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Z25 GLASS

This section shall be read in conjunction with the other related sections of the Specification, Preliminaries and Contract Conditions.

Z25.1 GENERAL

Z25.1.1 GLASS PROCESSOR

- a) The glass processor is **F.A.Firman (Harold Wood) Limited**, referred to as Firman Glass throughout this document.
- b) Any persons connected with this contract are welcome to visit the factory at any time by prior appointment.

Z25.1.2 APPLICATION AND PERFORMANCE

Z25.1.2.1 PROVISION OF INFORMATION

- a) The determination of glass types will be made depending on the information supplied to **Firman Glass** regarding:
 - specific application of the glass (intended use)
 - load requirements
 - method of fixing the glass
 - safety requirements
 - thermal insulation requirements
 - solar control requirements
 - acoustic requirements
 - colour requirements
 - specific glass type requirements
 - restrictions on materials usage
- b) **Firman Glass** cannot take into account any performance requirements of which they are unaware.

Z25.1.2.2 LOADS

- a) The glass type and thickness will be determined based on the design loads advised to **Firman Glass** - wind, snow, guarding / barrier, maintenance, explosions, or any other load mechanism; and the method of fixing the glass.
- b) **Firman Glass** will not determine loads from loading standards. If necessary for the purposes of quotation, **Firman Glass** will make assumptions about loads and request confirmation. Load determination for the glass will be the responsibility of the Project Architect or their Structural Engineer.

Z25.1.2.3 *FIXING*

- a) The detail of the frame or fixing is assumed to be appropriate for the type of glass.
- b) **Firman Glass** will not warrant or approve framing or fixing systems supplied and installed by other parties, as this is the competence of the glazing subcontractor and is generally covered by various standards.
- c) **Firman Glass** may give advice on framing or fixing systems when requested.
- d) Structural movement will be taken into account if values are advised and it is relevant to the immediate glass fixing.

Z25.1.2.4 *SAFETY*

- a) Safety glass to meet the requirements of Regulations and Standards will be provided for those panes identified by the glazing subcontractor.

Z25.1.2.5 *U VALUE, SOLAR CONTROL AND LIGHT TRANSMISSION*

- a) The glass will be matched, as a far as possible, to the requirements of the specification.
- b) Where a particular glass type is specified, this will be supplied if it can be obtained in forms which also meet the other requirements of the specification. If not, an alternative glass type will be offered.
- c) If it is not possible to find a match for the specified environmental control properties, a product will be supplied based on prioritising the following four parameters in order of importance:
 - U value
 - total solar transmission (or total shading coefficient)
 - colour or tint
 - light transmission

Z25.1.2.6 *ACOUSTICS*

- a) The glass thicknesses and types will be determined to achieve, as far as possible, the sound reduction requirements of the specification.
- b) There may be some deviation between the glass performance and the required sound reduction if this is detailed by octave bands.

Z25.1.2.7 *THERMAL STRESS*

- a) The responsibility for thermal stress checking is the province others.
- b) **Firman Glass** will supply a check list and perform the calculation if required, at an agreed cost.

c) Glass vulnerable to thermal stress cracking should be toughened or heat strengthened.

Z25.1.2.8 *IMPACT*

a) Glass may break, chip or scratch under impact, depending on the impact energy and the nature of the impacting body.

Z25.1.2.9 *DEFLECTION*

a) In order to be considered as supporting the glass, no part of a frame, or any fixing point, should deflect more than span/200 under the applied loads, where 'span' is an appropriate dimension of the glass.

b) The deflection of the glass relative to its supports may be up to span/65.

Z25.1.2.10 *RISK ASSESSMENT*

a) Information will be provided to form part of a risk assessment, if requested.

Z25.1.3 *GLASS TYPES*

Z25.1.3.1 *GENERAL*

a) The glass will be sourced from an appropriate supplier. There will be no certification of the origin of the glass.

Z25.1.3.2 *FLOAT GLASS*

a) The glass will conform to the classification of BS 952 and the requirements of BS EN 572-2.

b) Clear float glass is a commodity product and may be obtained from any reputable European supplier. Records are not kept which will trace the basic clear float glass used in any **Firman Glass** product.

Z25.1.3.3 *PATTERNED GLASS*

a) The glass will conform to the classification of BS 952 and the requirements of BS EN 572-5.

Z25.1.3.4 *TOUGHENED GLASS*

a) The glass will conform to the classification of BS 952 and the requirements of BS EN 12150.

b) Heat soaked toughened glass will either conform to BS EN 14179, or conform to BS EN 12150 and be heat soaked to the requirements of DIN 18516-4. Both regimes are estimated by their respective standards organisations to have a residual risk of nickel sulphide breakage of 1 pane in 400 tonnes of glass supplied (on average).

