BRANZ

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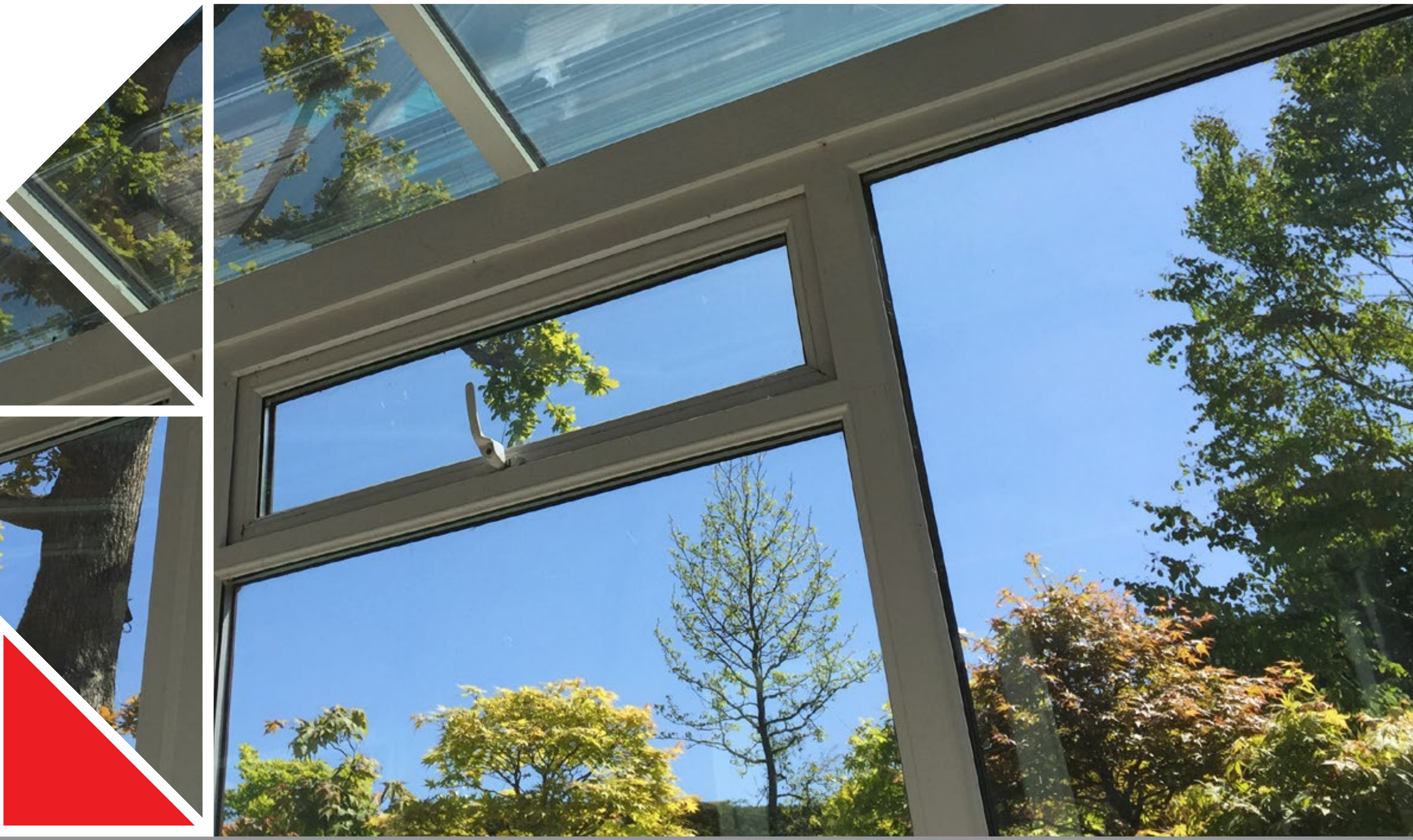


SPECIFYING GLAZING

March 2023

- Changing government regulations and the development of new technology are bringing big changes to the glazing in our doors, windows and skylights.
- This bulletin gives an overview of the different types of glazing available today and provides guidance around specification.
- The bulletin does not give details about insulating glass units (IGUs) or compliance with Building Code clause H1. Other bulletins cover those topics.

