

## PHYSICAL TOLERANCES FOR LAMINATED GLASS

All tolerances comply with the minimum requirements pertained within BS EN 12543 : 2011. Though ESG Ltd aims to surpass Industry Standards it reserves the right to defer from these improved tolerances and instead refer and supply in line with relevant industry standards. This applies to both new and existing contracts.

| <b>PHYSICAL TOLERANCES – LAMINATED GLASS SUPPLIED BY ESG LTD</b> |  |  |                                     |
|--|--|--|-------------------------------------|
| <b>Thickness</b>   | <b>No. Plies</b>   | <b>Tolerance (mm)</b>  |                                     |
|  | 3 Ply  | ±0.5   |                                     |
|  | 5 ply  | ±0.8   |                                     |
|  | 7 Ply  | ±1.0   |                                     |
|  | 9 Ply  | ±1.4   |                                     |
|  | 11 Ply   | ±1.7   |                                     |
|  | 13 Ply   | ±2.0   |                                     |
|  | 15 Ply   | ±2.3   |                                     |
|  | >15 Ply  | ±2.5   |                                     |
| <b>Length &amp; Width</b>  | <b>Nominal Dimension</b>   | <b>Laminated Glass Thick.</b>  |                                     |
|  | L or H   | ≤30mm  | >30mm                               |
|  | ≤2000  | ±2.0   | ±2.0                                |
|  | ≤3000  | ±2.5   | ±3.0                                |
|  | >3000  | ±3.0   | ±4.0                                |
| <b>Max Displacement for Cut and Stock Sizes</b>                  | <b>Nominal Dimension</b>   |  | <b>Max Permissible Displacement</b> |
|  | L or H   |  | Mm                                  |
|  | L,H ≤1000  |  | 2.0                                 |
|  | L <1000, H ≤2000   |  | 3.0                                 |
|  | L <2000, H ≤4000   |  | 4.0                                 |
|  | L, H >4000   |  | 6.0                                 |
| <b>Holes &amp; Notch Alignment</b>                               | All Products & Thicknesses   |  | ±2mm                                |
| <b>Bow</b>   | L & W <1000  |  | 2mm                                 |
|  | L & W 1000 ≥2000   |  | 4mm                                 |
|  | L & W 2000 ≥3000   |  | 6mm                                 |
|  | L & W >3000  |  | 9mm                                 |
|  | Polycarbonate Laminates  |  | 5mm/Linear Metre                    |
| <b>Quality Marking</b>   | All laminate products are to be stamped with a quality mark where information displayed on them will be in accordance with relevant standards, third party certifications and manufacturing licences.  |  |                                     |
| <b>Edges</b>   | All standard laminates to be edge trimmed to ensure uniform finish. Steps on laminates can be polished out but the interlayer must not be touched. Thermally treated glasses shall not be cut, sawn, drilled or edge worked after laminating. Cut edges must be ground off or edge worked so to minimise the risk of cuts when handling. Possible edge working techniques include arrissing, ground edged, smooth ground edged, polished edged, bevel edged, sawn edged, and water jet cut edged, and bevel edged with angle no greater than 60°±3°. |  |                                     |
| <b>LCD</b>   | <b>General Appearance</b>  | Haze is acceptable when viewing LCD switchable glass other than perpendicular, with levels of haze increasing as the viewing angle becomes more acute.       |                                     |
|  | <b>Borders</b>   | Optical distortions, creases and any other defect, including those to the film are permitted along all edges up to 5mm inwards.                              |                                     |
|  | <b>Holes/Notches/Cut-Outs</b>  | Visual distortions are permitted up to 10mm from edges of holes, notches and cut-outs.   |                                     |
| <b>Coloured Surfaces &amp; Interlayers</b>                       | <b>Colour Variances</b>  | Visual colour differences are permitted between samples and finished product where lighting, background conditions and panel size can create subtle changes. |                                     |

# VISUAL APPEARANCE TOLERANCES FOR LAMINATED GLASS

All tolerances comply with the minimum requirements pertained within BS EN 12543 : 2011.

