

Technical Manual

The following sections cover the methods and manufacturing capabilities for producing processed glass and Insulated glass units.

Sections

1. Cutting
2. Edge working
3. Toughening
4. Insulated glass units
5. Processed glass
6. Screen printing
7. Laminating
8. Heat soaking
9. Quality

1. Cutting

Glass Stock Sizes

- 3210mm x 2250mm
- 3210mm x 2550mm
- 3210mm x 6000mm
- 2140mm x 1320mm (*Patterned glass*)

Cut Size Tolerances

Nominal Size length (H) or width (B) of glass edge	Absolute tolerance (t) nominal thickness ≤12mm	Absolute tolerance (t) nominal thickness ≥12mm
Up to 500mm	±2mm	±2mm
Up to 1000mm	±2mm	±2mm
Up to 2000mm	±2mm	±2.5mm
Up to 3000mm	±2.5mm	±3.0mm
Up to 3500mm	±3.0mm	±4.0mm
Over 3500mm	±3.5mm	±5mm

Table 1: Cut size tolerances

Glass Squareness

Squareness is a comparison of diagonals

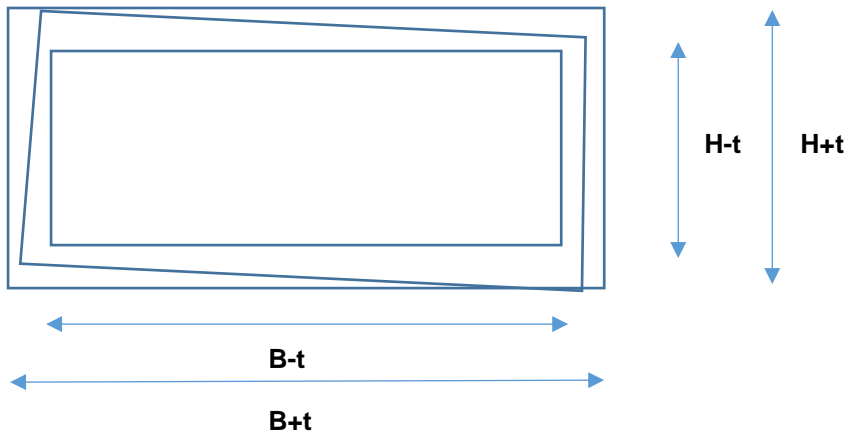
- ≤2000mm in size – 4mm allowance for glass ≤12mm thick
- ≥2000mm in size – 5mm allowance for glass ≥12mm thick

The dimensional deviation of the diagonals is derived by the following calculations:

Example: Pane with B x H = 1000 x 3000mm

➡ Dimensional deviation = 3.0mm

The dimensional tolerances is thus 3.0mm



In all cases of measurement, B is always classed as width and H will always be the height.

Glass Thickness

Below are the float glass thickness tolerances in accordance with EN 572-2 (See table 2)

Nominal Glass Thickness (mm)	Dimensional Tolerance
4	±0.2 mm
5	±0.2 mm
6	±0.2 mm
8	±0.3 mm
10	±0.3 mm
12	±0.3 mm
15	±1.0 mm
19	±1.0 mm



Table 2: Float glass thickness tolerances

Colour Variation

All glass supplied by TuffX processed glass Ltd can be sourced from different float glass manufacturers and cannot guarantee there will be no variation in colour.

2. Edgework

- Arrissed edge (*Sharp edges removed*)
- Full ground edge
- Full Polished edge
- Full high class polished edge

Cut-outs / notches in glass

Edge cut outs and corner cut outs must be provided with a radius (R) which is either larger than or equal to the glass thickness, but must measure in every case at least 10mm.

For cut out dimension allowances see **Table 7**

There are different tolerances for oversized insulated glass units which can be found in the Insulated glass units section

All cut outs either hand worked or machined are subject to specification. See **Table 3 & 4** below for tolerances

Cut Out Length	Tolerance
≤500mm	±5mm
≤1000mm	±6mm

Table 3: Edge cut out tolerances, hand worked, and arressed (See processing

Cut Out Length	Tolerance
≤2000mm	±4mm
≤3400mm	±4mm
≤6000mm	±5mm

Table 4: Edge cut out tolerances, CNC machining centre (See processing)

3. Toughened Safety Glass

All toughened glass produced at TuffX is compliant with EN12150-1 / 2 & class 1 impact tested.