1 INTRODUCTION

1.0.1 Changes in technology and government regulations, especially the requirements in the compliance documents for New Zealand Building Code clause H1, are substantially transforming the glazing in new windows, doors and skylights.

1.0.2 While a single sheet of float glass can be referred to as 'glass', what sits inside the frames of most new windows, doors and skylights today is two or three sheets of glass, referred to as an IGU (insulating glass unit), that can incorporate low-E coatings and other treatments and materials. The part of the window we look through is therefore less likely to be a single material referred to as 'glass' and more likely a system referred to as 'glazing'.

1.0.3 This bulletin gives an overview of the different types of glazing available today and gives guidance around their specification.

1.0.4 The increasing risk of new homes overheating due to thermal gain is also covered. This should be an important consideration in the specification of windows and glazing in all new homes.

1.0.5 The bulletin does not go into detail about the construction of IGUs nor the R-values that glazing must achieve to comply with clause H1. For more information on those topics, see Bulletin 680 *Insulating glass units* and Bulletin 670 *Specifying windows and doors under H1*.

2 GLASS AND HOW IT IS MADE

2.0.1 Flat window glass is called 'float glass' because of the way it is manufactured. Silica sand, the main ingredient in glass, is mixed with lime and soda and heated to approximately 1,500°C, typically using natural gas. The molten glass floats over a bed of molten tin (at 1,000°C) and is then cooled in a controlled manner to form a continuous sheet. Float glass is normally manufactured in thicknesses of 2–25 mm. Other additives such as magnesium and aluminium oxide can be put into the mix to help melting and make it run properly, and other oxides are added for colour. Recycled glass (called 'cullet') can be added and has the advantage of reducing the energy required in the process. Float glass technology is continuing to evolve with the refinement of the process to reduce energy use and byproducts and the development of new types of hot-applied coatings.

2.0.2 Float glass is not currently manufactured in New Zealand and is all imported. The closest manufacturer is in Australia. Glass for construction can be grouped under the broad headings of:

- clear float glass
- low-iron float glass (extra-clear float glass)
- body-tinted float glass (in a range of tint colours)
- coated float glass (reflective and/or low-E coated)
- patterned glass (with a surface texture)
- obscure glass (privacy glass)
- bent and curved glass.

2.0.3 These different types can be used individually or combined by laminating two or more sheets together or combining two or more sheets as IGUs. Glazing systems can also incorporate other materials such as acrylic or polycarbonate sheets typically to provide stronger glazing for security purposes.

2.0.4 Glass is processed in New Zealand to meet specific performance requirements. Processes available here include:

- cutting, drilling and edge working (grinding, polishing and bevelling)
- laminating
- toughening and heat strengthening
- IGU manufacture
- ceramic screen and digital printing
- colour coating
- mirror coating
- surface etching and engraving.

2.1 GLASS, CARBON AND GHG EMISSIONS

2.1.1 The production of glass requires high furnace temperatures and so its manufacture uses considerable amounts of energy. In November 2021, *Nature* magazine reported that, worldwide, glass manufacturing produces at least 86 million tonnes of carbon dioxide every year. The magazine also said that glass "could be the star of a net-zero carbon economy" because it can theoretically be recycled infinitely without losing any of its properties and recycling produces far less carbon dioxide than new manufacture. There are various technical and practical/logistical barriers to this, as there are specific requirements to manufacture float glass and only clean, clear recycled float glass can be used back in the production of float glass. A lot of glass used in buildings worldwide currently ends up in landfill.

2.1.2 In New Zealand, a considerable portion of window glass from processors and window manufacturers is recycled by 5R Solutions. There are number of regional facilities across New Zealand supporting two processing centres. The processed glass is used for the manufacture of glass wool insulation.

2.1.3 The BRANZ carbon tool CO_2NSTRUCT gives embodied carbon and embodied energy data for clear float glass based on an environmental product declaration from an Asian manufacturer.