## PRINCIPLE

The laminated glass is put in a vertical position, in front of and parallel to a matt grey screen, and is lit by diffuse daylight or equivalent. The laminated glass is visually inspected perpendicularly at a distance of 2m from the glass, (except for ESG Switchable LCD Privacy Glass which is 1m), with the matt screen on the other side of the glass. Any visible defects that are disturbing shall be marked. Vents are not permitted, nor are creases and streaks allowed in the visual area (Exceptions to this rule exist for ESG Switchable LCD Privacy Glass as detailed below).

Where no defects are visible from the specified distance the panel is deemed acceptable. If defects are observed from within the specified distance, the extent of such defects are to be within the tolerances detailed below and if not, then the panel may be rejected.

## PERMISSIBLE SPOT DEFECTS IN THE VISION AREA

Spot defects include opaque spots, bubbles and foreign bodies. Defects less than 0.5mm are permitted. Defects greater than 3mm are not permitted.

\*For laminates consisting of two panes the maximum size of defect is 2mm.

For ESG Switchable LCD Glass products, bubbles of any size are not permitted and any defect both spot or linear type which can be observed from a distance of 1 metre away should be rejected.

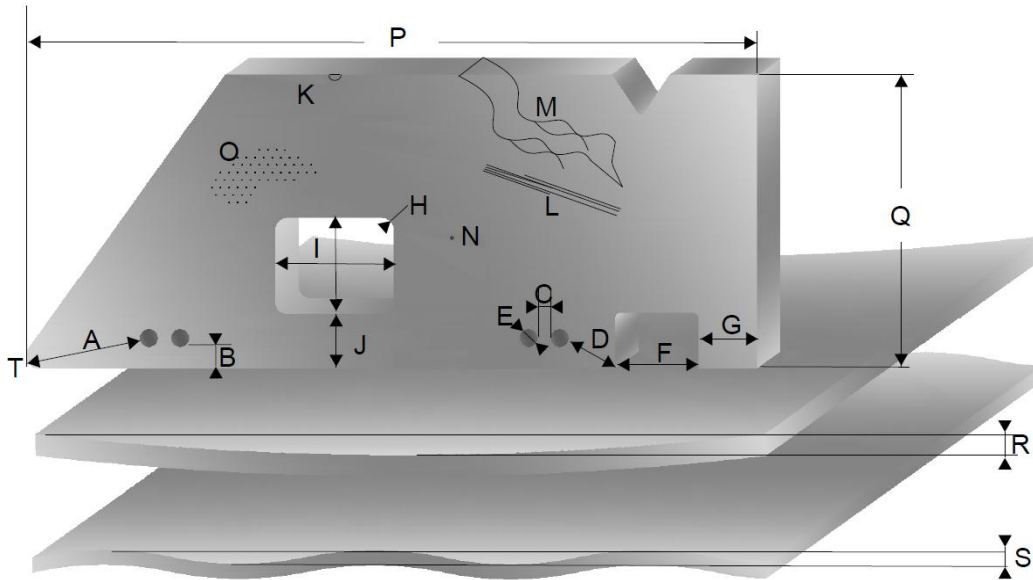
| Size of Defect                        |         | 0.5   | 0.5-1mm   | 1.0≤3.0mm        |                   |                  |
|---------------------------------------|---------|---|---|------------------|-------------------|------------------|
| Size of Laminate                      |         | Any Size  | Any Size  | ≤1m <sup>2</sup> | 1≤2m <sup>2</sup> | >2m <sup>2</sup> |
| No. or Density of Permissible Defects | 2 Panes | Max. 4 defects. Must be further than 200mm apart from each other. | Max. 2 defects. Must be further than 100mm apart from each other. | 0                | *1                | *1               |
|                                       | 3 Panes |   |   | 1                | 2                 | 2                |
|                                       | 4 Panes |   |   | 2                | 3                 | 3                |
|                                       | 5 Panes |   |   | 2                | 3                 | 4                |

## PERMISSIBLE LINEAR DEFECTS IN LAMINATES

Linear defects include foreign bodies, hairs, scratches or grazes.

