Manufacturing Tolerances and Inspection Guidelines

The following guidelines are intended to be used as a general guide to what tolerances and visual standards we work to only and not as a definitive guide to what our capabilities and limitations are. Unless otherwise stated within this document we work to the guidance within the latest British Standards available. We strongly advise that we are contacted should there be any issues or queries with any of the below guidance or where a specific requirement not covered by the below information is required. Where tolerances or requirements outside of those shown below are needed, this must be agreed in writing prior to an order being accepted.

Standards worked to

Quality Management System – ISO 9001:2015

Flat toughened glass – BS EN 12150

Curved toughened glass – BS ISO 11485

Laminated glass – BS EN 14449

IGU (Insulated Glass Units) – EN 1279

Heatsoaking – BS EN 14179

Contents

Novaglaze Ltd, Queensmill Rd, Huddersfield, **HD1 3PG**
T: *(01484) 517 010*
E: *sales@novaglaze.co.uk*
W: *novaglaze.co.uk*

Flat Glass

Dimensions

Table A

Nominal dimension	Tolerance	
	Nominal glass thickness up to (and including) 12mm	***Nominal glass thickness over 12mm***
Up to and including 2000mm	+-2.5mm	+-3mm
Between 2000mm and up to and including 3000mm	+-3mm	+-4mm
Over 3000mm	+-4mm	+-5mm

Overall glass dimensional tolerances are shown in Table A. These tolerances apply for flat toughened glass. Different tolerances apply to curved glass and are shown in the 'Curvature' section of this document.

All measurements should be taken using a calibrated tool with 0.5mm increments.

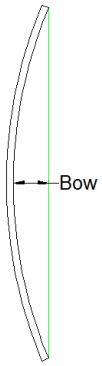
Edge Straightness (Bow)

Measuring Bow

The glass should be positioned vertically and supported on its longer side by two load bearing blocks at the quarter points.

Bow should be measured along the edges of the glass and across the diagonals, as the maximum distance between the concave face of the glass and a straight measuring device such as a metal ruler or stretched wire.

The tolerance for overall bow is 3mm per metre or 2mm, whichever is greater.



Squareness

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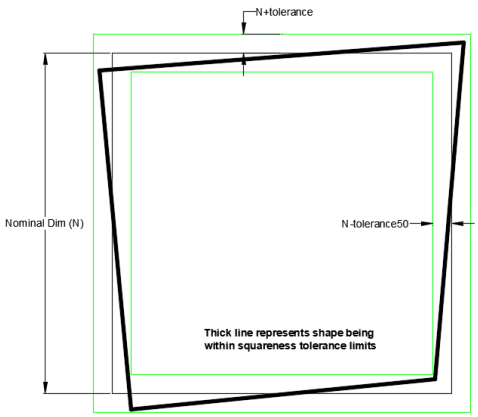
T: *(01484) 517 010*
E: *sales@novaglaze.co.uk*
W: *novaglaze.co.uk*

Squareness tolerance is based on ***Table A.*** The finished panel should fit within the limits given in the table as shown by diagram A.

Diagram A



Holes

General rules of thumb

1. Hole diameters shouldn't be less than the glass thickness in toughened glass.
2. Hole positions should be no less than one and a half times the glass thickness from the edge of the glass to the edge of the hole.
3. The distance between two hole edges should be at least twice the glass thickness
4. The distance from the edge of a hole to the corner of glass should be at least six times the glass thickness. Alternatively the width and height of a hole should add up to 100mm (when measured from the edge of the glass to the centre of the hole).

The above rules can, in certain situations, be exceeded. Where the holes are too close to the edge/corner, a relief slot is sometimes required to enable toughening. The relief slot is approx. 2mm wide and runs from the edge of the hole to the edge of the glass.

Tolerances on hole positions are as Table A.

Tolerances on the size of holes are as follows:

Up to 20mm diameter +-1mm.

Over 20mm +-2mm.