3 MAIN TYPES OF GLASS USED IN GLAZING WINDOWS AND DOORS

3.1 CLEAR FLOAT GLASS

3.1.1 Float glass offers high clarity and low distortion and is the most widely used type of glass in construction. It is typically available in thicknesses of 2–19 mm. Visible light transmission of clear float glass is around 80–90%, but this falls with glass thickness.

3.1.2 It is common for standard float glass to have a very slight green tint from the iron in the sand. Low-iron float glass is available that has almost none of this colour. This product typically has the highest level of visible light transmission – over 90% is possible – and this remains almost the same as thickness increases. Low-iron float glass is available in thicknesses of around 4–19 mm. This glass is ideal for use where a green tint would not be welcome, such as in a bathroom with white tiles on the walls (where it would need to be toughened to become safety glass).

3.2 SAFETY GLASS

3.2.1 Safety glass has been manufactured or treated to make it less likely to break, splinter or otherwise pose a threat when it is hit or when someone runs into it or falls against it. It may be that broken shards are held in place (laminated glass) or it may shatter into small relatively harmless particles (toughened glass). Safety glass must be tested and comply with the requirements of AS/NZS 2208:1996, BS EN 12150-2:2004, BS EN 14449:2005 or ANSI Z97.1-2015.

3.2.2 There are many different types of safety glass – eight types are listed in NZS 4223.3:2016 *Glazing in buildings – Part 3: Human impact safety requirements*. However, for practical purposes, the safety glass widely available in New Zealand falls into two main categories:

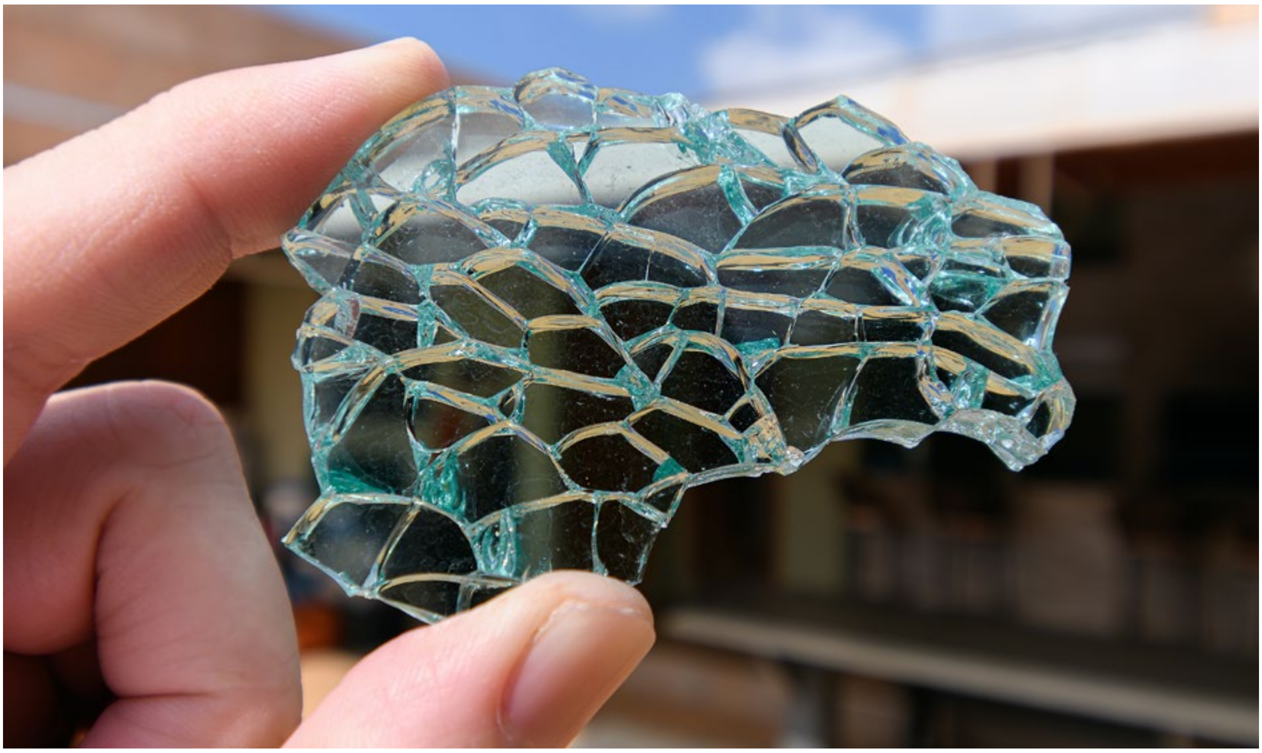
- Toughened glass breaks into small cube-like pieces that are much less likely to cause injury than ordinary float glass. Toughening involves heating float glass to around 620–650°C and then cooling it very quickly. There are a number of toughening furnaces across the country. Glass cannot be recut or otherwise reworked once it has been toughened, so it must be cut to the appropriate size and shape before undergoing the toughening process. Toughened glass should not be used where fire resistance is a requirement. In New Zealand, toughened glass is available in thicknesses of approximately 4–20 mm. The thickness selected depends on the required end use. Toughened glass is available with many options, including tinting, frosting and laminating. In a very few cases, toughened safety glass can shatter after installation due to tiny impurities in the original glass. A process after toughening called heat soaking is available that greatly reduces the risk of this happening.
- Laminated safety glass has a vinyl interlayer between two sheets of glass that holds the glass together if the window is broken. Laminated safety glass is available from around 6–20 mm thick. Options include laminated toughened glass, where two panes of toughened glass are laminated together, usually for additional safety.

