

British Thermal Unit (BTU)
The amount of energy required to raise one pound water to 170°F.

Bubbles
In float glass, a gaseous inclusion.

In laminated glass, a gas pocket in the interlayer material or between the glass and the interlayer.

Bullet Resistant Glass
A multiple lamination of glass and plastic that is designed to resist penetration from medium-to-super-power small arms and high-power rifles.

Butt Glazing
The installation of glass products where the vertical glass edges are glazed with silicone and without structural supporting mullions.

Capillary Tube Units
An insulating glass unit with a very small metal tube of specific length and inside diameter factory-placed into the unit's spacer to accommodate pressure differences encountered in shipping because of substantial changes in elevation and the pressure differences encountered daily after installation. (See also Breather Tubes.)

C.T.S
Abbreviation for cut-to-size glass.

Cast-In-Place Lamination
Lamination process where the interlayer is a liquid poured between the glass and then chemically cured to produce the final product.

Casting
Process of shaping glass by pouring into a mould or onto a table.

Channel Depth
The measurement from the sight line of the frame to the bottom of the channel.

Channel Glazing (Pocket Glazing)
A three sided, U-shaped opening in a sash or frame to accommodate a glass panel. Beads maybe fixed or removable.

Channel Width
The distance between the stationary and removable beads at the widest point.

Chemically Toughened Glass
Chemical strengthening of glass is brought about through a process known as ion-exchange. Glass is submersed in a molten salt bath at temperatures below the annealing range of the glass. In the case of soda/lime/silica glass, the salt bath consists of potassium-nitrate. During the submersion cycle, the larger alkali potassium icons exchange places with the smaller alkali sodium ions in the surface of the glass. The larger alkali potassium ions 'wedge' their way into the voids in the surface created by the vacating smaller alkali sodium ions. This 'strengthened' surface may penetrate to a depth of only a few microns. It is not a safety glass.

Chip
A small shallow piece of glass which has become detached from the original glass edge.

Cladding Glass
Special glass usually ceramic painted (Colourlite) in curtain walls or as a cover to columns and walls.
(See also Spandrel.)

Clips
Wired spring devices used in face glazing (putty) to hold glass in sash rebate without beads.

Cohesive Failure
Internal splitting of a sealant resulting from over stressing and insufficient elasticity and elongation to absorb the strain.

Colonial Bars
Horizontal or vertical bars that divide the sash frame into smaller panels of glass. Colonial bars are smaller in dimensions and weight than mullions.

Coolness Factor
(See Luminous Efficacy.)

Compound
A chemical formulation of ingredients used to produce a caulking, elastomeric joint sealant, etc.

Compression Set
The permanent deformation of a material after removal of the compressive stress.

Condensation
The appearance of moisture (water vapour) on the surface of an object caused by warm moist air coming into contact with a colder object.

Corrosion
The deterioration of metal by chemical or electrochemical reaction mainly caused by exposure to moisture and/or chemicals.

Cullet
Broken glass, excess glass from a previous melt or edges trimmed off when cutting glass to size. Cullet is an essential ingredient in the raw glass (batch) mix as it facilitates the melting process.

Cure
To alter the properties of a sealant by chemical reaction initiated by the action of air, heat and/or other catalyst.

Curved Glass
Flat glass which has been shaped while hot into cylindrical or curved shapes.

Cutting
Scoring glass with a diamond, steel wheel, or other hard alloy wheel and breaking it along the score. Other methods of cutting glass include water jet and laser.

Daylight Size
The clear unsupported opening size that admits light.

Decorated Glass
Clear or patterned - processed by craftsmen - stained glass, lead-lights, sandblasted, acid etched, embossed and screen-printed.

Deflection (Centre of glass)
The amount of bending movement of the centre of a glass panel perpendicular to the plane of the glass surface under an applied load.

Desiccant (Silica Gel)
Molecular sieve or extremely porous crystalline substance used to absorb moisture inside the air space of insulated glass units.

Design Pressure
Specified pressure a product is designed to withstand.

Dew Point
The temperature at which condensation of water begins when air is cooled.

Dice
The more or less cubical pattern of fracture of fully tempered glass.

Diffusing
Scattering, dispersing, as the tendency to eliminate a direct beam of light.

Diffuse Reflection
Glass used in picture framing to avoid reflections and the glare of lighting.

Direct Radiation (Transmittance)
The sun's emitted solar heat energy, which reaches us directly in varying intensity, due to atmospheric conditions. That portion of solar energy, which is directly transmitted through the glazing.

Draw Lines
Refers to the direction of flow (or pull) of glass during production. (See also Sheet Glass.)

Distortion
Alteration of viewed images caused by variations in glass flatness and is an inherent characteristic of heat treated glass.

Double Glazing
In general, any use of two panels of glass, separated by an air space, within an opening, to improve insulation against heat transfer and/or sound transmittance. In insulating glass units the air between the glass sheets is thoroughly dried and the space is sealed, eliminating possible condensation and providing superior insulating properties.

Dry Glazing
Also called compression glazing, this term is used to describe various means of sealing monolithic and insulating glass in the supporting framing system using pre-formed and extruded materials such as glazing gaskets.

Durometer
An instrument for measuring the relative hardness of materials such as rubber. Also, the term often used (loosely) as a synonym for relative hardness.

Edge Clearance
Nominal spacing between the edge of the glass and the bottom of the surrounding glazing pocket (channel).

Edge Cover
The distance between the edge of the glass and the edge of the rebate forming the sight opening of the window frame.

Edge Working
Grinding the edge of glass to a desired shape or finish.

Emissivity
The measure of a surface's ability to emit long-wave infra-red radiation.

Environmental Control Glass
The broad name for all types of glass that have a function in controlling heat, glare, noise or radiation.

EPDM
A synthetic rubber prepared by polymerising ethylene, propylene and a diene monomer.

Etch
To alter the surface of glass with hydrofluoric acid or caustic agents. Permanent etching of glass may occur from alkali and other run-off from surrounding building materials.

