AUSTRALIAN GLASS & WINDOW ASSOCIATION

TECHNICAL FACT SHEET: Guide to Visual Quality of Glass in Buildings and Customer's Expectation

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Introduction

Flat transparent glass, whether it be clear, tinted, or coated, supplied for buildings in Australia is almost exclusively manufactured using the float process, where molten glass is floated on a bed of molten tin. Glass made using this process is renowned for its extreme flatness. The raw float glass is converted into the end product through a range of processes including cutting, edge working, toughening and/or shaping.

The common processes applied to glass used throughout the building industry include;

- The application of a coating to the glass surface, i.e. Low-e glass or reflective glass.
- Laminating where two, or more, panes of glass are combined on each side of an interlayer.
- Toughening, where a pane of glass is heated and then quenched to increase its thermal and mechanical strength.
- Manufactured into Insulated Glass Units (IGUs) that are typically called in Australia, Double Glazing Unit (DGU).

Consumer Expectations

Most consumers perceive that glass is perfect and free from imperfections, however, the reality is that, like all man-made products, the finished product may have imperfections caused during processing, handling, transportation, or installation.

Generally, the purpose of glass is to be looked through and not looked at, and problems arise when a blemish or imperfection is noticed. Without a full understanding of glass properties, it can sometimes be difficult to look beyond the issue. When viewing, measuring, and understanding the quality of a pane of glass, AS/NZS 4667:2000 (Quality requirements for cut-to-size and processed glass) and AS 4666:2012 (Insulating glass units) are the Standards used by the Australian glass industry, but they are not easily understood by consumers.

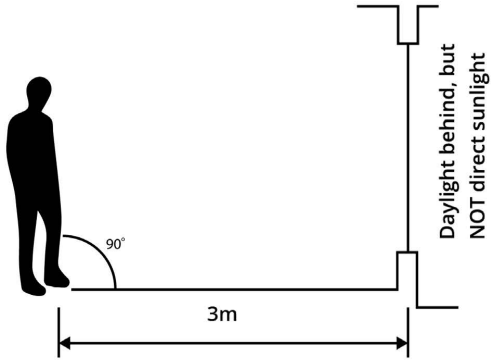
How defect assessments are conducted

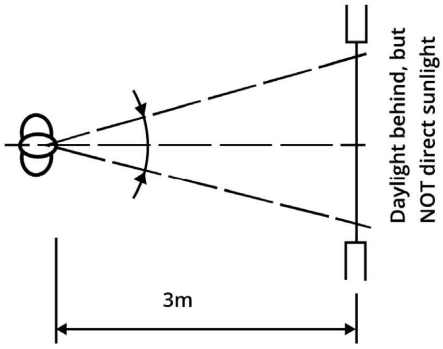
This Guide intends to provide consumers with an easy way to understand the allowable defects, blemishes and characteristics of glass.

This Guide applies to the assessment of the visible quality of glass for both single-glazed and double-glazed applications, used in Australian buildings and only to the glass that remains visible after the installation of the pane into its supporting frame.

Variations in the surface colour, texture and finish of glass should be viewed, where possible, from a normal viewing position. Before inspection for blemishes, the glass should be cleaned in accordance with the manufacturer's recommendations.

Diagrams: Method of Viewing - Defect Inspection





Under natural daylighting conditions, stand in a vertical position at an angle perpendicular (90 degrees) to the surface of the glass from inside the room and not less than 3 metres away from the glass and look for any visible defect. When it is impossible to stand back 3 metres, viewing should be done as far away from the glass as is possible.

Notes:

• Glass should not be in direct sunlight during the inspection.

• There may be minor variation based on State-Based Legislation or contractual conditions.

• Not only is the viewing distance and angle important, so to is the type of daylight you're looking into. Certainly, the glass can be viewed in the daylight, but it must not be direct sunshine.

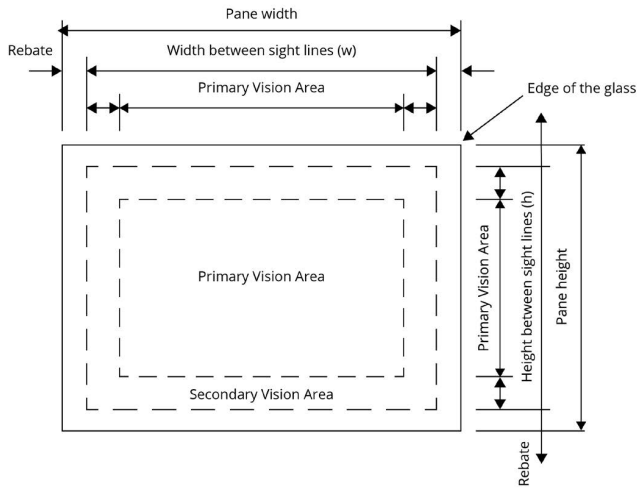
Image: Correct viewing position

Image: Incorrect viewing position, in direct sunlight

To understand variances in glass attributes, how the glass is to be viewed must be defined.