3.2.3 NZS 4223.3:2016 specifies the minimum requirements for glass and glazing in locations where people are at risk of injury from glass. The standard provides a means of compliance with the relevant performance requirements of Building Code clauses B1, F2 and F4.

3.2.4 Among other requirements, the standard requires safety glass in:

- glazing in bathrooms, ensuites or spa rooms within 2 m of the finished floor level
- glazing wholly or partly within 2 m vertically and within 2 m horizontally of the walking surface alongside spa pools and swimming pools
- doors (with a few exceptions).

3.2.5 The Window & Glass Association NZ has created a decision tree to help determine the right glass to specify under NZS 4223.3:2016 (excluding balustrades, fences and screens).



When toughened glass is broken, it shatters into tiny pieces, vastly reducing the danger of injury from flying shards of glass with sharp edges.

3.2.6 Glass barriers must also be safety glass. B1/AS1 cites, and partially modifies, the glass barrier requirements in section 22 of NZS 4223.3:2016. The standard has diagrams for several different barrier configurations that incorporate glass. The necessary glass thicknesses are provided for different types of safety glass.

3.3 SOLAR CONTROL GLAZING AND LOW-E COATINGS

3.3.1 Sunlight entry through glazing can be restricted by reflecting away most of the sun using reflective or low-emissivity (low-E) glazing. Low-E glazing has a microscopically thin transparent metal coating that allows light through in both directions but reflects long-wave infrared radiation and associated heat back, allowing glazing to keep a house warmer in winter or cooler in summer (through solar heat gain control). Some low-E glazing can also assist with a reduction in fading. The impact of low-E glazing in both summer and winter needs to be considered – a slight compromise at one time of year may be necessary to achieve an overall better energy performance outcome.

3.3.2 H1/AS1 and H1/VM1 5th edition amendment 1 include four levels of low-E glazing in the generic windows in Appendix E – Low-E_1 to Low-E_4. The numbers indicate different thermal performance levels of low-E coatings from basic to very high. Low-E coatings can be applied in two different ways:

- A hard-coat application takes place while the glass is still in a molten state. This gives a very durable coating.
- A soft-coat application is carried out after the glass has been manufactured. A soft coat is more vulnerable than a hard coat but is more efficient at reflecting heat energy.

3.3.3 Heat-absorbing glass, sometimes referred to as thermal glass, can reradiate some of the heat absorbed back to the outside and also help reduce glare. Some heat is also reradiated to the inside. All solar control glass reduces the amount of light entering a building, so a disadvantage is that, in winter, it reduces the amount of solar gain available to heat the interior. This glass comes in a range of colour tones, including grey, green and blue.

