



COOP LIVE
L10 - WINDOWS

© 2020 POPULOUS

Project Name: **COOP LIVE**
Drawing Number: **BRA-POP-ZZ-ZZ-SP-A-7062**
Document Title: **L10 - WINDOWS**
Status: **ISSUED FOR RIBA STAGE 4B UPDATE**
Revision: **P03**

COOP LIVE

DOCUMENT REVISIONS

Revision	Date	Prepared By	Approved By	Issue status
P00	11/05/2020	PG	DS	ISSUED FOR DRAFT RIBA STAGE 4A (T1)
P01	03/07/2020	PG	DS	ISSUED FOR RIBA STAGE 4A (T2)
P02	07/05/2021	MR	DS	ISSUED FOR RIBA STAGE 4B
P03	11/10/2021	MR	DS	ISSUED FOR RIBA STAGE 4B UPDATE

Specifications updated to in accordance with DCR 0019

L10 WINDOWS	1
GENERAL	1
110 WORKS INCLUDED	1
111 APPLICABLE DESIGN RESPONSIBILITY	1
112 TENDER SUBMITTALS	1
113 SAMPLES	1
114 MOCK-UPS, PROTOTYPES AND QUALITY BENCHMARKS	2
115 TESTING	2
PRODUCTS	3
210 TECHNICAL REQUIREMENTS	3
211 PERFORMANCE REQUIREMENTS	4
212 STEEL WINDOW SYSTEMS	7
213 ALUMINIUM WINDOW SYSTEMS	9
214 MATERIALS	10
215 SUPPORT STRUCTURE	10
216 FABRICATION	10
217 LIGHTNING PROTECTION AND EARTH BONDING	11
EXECUTION	12
310 INSTALLATION	12

L10 WINDOWS

GENERAL

110 WORKS INCLUDED

1. Scope of Works: This section of the Specification, when read in conjunction with the Drawings, provides particular requirements with respect to the following:
 - a. Windows.
2. Particular Interfaces
 - a. Complete the Detailed Design of all interfaces with adjoining trades prior to commencement of manufacture.
 - b. Ensure that all interfaces are fully co-ordinated prior to commencement.
3. Related Documents and Sections: Examine the Drawings and the Contract Documents for requirements that directly affect or are affected by Work of this Section. Other Documents and Sections that directly relate to work of this Section include, but are not limited to:
 - a. The Preliminaries, general provisions of the Contract, including General and Supplementary Conditions, and Architectural General Requirements Specification Sections.

111 APPLICABLE DESIGN RESPONSIBILITY

1. Design & Build Procurement Routes
 - a. Appoint a specialist sub-contractor to complete the Detailed Design maintaining at all times the intent portrayed on the Design Drawings whereby the Architect's role post-novation or during subsequent design stages shall be limited to checking compliance with quality, design and visual intent only.

112 TENDER SUBMITTALS

1. Tender Response
 - a. Provide tender submittals in accordance with the requirements of SUBMITTALS clauses of the A Section of the Specification.
 - b. Submit a design response with the Tender proposal, to include all profiles of typical conditions, with dimensions.
 - c. The Tender design response shall include:
 - 1). Samples where specified.
 - 2). List of Tests included.
 - 3). QA/ QC programme.
 - 4). List of proposed Working Drawings.
 - 5). Summary of deviations from the Specification.
 - 6). Outline technical specifications reflecting proposed materials/ systems, etc.
 - 7). A list of proposed suppliers and sub-contractors intended to be used.

113 SAMPLES

1. Pre-contract Samples: Sufficient samples of the following, including relevant trade literature and technical specifications, shall be provided in accordance with SUBMITTALS clauses of the A Section:
 - a. Samples of frame profiles, minimum 300mm long.
 - b. Glazing unit/glass sample of each variant minimum size 300mm x 300mm. Ground and tape edges to prevent injury.
 - c. 1 No. of each item of window furniture including surface mounted trickle ventilation.
 - d. 300mm length of integrated louvre (where forming part of the composite system).
2. Post Contract Samples: In accordance with SUBMITTALS clauses of the A Section, post contract samples of the following shall be provided:
 - a. Glazed corner of window of minimum size 450mm x 300mm.
 - b. Glazing unit/glass sample of each variant minimum size 450mm x 300mm. Ground and tape edges to prevent injury.
 - c. 1 No. of each item of window furniture including surface mounted trickle ventilation.
 - d. 300mm length of integrated louvre (where forming part of the composite system).