- c) Toughened glass is processed by **Firman Glass** in a roller hearth furnace.
- d) Toughened glass and heat soaked toughened glass processed by **Firman Glass** is known by the trade name FIRMATUFF
- e) FIRMATUFF conform to Class A to BS 6206 and Class 1(C) to BS EN 12600.

Z25.1.3.5 *HEAT STRENGTHENED GLASS*

- a) The glass will conform to the classification of BS 952 and the requirements of BS EN 1863.
- b) Maximum thickness of heat strengthened glass conforming to BS EN 1863 is 12 mm.
- c) Heat strengthened glass is processed by **Firman Glass** in a roller hearth furnace.
- d) Heat strengthened glass used in locations requiring a safety glass must be laminated. It is not a safety glass in monolithic form.

Z25.1.3.6 *COATED GLASS*

- a) The glass will conform to the classification of BS 952 and the requirements of BS EN 1096.
- b) The coated glass may be annealed, heat strengthened, toughened, or heat soaked toughened depending on the requirements of the specification. Heat strengthened coated glass will also be according to Z25.1.3.4. Toughened coated glass and heat soaked toughened coated glass will also be in accordance with Z25.1.3.3.

Z25.1.3.7 *BACK PAINTED GLASS*

- a) The glass will conform to the classification of BS 952 and the requirements of either BS EN 12150 for toughened glass or BS EN 1863 for heat strengthened glass.
- b) Back painted glass (e.g. for spandrel panels) processed by **Firman Glass** is known by the trade name Colorfirm™.
- c) Colorfirm™ is not available in heat strengthened form.
- d) Colorfirm™ on toughened glass conform to Class A to BS 6206 and Class 1(C) to BS EN 12600, apart from the marking clause.

Z25.1.3.8 *LAMINATED GLASS*

- a) The glass will conform to the classification of BS 952 and the requirements of BS EN 12543.
- b) Laminated glass may combine any of the glass types described in Z25.1.3.1 to Z25.1.3.6, depending on the requirements of the specification.
- c) The interlayers will be either pvb or cast-in-place (CIP) polyester resin, depending on the requirements of the specification and the types of glass requiring to be laminated.
- d) Pvb interlayers may be clear, tinted or translucent depending on the requirements of the specification.
- e) CIP interlayers will be clear.

Z25.1.3.9 *INSULATING GLASS UNITS*

- a) The units will conform to the classification of BS 952 and the requirements of BS EN 1279.
- b) Insulating glass units may combine any of the glass types described in Z25.1.3.1 to Z25.1.3.7, depending on the requirements of the specification.
- c) The life expectancy Firman Glass insulating glass units is 30+ years in good framing systems. This is not guaranteed.
- d) The standard warranty against seal failure for Firman Glass insulating glass units is 5 years in good framing systems. This can be extended for framing systems where the adequacy of the drainage and ventilation systems has been demonstrated to **Firman Glass**.
- e) The warranty from **Firman Glass** is with its direct customer. The warranty is not transferable.

Z25.1.4 DIMENSIONAL TOLERANCES

Z25.1.4.1 *SIZE*

- a) Float glass: up to 1 m length ± 1 mm; over 1 m length ± 2 mm.
- b) Patterned glass: up to 1 m length ± 1 mm; over 1 m length ± 2 mm.
- c) Toughened glass: up to 1 m length ± 1 mm; over 1 m length ± 2 mm.
- d) Laminated glass: up to 1 m length ± 2 mm; over 1 m length ± 3 mm.
- e) Insulating units: up to 3 m² area ± 1.5 mm; up to 8.5 m² area ± 2 mm; over 8.5 m² area ± 3 mm.
- f) Where insulating glass units incorporate laminated glass, the tolerances for both should be summed.

Z25.1.4.2 *SQUARENESS*

- a) Difference in diagonals of rectangular panes maximum 4 mm.

Z25.1.4.3 *THICKNESS*

- a) Monolithic glass: the thickness tolerance is according to the appropriate European Standard.
- b) Laminated glass: The thickness tolerance is the sum of the component glass tolerances with an additional ± 0.5 mm per interlayer.
- c) Insulating glass units: both panes ≤ 6 mm ± 1 mm; one pane over 6 mm ± 1.5 mm.
- d) Where insulating glass units incorporate laminated glass, the tolerances for both should be summed.

Z25.1.5 VISUAL APPEARANCE

Z25.1.5.1 *VISUAL QUALITY*

- a) Visual quality relates to imperfections in the glass such as spot faults (e.g. inclusions, stones, bubbles), linear or extended faults (e.g. scars, scratches), pinholes (in coatings or paints), and other localised imperfections.
- b) Colour is specified in Z25.1.6 and distortion is specified in Z25.3.1 and Z25.4.1.
- c) Subjective assessment is not acceptable for visual quality. **Firman Glass** will meet the objective visual quality requirements of the specification herein.