Cutouts/Features

Any features and cutouts must be considered on a case by case basis.

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Curved Glass

Where a tolerance isn't shown, the equivalent tolerance as shown in the flat glass section should be used.

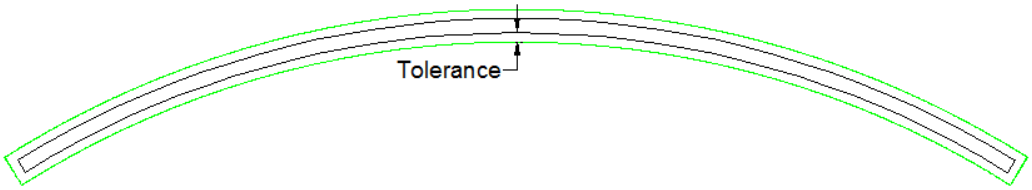
Dimensional Tolerances

Table B

Nominal dimension	Tolerance	
	Nominal glass thickness up to (and including) 8mm	***Nominal glass thickness over 8mm***
Radius	+-2/3 Glass thickness	+-½ Glass thickness
Girth (Arc Length)	+-2mm/m	+-3mm/m
Length (Height)	+-2mm/m	+-3mm/m

The above tolerances apply to all curved glass whether it be annealed, toughened or laminated (for tolerances on curved units please refer to the IGU section of this document). The nominal thickness is the thickness of the finished product.

The radius tolerance is measured as an envelope around the glass as in the diagram below. The glass should sit within this envelope to be within tolerance. It is not a numerical tolerance e.g. 10mm glass with a radius of 1000mm – the tolerance on the radius is not between 995mm and 1005mm (i.e. 1000mm +-5mm).



Twist Tolerance

Measuring Twist

We recommend twist is measured by placing the glass on a flat surface. If no twist is present, all four corners will sit flat on the surface. If twist is present, measure the distance between the surface and the corner.

Glass height	Twist Tolerance	
	Nominal glass thickness up to (and including) 12mm	***Nominal glass thickness over 12mm***
Upto 1200mm	4mm	6mm
Between 1200 and 1500	5mm	8mm
Between 1500 and 2000	6mm	9mm
Between 2000 and 2400	7mm	10mm
Over 2400	8mm	12mm

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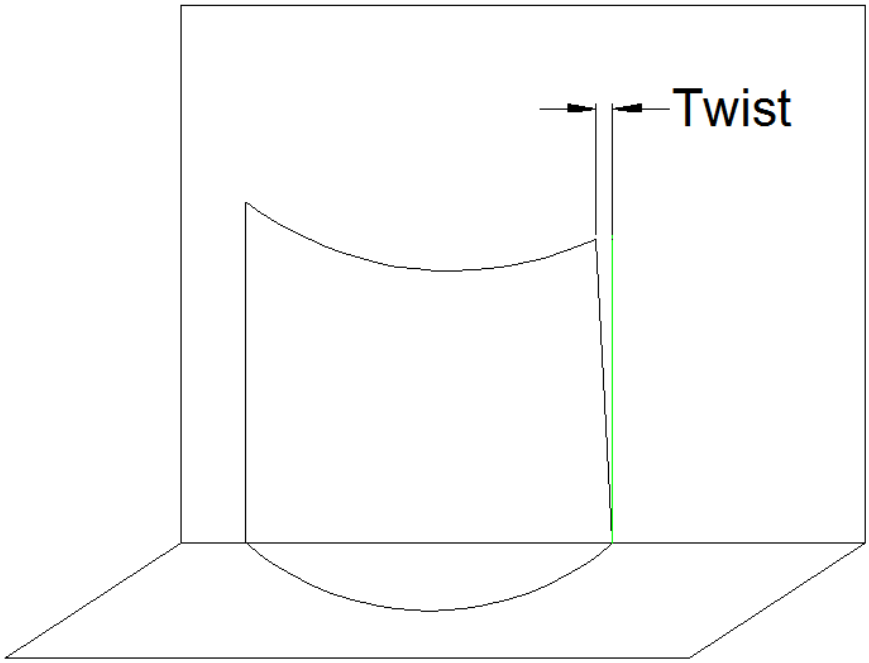

Edge Straightness Tolerance

The edge straightness tolerance in curved glass is 3mm per metre or 2mm, whichever is greater.