1. The rebate area is the part of the pane contained within the frame and is not visible. Therefore, defects only in the primary and secondary vision areas need to be considered.
2. Defects viewed in the primary vision area are unacceptable if visible from a distance of 3m, as described under How defect assessments are conducted (page 2). The primary vision area is illustrated in the diagram. The secondary vision area of a single-glazed window is a band of approximately 10% of the panel sightline size.
3. The secondary vision area of a single-glazed window is a band of approximately 10% of the panel sightline size.
4. The secondary vision area of a double-glazed window is a band of approximately 10-15% of the panel sightline size (Table 5.5 and 5.6 of AS 4666).
5. For IGUs, defects viewed in the secondary vision area may be accepted depending on the defect's type and size (Table 5.5 and 5.6 of AS 4666).
6. The viewing period should not be more than 60 seconds.

Diagram: Assessment of the glass pane



Visual/Surface Imperfections in Glass

Some visual defects and surface imperfections may be present in the glass. All inspections for defects must meet all the criteria mentioned in the clause above.

Glass imperfections/blemish (related to single layer)

Scratches, scars, and rubs (abrasion, scuff, tear)

Surface scratches on the glass are, without a doubt, the most common problem. A sharp or rough instrument may cause marking or tearing of the glass surface.

In respect to as Low-emissivity (Low-E) glass the coatings are actually harder than the glass and consequently is quite difficult to scratch. However, the marks might be abrasion marks. The consequence of the coating being very hard is that it can abrade other materials. So, materials rubbed across the coating can abrade and leave deposits on the surface. These abrasion marks can be cleaned off using the manufacturer's recommended procedure.

Image: Scratches on Glass

It is recommended not to use razor blades, steel wool or other metallic objects on Low 'E' coated glass. If metallic objects contact the coated surface, a thin layer of the metal removed from the object may be deposited on the Low 'E' surface which results in a discoloured stain which is difficult or impossible to remove using normal cleaning procedures.

Scratches should not be visible from 3 meters or more. For the maximum allowable number of scratches in primary and secondary vision are of IGU refer to Table 5.5 and 5.6 of AS 4666.

Imperfections within the glass such as seed, bubble, or blister impurities

Gaseous bubbles within the flat transparent glass, including laminated or toughened or coated glass, when viewed as described above, that are less than 1 mm in diameter, are not considered a defect.

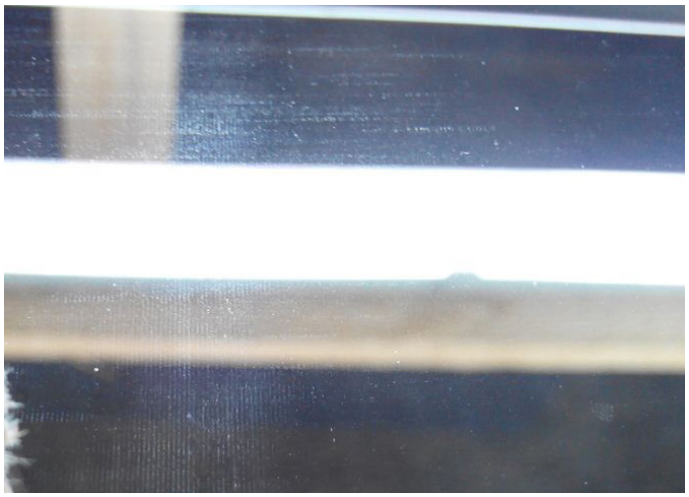
If the diameter of a single bubble is between 1 and 5 mm per 1.6 m x 1.6 m of glass area, this is also not considered a defect.

Bubble impurities that are more than 5 mm in diameter are not permitted within the glass and are a defect. For the maximum allowable number of the bubble in primary and secondary vision of an IGU refer to Table 5.5 and 5.6 of AS 4666.

Haze

Haze (a light and milky effect) is the scattering of light rays when visible light passes through a transparent material like glass. Haze can appear on coated glass such as Low-emissivity (Low-E) or laminated glass or tinted glass. The amount of haze in ordinary glass is very low and is not detected by the human eye. Haze is a characteristic that is a common consequence of the crystalline structure of the coating. Some of the light that enters glass is absorbed, and some scattered by components within the glass. If sufficient light is scattered, then it will appear as a haze in the glass. The visibility of haze depends on two criteria: the surrounding conditions and the brightness of the background.