Machine capabilities:

Glass Thickness	X (mm)	Y (mm)
4mm – 19mm	2400	4200

***Note: These are machine bed sizes only so IGU & processing parameters should be referred to**

Straightness

Deviation from straightness is dependent on thickness, on the other dimensions and the aspect ratio between the sides. The deviation appears in the form of warping which is categorised into two sections: General Bow & Local Bow. See **Table 5** below for tolerances.

Limitation of general and local bow On the basis of specifications in				
Type of Glass		Glass Thickness (mm)	Limitation related to:	
			General Bow (MM per M)	Local Bow (MM per 300mm)
TSG made from	Float Glass	4 – 19	3	0.5
	Patterned Glass	4 – 10	4	0.6

Table 5: Limitations of general and local bow on the basis of specifications in EN12150 Part 1

As detailed in the table, local bow is a reaction that occurs over a small area of glass and general bow is virtually end to end of the pane.

Horizontal Toughening

During the toughening process the glass is in contact with ceramic rollers at all times. This causes distortion known as rollerwave which is generally noticed through reflection. **Table 6** gives the roller wave limits for toughened glass products.

Float glass nominal thickness	Rollerwave maximum (mm)
3,4 & 5	0.5
6,8 & 10	0.3
12,15,19	0.15

Table 6: Roller wave Limits

Markings

Every pane of toughened safety glass, laminate glass & heat soaked glass will be stamped with mark that depicts the following:

- The number of the product standard & classification
- The name or trademark of the manufacturer

TuffX cannot guarantee the exact positioning of markings but do attempt to apply within the standard requirement

4. Insulated Toughened Safety Glass Units

Below are the minimum and maximum width sizes for glass within the stated m2

4mm Standard <i>*This applies to glass with an area of up to 2.9m2 and is below 3210mm in length</i>	
Maximum Width 900mm	Minimum Width 150mm

4mm Oversized <i>*This applies to glass with an area up to 2.9m2 and is over 3210mm in length</i>	
Maximum Width 900mm	Minimum Width 300mm

Restrictions apply*

***The maximum production line height for manufacturing insulated glass units is 1500mm. This means that insulated units cannot be greater than this dimension in both width and height within the same pane.**

***All non-roof vertical glazed units manufactured using 20mm bar will be subject to a maximum glass area of 2.6m2. If the glass is greater than 2.6m2 then 6mm glass will be used.**

4mm Patterned glass comes in stock sheets of 1320 x 2140mm. The only obscured glass larger than this is Satin (Opaque) @ 3210 x 2250mm.

Edgework

All 4mm & 6mm glass used in Igu's will have an arrisded edge. This is not a full ground edge.

Spacer bar thickness

10mm – 20mm in increments of 2mm (10, 12, 14, 16, 18, 20)

Spacer bar colour range

Thermal flexible spacer: Black, Grey

Cut-Outs / notches in glass

Cut outs are allowable. See **Table 7** for limitations

Pane Length	Smallest dimension (W)	Largest Dimension (L)
0mm – 1500mm	Up to 1/3 of dimension	Up to 2/3 of dimension
1500mm – 3250mm	Up to 1/3 of dimension	Up to 1/2 of dimension
3200mm – 4000mm	Up to 1/3 of dimension	Up to of 1/3 dimension

Table 7. Cut out limitations

Thickness tolerance at edge seal

Table 8 below shows thickness limits of Igu's for the respective glass combinations. Thickness tolerances for polished wired or wired ornamental glass are not covered within this.

	First Pane (Note 1 to this table)	Second Pane (Note 1 to this table)	IGU Thickness Tolerance
A	Annealed Glass	Annealed Glass	±1.0mm*
B	Annealed Glass	Toughened Glass	±1.5mm
C	Annealed Glass	Laminated Interlayered Glass (Note 2 to this table)	±1.0mm
		Thickness ≤6mm and total thickness ≤12mm Other cases	±1.5mm
D	Annealed Glass	Patterned Glass	±1.5mm
E	Toughened Glass	Toughened Glass	±1.5mm

Pane thicknesses are given as nominal thicknesses
 *Note1 Heat toughened safety glass
 *Note2 Laminate glass or laminate safety glass consisting of 2 annealed float glass panes (max thickness 12mm respectively) and a plastic interlayer

Table 8: Thickness tolerance of IGU

Triple glazed thickness tolerance

The thickness tolerance for multiple cavities are worked out as follows

1. Establish the tolerance for the separate composing formations – Glass / Cavity / Glass – using **Table 6**
2. Calculate the squares of these values
3. Add the squared values together
4. Work out the squared root of this sum