114 MOCK-UPS, PROTOTYPES AND QUALITY BENCHMARKS

1. Mock-ups: In accordance with SUBMITTALS clauses of the A Section, a mock-up of the following shall be provided:
 - a. Not required.
2. In accordance with SUBMITTALS clauses of the A Section, a prototype of the following shall be provided:
 - a. Not required.
3. Benchmarks: The following quality benchmark shall be provided in accordance with SUBMITTALS clauses of the A Section:
 - a. The first fully installed window element of each typology.

115 TESTING

1. Unless relevant and current test evidence to the acceptance of the Architect can be produced, allowance for testing by a fully accredited, nationally recognised independent testing organization shall be made.
2. Where required, undertake project specific testing and provide supporting certification that the window units have successfully passed tests for the following:
 - a. Air permeability: To BS EN 1026 to a pressure of 600 Pa.
 - b. Watertightness: To BS EN 1027 to a pressure of 600 Pa.
 - c. Operation and strength: To BS 6375: Part 2.
 - d. Repeated opening: To BS EN 1191.
 - e. Wind resistance: To BS EN 12211 based on maximum gust conditions.
 - f. Soft and heavy body impact: To BS EN 13049.
 - g. Explosion resistance: BS EN 13123 and BS EN 13124.
 - h. Glass explosion resistance: BS EN 13541, ISO 16933 and ISO 16934.

- i. Glass bullet resistance: ISO 16935.
- 3. Site hose testing:
 - a. Undertake a Site Water Hose Test in accordance with CWCT guidelines.
 - b. Where failure ensues, make joints watertight and re-test until no leakage occurs.
 - c. Extent of testing: Key junctions/locations agreed with the Architect based on a minimum of 5% by length of all critical joints.
- 4. Acoustic testing: In accordance with BS EN ISO 10140.
- 5. Ballistic resistance testing:
 - a. Provide independently verified certification that systems subject to ballistic resistance have been tested to those classifications and standards cited as part of the system narrative.

PRODUCTS

210 TECHNICAL REQUIREMENTS

- 1. Windows shall be in accordance with the following:
 - a. General: BS EN 14351 and BS 6375: Part 1.
 - b. Aluminium windows: BS 4873.
 - c. Steel windows: BS 6510.
 - d. Window hardware: BS EN 12209, BS EN 12051 and BS EN 1935 .
 - e. CE Marking.
 - f. BBA Accreditation.
- 2. The components of the entire assembly shall be covered by a single source warranty.
- 3. Manufacturer Qualifications:
 - a. Aluminium:
 - 1). CAB (Council for Aluminium in Building)
 - 2). CWCT (Centre for Window & Cladding Technology).
 - b. Steel: SWA (Steel Window Association)
 - c. Glazing: GGF (Glass and Glazing Federation).
- 4. Weather and watertightness:
 - a. Systems shall be based on pressure equalisation principles, unless accepted otherwise by the Architect
 - b. The works shall be based on more than a single line of defence.
 - c. Allowance shall be made to control the flow of any water that may enter the system and for directing this water to the outside, such that no water remains internally.
 - d. Systems shall be drained with precipitation draining to the outside in all instances. Water paths shall be indicated on the Working Drawings.
 - e. The works shall prevent infiltration due to ice dams/ water back-up.

- f. Wet applied seals for the purpose of preventing the ingress of water shall not be accepted with the exception of the structural silicone seals or wet seals used for sealing the works against adjacent interfacing systems.
- g. Weather seals shall be provided at all interfacing connections.