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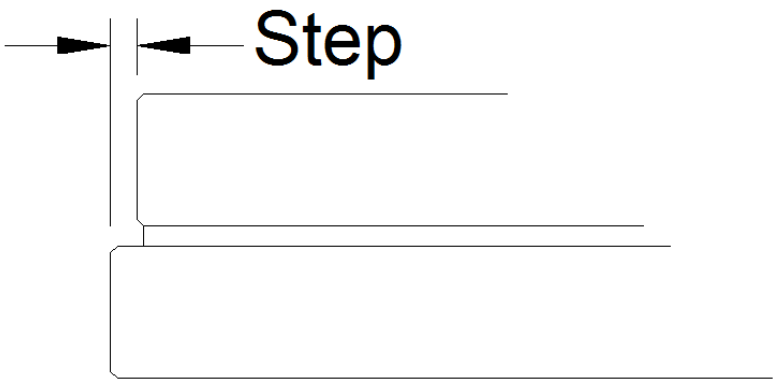
Laminated Glass

The tolerances given in the Flat Glass and Curved Glass sections should be used. Specific tolerances associated with laminated glass are shown below.

Edge Step Tolerance

The maximum edge step allowed on laminated glass is 2mm per metre or 2mm, whichever is greater.



Laminate Thickness Tolerance

The finished laminate thickness can vary due to the nature of the laminating process and the tolerances within the laminate's constituent parts. The tolerance we work to is +-1mm or 10% of the nominal laminate thickness- whichever is greater.

Inclusions within the laminate

Inclusions are acceptable so long as they are neither bunched nor obtrusive when viewed in line with our standard inspection guidelines. Inclusions should be no larger than 1mm.

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IGU's (Insulating Glass Units)

The tolerances given in the Flat Glass and Curved Glass sections should be used. Specific tolerances associated with IGU's are shown below.

Tolerance on IGU Thickness

The allowable tolerance on overall unit thickness is +-1.5mm.

Tolerance on edge step

The permissible edge step or misalignment of panes is 3mm/m or 3mm, whichever is greater.

Tolerance on Curved Units

The tolerance on the radius of curved IGU's is as below:

Tolerance of each individual component added together plus 2mm.

As an example: a 28mm unit made up of 2x6mm panes would have a tolerance of +-10mm (i.e. it would sit in an envelope of +-10mm around the unit as explained in the curved glass section of this document).

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Important Manufacturing Information