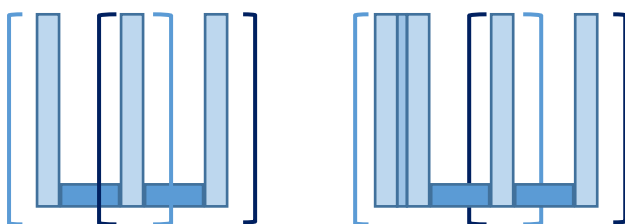


Fig1. Calculation of thickness tolerance for multi-cavity IGU

Stepped insulated units

The dimensional tolerances for the stepped edge overhang in insulated glass are as follows:

±3mm for stepped edges overhang up to 100mm

±4mm for stepped edges overhang up to 250mm

5. Processing

Product range

All glass produced for processing will be assessed at contract review for capability & stock availability.

Glass sizes

The minimum and maximum sizes allowable are:

Minimum - 80mm x 250mm (*1 edge will always be required to have 250mm as a minimum size*)

Maximum – 4000mm x 1800mm

Standard tolerance for finish product size is **+1mm -2mm**

Edgework

Arrissed edge (Sharp edges removed)

Full ground edge

Full Polished edge

Full high class polished edge



Polished edges on glass may differ in appearance. Certain orders may contain shaped glass which require different machines like a CNC to manufacture as opposed to a standard straight line edging machine

Drilling

Drill hole sizes: **6mm ≥ 85mm**

Listed below are prescribed specifications both for general positioning of drill holes and for tolerances in respect of deviations from said positioning.

The tolerances here apply to cylindrical and conical drill holes.