211 PERFORMANCE REQUIREMENTS

1. Comply with the general performance of Section A of the Specification and the following specific performance requirements.
2. Security
 - a. All external and façade windows shall effectively mitigate threats and provide effective resistance to intruders and thus have a minimum security rating of B3 to LPS 1175 Issue 8 (equivalent to SR2 to LPS 1175 Issue 7).
3. Structure
 - a. General: When calculating loads the worst combinations shall be considered, taking account of the fact that the pressure coefficients at various locations may determine more than one design criterion.
 - b. Deflections: The allowable deflection of any element of the works, when carrying full design loads, shall not exceed 15mm or 1/ 175 of its clear span in a direction normal to the plane of that element, whichever is the lesser value.
 - c. Wind Loads
 - 1). Generally: The works shall be designed to withstand without permanent deformation, the effects of wind loads. The works shall not depart from fixings under the design wind loads.
 - 2). The structure in respect to wind loads shall be constructed in accordance with the recommendations of BRE Digests 284 [287] and 406, in particular mindful of the variant consequences of subsequent partial and full blocking.
 - d. Inertial Loads: The works shall be capable of accommodating inertial loads arising due to the acceleration/ deceleration of moving sections including opening lights, doors and vents of the building or enclosure. Consult the Architect regarding the motion requirements for such elements.
4. Environmental
 - a. Thermal Movement
 - 1). All components shall be designed to resist thermal movement resulting from the maximum and minimum surface temperatures occurring. The design shall cater for all temporary and permanent conditions envisaged for the works.
 - 2). The service temperature range for components of the works shall be taken as -25°C and +90°C.
 - b. Moisture Movement: The works shall withstand movement without permanent deformation or any reduction in the specified performance:
 - 1). Due to changes in the moisture content of their components, resulting from variations in the moisture content of the air.
 - 2). Due to the expansion of absorbed or retained moisture caused by freezing.
 - c. Atmospheric Conditions: All works shall be fully capable of resisting the prevailing atmospheric conditions.

d. Condensation

- 1). Condensation shall not form, either on internal or external surfaces of framing members, glazing, solid panels, or interstitially within the construction of infill panels forming a part of the works, such that it may lead to damage or staining.
- 2). Interstitial cavities within the construction, where condensation may occur, shall be adequately drained and ventilated to the outside, such that the formation of such condensation is not detrimental to the performance nor causes damage or staining of the works.

e. Capillarity: The Detailed Design, gaskets, seals, etc. shall take into account and eliminate any possibility of water migration to the inside of the building due to capillarity, to the satisfaction of the Architect.

f. Weather and Water Penetration Resistance

- 1). The works shall be absolutely weatherproof and watertight, ensuring the prevention of water leakage onto the internal face of the works.
- 2). The works, including flashings and junctions with adjacent parts of the building, shall be fully weatherproof and watertight under all conditions with full allowance made for deflections and other movements.
- 3). The Detailed Design and construction of the works shall be such that all rigid or fixed joints shall remain rigid and accommodate all thermal, building structure or other movements and any applicable loads without compromising their watertightness. All movement joints shall also be finally designed and constructed to accommodate such loads or movements without compromising the glazing's watertightness.
- 4). The works shall prevent airflow from the outside to the inside of the building (and vice versa) through joints/ junctions, etc. to avoid areas of concentrated airflow.

g. Air Permeability/ Infiltration

- 1). The Detailed Design shall minimise airflow from the outside to the inside of the building through joints/ junctions to control concentrated airflow.
- 2). The works shall have a maximum air infiltration rate of:
 - a). 1.5 m³/ hr/ m² for fixed lights.
 - b). 2.0 m³/ hr/ per metre length for opening lights/ smoke vents.
- 3). Items i), ii) above shall be tested at a pressure of 600 Pa minimum when tested generally in accordance with BS EN 1026 as prescribed in BS 6375: Part 1.
- 4). Air leakage shall be distributed and not concentrated at any one location.
- 5). Provide actual air leakage results from tests for acceptance.

h. Thermal Performance Requirements

- 1). Detail the works to minimise cold bridging in any area of the system. The maximum thermal permitted transmittance (U-value) for the various areas of the works shall be as follows:
 - a). The area weighted average U-value for the works (double glazed vision area and frames) shall be 2.0W/ m²K or better.