3.3.4 Solar control films are multi-layered polyester films applied to glass to reflect and/or absorb the sun's rays. They may reduce heat gain by up to 80% and moderate the amount of visible light and glare entering the room. These films can also be applied to increase glass safety but are not a replacement for safety glass where required for compliance. They reflect a significant proportion of incoming heat but also reduce the transmission of daylight to the interior and solar gain needed in winter. They may not be suitable where thermal mass such as an exposed concrete floor is to be directly heated. They may also not be durable in situations of high exposure to UV light.

3.3.5 Designers/specifiers will need to pay careful attention to any impact added films and treatments may have on compliance with Building Code clause G7 *Natural light*. The glazing must comply with the requirement for sufficient natural light in occupied spaces. Any glazing with visible light transmittance of less than 70% cannot use the G7/AS1 compliance pathway and will need to use G7/AS2 or an alternative method.

Glass barriers must be safety glass that meets the requirements in section 22 of NZS 4223.3:2016 and B1/AS1.

3.4 TINTED GLASS

3.4.1 Tinted glass is most commonly made by adding metal oxides when the glass is manufactured, with a grey tint the most commonly used in New Zealand. It is used to reduce glare or fading from the sun because it can reduce light transmission by half or more. Tinted glass can also be used to reduce heat gain and to provide a level of privacy. The most commonly used tint is 5 mm grey, which has a visible light transmission of 49% compared to clear glass at 80%.

3.4.2 As with films and coatings, designers/specifiers will need to pay careful attention to any impact tinted glass may have on compliance with Building Code clause G7. Any glazing with visible light transmittance of less than 70% cannot use the G7/AS1 compliance pathway and will need to use G7/AS2 or an alternative method.

3.5 REFLECTIVE GLASS

3.5.1 Glass can be given a reflective coating that can act as a mirror. During daylight when the light intensity is greater on the outside, the glass acts as a mirror from the outside. This effect can be used to provide privacy for the building occupants, but it can also cause bright reflection and solar gain for surrounding buildings, motorists and pedestrians. Some building consent authorities have restrictions on the use of reflective glazing. At night, reflective glass acts as a mirror from the inside.

3.6 SOUND-REDUCING GLAZING

3.6.1 Laminated glazing, incorporating glass panes of differing thickness and specially formulated interlayers, is available in varying overall thicknesses (around 7–13 mm) to achieve a significant perceived reduction of sound. Using an IGU with different glass types and thicknesses can also provide good sound control.

3.6.2 Where higher noise reduction is required, windows can be purpose designed with increased air gaps and pane thicknesses, layering of glass and air seals and details to meet specific frequency ranges.

3.7 SECURITY GLASS

3.7.1 Security glass can be designed to cope with different types of risk:

- To resist penetration – for example, in the case of someone trying to smash their way through a window, laminated glass with a thicker interlayer than regular laminated glass (or multiple layers of glass and interlayers) is available. It is sometimes called 'anti-bandit' glass. Polycarbonates can also be used in addition to or in place of glass.
- Although there is not much demand for it in New Zealand, bullet-resistant glazing is designed and tested to resist ballistic impacts and is typically multi-laminate polycarbonate, acrylic or glass ranging around 19–63 mm in thickness.

4 OVERHEATING

4.0.1 Solar radiation from the sun includes ultraviolet light, visible light and infrared energy (heat). Each of these has significant impacts on buildings and people. The invisible infrared radiation can contribute to overheating problems for buildings and their occupants.

4.0.2 For a number of years, BRANZ research has identified that many new houses are at risk of overheating. Large areas of glazing for views and indoor-outdoor living together with a greater degree of airtightness in construction have contributed to this.

4.0.3 It is likely that the enhanced thermal performance required of new buildings in the Building Code clause H1 compliance documents will contribute to the overheating risk. The increase in R-values for insulation addresses conductive heat flow, but there is currently no regulation around radiation of heat through glazing into homes from the sun. (This is likely to be addressed in future Building Code document updates.)