Fenestration
Any glass panel, window, door, curtain wall or skylight unit on the exterior of a building.

Fins
Supporting glass panels incorporated into the design of glass facades installed at 90° angle to the glazed surface.

Figured Glass
(See Patterned Glass.)

Fire-Polish
To make glass smooth or glossy by the action of fire or intense heat.

Flare
A protrusion on the edge of a panel of a glass.

Flat Glass
A general term that describes float glass, sheet glass, plate glass and rolled glass.

Float Glass
Glass formed on a bath of molten tin. The surface in contact with the tin is known as the tin surface or tin side. The top surface is known as the atmosphere surface or air side.

Flush Glazing
Glass set in a aluminium frame without any external mullion or transom projections.

Frosted Finish
A surface treatment for glass, consisting of acid etching or sandblasting of one or both surfaces to diffuse transmitted light.

Fully Toughened Glass
Flat or curved glass that has been heat treated to induce a high surface and /or edge compression. Fully toughened glass, if broken, will fracture into many small pieces (dice) which are more or less cubical. Fully toughened glass is approximately 4 to 5 times stronger than annealed glass of the same thickness when exposed to uniform static pressure loads. Is sometimes called 'tempered glass'.

Gaskets
A pre-formed resilient rubber-like compound providing a continuous surround for glass and a weather tight seal when compressed.

Glass
A hard brittle substance, usually transparent, made by fusing silicates, under high temperatures with soda, lime, etc.

Glass Clad Polycarbonate
Two or more panels of flat glass bonded with urethane interlayer to one or more sheets of extruded polycarbonate in a pressure/temperature/vacuum laminating process.

Glassflux
A finely ground powder from one or more 'low melting' glasses.

Glazing
The securing of glass in prepared openings.

Glazing Bead
(See Bead.)

Glue Chip
Decorative glass produced by sticking material onto the glass with a glue. As the glue cures the material is stripped off the glass, the surface of which is plucked. This gives a random pattern.

Head
Top horizontal frame member of window/door frame.

Heat Absorbing Glass
Glass that absorbs an appreciable amount of solar energy. (e.g. tinted glass.)

Heat Resisting Glass
Glass able to withstand high thermal shock, generally because of a low coefficient of expansion.

Heat Strengthened Glass
Flat or bent glass that has been heat treated to a specific surface and/or edge compression range. Heat strengthened glass is approximately twice as strong as annealed glass of the same thickness when exposed to uniform static pressure loads. Heat strengthened glass is not considered safety glass and will not completely dice as will fully toughened glass.

Heat Treated
Term used for both fully toughened glass and heat strengthened glass.

Heat Transfer
Heat is transferred in the following manner:

Conduction - in which there is direct contact of molecules in a solid body, for example, the passage of heat along a metal bar of which one end is inserted in a fire.

Convection - in which actual movement of the medium, gas or liquid occurs, for example, heated air from a convection heater.

Radiation - by which heat passes from source to object without heating space between them for example, heat from the sun to earth.

Heel Bead
Sealant applied at the base of a channel, after setting the panel and before the bead is installed. One of its purposes is to prevent air and water ingress.

Hermetically Sealed
Made airtight by fusion or sealing. Referred to in the manufacture of insulated glass units.

High Transmittance Glass
Glass which transmits an exceptionally high percentage of visible light.

IGMA
Abbreviation for Insulating Glass Manufacturers Association.

Insulated Glass Unit (IG unit)
Where two or more panels of glass spaced apart and hermetically sealed to form a single unit with an air space between each panel. (Also see Double Glazing).

Interlayer
Any material used to bond two panels of glass and/or plastic together to form a laminate.

Jamb
Vertical frame member at the perimeter of the opening of a window or door.

Knocked Down Condition (KDC)
Fabricated framing components shipped loose for assembly at another location.

Laminated Glass
Two or more panels of glass permanently bonded together with one or more interlayers.

Lite
Another term for a panel or pane of glass, particularly used in the USA.

Live Load
Loads produced by the use and occupancy of the building or other structure and do not include construction or environmental loads such as wind load, snow load, ice load, rain load, seismic load or dead load.

Low Emissivity (or Low E)
A low rate of emitting absorbed radiant energy, i.e. long wave infra-red.

Luminous Efficacy
(Light-to-Shading Coefficient Ratio)
The visible transmittance of a glazing system divided by the shading coefficient. This ratio is helpful in selecting glazing products for different climates in terms of those that transmit more heat than light and those that transmit more light than heat. Also referred to as coolness factor.

Modulus
Stress at a given strain. Also tensile strength at a given elongation.

Monolithic Glass
A single homogeneous piece of glass as opposed to laminated glass or a insulated glass unit.

Multiple Glazed Units
Insulated glass units with three or more insulated panels of glass.

Mullion
A vertical frame member that supports and holds panels, glass or sashes.

Mirror
Glass silvered on one side producing a highly reflective surface.

Neoprene
A synthetic rubber with similar properties to natural rubber, but manufactured without sulphur for vulcanisation.

Nominal Thickness
The commonly used dimension by which the thickness is described. NB: Actual thickness of glass may not coincide with nominal thickness.

One-way Vision
Generic description of a reflective glass, which if glazed with appropriate lighting ratios, allows visual security to be maintained.

Obscure Glass
(See Patterned Glass.)

Opacifier
Applied polyester film or coating to the surface of reflective glass rendering it opaque. Suitable for use in spandrel and non-vision areas.

Organic
Any compound which consists of carbon and hydrogen with a restricted number of other elements, such as oxygen, nitrogen, sulphur, phosphorous, chlorine, etc.

Out-gassing
A gaseous bi-product from cleaners, solvents and sealants.

Pane
A single piece of glass in a window or door.

Patterned Glass
One type of rolled glass having a pattern impressed on one or both sides. Used extensively for light control, bath enclosures and decorative glazing. Sometimes called rolled, figured or obscure glass.