General Guidance

- Due to the range of products, processes, possible combinations of each and bespoke nature of our work, it's not always possible to know of issues until the product is produced. As with all bespoke work, we are very often asked to produce products that we haven't done before and inevitably, these come with their own bespoke challenges. We will always advise of a potential issue where possible.
- Holes, notches and cut outs are strongly recommended against in annealed glass. We would only recommend these in toughened glass.
- Normal clear glass has a natural green tint to it. This can affect the appearance of colours when glass is back painted. For example, white would appear to have a light green tint to it. For the most accurate colour, we advise low iron glass is used.
- Glass ordered at different times could show some shade difference in the colour. This is a result of using different batches of glass and as such isn't something we can control. Any variance isn't considered a defect in the product. This is important to note, especially when a re-order is required.
- The standards we produce our glass to are for architectural glass. Any products supplied are therefore intended for these applications only. Any use of the product outside of architectural applications is at the customer's discretion. Any inspections carried out must be carried out in line with the relevant architectural standard.
- Nickel Sulphide inclusions are sadly not something that we can control and are inherent in stock sheets we source. As such, in the event of any breakage that is found to have been caused by a Nickel Sulphide inclusion, Novaglaze do not accept liability for any replacement or any consequential losses resulting thereof. Heat soak testing can be undertaken to help highlight if any Nickel Sulphide inclusions are present in the glass. Please note however that the heat soak test doesn't provide 100% certainty.
- Depending on the process used, the edge finish can vary slightly between panels. All edgework is to a high standard but where a uniform finish is required, please specify when ordering. If nothing is specified, we will use our discretion when choosing which polishing process to use.
- Glass thicknesses can and do vary along the length of a panel. This is due to the manufacturing processes and are deemed to be acceptable providing they are within the relevant thickness tolerance.
- Corners will be supplied unfinished unless otherwise specified. If dubbed or radius corners are required, please advise us prior to ordering.
- White quality stamps will be applied to each panel. The location of the stamp will be at our discretion unless specifically stated when ordering. The standard location is at the bottom corner of one face.
- Deliveries will be made either loose-load or on an A-frame. It is the responsibility of our customers to unload the vehicle. If there are any specific delivery requirements, these should be discussed with us prior to ordering.
- Any edge lit glass should be inspected as per our standard guidelines and not with the edge lighting applied. Any apparent defects only visible when edge lighting is applied is not considered to be a fault of the product. Edge lighting any glass is done at the customer's discretion and risk.
- Where glass is supplied to us for processing any and all processing is carried out at the customers own risk. There will be no liability accepted from Novaglaze should there be any issues.

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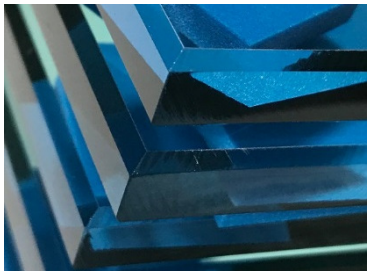
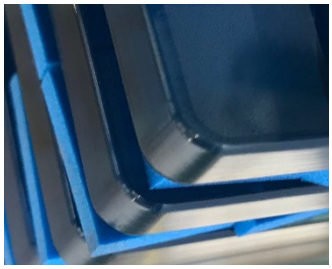
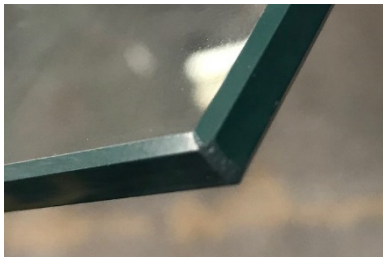
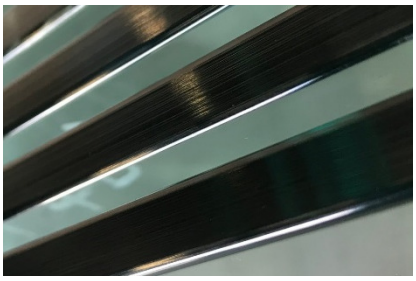
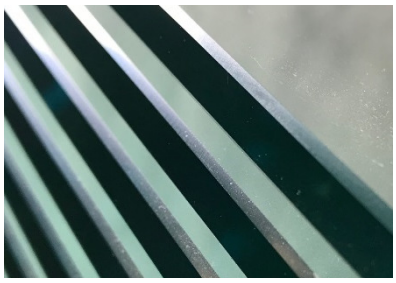
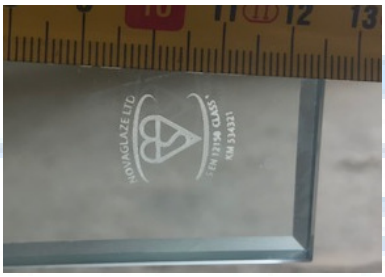




