

## SECTION 08 80 00 GLAZING

This performance guide specification is part of an architectural specification and is intended to provide a guideline for product selection and may not be appropriate for needs of specific projects.

Use of this specification is voluntary and the user needs to edit the guide specification to fit the needs of a specific project, applicable laws and regulations, end user requirements and safety considerations.

This performance guide specification provides no guarantee as to product performance, merchantability, or fitness for a particular purpose.

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### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. General: Read this Section in conjunction with other related Sections.
- B. Prescriptive Work
  - 1. Supply, deliver, install and warrant the work in strict compliance with the materials and workmanship requirements of the Architectural Specification.
  - 2. Where required to prepare Shop Drawings, these shall be limited to final detailing of components, systems, etc. indicated on the Design Drawings, necessary to demonstrate their safe installation.
  - 3. Where products are offered by the Contractor for acceptance by the Engineer, provide full supporting documentation in respect of the complete system or installation.
- C. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section.
  - 1. Windows
  - 2. Doors
  - 3. Glazed curtain walls
  - 4. Storefront framing
  - 5. Glazed entrances
  - 6. Skylights
  - 7. Passenger elevator
- D. Related Sections and documentation
  - 1. Estidama Pearl Rating System (PRS) - The Pearl Rating System for Estidama,

Building Rating System: Design and Construction document by Abu Dhabi Urban Planning Council (UPC).

## **PART 2 - PRODUCTS**

### **2.1 PRODUCT SELECTION**

#### **A. Source of Supply**

1. Glass: Obtain from single source from single manufacturer for each glass type.
2. Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

#### **B. Glass Products, General**

1. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed in accordance with ASTM C 1036.
2. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed in accordance with the performance requirements. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed in accordance with the performance requirements. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

#### **C. Type GL-101 Double Glazing**

1. Clear, double glazed insulated safety glass panels used in various locations as indicated on the Design Drawings.

#### **D. Type GL-102 Single Glazing**

1. Clear, single glazed safety glass panels used in various locations as indicated on the Design Drawings. Where required, glazing shall be able to resist the passage of smoke at a temperature of 140°C.

#### **E. Type GL-103 Double Glazing**

1. Clear, double glazed insulated laminated safety glass panels used with Type FL-901 Glass Flooring Assembly at base of internal exposure light well voids. The DGUs shall have a stepped edge to support applied loads (Live Load of 2.4kN/ m<sup>2</sup>) without compressing the spacer. The units shall be bedded on steel angle supports and silicone pointed.

#### **F. Type GL-104 Double Glazing**

1. Clear, double glazed insulated safety glass panels used with Type RFL 201 Roof Light Assembly (Refer to Section 086200 Unit Skylights).

#### **G. Type FL-901 Glass Flooring Assembly**

1. Glass flooring assembly comprising double glazed glass panels with metal framing including all necessary supports, bracketing and fastenings required to complete the installation.
  2. Substrate: As indicated on the Design Drawings.
  3. Glazing: Double glazed glass panels Type GL-103. Ensure glass floor assembly can withstand minimum of 525kg concentrated load due to the equipment weight of Type ASE-411 Atria Cleaning Machine used to clean the internal portion of the atria. Adjust panel composition if necessary.
  4. Framing: Metal framing fastened to floor substrate.
    - a) Material: Extruded profile aluminum framing.
    - b) Finish: Polyester powder coated (PPC)
  5. Fastenings: All fastenings shall be concealed.
  6. Profile and configuration as indicated on the Design Drawings.
- H. Type FL-902 Glass Flooring Assembly
1. This flooring assembly consists of a triple laminated glass panel with etched top surface to the acceptance of the Engineer.
  2. The support members of the assembly the structural components within Type AM-301 Metal Bridge Platform Assembly connections as indicated on the Design Drawings.
  3. Refer to the Design Drawings for the connection illustrating how the glass panel sits within the platform assembly. Metal connection members shall have a PVDF finish and the color shall be confirmed by the Engineer.
- I. Fastenings: All fastenings shall be concealed.
- J. Provide clear silicone joints to the acceptance of the Engineer when full assembly units are not achievable. Review joint locations with the Engineer.