Pocket Glazing
(See Channel Glazing.)

Points
Thin, flat, triangular or diamond shaped pieces of zinc used to hold glass in wood sashes by driving them into the wood.

Polariscope and G.A.S.P. Laser
A device for examining the degree of strain in a sample of glass. (Either edge or surface compression).

Polished Plate
Glass that has been ground and polished on both sides to produce optically high quality.

Polished Wired Glass
Transparent wired glass that has been ground and polished on both surfaces.

Polyvinyl Butyral Interlayer
An extremely tough resilient plastic film used to bond glass together in the laminating process.

Polyisobutylene
Typically the primary seal in a dual seal IG unit and the key component in restricting moisture vapour transmittance.

Polysulphide Sealant
Polysulphide liquid polymer sealants. They can be converted to rubbers at room temperature without shrinkage upon addition of a curing agent.

Polyurethane Sealant
An organic compound formed by the reaction of a glycol with an isocyanate.

Polyvinyl Chloride (PVC)
Polymer formed by polymerisation of vinyl chloride monomer. Sometimes called vinyl.

Pre-Shimmed Tape Sealant
A sealant having a pre-formed shaped containing solids or discrete particles that limit its deformation under compression.

Primer
A coating specifically designed to enhance the adhesion of sealant systems to certain surfaces, to form a barrier to prevent migration of components, or to seal a porous substrate.

Processed
Glass which has undergone further treatment after manufacture (e.g. laminated, toughened, curved, silvered, coated etc).

PVC
(See Polyvinyl Chloride.)

Pyrolytic
A glass which has a coating deposited during the glass manufacturing process. The coating is fired into the glass surface at 700˚C and is therefore extremely hard and durable.

Quench Pattern
(See Strain Pattern.)

Racking
A movement or distortion of sash or frames causing a shape in angularity of corners.

Rebate
An 'L' shaped section which can be face glazed or receive a removable glazing bead to hold the panel of glass in place.

Reflective Glass
Glass with a metallic coating to reduce solar heat gain. (See also Solar Control Glass.)

Relative Heat Gain
The amount of heat gain through a glass product taking into consideration the effects of solar heat gain (shading coefficient) and conductive heat gain (U-value). The value is expressed in (W/m^2). The lower the relative heat the more the glass product restricts heat gain.

Roller-wave Distortion
Waviness imparted to horizontal heat treated glass while the glass is transported through the furnace on a roller conveyor. The waves produce a distortion when the glass is viewed in reflection.

Rolled Glass
Glass formed by rolling, including patterned glass and wired glass. (See also Patterned Glass.)

Rub
A series of small scratches in glass generally caused during transport by a chip lodged between two panels.

R-value
The thermal resistance of a glazing system. The higher the R-value the less heat is transmitted throughout the glazing material. The R-value is the reciprocal of the U-value

STC (Sound Transmittance Class)
A single number rating derived from individual transmittance losses at specified test frequencies. It is used for interior walls, ceilings and floors and in the past was also used for preliminary comparison of the performance of various glazing materials.

STL (Sound Transmittance Loss)
The reduction of the amount of sound energy passing through a wall, floor, roof, etc. It is related to the specific frequency (Hz) at which it is measured and it is expressed in decibels (dB). Also called Transmittance Loss (TL).

Sandblasted Finish
A surface treatment for glass obtained by spraying the glass with hard particles to roughen one or both surfaces of the glass.

The effect is to increase obscurity and diffusion, but it makes the glass weaker and harder to clean.

Safety Glass
Processed glass types which satisfy the requirements of AS/NZS 2208 for safety glazing. Laminated, toughened safety glass are rated Grade A. Wired glass is rated Grade B.

Salt Spray Test
Accelerated corrosion test in which samples are exposed to a fine mist of salt water. Primarily used to test silvered glass.

Salvage Edges (Bulb Edge)
The extreme lateral edges of the glass ribbon which are stripped off and recycled.

Sash
The moveable window frame which contains the glass pane.

Seeds
Minute bubbles in float glass.

Security Glass
Glass not just designed as Grade A safety but to also withstand various forms of violent attack. They are usually special combinations of laminated glass and can incorporate toughened glass and polycarbonates - see G.James ArmaClear range (BR, PA and PS).

Setting Blocks
Generally rectangular, cured extrusions of neoprene, EPDM, silicone, rubber or other suitable material on which the glass product bottom edge is placed to effectively support the weight of the glass.

Shading Coefficient
Ratio of the solar heat gain through a specific glass product compared to the solar heat gain through 3mm clear glass.

Sheet Glass
Refers to the drawn sheet process, which is pulled up vertically and consequently embodies inherent lines of distortion. It is a fire finished glass.

Shadowgraph
A test rig for inspecting glass with respect to distortion and other defects.

Shelf Life
Used in the glazing and sealant business to refer to the length of time a product may be stored before beginning to lose its effectiveness. Manufacturers usually state the shelf life and the necessary storage conditions on the package.

Shims
(See Spacers.)

Shore 'A' Hardness
Measure of firmness of a compound by means of a Durometer Hardness Gauge (A hardness range of 20-25 is about the firmness of an art gum eraser. A hardness of 90 is about the firmness of a rubber heel.

Sight Line
The line along the perimeter of the glazed panel corresponding to the edge of stationary or removable bead. The line to which sealants contacting the glazed panel are sometimes finished off.

Silicone Sealant
One part or two part elastromeric adhesive, rubber sealant which cures at room temperature (also referred to as room temperature vulcanising (RTV)). Its inorganic composition means silicone sealant is unaffected by UV, ozone and extremes of hot and cold. Further it will not break-down or lose adhesion and for this reason is widely used in most glazing applications.

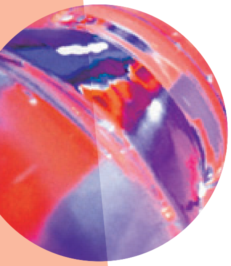
Silkscreen
A decorating process in which a design is printed on glass through a fine silk mesh or similar screen.