Z25.1.5.2 VISUAL QUALITY VIEWING CONDITIONS

- a) Viewing distance for all glass is 3000 mm, except for Colorfirm™ back painted glass (spandrel glass) where the viewing distance is 5000 mm.
- b) Viewing is at direction at right angles to the glass.
- c) The glass is viewed uniformly lit and against a uniform background, out of direct sunlight.
- d) The **critical area** is an ellipse $\frac{3}{4}$ of the height and $\frac{3}{4}$ of the width of any pane.
- e) The **perimeter area** is a border of 50 mm width in single glazing (including laminated glass) or 50 mm inside the spacer sight line in insulating glass units.
- f) The **viewing area** is the remainder of the glass surface not included in the critical area or the perimeter.
- g) For panes or units containing more than one product with different visual quality criteria, the visual quality criteria to be used are the least onerous.

Z25.1.6 COLOUR

- a) The colour variation for any glass type will be within manufacturing tolerances.
- b) The colour of different thickness of the same product will be affected by the glass tint. This effect also includes clear glass, which has a slight green tint.
- c) Glass with the same nominal colour, but manufactured by different processes, manufactured at different dates, or processed at different manufacturing facilities, may be from different batches and may show a wider colour variation than glass all manufactured from the same batch at the same time.
- d) Identical panes of glass may appear a different colour depending on the angle of view and the reflected image.

Z25.1.7 EDGE QUALITY

- a) Edges will be clean cut, clean cut and arrissed, ground and arrissed, or polished and arrissed, to meet the requirements of the glass and the specification as appropriate.
- b) Cut edges will be generally free from vents, shelling and severe feathering. Mild feathering is allowed.

c) Cut edges for use in framed glazing systems may have shallow edge damage or conchoidal fractures (shells) which do not adversely affect the glass strength and do not project beyond the unit edge seal (or the framing edge cover for single glass).

d) Ground and Polished edges may include small ground out chips and shells up to 2 mm deep extending 5 mm across the surface of the glass and 10 mm across/along the edge.

e) Glass shall not be cut or nipped on site.

Z25.1.8 QUALITY CONTROL

a) The glass is processed in a factory with a management system based on BS EN ISO 9001:2000.

b) FIRMATUFF factory production control is assessed by BSI (Kitemark number 7311).

Z25.1.9 LABELLING AND MARKING

Z25.1.9.1 LABELLING

a) Each pane or unit will be labelled with removable labels containing the following information.

- **Firman Glass** works order number and item number
- Customer order number
- Customer pane reference (where requested)
- overall size
- glass description
- cavity width (if applicable)
- gas filling (if applicable)

b) Each unit will be labelled with removable labels to indicate the presence of a coated glass (if applicable).

Z25.1.9.2 MARKING

a) Each pane of FIRMATUFF toughened glass will be permanently marked with the **Firman Glass** logo and the classification BS EN 12150

b) Each pane or heat strengthened glass will be permanently marked in with the **Firman Glass** logo, the words 'HEAT STRENGTHENED' and the classification BS EN 1863.

c) **Firman Glass** cannot determine the mark position on glass produced outside their control.

d) **Firman Glass** will, when requested, endeavour to comply with customers' requirements on specific mark positions. However, should a mark be positioned other than as requested, this does not make the glass reject able by the customer, provided its position conforms to the requirements of BS 6262-4

Z25.1.10 CONTROL SAMPLES

a) Control samples for quality will not be provided. It is not possible to provide samples representative of the 'range' of quality in any respect. Quality is to be judged according to the objective criteria in the specification herein.

Z25.2 ANNEALED GLASS

Z25.2.1 TRANSPARENT GLASS

a) Unless otherwise required by the specification, all transparent glass, whether it is low iron, clear, tinted, or coated, used in laminated glass or insulating glass units, will be float glass.

b) Float glass may show distorted reflections in use, either due to distortions induced by the fixing system or due to the pressure and temperature effects on insulating glass units.

c) Visual quality limits are as follows:

- **Critical area:** Defects which are visually obtrusive seen from the viewing distance are not allowed.
- **Vision area:** Up to two of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 50 mm, scratches no longer than 20 mm, areas of crush marks up to 25 mm long. Other defect types and larger sizes which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
- **Perimeter area:** Up to five of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 100 mm, scratches no longer than 50 mm, scars no wider than 3 mm or longer than 20 mm, areas of crush marks up to 50 mm long, seed / stones / pickup / bubbles up to 2 mm diameter. Other defect types and larger sizes of these which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
- **Clusters:** Clusters of defects which are not individually significant are not allowed.