Above - Examples of corner work (L-R): Sharp, Radius, Dubbed

Above – Examples of edgework (L-R): CNC finish, SLE finish




Above – Examples of quality stamps (L-R): Normal face stamp, Edge stamp

Annealed Glass Specific Guidance

- Curved annealed glass with a large angle of curvature can sometimes show a very faint line vertically down the centre of the glass. This is a result of the manufacturing process and isn't considered a defect of the product.
- Some curved glass can have a curve which then transitions into a flat section(s). The point at which they meet can, depending on the glass size, spec and shape, deviate from a smooth transition and show a slight 'bump' in the glass. This is considered a by-product of the process and as such isn't considered to be a defect.
- Machines polished edges are not always possible on some curved glass. In these instances, we will hand polish these edges. The finish is slightly different from a machine finish. Please contact us if you would like to see examples.
- Some panels will have different quality edge finishes on the same panel. This is due to the limitations of the process and will not be accepted as reasons for rejection. If uniform finishes are required, please contact us prior to placing an order.

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Toughened Glass Specific Guidance

- Curved toughened glass will flatten out towards the end of the bends. The severity depends on factors such as the glass thickness, height, width and radius. The flat sections typically range from between 50mm to 150mm although occasionally flat sections can exceed this range.
- Coated glass can show elevated levels of distortion compared to clear or low iron glass. A 'line' of optical distortion can sometimes be seen running horizontally through the centre of some coated glass. In these instances, this is considered a result of the manufacturing process and as such is not considered a defect.
- Thicker glass (10mm and up) can sometimes show increased levels of surface imperfections or small imprints in the surface (known as roller pick-up) than thinner glass of equivalent specification and size.
- Curved glass which has a radius over 20000mm can be difficult to keep to a true radius. The radius can appear to have flat sections which is a result of the manufacturing process and is considered to be acceptable.
- Curved glass which is produced to a tight radius can show more surface imperfections and optical distortion than that to a shallower radius.
- When curved glass is used for frameless glazing, due to the flat sections at each end of the panels, a run of several panels can appear to have flat sections and not be continuous and smooth when looking down the curve. Although not always a problem, it is something to be aware of. We recommend using a handrail to cover the top edge if this is a potential issue.
- Tolerances on bow must be considered when panels are adjacent to one another. E.g. if two panels are side by side and have 2mm of bow – the difference can appear larger if one panel bows one way and the other is bowing the opposite way (i.e. effectively creating the appearance of 4mm of bow). Each panel must be considered on an individual basis when being measured for bow. Also worth noting is that this can happen on both curved and flat glass.
- The very nature of the toughening process means it's not possible to produce a pane of toughened glass as flat as annealed glass. All toughened glass will show signs of roller wave (a very slight waviness in the glass which is most visible when viewed at an angle). The severity of the roller wave will depend on the glass type, thickness, size, radius (if curved) and any features such as holes and cut outs.
- Curved toughened glass will show different levels of distortion and imperfections than flat toughened glass.
- 4mm glass does show more signs of optical distortion (such as roller wave) than thicker glass due to the higher temperatures required to toughen it.
- Larger glass panels (large girths over 2200mm and panels with areas larger than 4sqm) and very small panels (typically less than 0.5sqm) can show higher levels of optical distortion.

Laminated Glass Specific Guidance

- The nature of the laminating process means there will be a 'V-shape' down the edge of the glass where glass panes are joined.
- Large flat toughened laminates (typically 3sqm and up) will occasionally require a slightly thicker interlayer to allow for any distortion in the toughened glass.
- Curved laminated glass does often require a thicker interlayer to absorb any deviations caused through the bending process. The thickness required will depend of factors such as: size of the glass, radius, thickness of the glass, complexity and number of any shapes/features.

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T: *(01484) 517 010*
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- We offer two types of laminating; EVA and CIP. CIP has a very faint line around the perimeter of each exposed edge, approximately 6mm in. We will always use EVA where possible but we reserve the right to use whichever process we feel necessary unless specifically agreed otherwise.
- Due to certain manufacturing restrictions, a resin interlayer is sometimes required to be used. The nature of the process requires us to apply an edge tape which can show a very faint line approximately 6mm in from each edge. This line is only visible when viewed close up and at certain angles. The line is considered part of the manufacturing process and isn't considered a defect within the product. Additionally, a clear silicone 'plug' may be visible in the corner of the glass. Again, this is a part of the manufacturing process and isn't considered to be a defect.
- When a flush edge is required this must be highlighted to us before an order is placed.