Sill
The bottom horizontal member of the window/door frame.

Silvering
The application by chemical or other methods of a film of silver to a glass surface to create mirrors.

Sloped Glazing
Any installation of glass that is less than 70° from vertical.

Smoke
Streaked areas appearing as slight discolouration on glass.



Solar Control Glass
Tinted and/or coated glass that reduces the amount of solar heat gain transmitted through a glazed product.

Solar Energy Reflectance
In the solar spectrum, the percentage of solar energy that is reflected from the glass surface(s).

Solar Energy Transmittance
The percentage of ultra-violet, visible and infra-red energy within the solar spectrum that is transmitted through the glass.

Solar Heat Gain Coefficient
The ratio of directly transmitted and absorbed solar energy that enters into the building’s interior (when compared to an open space). Solar heat gain includes directly transmitted solar heat and absorbed solar radiation which is then re-radiated, conducted, or convected.

Spacers (Shims)
Small blocks of neoprene, EPDM, silicone or other suitable material, placed on each side of the glass product to provide glass centring, maintain uniform width of sealant bead and prevent excessive sealant distortion.

Spandrel
The panel(s) of a wall located between vision areas of windows which conceal structural columns, floors and shear walls.

Spectrally Selective Glass
Tinted and/or coated flat glass that selectively reduces the amount of ultra-violet and infra-red transmittance.

Stain
Discolouration of either a glass or finished aluminium surface caused by alkalis that leach from surrounding materials such as pre-cast or cast-in-place concrete or from sealants, pollutants or other contaminants.

Stained Glass
Refers to the craft of lead-lighting - glass which is coloured by fusing pigments to the surface or windows made up of pieces of stained glass.

Stones
Any crystalline inclusion embedded in the glass.

Strain
The percentage of elongation or compression of a material or portion of a material caused by an applied force.

Strain Pattern
A specific geometric pattern of iridescence or darkish shadows that may appear under certain lighting conditions, particularly in the presence of polarised light (also called quench pattern). The phenomena is caused by the localised stresses imparted by the rapid air cooling of the tempering operation. Strain pattern is characteristic of all heat treated glass.

Stress (Residual)
Any condition of tension or compression existing within the glass, caused by incomplete annealing or induced temperature gradient during the manufacture of heat treated glass.

Substance
Refers to the thickness of glass expressed in mm.

Surface Modified
Glass whose surface has been modified in such a way that it reduces solar heat gain by reflection rather than absorption.

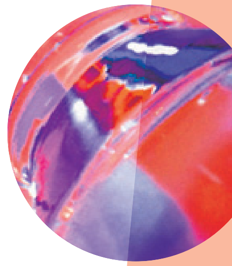
Structural Glazing Gaskets
Cured elastomeric channel-shaped extrusions used in place of a conventional sash to install glass products onto structurally supporting sub-frames, with the pressure of sealing exerted by the insertion of separate lockstrip wedging splines.

Structural Silicone Glazing
The use of a silicone sealant for the structural transfer of loads from the glass to its perimeter support system and retention of the glass in opening.

Substrate
A base material to which other materials are applied.

Tape Sealant
A sealant having a pre-formed shape and intended to be used in a joint under compression.

Thermal Endurance
The relative ability of glass to withstand thermal shock.



Thermal Stress
Stress generated in glasses as a consequence of temperature differentials such as hot centre and cold edges (in the frame).

Tinted Glass
Glass with colourants added to the basic glass batch that give the glass colour, as well as, light and heat reducing capabilities. The colour extends throughout the thickness of the glass. Typical colours include bronze, grey, dark grey, aquamarine, green, deep green and blue.

Tong Marks
Small, surface indentations near and parallel to one edge of vertically toughened or vertically heat strengthened glass resulting from the tongs used to suspend the glass during the heat treating process.

Transmittance
The ability of the glass to pass light and/or heat, usually expressed in percentages (visible transmittance, thermal transmittance, etc).

Transom
A cross piece which separates a door from a window above. The horizontal member that supports panels, glass, sashes or sections of curtain wall.

Two-Part (Multi-Component) Sealant
A product comprised of a base and curing agent or accelerator, necessarily packaged in two separate containers which are uniformly mixed just prior to use.

Total Heat Gain
The sum of direct solar transmittance plus the proportion of absorbed energy, which is re-radiated to the inside of the glazing.

Toughened Glass
(See Fully Toughened Glass)

Ultra-violet
The name of the invisible portion of the light spectrum with wave lengths shorter than 380 nanometres.

U-value
A measure of air-to-air heat transmittance (loss or gain) due to thermal conductance and the difference in indoor and outdoor temperatures. As the U-value decreases, so does the amount of heat that is transferred through the glazing material. The lower the U-value, the better the insulation.

Vents
Small cracks at the edges of glass that can lead to breakage.

Vinyl Back Mirror
Organic vinyl backing applied to mirrors that holds the glass together when broken.

Visible Light Reflectance
The percentage of visible light (380 to 780 nanometres) within the solar spectrum that is reflected from the glass surface.

Visible Light Transmittance
The percentage of visible light (380 to 780 nanometres) within the solar spectrum that is transmitted through glass.

Weathering (also Stain)
Attack of a glass surface by atmospheric elements.

Weep Holes
Small holes or slots in the sash or framing system which allows water to drain to the building exterior.

Wet Seal
Application of an elastomeric sealant between the glass and sash to form a weather-tight seal.

Wired Glass
Rolled glass having a layer of meshed or stranded wire embedded near to the centre of thickness of the panel. This glass is available as polished glass (one or both surfaces) and patterned glass.

How to complete the Thermal Safety Assessment Request

(For further information on Thermal Breakage refer Section 1.11)

Vision / Sloped Glazing

Location
City, town or country where building is located.

Glass Type
Full description required, e.g. IG unit comprising 6mm TS40 (2) on Green/12mm airspace/6mm Energy Advantage (3).