## 2.2 DESIGN CRITERIA

- A. Glazing panels as described shall be integral to the glazed systems described in other Work Sections and as indicated on the Design Drawings to provide a consistent design irrespective of material.
- B. Select all glazing materials and systems to comply with the performance requirements.
- C. The final glass thickness, type and make-up in the various locations shall be determined, paying full attention to the safety requirements. Final selection of glass thickness, together with type and location of interlayer and coatings shall remain the Contractor's responsibility.
- D. Certain glazing panels shall be used for both vertical and inclined conditions. Make any

modifications necessary for use in all intended conditions, whilst maintaining the visual requirements. Laminated glass shall be used for single glazed units and the inner/ lower panel of multiple glazed units for inclined/ overhead conditions.

- E. Where edges are exposed, i.e. bonded and unframed they shall be suitable for open jointing or weather sealing jointing as described and indicated on the Design Drawings. Propose the treatment to the visible glass edge for acceptance by the Engineer.
- F. Where applicable, include a solid black applied finish to the perimeter of the glazing to conceal the silicone bonding and frame behind, as accepted by the Engineer through sampling.
- G. Spacer bars to double glazed units shall be black.
- H. For bolt/ point fixed structural glass assemblies laminated glass shall be used for single glazed units and the outer and inner panes forming double glazed units. The integrity of double glazed units used in such assemblies shall be maintained at each hole position using black bosses, color coordinated sealing rings and suitable sealants.
- I. Provide glass with a colour rendering index (Ra) as specified, both for the transmittance and the reflected spectrum and provide detailed reflected and transmitted spectrum data for the purpose of identifying/ anticipating the possible problems with colour reflection. Demonstrate this by provision of full size samples of each glass type, which are to be viewed under representative lighting conditions and accepted prior to material manufacture.
- J. Ensure that glass does not contain impurities, which would detract in any way from the performance of the glazing system.
- K. All glass shall be free from bubbles, smoke vanes, air holes, scratches or any other visible defects unless described as acceptable elsewhere in the Architectural Specification.
- L. Mirror glass is not acceptable unless described as acceptable elsewhere in the Architectural Specification.
- M. The work shall be designed to ensure that the glazing does not crack or distort or is damaged in any way through differences of temperature on the surfaces of the glazing.
- A. Laminated Glass
  - 1. The Design Drawings shall show the visual requirements of the Engineer. Final selection of glass type and thickness of each layer, together with type, opacity, density and location of interlayer and coatings shall be accepted by the Engineer prior to ordering materials.
  - 2. All glass shall meet the color and quality standards set by the Control Samples.
- N. References to applied coatings (such as but not necessarily limited to low emissivity (low E), high performance, acoustic) shall not affect the appearance/ hue of the glass, outside that accepted by the Engineer through sampling.
- O. Where indicated on the Design Drawings, applied finishes, as described, shall be undertaken

to the glazing panels.

- P. Safety manifestation shall be included to comply with the requirements of the Architectural Specification using methods, patterns and colors acceptable to the Engineer.
- Q. Ceramic screen printed modesty/ manifestation shall be included, as indicated on the Design Drawings.

## 2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 and ICC's International Building Code by a qualified professional engineer, using the following design criteria.
  1. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/ SEI 7, based on heights above grade indicated on the Design Drawings.
    - a) Wind Design Data: As indicated on the Design Drawings
    - b) Basic Wind Speed: 44.5 m/s
    - c) Importance Factor: = 1.0
    - d) Exposure Category: C
  2. Vertical Glazing: For glass surfaces sloped 15° or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
  3. Sloped Glazing: For glass surfaces sloped more than 15° from vertical, design glass to resist each of the following combinations of loads:
    - a) Outward design wind pressure minus the weight of the glass. Base design on glass type factors for short-duration load.
    - b) Inward design wind pressure plus the weight of the glass plus half of the design snow load. Base design on glass type factors for short-duration load.
    - c) Half of the inward design wind pressure plus the weight of the glass plus the design snow load. Base design on glass type factors for long-duration load.
  4. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15° from vertical, design glass for a probability of breakage not greater than 0.001.
  5. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass

deflection at design wind pressure to not more than 1/ 50 times the short-side length or 25mm, whichever is less.

6. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- C. Windborne-Debris-Impact Resistance: Provide exterior glazing that passes either basic-protection or enhanced-protection testing requirements in ASTM E 1996 for the appropriate Wind Zone when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than glazing indicated for use on the Project and shall be installed in same manner as glazing indicated for use on the Project.
1. Large-Missile Test: For glazing located within 9.1m of grade.
  2. Small-Missile Test: For glazing located more than 9.1m above grade.
  3. Large-Missile Test: For all glazing, regardless of height above grade.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below.
1. For monolithic-glass lites, properties are based on units with lites of nominal thickness indicated.
  2. For laminated-glass lites, properties are based on products of construction indicated.
  3. For insulating-glass units, properties are based on units of nominal thickness indicated for overall unit and for each lite.
  4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as W/ m<sup>2</sup>x K.
  5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
  6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
1. Temperature Change: 67°C, ambient; 100°C, material surfaces.
- F. Glass Types:
1. Type GL-101: Clear, double glazed insulated safety glass panels, to meet the following criteria:
    - a) Light transmission factor: Not less than 65%.
    - b) Exterior light reflectance: Not greater than 12%.
    - c) Total solar transmission (G-value): Not greater than 55%.

- d) Color rendition index of glass: Not less than 95Ra (D65).
  - e) U-value: Not greater than 1.6 W/ m<sup>2</sup>K.
  - f) High performance coating: Yes
  - g) Low e coating: Yes.
  - h) Shading coefficient: 0.64.
2. Type GL-102: Clear, single glazed safety glass panels, no special thermal or optical performance required.
  3. Type GL-103: Clear, double glazed insulated safety glass panels, to meet the following criteria:
    - a) U-value: Not greater than 2.0 W/ m<sup>2</sup>K.
  4. Type GL-104: Clear, double glazed insulated safety glass panels with a stepped unit edge as indicated on the Design Drawings for the usage at the roof light assembly, to meet the following criteria:
    - a) Light transmission factor: Not less than 65%
    - b) Exterior light reflectance: Not greater than 12%
    - c) Total solar transmission (G-value): Not greater than 55%
    - d) Color rendition index of glass: Not less than 95Ra (D65)
    - e) U-value: Not greater than 2.0 W/ m<sup>2</sup>K
    - f) High performance coating: Yes
    - g) Low e coating: Yes
  5. Glass type, composed of triple lamination and with features and attributes required for a flooring application at the recommendation of the glass manufacturer.
- G. Values indicated are regarded as the minimum the glass must achieve.
  - H. Confirm the total solar transmission (G-value) for each glass type specified for review by the Engineer. Glass manufacturers and types shall be acceptable to the Engineer only if they meet the performance and visual requirements defined by the Architectural Specification.
  - I. Damage such as shark teeth, serration hackle, sharp flare, flake chips, rough chips, feathered edges, shells or other imperfections shall not be acceptable if detrimental to the visual and performance criteria of the glass.
  - J. Distortion shall be kept to an absolute minimum with no local defects (such as tong marks) producing irregular reflections being allowed. All glass shall be manufactured and processed in accordance with quality control procedures to ISO 9000 which are independently maintained.
  - K. Stresses in glazing: Ensure that no glass or glazing combination develops stresses that may

lead to damage of glass, glazing materials, components and/ or framing systems.

- L. Where combinations of glass types are used in a unit, the least stringent criteria for viewing shall be used in accordance with the relevant standards.
- M. Fire resisting glass shall provide the fire ratings specified, tested according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.
- N. Toughened/ Tempered Glass: The use of toughened/ tempered glass shall be justified by risk assessment and/ or calculations, with the general aim of minimizing its use.
- O. Acoustic Performance: Documentation shall be provided for consideration and assessment by the Acoustic Engineer which provides an estimate of the sound reduction indices for the complete curtain wall system in the 8 octave bands from 63kHz to 8kHz.