Z25.2.2 SHAPE

a) Annealed glass will not normally be provided if there are holes, cut-outs, notches, or re-entrant corners. Panes having these characteristics will be toughened or heat strengthened as appropriate.

Z25.2.3 TINTED GLASS

a) Tinted glass of a particular tint supplied for the contract will be obtained from a single manufacturer, identified by a trade name.

b) Tinted glass with different tints may be obtained from different manufacturers.

c) The solar and light reflectance and transmittance will be within 3% of the manufacturers quoted performance figures.

d) The tinted glass may have a colour variation, both in transmission and reflection, within the manufacturer's tolerances (known as the 'colour box') for the product.

e) Samples will show the general colour of the glass, but it is not possible to provide samples to show a range of variations.

Z25.3 TOUGHENED GLASS

Z25.3.1 DISTORTION

a) Maximum bow 0.3 % (3 mm/m) along each edge and diagonal.

b) Roller wave maximum:

- 4 mm toughened - 0.3 mm
- 5 mm toughened, - 0.3 mm
- 6 mm toughened - 0.3 mm;
- 8 mm toughened - 0.3 mm
- 12 mm/15mm toughened- 0.3 mm
- 19 mm toughened - 0.3 mm

c) Edge dip maximum:

- 4 mm toughened - 0.4 mm
- 5 mm toughened - 0.4 mm
- 6 mm toughened - 0.3 mm
- 8 mm to 15mm toughened - 0.3 mm
- 19 mm toughened - 0.3 mm

d) Where the pane is more than 2950 mm wide, the roller wave will be aligned vertically. Where the pane is more than 2950 mm high, the roller wave will be aligned horizontally. For panes with both dimensions less than 2950 mm, the roller wave will be aligned as requested.

Z25.3.2 SHAPE

a) Limitations will be imposed on the position and size of holes, cutouts and notches, and on the sharpness of re-entrant corners, in order that the glass can be successfully processed and the strength of the glass is not compromised.

Z25.3.3 EDGE WORKING

a) Edge working of toughened glass will be a minimum clean cut arrissed. Ground and arrissed or polished and arrissed will be supplied where requested.

Z25.3.4 SURFACE COMPRESSIVE STRESS

a) Surface compressive stress is controlled by particle count to BS EN 12150 on sample test breakages.

Z25.3.5 APPEARANCE

a) The presence of 'leopard spots', also known as toughening marks, quench marks, iridescence or anisotropy, is unavoidable and is not a fault.

Leopard spots arise from local variations in the toughening stress because the cooling air is blown at the glass through an array of nozzles. Immediately under a nozzle the cooling effect and stress is greater than away from the nozzles. If the glass is static, then spots of greater stress are formed. If the glass or the quench head is moving then the spots are smeared. These local variations in toughening stress are present in every pane of toughened glass. Glass has a natural property which twists polarised light when the glass is stressed, so the slight variations in toughening stress are visible when the glass is viewed in polarised light. Since light can be polarised by a variety of effects – reflection, blue sky (especially in the evening), and hazy sky or light cloud, for example – the effect will show up from time to time.

The pattern of the leopard spots is determined by the mechanics of the toughening plant (usually not in the control of the operators) and can vary from distinct spots, to linearly smeared spots to smeared areas.

Any coating treatment which increases visible reflection in relation to the light transmission of the glass will also increase the visibility of leopard spots.

b) The glass surface may show roller marks, also known as roller pickup, dimpling, or orange peel. This will be minimised, but may be present on any glass thicker than 6 mm. Roller marks in sufficient numbers to give an orange peel effect will be rejected in vision glass.

Roller marks are small imprints in the surface of the glass formed during contact with the hot rollers when the glass is soft, or due to minor contamination of the rollers when the glass is soft, when the contamination may stick in the imprint. They are more prevalent on thick glass (which is heavier and is in the oven for a longer period than thinner glass) and on enamelled glass (which has to be heated to a higher temperature to fire in the enamel).

c) Visual quality limits are as follows:

- **Critical area:** Defects which are visually obtrusive seen from the viewing distance are not allowed.
- **Vision area:** Up to two of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 50 mm, scratches no longer than 20 mm, areas of crush marks up to 25 mm long. Other defect types and larger sizes which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
- **Perimeter area:** Up to five of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 100 mm, scratches no longer than 50 mm, scars no wider than 3 mm or longer than 20 mm, areas of crush marks up to 50 mm long, seed / stones / pickup / bubbles up to 2 mm diameter. Other defect types and larger sizes of these which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
- **Clusters:** Clusters of defects which are not individually significant are not allowed.