Glass Sizes
Largest and smallest panel sizes required as the size of the glass has an effect on thermal stress.

Glass Application
Options are fixed glass, sliding windows and doors (which include double hung windows) and openable awning or casement sashes. The window configuration may effect thermal stress, e.g. a fully opened sliding door/window can act as a double glazed unit increasing the amount of solar absorption to the outer lite.

Glass Orientation
This refers to the aspect of the facades containing glass. If glass is installed to all four sides of the building, tick all four boxes. The angle of the glazing is also required, as glass glazed on a slope is subject to higher solar radiation than panels glazed vertically.

Glazing Type
Options include the following:

- Glass fully glazed (captive) in a frame
- 2-sided captive – vertical is framing only to the vertical edges with no framing to the horizontal edges.
- 2-sided captive – horizontal is the reverse of 2-sided captive vertical.
- 4-sided structural is glass retained by silicone only without any framing.

Frame Material
Options are metal (aluminium/steel), wood/timber or PVC.

Frame Colour
Options include Light (clear anodised, white), Medium (light grey, light blue) or Dark (black, dark bronze).

Overhead Shading
Distance (mm) any overhang, soffit or awning extends beyond the front of the glass.

Mullion Projection
Distance (mm) the mullion extends beyond the front of the glass.

Transom Projection
Distance (mm) the transom extends beyond the front of the glass.

Depth of Column
Distance (mm) a column extends beyond the front of the glass face creating a vertical shadow.

Depth of Set Back
Distance (mm) from extreme building face of the glass in a 'punched' (recessed) window.

Blinds/Drapes Behind Glass
Will blinds or drapes be installed to the inside of the glass?

Ventilated Airspace
Will the space between blinds/drapes and the glass be ventilated? The criteria for a ventilated airspace are:

- A 50mm clearance between the glass and the shading device
- A 38mm clearance between the top and bottom or one side and bottom between shading device and surround

Colour of blinds
Refers to the colour of the blinds/drapes, either light (white) or dark (black).

Venetian Blinds Between Two Glasses
Will venetian blinds be installed between any two glasses (i.e. double glazed or jockey sash windows)?

Gaps (Glass-Blind-Glass)
Distance (mm) between glass to blind to glass.

Spandrel Glass

Glass Type
Full description required, for example 6.38mm TS21 Clear Laminated.

Glass Sizes
Largest and smallest panel sizes required as the size of the glass has an effect on thermal stress.

Backup Wall
Does the spandrel cavity contain a backup wall of masonry, metal sheeting or other material?

Colour of Backup Wall
Refers to the colour of the backup wall material, either light (white) or dark (black).

Distance from Wall to Glass
Distance (mm) from back of spandrel glass to backup wall.

Airspace Ventilated
Is there a cavity behind the spandrel glass and is it fully sealed or ventilated (preferable at the top and bottom) to allow airflow?

NB: If you require assistance in completing the Thermal Safety Assessment Request, please contact our Technical Advisory Service.

G.James Thermal Safety Assessment Request

PHOTOCOPY, COMPLETE FORM AND SEND TO G.JAMES SAFETY GLASS

The following information is required to conduct a Thermal Safety Assessment. Please complete all relevant sections. The accuracy of the assessment is based on the information supplied.

Company Name ____________________ Contact ____________________

Phone No. ____________________ Fax No. ____________________

Project Reference ____________________ Location ____________________

Vision / Sloped Glazing

Glass Type (Full Description) ____________________

____

Glass Sizes

Largest ____________________

Smallest ____________________

Glass Application

☐ Fixed Glazed ☐ Sliding Windows/Doors

☐ Openable Sash

Glass Orientation

☐ North ☐ South ☐ East ☐ West

☐ Vertical ☐ Sloped Angle ____________________

Glazing Type

☐ Fully Captive ☐ 2-Sided Captive – Vertical

☐ 2-Sided Captive – Horizontal ☐ 4-Sided Structural

Framing Material

☐ Metal ☐ Wood ☐ PVC

Frame Colour

☐ Light ☐ Medium ☐ Dark

Overhead Shading ____________________ mm

Mullion Projection ____________________ mm

Depth of Column ____________________ mm

Transom Projection ____________________ mm

Depth of Set Back ____________________ mm

Blinds/Drapes Behind Glass

☐ Yes ☐ No

Colour of Blinds

☐ Light ☐ Dark

Ventilated Air Space

☐ Yes ☐ No

Venetian Blind Between Two Glasses

☐ Yes ☐ No

Gaps (Glass-Blind-Glass)