### 2.3 MATERIALS

- A. Material Selection Requirements: Comply with Masdar City requirements for restricted materials and product selection given in Section 016105 Restricted Materials and Section 016200 Product Selection and Evaluation within the Masdar City Master Specification Division 01 General Requirements document.
  - 1. In addition comply with the requirements within 003250 Supply Chain Code of Conduct document as issued by Masdar City.
  - 2. Review Process: Key materials to be reviewed based on the Masdar City questionnaire and submitted to the Masdar City supply chain team. Materials on Masdar City's The Future Build website portal have undergone this process.
- B. Low Toxicity Materials: All building materials shall comply with the low toxicity material requirements as stated in PBRS Credit SM-1 within the UPC's Pearl Building Rating System: Design & Construction document.
  - 1. To meet this PBRS Credit, all building materials must not contain materials or compounds with over 1% of constituent materials with the designated R-phrases listed in the UPC document. Submit confirmation that materials comply with the EU Risk Phrases (R-Phrases) Directive 67/ 548/ EEC. Annex III.
- C. Regional Material Components: Provide materials sourced from the region that comply with the requirements as stated in PBRS Credit SM-9 within the UPC's Pearl Building Rating System: Design and Construction document and as indicated within the Masdar Siemens HQ Estidama KPI Tracker document.
- D. All materials shall comply with LEED CS-IEQ Credit 4.1 Low Emitting Materials - Adhesives and Sealants and CS-MR Credit 5: Regional Materials requirements given in the USGBC document.
- E. Glass to be in accordance with the following.
  - 1. Float Glass: ASTM C 1036.
  - 2. Toughened/ tempered Glass: BS EN 12150 and BS EN 14179: Part 1 for heat soak



tested toughened glass.

3. Ultraclear Float Glass: ASTM C 1036, complying with other requirements specified and with visible light transmission not less than 91%.
4. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
  - a) Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated
  - b) For uncoated glass, comply with requirements for Condition A
  - c) For coated vision glass, comply with requirements for Condition C (other coated glass)
5. Ceramic-Coated Vision Glass: Heat-treated float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's Tempering Division's "Engineering Standards Manual" and with other requirements specified.
6. Reflective-Coated Vision Glass: ASTM C 1376, coated by pyrolytic process or vacuum deposition (sputter-coating) process, and complying with other requirements specified.
7. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B, Type I, Quality-Q3, and complying with other requirements specified.
8. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
  - a) Construction: Laminate glass with polyvinyl butyral interlayer and cured-transparent-resin interlayer in accordance with interlayer manufacturer's written recommendations.
  - b) Interlayer Thickness: Provide thickness not less than that indicated and as required in accordance with requirements.
  - c) Interlayer Color: Clear unless otherwise indicated.
9. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, with "Windborne-Debris-Impact Resistance" Paragraph in "Glass Products, General" Article, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
  - a) Construction: Laminate glass with one of the following in accordance with interlayer manufacturer's written recommendations:

1. Polyvinyl butyral interlayer.
  2. Polyvinyl butyral interlayers reinforced with polyethylene terephthalate film.
- b) Interlayer Thickness: Provide thickness not less than that indicated and as required in accordance with the performance requirements.
  - c) Interlayer Color: Clear unless otherwise indicated.
10. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E 2190, and complying with other requirements specified.
- a) Sealing System: Dual seal, with manufacturer's standard primary and secondary.
  - b) Spacer: Manufacturer's standard spacer material and construction.
  - c) Desiccant: Molecular sieve or silica gel, or blend of both.
11. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; minimum 8mm total; complying with testing requirements in 16 CFR 1201 for Category II materials.
- F. Glazing Gaskets
1. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
    - a) Neoprene in accordance with ASTM C 864.
    - b) EPDM in accordance with ASTM C 864.
    - c) Silicone in accordance with ASTM C 1115.
    - d) Thermoplastic polyolefin rubber in accordance with ASTM C 1115.
  2. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
    - a) Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.
  3. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, in accordance with ASTM C 542, black.
- G. Glazing Sealants
1. VOC Content: Sealant products shall comply with VOC limits as stated in PBRS Credit LBi-2.1 within the UPC's Pearl Building Rating System: Design and Construction document.
  2. General:

- a) **Compatibility:** Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and site experience.
  - b) **Suitability:** Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
  - c) Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/ L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - d) **Colors of Exposed Glazing Sealants:** As selected by Engineer from manufacturer's full range.
  - e) Provide structural silicone adhesive, which shall be obtained from a single source manufacturer and applied strictly in accordance with the manufacturer's written recommendations.
  - f) For marine, or similar environments, the structural silicone shall be resistant to damage from algae or attack by birds.
3. **Glazing Sealant:** Neutral-curing silicone glazing sealant in accordance with ASTM C 920, Type S, Grade NS, Class 100/ 50, Use NT.
  4. **Glazing Sealant:** Neutral-curing silicone glazing sealant in accordance with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
  5. **Glazing Sealant:** Neutral-curing silicone glazing sealant in accordance with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
  6. **Glazing Sealant:** Acid-curing silicone glazing sealant in accordance with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
  7. **Glazing Sealants for Fire-Rated Glazing Products:** Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.
- H. **Glazing Tapes**
1. **Back-Bedding Mastic Glazing Tapes:** Preformed, butyl-based, 100% solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and in accordance with ASTM C 1281 and AAMA 800 for products indicated below:
    - a) AAMA 804.3 tape, where indicated.

- b) AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
  - c) AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
2. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and in accordance with AAMA 800 for the following types:
- a) AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
  - b) AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.
- I. Miscellaneous Glazing Materials
- 1. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
  - 2. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
  - 3. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85,  $\pm 5$ .
  - 4. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
  - 5. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking). Provide hardwood where recommended by manufacturer in fire-rated assemblies.
  - 6. Cylindrical Glazing Sealant Backing: In accordance with ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
  - 7. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

## 2.4 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, in accordance with system performance requirements.

- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.
- D. The method of glazing adopted shall take account of the manufacturing tolerances in the glass, thus minimizing the effects of distortion resulting.
- E. The glass shall be clearly marked to show its intended final position and orientation.
- F. Where it is necessary to meet the requirements of the local Building Regulations and any other health and safety requirements, manifestation shall be provided. The type of manifestation shall be agreed with the Engineer and samples provided for acceptance.
  - 1. Manifestation:
    - a) Location: As indicated on the Design Drawings.
    - b) Application:
    - c) Factory applied: Ceramic fritting, screen printed.
    - d) Site applied: Acid etched/ vinyl adhesive backed film/ etchlite/ sand blasting.
    - e) Color: As defined in the particular requirements.
    - f) Setting out: Carefully set out to scan across panels to give a consistent rhythm and spacing across the length of the façade.
- G. Laminated Glass
  - 1. Laminated glass shall consist of a number of sheets of flat glass with polyvinylbutyral (PVB) of not less than 0.375mm thick, or methyl metacrylate resin interleaving between each layer. The layers can be clear, translucent or colored depending on the design intentions of the glazing. The glass may be annealed, heat strengthened or heat soak toughened, as required to meet the performance requirements of the Architectural Specification.
  - 2. Laminated glass edges shall be sealed with materials compatible with the interlayer. Delamination of the laminated glass for any reason shall not be acceptable.
  - 3. The bottom supported edges of laminated glass panes shall be cut flush over the width of the pane to provide even distribution of vertical load to the setting blocks.
- H. Toughened/ Tempered Glass
  - 1. All toughened/ tempered glass shall be heat soak tested to BS EN 14179: Part 1 paying particular attention to temperature and duration of treatment. Demonstrate that the surface temperature of all glass was maintained at  $290^{\circ}\text{C} \pm 10^{\circ}\text{C}$  for 2 hours. Keep records of heat soaking for each batch for QA/ QC inspection purposes before dispatch to site.
  - 2. Exposed edge working shall be flat ground with small ground arris and have a frosted

appearance. Small shells and/ or chips, exceeding a maximum diameter of 2mm, shall be ground out prior to toughening.