Position of holes

The drill hole positioning and tolerances are shown in **Fig.2**

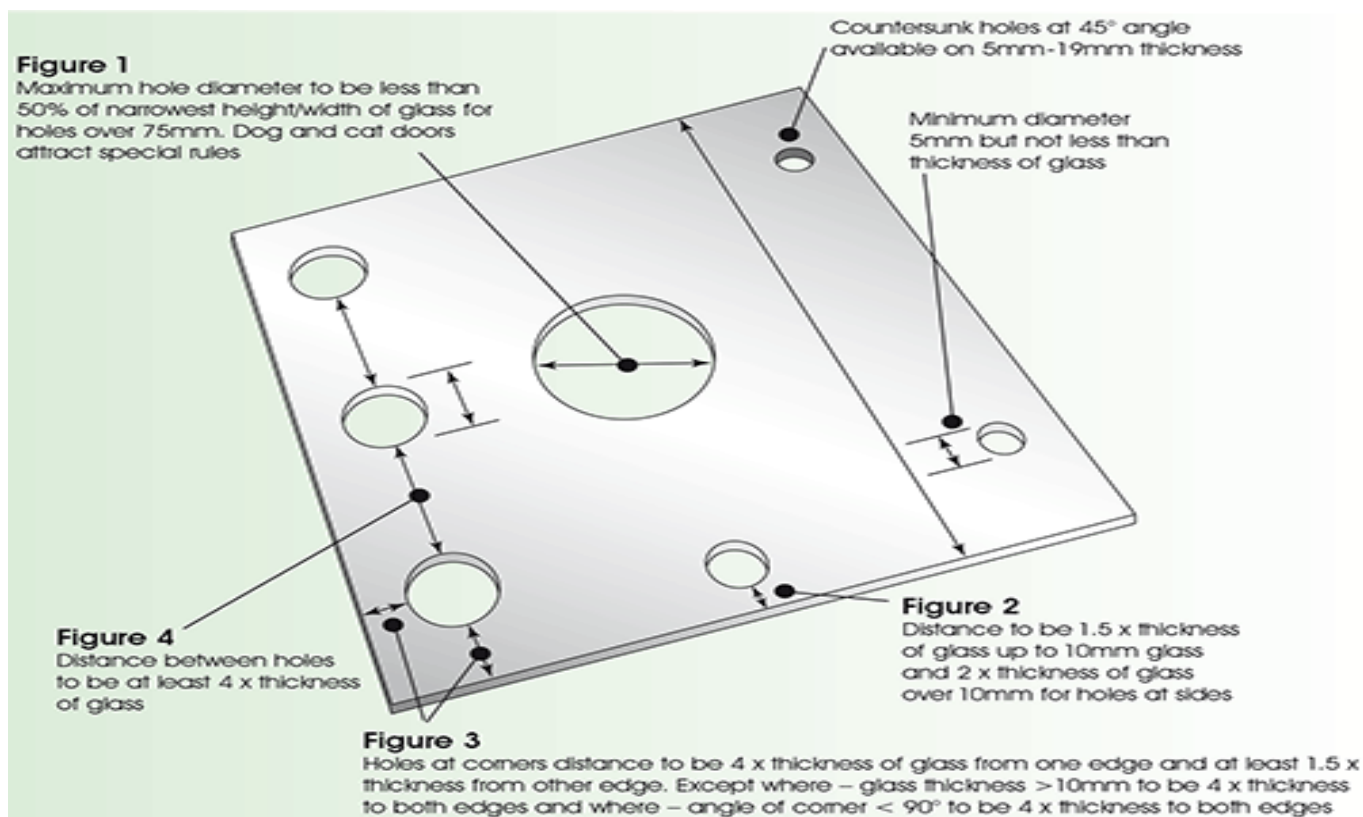


Fig.2 Position of holes and tolerances

Hole sizes

All drill hole sizes are to be as accurate as possible with a working tolerance of $\pm 1\text{mm}$

Hole positioning

All drill holes are to be located as accurate a possible with a working tolerance of $\pm 2\text{mm}$

Corner cut – off & Corner / edge cut – outs

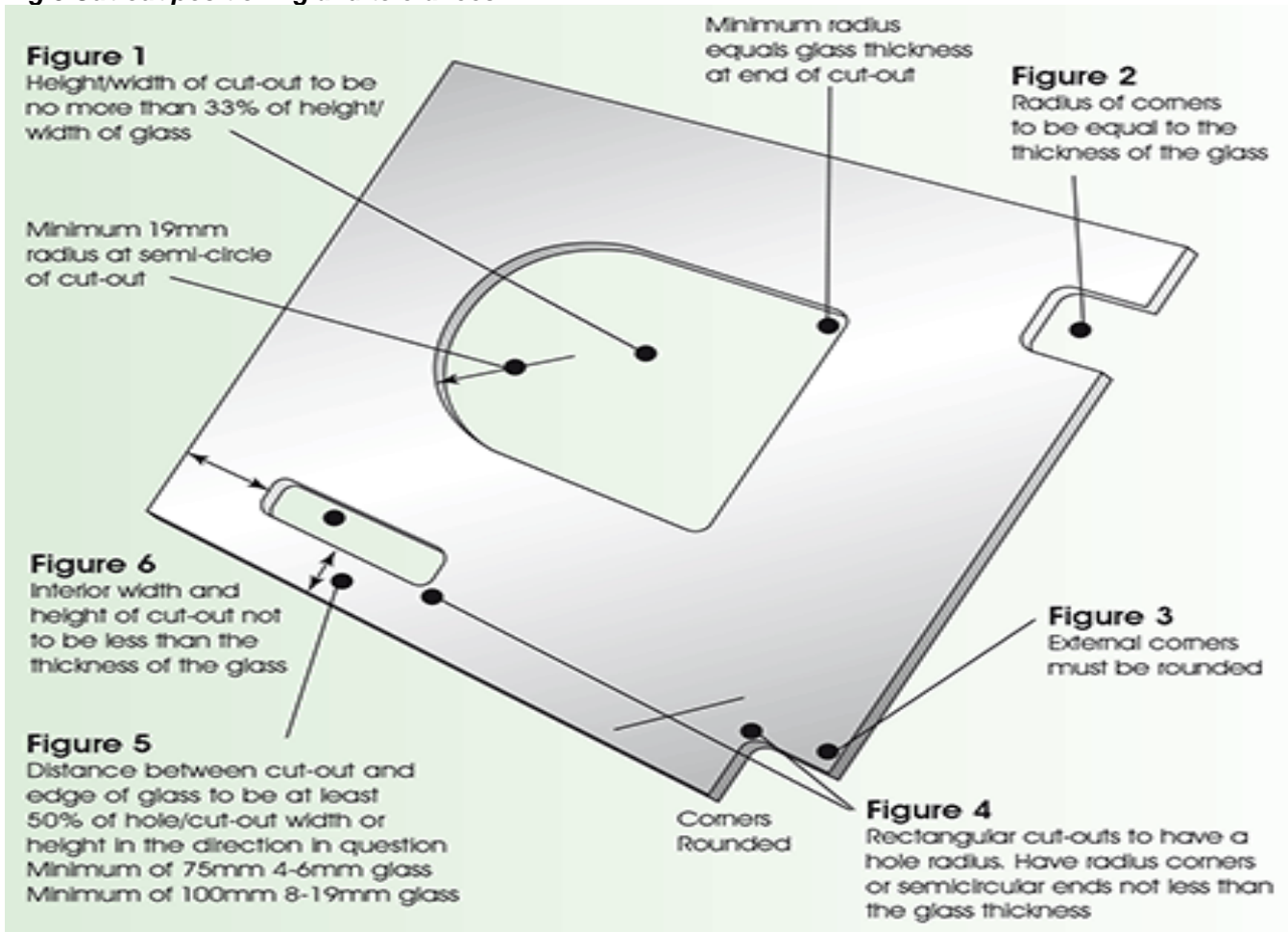
Edge cut-outs & corner cut-outs must be provided with a radius (R) which is either larger than or equal to the thickness of the glass, but must measure in every case no less than 10mm.