Linear defects are permitted so long as they cannot be observed from a distance of 2 metres.

# SINGLE PANE QUALITY & PROCESSING TOLERANCES



|     |                          | QUALITY TOLERANCES   |   |
|-----|--------------------------|--|---|
| No. | CATEGORY                 | FLOAT GLASS  | TOUGHENED GLASS   |
| A   | HOLES FROM ACUTE CORNERS | Min. Glass Thickness   | Min. 6X Glass Thickness   |
| B   | HOLES FROM EDGES         | Min. Glass Thickness   | Min. 1.5 X Glass Thickness  |
| C   | HOLE TO HOLE DISTANCE    | Min. 5mm   | Min. 1.5 X Glass Thickness  |
| D   | HOLES TO CORNERS         | Min. 5mm   | Min. 3.5 X Glass Thickness  |
| E   | HOLE DIAMETER            | Any Hole Size<br>(Same hole diameter and position tolerances)                              | Min. 1 X Glass Thickness<br>4≥20mm hole diameter = ±1.0mm<br>20≥100+ hole diameter = ±2.0mm<br>Hole position on Glass = ±2.0mm  |
| F   | NOTCH WIDTH              | Same   | Min. 25mm if cut or arrissed<br>Min. 40mm if Polished Edge  |
| G   | NOTCH DISTANCE TO CORNER | Same   | Min. 3 X Glass Thickness or 40mm whichever is greatest  |
| H   | INTERNAL RADIUS          | 1. Ground Edges – Internal radius 7mm min.<br>2. Polished Edge – Internal radius 18mm min. | 1. Ground Edges – Internal radius must be equal to ½ glass thickness or 7mm whichever is the greater.<br>2. Polished Edges – Internal radius of 18mm min.                           |
| I   | MINIMUM CUT-OUT          | Same   | Min. 20 X 20 if Ground Finish<br>Min. 40 X 40 if Polished Edge  |
| J   | CUT-OUT TO EDGE DISTANCE | Same   | Min. 3 X Glass Thickness if Cut<br>Min. 45mm if Polished Edge if 4mm to 10mm Thickness is processed. 12mm Thickness and above 100mm Min.  |
| K   | SHELLS                   | Same   | Glass ≤8mm Thick Max 2mm if Glass Arrissed. Glass >8mm Thick Max 4mm if Glass Arrissed.   |
| L   | SCRATCHES                | Same   | Not Permitted if seen from 2m distance  |
| M   | CRACKS                   | Same   | Not Permitted   |
| N   | SEEDS                    | Same   | Max 3 No. If ≤1mm. Seeds >1mm not permitted   |
| O   | PITTING                  | N/A  | Not Permitted When Observed from 2m   |
| P   | OVERALL LENGTH           | Same   | +2mm Unless Label States Otherwise  |
| Q   | OVERALL HEIGHT           | Same   | +2mm Unless Label States Otherwise  |
| R   | OVERALL BOW              | Same   | Max. 3mm/Linear Metre for Non Laminated<br>Laminated L or W <1m = Max 2mm<br>Laminated L or W 1m≥2m = Max 4mm<br>Laminated L or W 2m≥3m = Max 6mm<br>Laminated L or W >3m = Max 9mm |
| S   | ROLLERWAVE               | Same   | Glass 3-5mm =Max 0.5mm,<br>Glass 6-10mm = Max 0.3mm<br>Glass 12-19mm = Max 0.15mm   |
| T   | RADIUS CORNERS           | +2mm   | +2mm Unless label states otherwise  |
| U   | MECHANICAL STRENGTH      | N/A  | Min. 120 N/mm <sup>2</sup>  |

\* For visual quality tolerances view glass in a vertical position at right angles and lit by diffuse daylight or equivalent.