3. Ensure that glass heat treatment requirements are satisfactory to meet wind, impact, thermal or other loads anticipated in the work. The manufacturer of the toughened/ tempered glass shall be made aware of its intended use in the construction. Any drilling and notching shall be carried out with the agreement of the manufacturer of the toughened/ tempered glass and prior to the toughening being carried out. All toughened/ tempered glass shall be tempered on a roller heat furnace eliminating tong marks.
  4. Ensure that the toughening process does not produce iridescence, distortion, roll marks or ripples in the glass which are unacceptable to the Engineer. Such anticipated imperfections shall be demonstrated by the provision of full size samples prior to commencement of glass production. The Engineer will examine the samples provided and reasonably advise what is acceptable and what is unacceptable. All glass produced for The Work shall comply with the acceptable samples as a minimum standard.
  5. Prior to commencement of manufacture, advise the Engineer of the glass supplier and the premises where fabrication and processing shall be carried out.
- I. Double Glazed Units
1. Unless otherwise specified, double glazed units shall be hermetically sealed units. Double glazed units shall utilize panes of unequal thickness, unless otherwise specified. The outer panes shall be thicker to minimize the effects of pillowing.
  2. Spacers shall be of adequate rigidity for their purpose, be continuous, with bent corners and shall have welded joints sealed to ensure the integrity of the seal and to provide a consistent moisture seal around the entire perimeter of the unit. They shall accommodate the seal and contain desiccant, allowing both to operate at maximum efficiency.
  3. Spacers shall separate glass panes and the units shall have a mechanically applied primary polyisobutylene seal between glass and spacer. This shall provide a continuous vapor-proof barrier to a minimum width of 2mm and a secondary two part silicone seal to the perimeter of the units to carry wind loads.
  4. Drainage of water along edge seals shall not be permitted.
  5. All double glazed units shall be assembled in controlled temperature and humidity conditions. Breather tubes shall be used, if necessary, during manufacture and transportation. These shall be thereafter removed and the units sealed prior to manufacture.
  6. With regard to mechanically restrained glazing systems, the manufacturer shall confirm the maximum compression allowable on the edge of the units.

7. State the maximum concavity and convexity that will occur under the ambient climatic conditions and barometer pressure differentials anticipated by the requirements of the Architectural Specification.
  8. The bottom supported edges of laminated glass panes within vertical double glazed units shall be ground flush over the width of the pane to provide even distribution of load to the setting blocks.
  9. Load transfer/ spacers blocks under double glazed units shall be positioned to fully support both internal and external panes so that neither pane is cantilevered on an edge seal.
- J. Tolerances
1. Toughened/ Tempered Glass: The glass shall conform to the following requirements in the horizontal toughening process:
    - g) Maximum overall bow: 0.003mm per millimetre measured along the glass edge.
    - h) Maximum local bow: The maximum deviation for flatness from peak to trough shall not exceed 0.3mm per 300mm or 0.15mm at the edge.
    - i) Rollerwave: Glass shall be sized to provide for the consistent and horizontally aligned orientation of ripples throughout the work. The maximum deviation for flatness from peak to trough shall not exceed 0.08mm. In any event, state in the Tender submission proposals to control the extent of rollerwave, if any. Provide full size samples of all specified heat treated glass to signify the range of rollerwave throughout the work, prior to commencing production of the glass.
    - j) Edge dip: 0.25mm maximum.
  2. Curved Glass:
    - k) The maximum variation in curved form shall be  $\pm 4$ mm from the theoretical form.
    - l) The maximum variation in adjacent glass edges when installed shall be 1mm per 1000mm.
    - m) The maximum difference between curved adjacent glass edges when installed shall be 3mm.
    - n) All curved glass panels shall be continuously curved from edge to edge for the full radius with no straight returns.
    - o) The maximum allowed deviation of the length and width of sheets shall be  $\pm 4$ mm for dimensions up to and including 2000mm and  $\pm 4.5$ mm for dimensions over 2000mm.
    - p) The maximum allowed deviation of the diagonal dimension of any sheet shall be  $\pm 7$ mm for dimensions over 2000mm.