Image: Haze on Glass



It is possible for a glass product to exhibit haze at certain times of the day and not at another. It is also possible for the same type of glass to display haze in one location and not in another. With any coated glass, it is possible to see the presence of the coating under a certain angle and intensity of the lighting. Haze sometimes has the appearance of a blue-grey film or dust on the coated glass. Haze can occur in both clear and coloured laminate, with it more evident in grey laminate. Haze is very dependent on the angle and intensity of the light. Some colour variations such as a blue haze may exhibit in Low-E glass, especially noticeable if part of the glass is shaded.

Haze is not considered a manufacturing defect.

Anisotropy or iridescence or photoelasticity

While these sounds technical, it simply means where glass surface can appear alternately light and dark (sometimes known as 'leopard spots') when polarised light is incident on it. The effect can be accentuated when there are two or more layers of toughened glass in an IGU. The marks are often most visible in particular lighting and when viewed through polarized sunglasses.

Anisotropy is not considered a defect and an inherent part of the tempering process.

Images: Examples of Anisotropy

Roller wave

Roller wave can be seen in toughened and heat-strengthened glass. Glass is generally toughened in a horizontal roller hearth furnace, where glass is carried through and oscillated on ceramic rollers under high heat (approx. 600°C) at this temperature glass starts to soften and can therefore creep between the rollers causing alternating high and low points resulting in the glass exhibiting optical distortion.

The valleys this produces are virtually imperceptible to the human eye in the factory. However, when the glass is installed in a building, the surroundings and the varying light conditions can make it so that even very small amounts of distortion can be seen.

Glass surface distortion from roller waves is a normal attribute of heat-treated toughened glass.

This distortion is more noticeable in reflective or dark tinted glass. This distortion is also more noticeable in thinner toughened glass, for example The roller wave distortion is more visible on 4 mm toughened glass than say 6 mm toughened glass.

Glass distortion from roller wave is not considered a defect.

Image: Roller wave on building windows

The ceramic rollers will invariably have very small particles of glass dust deposited from the passing of previous panels. These tiny particles can also become more apparent in direct sun as the light is dispersed across the glass surface and can often give off a sparkling effect.

Edge Kink

Edge kink is seen in toughened glass and is caused by the same means as roller wave described above but is found at the edges of the glass where it can become more visible. It is more noticeable in toughened mirror products such as those used for splashbacks.

As with roller wave edge kink is a normal attribute of heat-treated toughened glass and thinner toughened glass.

Preferential Wetting Patterns

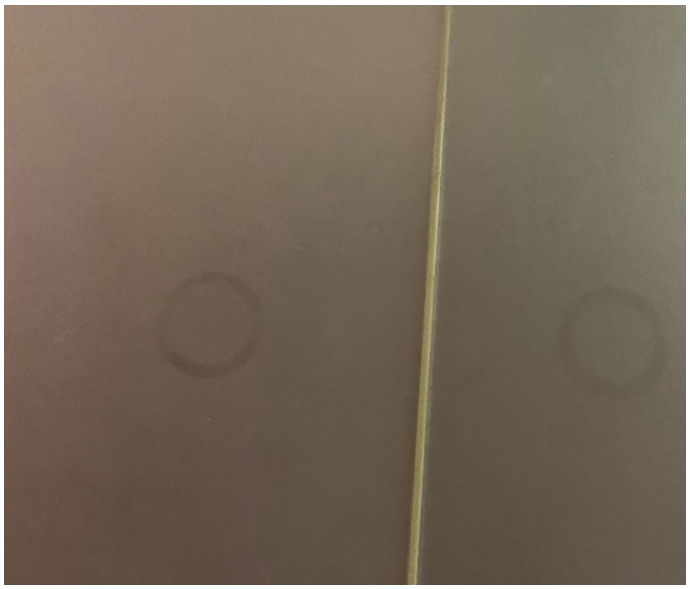
These patterns are visible when the glass surface gets wet from rain, condensation or washing and are caused by manufacturing tools equipment and devices such as vacuum lifters and separation pads that come into contact with glass during manufacture, handling and installation.

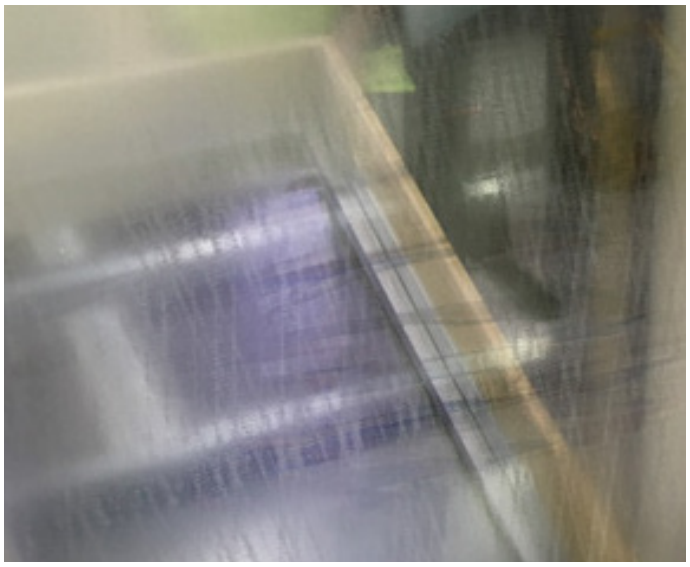
Although these tools, equipment and devices leave no visible residue on the glass, they do change the surface condition, creating patterns on the glass surface that show when it gets wet.