Z25.3.6 HEAT SOAKED TOUGHENED GLASS

a) Records are kept for 12 years for each batch of glass heat soaked including date, heat soak oven and oven temperature record, together with the **Firman Glass** works order number and item number and the position of each pane on the heat soak stillage.

b) Records of heat soak breakages are not retained. Keeping such records is meaningless, since glass can break in the heat soak oven for reasons other than nickel sulphide.

Z25.4 HEAT STRENGTHENED GLASS

Z25.4.1 DISTORTION

a) Maximum bow 0.3 % (3 mm/m) along each edge and diagonal.

b) Roller wave maximum:

- 4 mm - 0.3 mm
- 5 mm - 0.3 mm
- 6 mm - 0.3 mm
- 8-12 mm - 0.3 mm

c) Edge dip maximum:

- 4 mm - 0.4 mm
- 5 mm - 0.4 mm
- 6-12 mm - 0.3 mm

d) Where the pane is more than 2950 mm wide, the roller wave will be aligned vertically. Where the pane is more than 2950 mm high, the roller wave will be aligned horizontally. For panes with both dimensions less than 2950 mm, the roller wave will be aligned (insert direction).

Z25.4.2 SHAPE

a) Limitations will be imposed on the position and size of holes, cut-outs and notches, and on the sharpness of re-entrant corners, in order that the glass can be successfully processed and the strength of the glass is not compromised.

Z25.4.3 EDGE WORKING

a) Edge working of heat strengthened glass will be a minimum clean cut arrissed. Ground and arrissed edges or polished and arrissed edges will be supplied where requested.

Z25.4.4 APPEARANCE

a) The presence of 'leopard spots', also known as toughening marks, quench marks, iridescence or anisotropy, is unavoidable and is not a fault.

Leopard spots arise from local variations in the toughening stress because the cooling air is blown at the glass through an array of nozzles. Immediately under a nozzle the cooling effect and stress is greater than away from the nozzles. If the glass is static, then spots of greater stress are formed. If the glass or the quench head is moving then the spots are smeared. These local variations in toughening stress are present in every pane of toughened glass. Glass has a natural property which twists polarised light when the glass is stressed, so the slight variations in toughening stress are visible when the glass is viewed in polarised light. Since light can be polarised by a variety of effects – reflection, blue sky (especially in the evening), and hazy sky or light cloud, for example – the effect will show up from time to time.

The pattern of the leopard spots is determined by the mechanics of the toughening plant (usually not in the control of the operators) and can vary from distinct spots, to linearly smeared spots to smeared areas.

Any coating treatment which increases visible reflection in relation to the light transmission of the glass will also increase the visibility of leopard spots.

b) The glass surface may show roller marks, also known as roller pickup, dimpling, or orange peel. This will be minimised, but may be present on any glass thicker than 6 mm. Roller marks in sufficient numbers to give an orange peel effect will be rejected in vision glass.

Roller marks are small imprints in the surface of the glass formed during contact with the hot rollers when the glass is soft, or due to minor contamination of the rollers when the glass is soft, when the contamination may stick in the imprint. They are more prevalent on thick glass (which is heavier and is in the oven for a longer period than thinner glass) and on enamelled glass (which has to be heated to a slightly higher temperature to fire in the enamel).

c) Visual quality limits are as follows:

- **Critical area:** Defects which are visually obtrusive seen from the viewing distance are not allowed.
- **Vision area:** Up to two of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 50 mm, scratches no longer than 20 mm, areas of crush marks up to 25 mm long. Other defect types and larger sizes which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
- **Perimeter area:** Up to five of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 100 mm, scratches no longer than 50 mm, scars no wider than 3 mm or longer than 20 mm, areas of crush marks up to 50 mm long, seed / stones / pickup / bubbles up to 2 mm diameter. Other defect types and larger sizes of these which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
- **Clusters:** Clusters of defects which are not individually significant are not allowed.

Z25.5 COATED GLASS

Z25.5.1 COATED GLASS TYPE

- a) Coated glass of a particular type supplied for the contract will be obtained from a single manufacturer, identified by a trade name.
- b) Coated glass of different types may be obtained from different manufacturers.
- c) The solar and light reflectance and transmittance will be within 3% of the manufacturers quoted performance figures. Detailed spectral data will not be provided.
- d) The coated glass may have a colour variation, both in transmission and reflection, within the manufacturer's tolerances (known as the 'colour box') for the product.
- e) All coatings can produce chromatic aberration depending on the lighting conditions and the angle of view.
- f) Samples will show the general colour of the glass, but it is not possible to provide samples to show a range of variations.

Z25.5.2 COATED GLASS DURABILITY

- a) The coated glass type is selected in accordance with the following criteria:
- coated surface exposed to external weathering - Class A to BS EN 1096;
 - coated surface exposed to the internal building environment - Class A or Class B to BS EN 1096;
 - coated surface on one the cavity surfaces in an insulating glass unit - Class A or Class B or Class C to BS EN 1096.