- q) The maximum allowed deviation of the top and bottom edges (i.e. the curved edges) measured on the face of the glass and perpendicularly to the curvature shall be  $\pm 3$ mm.
- r) Ensure that the double glazed units are flat (with a maximum deviation of 1/ 1000 at the centre of the glass pane when measured diagonally) when finally installed.

## 2.5 FINISHING

### A. Glass Coatings

- 3. Surface coatings: A highly uniform, low reflection and durable quality is required of any surface modified glass. Such coatings shall be consistent in color, durable and sufficiently hard on exposed surfaces to avoid damage.
- 4. Ceramic Frit Coatings:
  - a) Tolerances for positioning and sizes of prints shall comply with optical quality determined viewing from a distance of 3000mm using daylight without direct sunlight or direct spotlight, perpendicularly to the glass, for no more than 20 seconds.
  - b) Apply smoothly and consistently over the whole, or part, of each glazed area as indicated on the Design Drawings. Use a screen printing application method unless otherwise agreed.
  - c) Fuse into the surface of the glass, thus providing a permanent layer (with the exception of the exposed internal surface).
  - d) The coatings shall have similar sheen, chromaticity and luminosity, to give non-discernible colour difference when viewed by eye and illuminated by a standard light source, and shall colour match. All ceramic fritting shall be opaque and to a color to be agreed with the Engineer.



- e) Extent: Unless noted otherwise, the frit pattern shall extend to the glass edges. There shall be no clear border.
5. Requirements for coatings/ surface modified glass:
- a) A highly uniform, low reflection and durable quality is required of any surface modified glass. Such coatings shall be neutral in color, durable and sufficiently hard on exposed surfaces to avoid damage. For the purposes of the Architectural Specification, neutral shall be defined as a color having no unacceptable hue quantified by range of samples and being capable of refracting light without chromatic aberration when viewed from any direction.
  - b) Unless otherwise agreed, all low E glass shall be produced from a single source on a single process.
  - c) All glass coatings shall be provided from a single manufacturer/ supplier unless agreed otherwise by the Engineer.
6. Coatings/ Treatments/ Interlayers shall not crack, disintegrate or corrode in any way under the extremes of conditions outlined in the Architectural Specification.
7. Advise the Engineer, prior to commencement of the glass coating, the name of the supplier and applicator, together with the location of the premises where this work shall be carried out.
- B. High Performance Glass Coatings
- 1. Where soft coatings are used in double glazed units the glass shall be edge stripped on the coating side to a width corresponding to the width of the spacer bar (complete with butyl strip) such that when the panes are sealed together no discolouration to the coating by the butyl strip occurs around the perimeter of the double glazed unit. The occurrence of a red or blue line around the perimeter of the glass panes shall be deemed unacceptable.
  - 2. Where soft coatings are applied to glass panes they shall be suitably protected up until time of installation with the double glazed unit and all handling of glass shall be carried out using protective cotton or surgical gloves so as not to damage the surface of the coating with fingerprints. After protection is removed from the coated glass panes the panes must be installed into the double glazed units and sealed within the recommended time by the coating manufacturer, to avoid any atmospheric deformation of the surface.
- C. Glass Body Tints
- 1. Provide evidence from the glass manufacturer that the correct body tinting has been incorporated at the appropriate stage into the materials used by the glass manufacturer when this has been specified on the Design Drawings.
  - 2. Provide evidence that the correct surface modified tinting has been applied by the



glass manufacturer, where this has been specified on the Design Drawings.

**END OF SECTION**