- 2). The average U-value through the works shall comply with the above requirements and meet all Statutory requirements as well as Part L of the Building Regulations.
 - 3). Submit thermal calculations for the various components and the average thermal performance of the proposed works to comply with the specified requirements.
5. Solar Performance Requirements
- a. General:
 - 1). Data sheets for project specific glass build-ups in accordance with BS EN 410 (light transmittance, radiant transmittance of glazing) with tolerances of +/-3% for flat glazing, shall be submitted in respect of solar and visible light performance confirming compliance with the Specification. Facilities shall be maintained to evaluate and report on expected solar performance under varying conditions of solar radiation and external/ internal air velocity.
 - 2). The works 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.
 - 3). All specified criteria are nominal values.
 - b. Confirm the total solar transmission (G-value) for each glass type specified for review by the Architect. Glass manufacturers and types shall be acceptable to the Architect only if they meet the performance and visual requirements defined by the Specification.
 - c. Local Factors
 - 1). Visit the Site in order to become familiar with local requirements. Local microclimatic conditions shall be taken into account and grades of materials assessed as suitably durable for the location shall be selected.
 - 2). An assessment of microclimatic conditions shall be made with due allowance for any factors likely to have an adverse effect upon materials intended for the Contract. More appropriate materials shall be substituted if adverse effects are predicted.
6. Durability
- a. General: The performance criteria shall be satisfied for the full design life of the works, as stated in the Specification, provided always that the maintenance has been carried out as specified.
 - b. Impact and Abrasion Resistance
 - 1). The works shall resist abrasion from agreed cleaning methods and maintenance systems without any noticeable change in surface appearance. Generally, surfaces shall be sufficiently hard (including glass coatings) to resist all reasonable impacts from hand-held objects in accordance with BS EN 356.
 - 2). Provide certification to demonstrate that areas of the works required to have five minutes resistance to manual attack have been tested in a manner as described in BS EN 356.
 - 3). The extent of any damage determined through testing shall be recorded and, where possible, quantified. Samples shall be submitted to the Architect.
7. Demountability

- a. Elements of the works shall be individually and independently removable ensuring access for maintenance.
 - b. The removal of units shall not affect the performance or safety of any other part of these, or adjacent, works.
8. Ballistic Resistance
- a. Refer to specific performance requirements defined within the system narrative hereunder.
9. Sustainability
- a. Refer to Section A.600 series SUSTAINABILITY clause, determine and evaluate the applicability of the specified requirements including BREEAM Credit Requirements to the works specified in this Section of the Specification. Comply with all relevant requirements.

212 STEEL WINDOW SYSTEMS

1. Type EWS-241 Steel Window System
- a. Description: Acoustic and thermally rated steel framed security window system with integrated framed glazed terrace doors (where indicated on the Design Drawings).
 - b. Conformance: BS 6375, BS 6510, BS EN 356, LPS 1175 and LPS 1270.
 - c. Specific Performance: Refer to the Facade Types Matrix.
 - d. Configuration: Fixed and/or opening lights as indicated on the Design Drawings.
 - e. Framing: Thermally broken mild steel profiles.
 - f. Glazing: Fully sealed laminated safety glass insulated glazing unit.
 - g. Reveal and Sill: Folded sheet steel.
 - h. Locking: System-compatible security locks to RC2 to BS EN 1627 and in conformance with BREEAM.
 - i. Finish: PPC to Qualicoat Class 2.
 - j. Colour: RAL 9011.
 - k. Integrated terrace access door: Refer to system Type EWS-355 defined within Section L25 of the Specification.
 - l. Indicative Product:
 - 1). Manufacturer: Schueco International, or acceptable equivalent.
 - 2). Reference: Jansen Steel Systems - Janisol. To be confirmed.
2. Type EWS-243 Steel Vertically Sliding Window System
- a. Description: Custom fabricated, thermally rated steel framed vertically sliding window system.
 - b. Conformance: BS 6375, BS 6510, BS EN 356, LPS 1175 and LPS 1270.
 - c. Specific Performance: Refer to the Facade Types Matrix.
 - d. Type: Motorised, in module notionally 4.5m maximum bays fixed between columns.
 - 1). Location: Behind the GRC clad concertina external doors.

- 2). Operation: Localised operation and BMS interface. Refer to the Services Engineer's Documentation.
- e. Configuration: Vertically-sliding lights as indicated on the Design Drawings.
- f. Framing: Thermally broken hot rolled mild steel profiles.
- g. Glazing: Fully sealed laminated safety glass insulated glazing unit.
- h. Reveal and Sill: Folded sheet steel.
- i. Finish: Powdertech Blackened Steel PPC to Qualicoat Class 2.
- j. Indicative Product:
 - 1). Manufacturer: Vitrocsa, or acceptable equivalent.
 - 2). Reference: To be confirmed.