The cut out criteria is shown in **Fig.3**

Edge cut out arrissed tolerances are also available on **Pg. 2 Table 2**

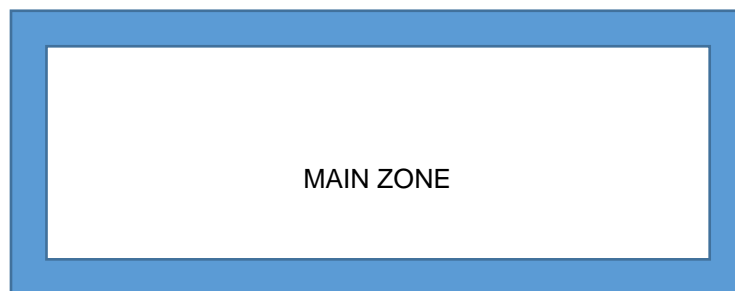
Edge cut out polished tolerances are also available on **Pg.2 Table 3**

Fig.3 Cut-out positioning and tolerances



6. Screen-printing

All inspections of screen printed products are to be performed using the criteria set in the visual inspection section of this document.



Edge zone circumference 15mm

*If visible edges are requested when the order is placed then the edge zone will be omitted and the main zone will extend to the edge of the pane. Optical quality requirements are given in **Table 9 Below**

All non-ground or polished edges (Arrissed) will require a 2mm scrape off tolerance on all edges to combat paint lifting

Defect – types/ Tolerances for entirely or partial printed glass		
Type of defect	Main Zone	Edge Zone
Defects in print punctual* and or linear	Area: Max 25mm ² Quantity: Max 3 of which none ≥25mm ²	Width Max 3mm, sporadically 5mm Length: no restriction
Hairline Scratches (Only visible by incident of changing light)	Permitted up to 10mm in length	Permitted / No restriction
Cloudy / Misty area / Shadowing	Not permitted	Permitted / No restriction
Water Stains	Not permitted	Permitted / No restriction
Colour over-run at edges	Not relevant	Permitted
Dimensional tolerance for edge printing and partial printing** See fig.4 Print Height	Depending on width of printing	
≤100mm ≤500mm ≤1000mm ≤2000mm ≤3000mm ≤4000mm	±1.5mm ±2.0mm ±2.5mm ±3.0mm ±4.0mm ±5.0mm	
Position tolerance for printing** (Only for partial printing)	≤2000mm: ±2mm ≥2000mm: ±4mm	

Table 9. Defect tolerances

Screen print size capabilities

Minimum Size – 1 length being no shorter than 250mm

Maximum Size – 2800 x 1500mm (**Refer to toughening parameters for glass size capability**)

Colours

All colours are available subject to matching RAL chart codes. In the event of a colour being sought from another source, then the nearest RAL code will be selected and approved

Colour Variation

In the event of an order being across paint batches, there is a possibility of shade / colour variance.

7. Laminate Glass

Size capabilities

Minimum Size / Maximum Size (**See toughening parameters**)

C.I.P Interlayer thickness – 1.5mm

EVA Interlayer thickness – 1.5mm

Methods of application – Cold pour resin which is applied through a metering pump and bonded under UV light or EVA sheets which are interlayered with the glass under heated conditions. EVA must be requested by the customer when ordering as C.I.P is manufactured as standard.