Z25.5.3 APPEARANCE

- a) Visual quality limits are as follows:
- **Pinholes:** Pinholes which can be seen from the viewing distance are allowed anywhere on the pane, provided they are not more than 1.5 mm diameter, nor more than 1 per square metre of pane. Pinholes which cannot be easily seen from the viewing distance are allowed irrespective of size, position or number.
 - **Critical area:** Defects, other than pinholes, which are visually obtrusive seen from the viewing distance, are not allowed.
 - **Vision area:** In addition to pinholes, up to two of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 50 mm, scratches no longer than 20 mm, areas of crush marks up to 25 mm long. Other defect types and larger sizes which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
 - **Perimeter area:** In addition to pinholes, up to five of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 100 mm, scratches no longer than 50 mm, scars no wider than 3 mm or longer than 20 mm, areas of crush marks up to 50 mm long, seed / stones / pickup / bubbles up to 2 mm diameter. Other defect types and larger sizes of these which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
 - **Clusters:** Clusters of defects which are individually insignificant are not allowed.

Z25.5.4 EDGE STRIPPING

- a) Where the coated glass manufacture advises it, the coated glass will be edge stripped (have the coating removed) in the area of the interface between the glass and the seal of insulating glass units.
- b) Due to the tolerances of glass size, edge stripping and spacer bar manufacture, there are two alternatives.

- (i) Edge strip within the width of the sight line, so that between the spacer bars there is no uncoated glass. This will give a variable width overlap of the coating with the spacer bar that is up to 4 mm. The coating gives an interference effect, a metallic colour depending on the coating type, when close to or in contact with other material, which shows easily when the background is dark. This is **not** a fault.
- (ii) Edge strip so there is no possibility of overlap, leaving a variable width uncoated band round the edge of the sight line up to 4 mm wide.

Unless otherwise advised alternative (i) will be used.

Z25.6 BACK PAINTED GLASS

Z25.6.1 COLORFIRM™ BACK PAINTED GLASS

a) Colorfirm™ painted glass is formed by spraying glass with a two pack coloured acrylic resin system. This is an air dry system which can be applied to monolithic glass such as toughened, textured and annealed.

b) The colour may be a standard colour, a colour defined by a RAL, BS or other common colour code system or a colour to match a proffered sample. An exact match to any requested colour is not guaranteed. For non-standard colours, it is recommended that colour samples are approved by the specifier.

c) Some colours are more difficult to manufacture consistently - white shades can be problematic.

d) Colorfirm™ is designed for use in spandrel areas of buildings, i.e. positioned in front of an opaque structure with no possibility of back-lighting.

e) Colorfirm™ appears opaque when situated in appropriate positions, but, if back-lit, will display variations in paint thickness, pinholes and other blemishes which are insignificant in a spandrel situation.

f) We recommend the use of Dow Corning C60 low modulus silicone for paint compatibility.

g) Any silicone / adhesive used on the paint surface and on the substrate should be checked for suitability and compatibility with both.

Z25.6.1.1 VIEWING CONDITIONS

a) The glass shall be viewed from a distance of 5000 mm under uniform lighting conditions, with the glass placed in front of a uniform dark background in a manner which excludes any form of back-lighting.

Z25.6.1.2 VISUAL QUALITY

a) Visual quality limits are as follows:

- All visible areas: Defects which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowable in any number.

Z25.6.1.3 COLOUR

a) Colorfirm™ can show differences in colour from one pane to another, within the colour tolerances of the frit mix. Where possible, all panes for one job are manufactured using the same batch of frit. For pale colours, the shade may also be affected by the natural variation in the greenish tint of the clear glass.

Z25.6.1.4 OPACITY

a) Colorfirm™ is not opaque. For dark colours, the product appears to be opaque when used in its correct application as a spandrel pane. Pale colour Ceramalite™ may shadow through variations in the materials behind it.

Z25.6.1.5 VISUAL QUALITY

a) Visual quality limits are as follows:

- **Pinholes:** Pinholes which can be seen from the viewing distance are allowed anywhere on the pane, provided they are not more than 1.5 mm diameter, nor more than 1 per square metre of pane. Pinholes which cannot be easily seen from the viewing distance are allowed irrespective of size, position or number.
- **Critical area:** Defects, other than pinholes, which are visually obtrusive seen from the viewing distance are not allowed.
- **Vision area:** In addition to pinholes, up to two of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 50 mm, scratches no longer than 20 mm, areas of crush marks up to 25 mm long. Other defect types and larger sizes which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
- **Perimeter area:** In addition to pinholes, up to five of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 100 mm, scratches no longer than 50 mm, scars no wider than 3 mm or longer than 20 mm, areas of crush marks up to 50 mm long, seed / stones / pickup / bubbles up to 2 mm diameter. Other defect types and larger sizes of these which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
- **Clusters:** Clusters of defects which are individually insignificant are not allowed.
- **Read through:** No possibility of read through is allowed.