IGU (Insulated Glass Unit) Specific Guidance

- As IGU's and laminates consist of multiple monolithic panes, it is expected that multiple panes do show increased levels of optical distortion e.g. we would expect a three pane IGU to have approx. three times the optical distortion of a monolithic panel of equivalent size and spec.
- Occasionally on curved glass, aluminium bar cannot be used as a spacer due to the radius. On these occasions we will use a flexible bar. If a specific spacer isn't stated at the time of order, we reserve the right to choose which bar is most suitable for manufacture.
- Our standard IGU sightline is approximately 12-14mm however this can vary depending on the unit size and specification. As manufacturers we don't assume design responsibility for the depth of seal required for a particular application and will use our standard depth unless another is specified.
- Our standard spacer bar is silver aluminium. Where a warm edge spacer must be used, this should be highlighted when ordering.

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Inspection Guidelines

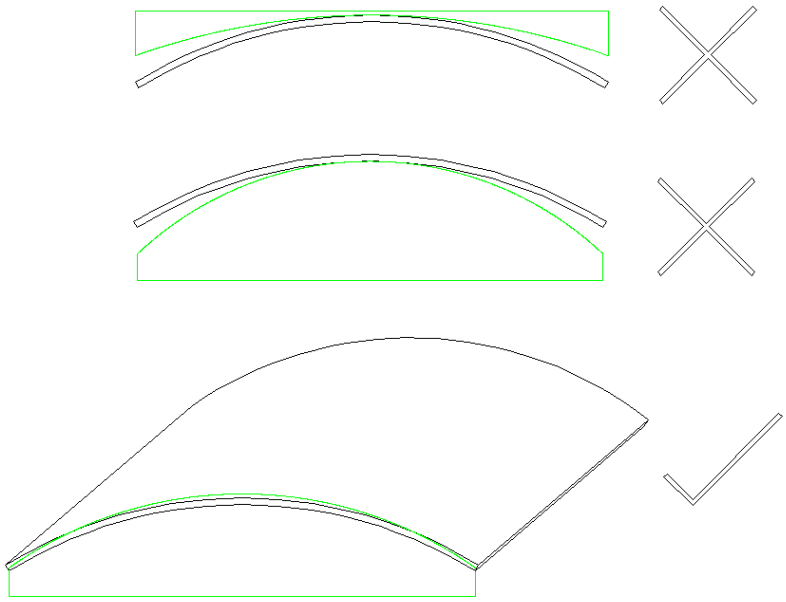
Our standard inspection criteria is stated below. Unless it is otherwise explicitly agreed in writing prior to an order being placed, these guidelines should be used when inspecting the glass we supply. We appreciate that certain projects require more demanding inspection criteria and these should be discussed with us prior to placing an order.

1. Glass should be inspected vertically in natural daylight conditions, away from direct sunlight and other high intensity light sources (e.g. spotlights). There should be no background lighting present during the inspection.
2. Glass should be inspected perpendicularly to the glass surface and not at an angle.
3. Glass should be inspected from a distance of 3 metres away with the naked eye.
4. Glass should not be inspected in reflection

If a blemish is present, its obtrusiveness should be judged by looking through the glass, as opposed to at it.

Checking a curve

When checking a curve, the template must be placed against the glass edge and not against the face of the glass. This is essentially the same as though the glass was placed in a channel. When placed against either the inside or outside face of the glass, any slight, but within tolerance deviation in the curve can have a misleading impact at another part of the bend and is why the glass shouldn't be checked in this way. The curve tolerances we work to on curved glass act as an envelope around the glass within which the glass must sit as shown in the diagrams below.



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