__________ mm and __________ mm

Spandrel Glass

Glass Type (Full Description) ____________________

____

Glass Sizes

Largest ____________________

Smallest ____________________

Backup Wall

☐ Yes ☐ No

Backup Wall Colour

☐ Light ☐ Dark

Distance from Wall to Glass ____________________ mm

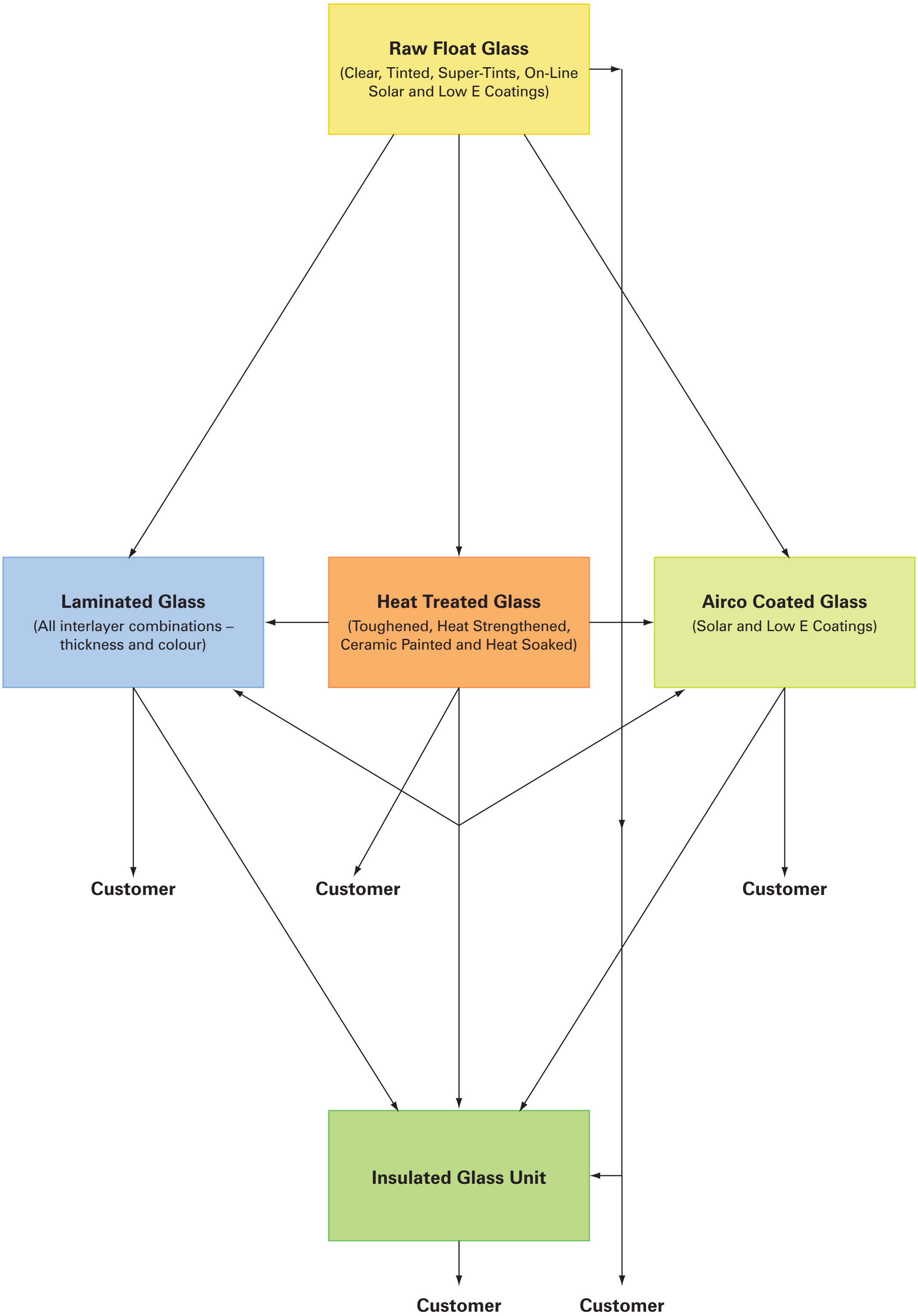
Airspace Ventilated

☐ Yes ☐ No

Signed ____________________ Date ____________________

Glass Processing Flow Chart

(Possible Combinations)



Index

A

acoustic spectrum 24
Amiran 63
anti-bandit glass 33
aquatic glazing 68
ArmaClear bullet resistant glass
- applications 56
- framing & accessories 57
- glazing 81
- performance 58
- process 56
- product types 57
- properties 56

ArmaClear physical attack glass
- applications 58
- framing 59
- glazing 81
- performance 59
- process 58
- product types 58
- properties 58

ArmaClear prison shield glass 59
Azurlite 29

B

back-up material 20
balustrades 36
bevelling 14
bi-folding doors 41
Borofloat 64,65
Borosilicate 64,65
Brewsters fringes 55
brillant cut 13
Broadline 73
bullet resistant glass 56
butt-joint glazing 79
butyl tapes 77

C

ceiling domes 62
ceramic painted glass 26,41
ceramic painted patterned glass 74
clear float 28
coated glass
- definitions 49
- handling criteria 50
- process 48

coated surface identification 11
coincidence dip 25
colour perception 23
Colourlite 41
- applications 42
- process 42
- properties 42

condensation 54
Contraflam 65
conversion factors 86
convex mirrors 62
coolness factor 19
curved toughened glass 44
- acceptance criteria 47
- applications 46
- available curves 46
- glazing 47,81
- maximum sizes 46
- measuring 46
- process 44
- standards 47
- terminology 44

cut-outs 15
cyclone resistant laminate 33
cylinder process 6

D

damaged weighted transmission (Tdw) 22
data shielding glass 69
daylighting 23
decorative glass 72
dew point 55
Diamant 29
diffused reflection glass 63
dry glazing 76

E

edgework 13
edge delamination 33
elastomeric sealants 77
electromagnetic spectrum 17
electronic security 68
Evergreen 29

F

fade control 21
Faradays cage principle 68
figured rolled pattern glass
- applications 74
- characteristics 74
- process 72
- types 72

finite element analysis 10
fire rated glass 64
fire rated products 65
fire rated systems 64
- insulated 65
- non-reinforced 65
- reinforced 65

fire resistant levels (FRL) 64
FireLite 64,65
flat grind 13
flat polish 13
flat smooth 13
Flemish 73
float glass process 7
Fourcault process 7
frameless entries 40
frameless showerscreens 38

G

Georgian wired glass 65,72
Glacier 73
glass
- assemblies 38
- blocks 65,66
- breakage characteristics 16
- care and storage 12
- ceramics 64
- cleaning 12,50
- decorative 72
- edge condition 20
- floors 70
- history 6
- processing 13
- processing flow chart 100
- properties 8
- setting blocks 79
- staining 11
- stair treads 70
- strength 9
- strength design 9
- surface identification 11
- thickness tolerances 10

glazing
- annealed glass 80
- bullet resistant glass 81
- butt-joint 79
- considerations 80
- curved glass 81
- dry 76
- heat treated glass 80
- laminated glass 80
- physical attack glass 81
- structural 79
- techniques 76
- Twin-Glaze units 80
- weatherseal 80
- wet 77

glossary 88
Glue Chip 73

H

heat resistant glass
- Borofloat 64
- Borosilicate 64
- FireLite 64
- glass ceramics 64
- toughened 63
- Robax 64

heat soak testing 43
heat strengthened glass
- characteristics 16
- process 34
- properties 35

heat treated glass
- applications 36
- available sizes 35
- characteristics 42
- glazing 80
- manufacturing guidelines 36
- process 34
- process limitations 37
- properties 35
- strength 9

holes 15

I

insulated glass units
- applications 53
- characteristics 55
- glazing 80
- heat gain/loss 54
- manufacturing guidelines 53
- process 52
- properties 53