Offset Tolerances

Offset tolerances (d) only occur in all forms of edge finishing and edge machining possible for these products. These are listed in **Table 8** below. Width (b) & length (h) must be considered separately.

Nominal dimensions (b)	Largest permissible offset (d)
B,H <1000mm	2.0mm
B,H < 2000mm	3.0mm
B,H > 2000mm	4.0mm

Table 10. Largest permissible offset (d)

Thickness Tolerances

The thickness of the laminate pane shall not exceed the sum of the individual sheets min / max thickness as given in the standard for float glass EN572 -2. (**See table 2**)

If the total thickness of the interlayer is <2mm, there applies an additional maximum dimension tolerance of +/- 0.1mm. In the case where manufacturing necessitates additional layers of interlayer there is to be taken into account for interlayers of >2mm a maximum dimensional tolerance of +/- 0.2mm.

Example: A laminated glazing panel, manufactured from two panes of float glass with a nominal thickness of 3mm and an interlayer of 0.5mm. The maximum dimensional tolerance for float glass with a nominal thickness of 3mm is +/-0.2mm; the maximum dimensional tolerance for the interlayer is +/- 0.1mm. Therefore, the nominal thickness allowance is 6.5mm and the maximum dimensional tolerance is 0.5mm.

Tolerances for drill holes

For <24mm element thickness $\pm 2.0\text{mm}$
 For >24mm element – thickness $\pm 2.5\text{mm}$



8. Sandblast

Minimum size – 150mm
 Maximum size – 4000mm

*Note, Maximum size applies to 10mm glass and below. Any thickness above 10mm will be a maximum size of 3200mm.

9. Heat soaked Glass

Size Capabilities

Minimum / Maximum Size (**See Toughening Parameters**)
 Glass thickness – 4mm – 19mm

10. O&M

Handling and storage

Delivery, handling and site storage methods must be agreed for each site. Upon delivery of the glass check marks and labels on the packing or glass to ensure compliance with the specification.

Edges and corners of glass are particularly vulnerable to damage during handling, storage and installation. Inspect the cut edges of the glass for excessive flaws such as large shells that may compromise the strength and performance of the glass.

Check all surfaces for any signs of damage. If in doubt seek advice from the manufacturer. Glass should not be stored or stacked horizontally. Store panels on edge at an angle of 3° to 6° from the vertical, with sufficient lateral support to

prevent bowing, in a clean dry, ventilated place, avoiding direct sunshine and other sources of heat. Factory applied protection such as cork pads or shrink-wrapping should not be removed until the glass is ready for installation. When the packaging has been removed it is advisable to cover the remaining glass to prevent ingress of dust and grit that may cause subsequent scratching. If any moisture or condensation is apparent between the panes of stacked glass, separate immediately and dry thoroughly, otherwise permanent staining may result. If water is allowed to remain in contact with the glass for an extended period it can form a concentrated alkaline solution and will attack the glass surface causing permanent damage and in extreme cases even "welding" the sheets together. Carefully inspect all glass before installation.

Post installation

It is recommended that glass is protected during construction to avoid harmful contamination for example from concrete and mortar slurry, paint and plaster. Protecting the glass will simplify the cleaning process after construction work finishes. If the glass is not protected it should be cleaned frequently during construction as dirt and residue appears both externally and internally. Frequent cleaning is required whilst construction continues since chemicals in dust and particularly in cement may be activated by rain and cause permanent corrosion of the glass surface. Paint or plaster should not be allowed to splash or run onto the glass. Any that does get onto the glass should be cleaned off immediately whilst still wet. The production labels and transport pads affixed onto the glass for delivery to site should be removed within 24 hours of glazing. If left on the glass for an extended period of time and exposed to sunlight the adhesive can harden making it more difficult to remove. A solvent such as acetone may be used in small amounts to spot clean residues of adhesive left on the glass taking care not to allow contact with glazing seals, gaskets, any paint finishes or the perimeter edge seal of an insulating glass unit.