3. ~~Type EWS-245 Steel Security Window System~~

- a. ~~Description: Acoustic and thermally rated steel framed stadium ticket window and integrated security counter with secure cash tray and audio system.~~
- b. ~~Conformance:~~
 - 1). ~~BS 6510—Steel windows.~~
 - 2). ~~BS EN 1522 and BS EN 1523—Ballistic as a window (Test).~~
 - 3). ~~BS EN 356—Physical attack.~~
 - 4). ~~BS EN 1063—Glazing (Test).~~
 - 5). ~~BS EN 14351: Part 1 and BS 6375—Weather and Integrity.~~
 - 6). ~~BS EN ISO 10140—Acoustics (Test).~~
- c. ~~Specific Performance: Refer to the Facade Types Matrix.~~
- d. ~~Configuration: Fixed and/or opening lights as indicated on the Design Drawings.~~
- e. ~~Support: Thermally broken hot rolled mild steel profiles of the manufacturer's determination as required to fulfil stipulated performance requirements.~~
- f. ~~Elemental:~~
 - 1). ~~Security screen:-~~
 - a). ~~Thermally broken, hot rolled steel profiles achieving the Architect's design intent.~~
 - b). ~~Fulfilling all performance criteria.~~
 - c). ~~Powdertech Blackened Steel PPC to Qualicoat Class 2.~~
 - 2). ~~Glazing:-~~
 - a). ~~DGU with Low E coating.~~
 - b). ~~Ballistic rating: As defined within the Facade Types Matrix.~~
 - c). ~~Thermal performance: As defined within the Facade Types Matrix.~~
 - 3). ~~Security counter:-~~

- a). ~~System compatible self supporting bespoke counter incorporating cash handling trays.~~
- b). ~~Counter surface divided/separated to reduce thermal transmission from staff to customer face.~~
- c). ~~Access pathways for audio, card payment and ancillary items.~~
- d). ~~Material: Homogenous acrylic composite, as Corian by Dupont® in colour tone 'Rain Cloud'.~~
- 4). ~~Cash handling trays: Grade 1.4401 stainless steel, system compatible secure transaction tray with bespoke homogenous acrylic composite sliding top overlaid externally with black patinated hot rolled steel to Architect's acceptance.~~
- 5). ~~Audio system:~~
 - a). ~~Bespoke configured 2 way audio system incorporated into counter design.~~
 - b). ~~Customer Side: Fixed microphones and speakers, flush mounted, in stainless steel.~~
 - c). ~~Staff Side : Desk top console with option for headsets.~~
 - d). ~~Hearing Induction Loop required at each position.~~
- 6). ~~Pedestal Units / Cash Drawer: Each serving position to supplied with a pedestal comprising lockable drawer and void capable of housing computer system unit.~~
- g. ~~Indicative Product:~~
 - 1). ~~Manufacturer: Architectural Armour Ltd.~~
 - 2). ~~Reference: Box Office Counter and Screen.~~

213

ALUMINIUM WINDOW SYSTEMS

1. Type EWS-242 Aluminium Window System
 - a. Description: Acoustic and thermally rated aluminium framed 'observation' window system.
 - b. Conformance: BS 6375 and BS 4873.
 - c. Specific Performance:
 - 1). Thermal: To be confirmed.
 - 2). Security: Not required.
 - d. Configuration: Fixed and/or opening lights as indicated on the Design Drawings.
 - e. Framing: Thermally broken extruded aluminium profiles.
 - f. Glazing: Fully sealed clear laminated safety glass insulated glazing unit.
 - g. Reveal and Sill: Folded sheet aluminium.
 - h. Finish: Polyester powder coated to Qualicoat level 2 in colour indicated on the Colour Schedule.
 - i. Indicative Product:

- 1). Manufacturer: Neuffer, or acceptable equivalent.
- 2). Reference: To be confirmed.