4.0.4 The amount of heat that can pass through glazing by radiation is measured by the solar heat gain coefficient (SHGC). This is a figure from 0–1, where 1 is 100% heat flow through glazing. The SHGC figure is independent of the R-value of glazing – two windows with the same construction R-value can have different SHGC figures. Where overheating is a risk, designers should consider the most appropriate SHGC for the glazing in a project. SHGC figures for some generic glazing options are given in Table 2 of Bulletin 670 *Specifying windows and doors under H1*.

4.0.5 In addition to specifying the appropriate glazing, designing appropriate shade devices and ventilation paths is also a key part of preventing a house from overheating. It is particularly important to consider eaves or other shade devices on the north side of a house to avoid hot midsummer sun passing through the glazing and to consider how to reduce late afternoon/early evening summer sun entering windows on the west side of the building in addition to ventilation.

5 CLEANING AND MAINTENANCE

5.0.1 Protective film on glass or windows should be left on until after construction is complete, assuming this is within a few months of the windows being installed. Strippable films should not be left on glazing for periods longer than a few months, particularly with exposure to sunlight and/or heat. Sticky production labels can be removed from glass immediately.

5.0.2 If concrete or mortar splashes onto glazing, it should be removed immediately with clean warm water and mild detergent.

5.0.3 Avoid using scrapers with metal blades on glazing or windows as the surfaces can be easily damaged. If paint splashes or any other substances have landed on glazing and hardened, check what the glazing supplier recommends to remove it.

5.0.4 As part of the maintenance information provided to the client at the end of building work, point out that regular washing of glazing and windows will help ensure long-term durability. Cleaning should start at the top and work to lower levels. Use warm water to wet the glass and soften any dirt or debris then clean with mild detergent or non-abrasive cleaners or a proprietary product. Rinse with clean water and dry with a clean squeegee, cloth or paper towel to avoid the appearance of water spots. For best results, don't clean in direct sunlight at the hottest time of day.

5.0.5 In urban areas, washing glazing and windows once every 3–6 months may be sufficient. In areas exposed to seaspray, dust or agricultural or other air pollutants, clean more frequently as necessary.

6 CAUSES OF FAILURE – THERMAL STRESS

6.0.1 Tinted glass, whether a body tint or a surface coating, absorbs solar radiation and can get quite hot. This can lead to thermal stress, which will cause cracking if the heat is unevenly distributed or part of the pane is in shadow.

6.0.2 When a pane of glass is heated by sunshine but the edges are shaded by the frame and surrounds, the warmer part will try to expand and the cooler part will resist expansion. This sets up stresses in the glass that, if they exceed its tensile strength, will cause it to crack.

6.0.3 Clear float glass very rarely cracks as a result of thermal stress since it absorbs little heat, and temperature differences over the pane are usually less than 40°C. Solar-control glass that absorbs more than 60% of visible solar energy (an SHGC of less than 0.4) is likely to have temperature gradients greater than 40°C. If used in high sun exposure situations, the glass should be toughened or heat treated to resist thermal stress cracking.

7 OPTIONS FOR GLAZING OTHER THAN GLASS

7.0.1 As technology advances, materials other than float glass are being used in glazing:

- Acrylic sheets weigh less than glass but have much greater impact strength. They can have similar or greater visible light transmission than glass at 90% or more. Architectural acrylics available in New Zealand typically have proprietary names.
- Polycarbonate sheets have greater structural strength and impact resistance than both glass and acrylic. Polycarbonate is sometimes promoted for uses where security is a priority such as glazing in porches and is widely used in laminates for locations where security is paramount.

7.0.2 As with all construction elements, the compatibility of materials used in glazing should always be carefully considered. This is of particular relevance under Building Code clause B2 *Durability*.

8 RESOURCES

BRANZ BULLETINS

BU680 *Insulating glass units*

BU670 *Specifying windows and doors under H1*

BU659 *Upgrading the thermal performance of timber windows*

BU658 *Timber windows*

BU656 *Designing to avoid houses overheating*

BU638 *Finishes on architectural hardware*

BU636 *Protecting glass from damage*

WGANZ

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