Checks prior to cleaning

Before proceeding with cleaning, determine whether the glass is clear, tinted or reflective. Surface damage can be more noticeable on reflective glass when compared with clear uncoated glass. If the reflective coated surface is exposed, either externally or internally, special care must be taken when cleaning as scratches can remove the coating and result in visible changes to the light transmittance. Specialist glass such as SGG BIOCLEAR requires particular cleaning methods and the specific instructions for this product must be followed (contact SAINT-GOBAIN GLASS). Tinted and coated glasses should not be cleaned in direct sunlight, as the glass may be too hot for optimum cleaning. The cleaning solution will dry before effective cleaning has occurred and the dry surface may also promote scratching. Excessive temperature changes of the glass should also be avoided, for example splashing hot water on cold glass or cold water on hot glass. It is recommended that cleaning operators begin by cleaning a small area or window first then stop and examine the surface for any damage to the glass or coating bearing in mind that some types of scratches may be more visible under certain lighting conditions or times of the day. Cleaning operations should commence at the top of the building and continue down to lower levels to reduce the risk of leaving residue and cleaning solution on glass.

Standard Cleaning Procedure

Cleaning during continuing construction work differs from ordinary routine cleaning mainly through the careful removal of debris from the glass surface. This is a delicate procedure and should be carried out by specifically trained professionals or advice sought before cleaning.

Cleaning should start by thoroughly soaking the glass with clean water and mild soap solution to loosen dirt or debris. Using mild, non-abrasive commercial window washing solution, uniformly apply the solution to the glass surfaces by spraying or sponge. Using a circular motion and light to medium pressure, wipe the cleaning solution on the glass. Rinse the glass immediately with generous amounts of clean water making sure to remove all the cleaning solution. Use a clean lint-free cloth or a squeegee to dry the glass surface. Care should be taken to ensure that no metal parts of the cleaning equipment make contact with the glass surface and that no abrasive particles are trapped between the glass and cleaning materials. All water and cleaning solution residue should be dried from window frames, seals and gaskets to avoid any potential deterioration of these materials. If residue is still present on the glass then the steps above should be repeated. Abrasive cleaners, powder based cleaners, scouring pads or other harsh materials should not be used to clean the glass or frame surrounds. Excess glazing compounds and sealants should be carefully removed from the glass and frame surrounds, taking care not to scratch the finished surfaces with tools or abrasives. Avoid scraping the glass with metal scrapers or blades. A solvent such as white spirit or professional glass cleaner may be used to remove any glazing compound, finger marks or grease on glass but **NEVER** on powder coated frames (*Infinity or Glow products*) taking care

not to allow contact with glazing seals, gaskets, any paint finishes or the perimeter edge seal of an insulating glass unit. The glass can then be cleaned following the procedure above. When paint or other construction materials cannot be removed by standard cleaning procedures, a new 25mm razor blade may be used on non-surface treated or non-coated glass surfaces. It should be used only on small spots and scraping carried out in one direction only.

Note* this practice can cause a concentration of small hairline scratches that may be visible under certain lighting conditions.

Glass staining

Water runoff flowing over the façade of a building may carry contaminants onto the surface of the glass. These contaminants cause stains on the glass and can be extremely difficult to remove, sometimes even chemically bonding to the glass surface. The most effective way of addressing this problem is to prevent runoff reaching the glass at the design stage by use of suitable drainage techniques employing flashings, reveals or drips for example. Lime scale and concrete stains can occur where rainwater has passed over masonry, concrete or mortar onto the glazing below.

Insoluble salts of calcium crystallise on the glass surface and become chemically bound to it making it extremely difficult to remove using standard cleaning procedures. Organic sealants may leach out solvents, oils or plasticisers and these may adhere very strongly onto the glass surface and cause staining. The sealant may not necessarily need to be adjacent to the glass to cause this problem as they could be carried over the glass by water runoff. This tends to be a greater problem when the building is new. Consult the sealant manufacturer for advice and follow their recommendations. Weathering metals release oxides as they age and can cause staining on adjacent glazing. They occur where rainwater passes over metal flashing or other architectural elements and deposits metal oxides onto glazing. Iron, zinc, lead and copper are particularly prone to cause problems of this nature. The oxides adhere tenaciously onto the glass and expensive chemical cleaning techniques may be required if they are left on the glass for any length of time. Glass should be examined frequently during construction to see if any build up is occurring. If so the glass should be cleaned immediately.

Weld splatter

This causes a rough and pitted surface on glass. Any glass that has been damaged by weld splatter should be replaced, as the strength of the glass will have been unpredictably reduced. Temporary screens should be installed if welding, sandblasting or other potentially damaging construction process is being carried out near the glass.