- solar control . . . 54
- spandrel design . . . 26
- strength . . . 9
irregular shapes . . . 15

K

Kosciusko . . . 73

L

laminate mirror . . . 61
laminated glass
- applications . . . 32
- benefits . . . 31
- characteristics . . . 16,33
- glazing . . . 80
- process . . . 30
- strength . . . 9
lead glass . . . 62
low E (Low Emissivity) . . . 50
low iron glass . . . 29
luminous efficacy . . . 19
Luxar . . . 63

M

mirror . . . 60
- applications . . . 60
- handling & processing . . . 60
- installation . . . 81
- process . . . 60
- types . . . 60
mirror doors . . . 61
mist free mirrors . . . 61
mitre . . . 13

N

Narrow Reeded . . . 73
neoprene . . . 76
New Cathedral . . . 73
Newtons rings . . . 55
nickel sulphide inclusion (NiS) . . . 43
non-reflecting glass . . . 63
notches . . . 15

O

Obscura . . . 73
off-line coatings . . . 48
one-way mirror . . . 61
on-line coatings . . . 48
opacifier (organic) . . . 26
Optigray . . . 29
Optilight . . . 32

P

patterned glass . . . 72
Patternlite . . . 74
- applications . . . 75
- process . . . 75
- properties . . . 75
- types . . . 75
performance terms . . . 18
physical attack glass . . . 58
picture glass . . . 63
pillowing . . . 55
Polished wired . . . 65,72
prison shield glass . . . 59
product standards . . . 83
Promaclear . . . 65
Promaglas . . . 65
putty based compounds . . . 77
pyrolytic glass . . . 48
Pyrobel . . . 65
Pyrostop . . . 65
Pyroswiss . . . 65

Q

quality management systems . . . 83
quench pattern . . . 42

R

RAT equation . . . 17
reflective glass . . . 48
Robax . . . 64
roller-wave . . . 42
rough arris . . . 13
Roughcast . . . 73
round and polished . . . 13

S

Satinlite . . . 73
Scintilla . . . 73
Seadrift . . . 73
sealant
- adhesion . . . 78
- compatibility . . . 78
- selection . . . 77
- silicone . . . 77
- stain testing . . . 78
- surface & joint preparation . . . 78
- tooling . . . 78
Securiflam . . . 65
security glass . . . 56
Shade-12 . . . 66
shading coefficient (SC) . . . 18
shadow boxes . . . 26
silicone applications . . . 77
silver glass . . . 60
smooth arris . . . 13
solar
- control . . . 18
- energy reflectance . . . 18
- energy transmittance . . . 18
- heat gain coefficient (SHGC) . . . 18
- spectrum . . . 17
Solarplus . . . 48
- coatings . . . 50
- low E . . . 51
sound
- acoustic spectrum . . . 24
- coincidence dip . . . 25
- design levels . . . 23
- glass performance . . . 25
- insulation . . . 23
- insulation measures . . . 24
- intensity . . . 24
- perceived loudness . . . 23
- traffic noise reduction . . . 25
- transmission class (STC) . . . 25
- transmission loss (STL) . . . 25
spandrel design . . . 26
Sparkle . . . 73
special processing . . . 15
special purpose windows . . . 59
Spotswood . . . 73
sputtering process . . . 49
Squarelite . . . 73
stacking doors . . . 41
standards . . . 82
Starphire . . . 29
STC . . . 25
STL . . . 25
stocklines . . . 84
Strata . . . 73
structural glazing . . . 79
Supergrey . . . 29
supertints . . . 29
suspended assemblies . . . 38
Swissflam . . . 65

T

Tandarra . . . 73
test facilities . . . 83
thermal breakage . . . 19
thermal heat transfer . . . 18
thermal safety assessment request form . . . 99
thermal stress
- causes . . . 19
- factors . . . 19
tinted float . . . 28
total solar energy transmittance . . . 18
toughened glass
- characteristics . . . 16
- curved . . . 44
- process . . . 34
- properties . . . 35
train windows . . . 59
Twin-Glaze units
- applications . . . 53
- characteristics . . . 55
- glazing . . . 80
- heat gain/loss . . . 54
- manufacturing guidelines . . . 53
- process . . . 52
- properties . . . 53
- solar control . . . 54
- spandrel design . . . 26
- strength . . . 9

U

U-value . . . 18
units of measure . . . 86

V

venetian strip mirror . . . 62
visible light reflectance . . . 18
visible light transmittance . . . 18

W

weatherseal glazing . . . 80
welding glass . . . 66
wet glazing . . . 77
wired safety glass . . . 16

X

X-ray glass . . . 62

Registered Names

- Solarplus, Optilight, Twin-Glaze, ArmaClear, Colourlite and Patternlite are registered names of G.James Australia Pty. Ltd
- Arctic Blue, Evergreen, Supergrey, Eclipse, Georgian, K Glass, Anti-bandit, Reflectafloat, Pyrostop and Energy Advantage are registered trade names of Pilkington
- Azurlite, Optigray, Solargreen, Solarcool, Sungate and Starphire are registered trade names of PPG Industries Inc.
- Contraflam, Pyroswiss, Securiflam and Swissflam are registered trade names of Vetrotech Saint-Gobain International
- Borofloat, Borosilicate, Robax and Amiran are registered trade names of Schott
- Stopsol and Pyrobel are registered trade names of Glaverbel
- FireLite is a registered trade name of Nippon Electric Glass Co. Ltd
- Panasap is a registered trade name of P.T. Ashimas Flat Glass Co., Ltd
- Diamant is a registered trade name of Saint-Gobain
- Promaclear is a registered trade name of Promat Worldwide/Etex Group
- Luxar is a registered trade name of Hy-Tech-Glass
- Santoprene is a registered trade name of Monsanto
- AIRCO is a registered trade name of the BOC Group

Acknowledgements

We are grateful to the many manufacturers and associations from whose publications we have sourced information for this handbook. If we have omitted anyone, it has certainly not been intentional and we apologise. Thanks also to the G.James staff who have contributed to the success of this publication.