Z25.7 LAMINATED GLASS

Z25.7.1 GENERAL

a) Laminated glass can be manufactured from any of the glass types described in clauses Z25.2 to Z25.6.

b) Laminated toughened glass may have all panes toughened or may also incorporate heat strengthened glass, depending on the contract requirements for glass types and whether the laminate is appropriate to resist the applied loads.

Heat strengthened glass is only 1/3 of the strength of toughened glass and has a maximum thickness of 12 mm per pane for heat strengthened glass conforming to BS EN 1863. In some applications, particularly where the glass is bolt fixed through the heat strengthened glass, it is not possible to provide a commercially viable product appropriate to resist the applied loads. In such cases, any request for toughened / heat strengthened combinations will not be complied with.

c) The tolerances and visual appearance of the individual panes will be as described in the relevant clauses.

d) The edges of laminated glass will not be sealed.

e) There may be some visual deterioration / delamination over time at the edges of laminated glass of any type. This is not structurally significant.

f) The edges of all laminated glass may have a small step between the panes. The setting block or other supporting material should be of a consistency to take this into account.

g) The edges of laminated toughened glass and laminated heat strengthened glass may have a step up to 3 mm due to the dimensional tolerances of the component panes and the tolerance on assembly.

Z25.7.2 APPEARANCE

a) Visual quality limits for the pane excluding the edges and edge tape border are as follows:

- **Critical area:** Defects which are visually obtrusive seen from the viewing distance are not allowed.
- **Vision area:** Up to two of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 50 mm, scratches no longer than 20 mm, areas of crush marks up to 25 mm long, bubbles and other objects in the interlayer no more than 2 mm diameter. Other defect types and larger sizes which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.

- **Perimeter area**, excluding the edges / edge tape border: Up to five of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 100 mm, scratches no longer than 50 mm, scars no wider than 3 mm or longer than 20 mm, areas of crush marks up to 50 mm long, seed / stones / pickup / bubbles up to 2 mm diameter. Other defect types and larger sizes of these which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
- **Clusters:** Clusters of defects which are individually insignificant are not allowed.

b) Visual quality limits for the interlayer at the edges of pvb laminated glass used in unframed situations are as follows:

- Delamination or bubbles in the edge of the interlayer intruding up to 5 mm into the glass are allowed up to 1 per metre length of perimeter, with no more than 2 on any one edge.
- Delamination or bubbles in the edge of the interlayer intruding up to 3 mm into the glass are allowed up to 10% of the edge.
- Delamination or bubbles in the edge of the interlayer intruding up to 2 mm are allowable in any quantity.

Externally glazed PVB laminated glass with exposed edges has no warranty unless drawings are provided to Firman Glass including a glazing methodology with the enquiry AND Firman Glass provides written approval of all drawings and/or glazing methods prior to the manufacture of any glass commencing. Specifically relating to, but not limited to, moisture retention by the glazing system; drainage and ventilation arrangements; glazing sealants used; retention systems which have a clamping action upon the glass, which may include bolts, brackets, clamps and fixing plates; torque settings for the glazing system; and the glazing system complies with the specialist system providers recommendations, or the procedures and standards contained within BS 6262, BS 644, BS EN 14351, BS 6375, BS 4873, BS 6510, BS 7412, BS 8529 & BS 8000-7 where applicable.

Only when all of the above conditions are satisfied will Firman Glass provide to the customer a warranty for the use of PVB laminated glass glazed externally with exposed edges and this will run for a period of 12 MONTHS ONLY commencing from the date of delivery of the glass.

- Laminated glass using multiple Vanceva coloured interlays are more susceptible to edge defects. Multiple bubbles in an area up to 10mm x 10mm can be expected in the laminated glass corners, these are not structurally significant and are not cause for the glass panels to be rejected. These corner defects can be expected in addition to other edge defects previously described.

c) Visual quality limits for the interlayer and the edge tape at the edge tape border of CIP laminated glass used in unframed situations are as follows:

- The interface between the clear edge tape and the interlayer is visible due to the difference in refractive index of the two materials.
- The interface may display a feint blue interference effect, which is more obvious when the glass is viewed against a dark background.
- Unadhered areas of the edge tape are allowed up to 20% of the perimeter.
- Bubbles at the interface between the clear edge tape and the interlayer up to 3 mm are allowable up to 1 per pane.
- Bubbles at the interface between the clear edge tape and the interlayer up to 2 mm are allowable up to 4 per pane.
- Bubbles at the interface between the clear edge tape and the interlayer less than 1 mm are allowable in any quantity.

d) Some delamination may occur over or around any bolt fixing inserts in toughened and laminated glass. This is not structurally significant.

e) Any bolt fixings should be designed specifically for use with laminated glass.