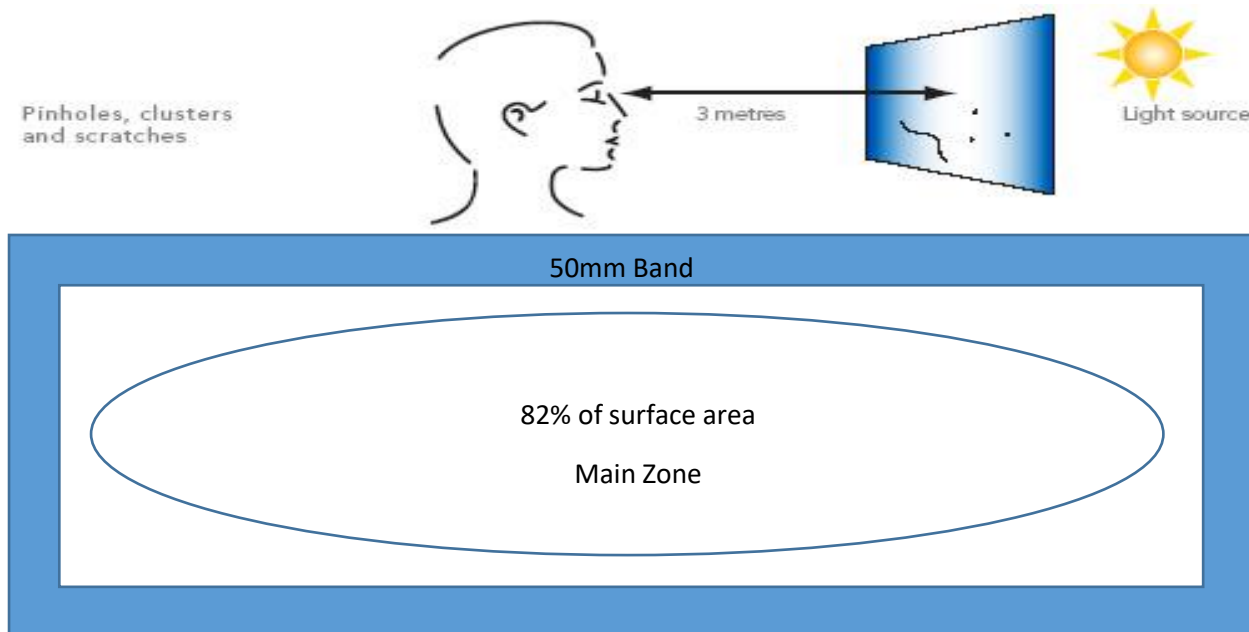
Regular maintenance

It is essential that all installations are inspected and maintained during the lifetime of the building at regular intervals as recommended by the sealant and framing system manufacturers. The regular routine cleaning of the glass following the standard cleaning procedure detailed above will help to preserve the original appearance and performance characteristics.

11. Quality

Visual assessment

Toughened safety glass shall be deemed acceptable if the following phenomena are neither obtrusive nor bunched: hairlines or blobs; fine scratches not more than 25mm long; minute imbedded particles. Obtrusiveness of blemishes shall be judged by looking through the glass, not at it, when standing at right angles to it on the room side at a distance of not less than 3 metres in natural daylight and not in direct sunlight. The area to be viewed is the normal vision area with the exception of a 50mm wide band around the perimeter of the glass. Pattern ghosting can occur on glasses with a textured finish.



The IGUs / single glazing shall be viewed at near normal incidence, i.e. at right angles, to the glass surface from the room side, standing at a distance of not less than 2 metres away from the inner glass surface for annealed float glass and 3 metres away for all other glass types.

The assessment of visual quality of the panes of glass should be carried out in natural daylight but not in direct sunlight and with no visible moisture on the surface of the inner or outer glass panes.

The use of strong lamps and/or magnifying devices is not allowed.

It is not permissible to find defects at close range and then mark them so as to be visible from the given viewing distance.

As a general rule those surface coated glasses which can be toughened may exhibit different visual characteristics or a slight colour variation as a result of toughening.

Quality & Manufacturing Standards

TuffX Processed Glass Ltd is **ISO9001:2015** accredited.

TuffX Processed Glass Ltd is licensed to produce glass to the following standards:

- **EN 12150 1-2** *Thermally toughened soda lime silicate safety glass*
- **EN 1279 Part 1, 5 & 6** *Hermetically sealed insulated glass units*
- **EN12543 1-6** *Laminated glass and laminated safety glass*
- **EN 1863 -1** *Heat Strengthened Glass*
- **EN14179 1-2** *Heatsoaked thermally toughened soda lime silicate safety glass*