These patterns do not affect the functionality, performance or longevity of the units and fade over time.

Preferential Wetting Patterns are not considered a defect.

Images: Preferential Wetting Pattern on shower door





Glass imperfections/blemish (related to IGU)

Single and double glazing will have similar visual quality levels, although some characteristics are specific to IGUs. IGUs that are assembled from two sheets of toughened or heat strengthened glass may exhibit an increased level of visual distortion when compared to each of the components.

Other optical effects that may occur in IGUs are:

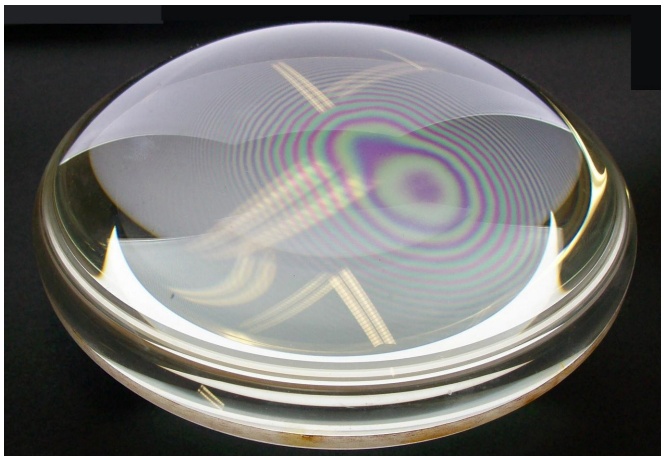
Deflection and Reflection

Small changes in temperature and pressure can cause the glass to bow outwards or inwards and change the images reflected from the window, as shown in the image on the right. These distortions are unavoidable and cannot be eliminated. The use of thicker glass will reduce glass deflection under wind loads.

Newton's Rings

In a large IGU, the two glass panes may be displaced by air pressure until they come close to touching in the middle. When this happens, Newton's Rings may form in the unit's centre, they are an optical phenomenon that is roughly circular and exhibits coloured bands. Correct specification of glass thickness for the design wind pressure minimises the chance of these rings.

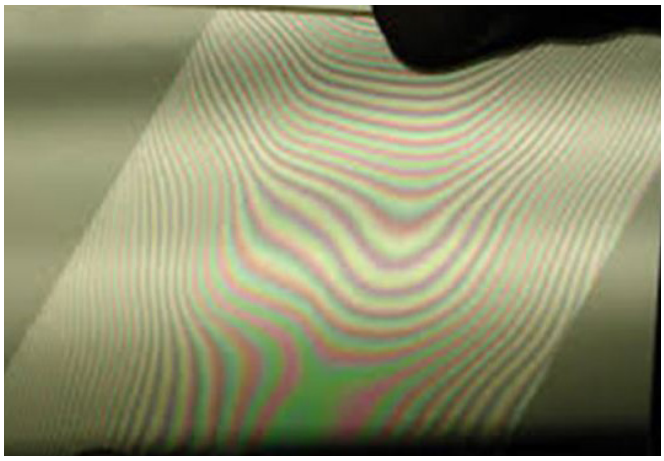
Newton's Rings are a naturally occurring phenomenon and are not considered to be a defect.



Brewster's Fringes

Brewster's fringes are often only visible in IGUs under certain lighting conditions when multiple light reflections occur. These interference fringes are faint coloured bands of irregular shapes, and they can be located anywhere over the surface.

Brewster's Fringes not considered a defect.



Summary

The five steps to evaluate glass: When is a defect not a defect?

1. Clean the glass in accordance with manufacturers recommendations.
2. Stand back 3 meters.
3. Face the glass straight-on at 90 degrees.
4. View in daylight but not direct sunlight.
5. Inspect the central 80% portion of the glass.

Under these conditions, if you can't see the blemish from 3 metres – it isn't a defect.

References

- AS 4666-2012 (Insulating glass units)
- AS/NZS 4667-2000 (Quality requirements for cut-to-size and processed glass)
- AS/NZS 4668-2000 (Glossary of terms used in the glass and glazing industry)

AS 1288-2021 (Glass in buildings — Selection and installation)

If you would like to learn more about this technical fact sheet, please email technical@agwa.com.au