G.James wishes to acknowledge the following for their contributions:

- Dorma
- Dow Corning
- DuPont
- Glaverbel Group
- Guardian Industries Corp.
- Metropolitan Glass (NZ)
- Nippon Electric Glass
- P.T. Asahimas Flat Glass Co. Ltd
- Pilkington (Australia) Limited
- Pilkington United Kingdom Limited
- Pilkington North America
- P.P.G. Industries Inc. (George Fethers & Co.)
- R.E. Mandl & Co. Pty Ltd
- Reed Educational and Professional Publishing Australia
- Saint-Gobain
- Schott
- Solutia Inc.
- Viracon
- J.Weck GMBH U. Co./Obeco Glass Blocks

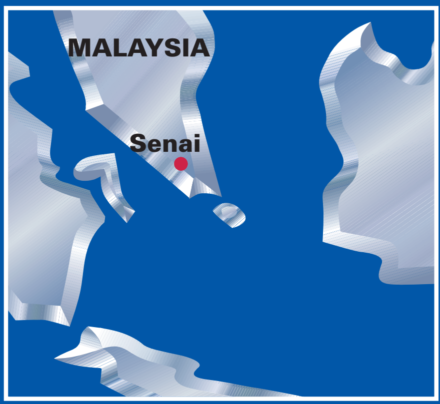
References

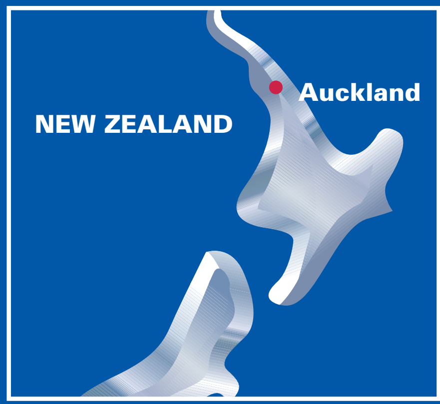
- About Glass… – *Flachglas AG*
- AMIRAN Anti-reflective glass, Transparent Solution for Exterior/Interior Applications – *Schott Glas*
- FireLite, FireLite Applications in Japan – *Nippon Electric Glass*
- Glass in Architecture and Decoration – *Raymond McGrath*
- Glass in Building, Butterworth Architecture – *Button and Pye*
- Glass in Building – *Saint-Gobain*
- Glass Processing Days 1997, Educational Glass Conference – *Tamglass Engineering*
- Glazing Manual, 1997 Edition – *Glass Association of North America*
- Guardian Architectural Glass, A Worldwide Presence – *Guardian*
- Guardian Industries, Global Product Selection Guide – *Guardian*
- Laminated Architectural Glass, 1994 Specification Guide – *Monsanto, the Chemical Group*
- LX Radiation Shielding Lead Glass – *Nippon Electric Glass*
- Metropolitan Glass Catalogue and Reference Guide, 4th Edition – *Metropolitan Glass*
- National Glass Catalogue and Reference Guide 2000, 2nd Edition – *National Glass Pty Ltd*
- New Zealand Design Trends, The Specifier's Guide, Volume 13 No.7 – *Trends*
- Pilkington Glass and Thermal Safety, January 1980 – *Pilkington Flat Glass Limited*
- PPG Architectural Glass 1999 – *PPG Glass Technology*
- Silicone Structural Glazing Manual – *Dow Corning*
- The Glass and Glazing Handbook, 1998 – *Noel C Stokes*

Disclaimer

While drawing on our experience of almost 90 years in the glass industry, we have also drawn from industry publications and many manufacturers literature from around the world. G.James have been careful and diligent to ensure the accuracy of all the information contained in this handbook but to the extent limited by law G.James accepts no responsibility for any inaccuracies of any kind.

Due to continual product development, G.James reserves the right to alter product specifications without notice.





G.James
is glass

www.gjames.com.au

Queensland
G.James Safety Glass Pty. Ltd.
1007 Kingsford Smith Drive,
Eagle Farm, Brisbane
Ph: 61 7 3877 2866
Fax: 61 7 3877 2295

New South Wales
G.James Safety Glass Pty. Ltd.
26 Long Street,
Smithfield, Sydney
Ph: 61 2 9732 2111
Fax: 61 2 9732 2199

Victoria
G.James Safety Glass Pty. Ltd.
217 Rex Road,
Campbellfield, Melbourne
Ph: 61 3 9219 2000
Fax: 61 3 9219 2099

Asia Pacific
G.James Industries (Malaysia) Sdn. Bhd.
Lot 2596, Jalan Perindustrian 3, Kawasan
Perindustrian Senai Fasa 11, 81 400
Senai, Johor, Malaysia
Ph: 60 7 599 3266 Fax: 60 7 599 3212

Other G.James branches are located at:

Queensland:
Logan City, Narangba, Ipswich, Gold Coast,
Toowoomba, Sunshine Coast, Gympie,
Hervey Bay, Bundaberg, Gladstone, Rockhampton,
Mackay, Townsville & Cairns

New South Wales:
Lismore, Port Macquarie, Taree
& Newcastle

Western Australia:
Perth

Asia Pacific:
Auckland (New Zealand)