Z25.7.3 TOLERANCES

a) In addition to the tolerances on the individual panes, there are tolerances due to the cutting of laminated annealed glass or due to the assembling of glass panes made to size.

Z25.7.3.1 CUT LAMINATED GLASS

(i) 3 ply laminate with both panes 6 mm or thinner:

Edge step up to 1 mm.

(ii) 3 ply laminate with one or more panes thicker than 6 mm:

Edge step up to 2 mm.

Z25.7.3.2 ASSEMBLED LAMINATED GLASS

(i) Two adjacent edges, nominally flush:

Edge step up to 1 mm.

(ii) Other edges:

Edge step up to 3 mm, or the sum of the tolerances of the individual panes, if less.

(iii) Centres of nominally concentric holes may up to 4 mm out of line due to the cumulative tolerances on glass size and hole positions.

Z25.8 INSULATING GLASS UNITS

Z25.8.1 GENERAL

- a) Firman Glass insulating glass units may incorporate any type of glass described in clauses Z25.2 to Z25.7.
- b) Insulating glass units are dual seal made in accordance with BS EN 1279.
- c) Spacer bar will be silver or black, steel or aluminium, containing the desiccant, assembled with corner keys
- d) Sight line
 - (i) Standard sight line is 13 mm. Larger sight lines can be provided if required for structural sealant glazing situations.
 - (ii) Tolerance on the sight line is ± 2 mm for rectangles and ± 3 mm for shaped panes.
 - (iii) Bow / waviness of the spacer bar within the allowable sight line tolerances is allowed.
- e) Primary seal is butyl, nominal minimum width 2 mm.
 - (i) Gaps and lengths less than 1 mm wide, totalling (on both faces) no more than 0.25% of the lengths of the long edges, are allowed in not more than 5% of supplied units.
 - (ii) Lengths totalling (on both faces) no more than 1% of the lengths of the long edges are allowed to have width less than 2 mm but not less than 1 mm in each unit.
 - (iii) Butyl may intrude inside the sight line by up to 3 mm at each corner. Butyl may intrude inside the sight line by up to 2 mm along the edges for lengths totalling up to 2% of the unit perimeter.
- f) Secondary seal is two part silicone Dow Corning 993
 - (i) Voids / bubbles up to 3 mm diameter are allowed, no more than 1 per metre length of edge, in not more than 5% of supplied units.
 - (ii) No intrusion of the secondary seal inside the sight line is allowed.
- g) No edge tape is applied.
- h) Units are manufactured at ambient atmospheric pressure and factory temperature at the time of manufacture.

i) The bow or dish displayed by insulating glass units depends only on the difference between manufacturing conditions and the variable temperature and atmospheric pressure conditions on site. These latter are outside the control of Firman Glass. No breather tubes will be used.

j) Structural and weather seals should be compatible with the silicone edge seal (Dow Corning 993).

Z25.8.2 APPEARANCE

a) Visual quality limits are as follows:

- **Critical area:** Defects which are visually obtrusive seen from the viewing distance are not allowed.
- **Vision area:** Up to two of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 50 mm, scratches no longer than 20 mm, areas of crush marks up to 25 mm long, bubbles and other objects in the interlayer no more than 2 mm diameter. Other defect types and larger sizes which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
- **Perimeter area**, excluding the edges / edge tape border: Up to five of the following defects which are visually obtrusive seen from the viewing distance are allowed - sleeks no longer than 100 mm, scratches no longer than 50 mm, scars no wider than 3 mm or longer than 20 mm, areas of crush marks up to 50 mm long, seed / stones / pickup / bubbles up to 2 mm diameter. Other defect types and larger sizes of these which are visually obtrusive seen from the viewing distance are not allowed. Defects which are not visually obtrusive seen from the viewing distance are allowed irrespective of size, position or number, but not in clusters.
- **Clusters:** Clusters of defects which are individually insignificant are not allowed.

Z25.8.3 TOLERANCES

a) In addition to the tolerances on the individual panes, there are tolerances due to the assembling of glass panes made to size.

(i) Dimensional tolerances:

up to 3 m ² area	±1.5 mm
up to 8.5 m ² area	±2 mm
over 8.5 m ² area	±3 mm

(ii) Two adjacent edges, nominally flush:

Edge step up to 2 mm.

(iii) Other edges:

Edge step up to 3 mm, or the sum of the tolerances of the individual panes, if less.

(iv) If one or more of the panes are laminated glass, then the tolerances may be higher.