214 MATERIALS

1. Steel: Refer to Section Z11.
2. Steel finishes:
 - a. General: Section Z30.
 - b. Polyester powder coatings: Section Z31.
3. Aluminium: Refer to Section Z11.
4. Aluminium finishes:
 - a. General finishes: Refer to Section Z30.
 - b. Polyester powder coatings: Shall be an 'Super Durable' Advanced Polyester to Qualicoat 2 – Refer to Section Z31.
5. Glass: Refer to Section Z25.
6. Fixings: Refer to Section Z20.
7. Sealants: Refer to Section Z22.
8. Gaskets: Refer to Section Z36.
9. Homogenous Composite Acrylic
 - a. Physical Characteristics:
 - 1). Flexural-E-modulus: 8900 MPa to BS EN ISO 178.
 - 2). Flexural strength: 70 MPa to ASTM D638.
 - 3). Tensile strength: Circa 70 MPa to BS EN ISO 527.
 - 4). Breaking elongation: 1% to BS EN ISO 178.
 - 5). Density: Circa 1750 kg/m³ to BS EN ISO 1183.
 - 6). Ball Indentation Hardness: 257 N/mm² to BS EN ISO 239.
 - 7). Flame retardant properties: B-s1-d0 to BS EN 13823 and BS EN ISO 11925: Part 2.
 - b. The homogenous composite acrylic shall be applied to deliver a monolithic appearance. Any fabrication joints shall be infilled, ground and polished such that they become visually indiscernible. Allowance shall be made for this process to be undertaken on site in the case of large unit fabrication.

215 SUPPORT STRUCTURE

1. Provide a support system, as necessary, having due regard for any requirements in excess of that indicated in the Structural Engineer's documentation and also any requirements indicated on the Drawings. The support system shall include all necessary sub-constructions/ assemblies including, but not limited to, framing, brackets, cleats, angles and other components.

216 FABRICATION

1. Tolerances for Manufacture

- a. It shall be ensured that the design tolerances are adhered to.
- b. The provisions intended to accommodate the construction tolerances of the surrounding elements shall be stated and shown on the Working Drawings. Any further information necessary shall be obtained from the Architect when completing the Working Drawings.
- c. Specific tolerances to be adhered to:
 - 1). The accuracy required for the tolerances of the works shall be as set out below:
 - a). Level of horizontal members: $\pm 2\text{mm}$ from datum in any 1500mm, non-cumulative.
 - b). Plumb of vertical members: $\pm 2\text{mm}$ in the height.
- d. A detailed list of tolerances to which the components shall be fabricated, within the requirements of the Specification and overall geometric requirements, shall be submitted with the Tender. All tolerances shall be submitted for review by the Architect. As a minimum the statement of tolerances shall include the following:
 - 1). Thickness.
 - 2). Out of plan.
 - 3). Straightness normal to plane.
 - 4). Longitudinal.
 - 5). Horizontal.
 - 6). Vertical.
 - 7). Diagonal.
 - 8). Eccentricity.
- e. All finished metal surfaces shall be flat and free from undulations and irregularities.
 - 1). Twist of frame: $\pm 1.5\text{mm}$ - there shall be no warping of frame.
 - 2). Line of frame: $\pm 2\text{mm}$ overall difference between adjacent standards not to exceed 2mm.

217 LIGHTNING PROTECTION AND EARTH BONDING

1. General

- a. Bonding to metal components shall be provided in accordance with BS EN 62305: Part 1, BS EN 62305: Part 2, BS EN 62305: Part 3 and BS EN 62305: Part 4 to ensure continuity between adjacent sections, both vertically and horizontally over the whole façade. Bonding between sections shall have a minimum cross section of 50mm^2 . Any bolts used for bonding shall be of a minimum size of M10.
- b. Bonding to structural steelwork shall be carried out at intervals at no greater than 10m horizontally and 20m vertically. The first level of bonding to the structural steelwork shall be at the highest floor level of each part of the building.
- c. Provide studs/ bolts for subsequent connection.

- d. All straps/ connections shall be concealed.
- e. No straps shall be fixed along copings.

EXECUTION

310 INSTALLATION

1. General Requirements

- a. Install the works in accordance with the manufacturer's written recommendations, BS 8000 and/or BS 8213.
- b. For elements of high performance including, but not necessarily limited to system Type EWS-245 (Stadium Ticket Window and Security Counter) the works shall be installed by the contracting division of the manufacturer or where this provision is not possible, by a licensed or approved installer with a minimum demonstrable track record of similar projects undertaken within the last 5 years.
- c. The works shall be erected plumb (or at the angles prescribed) and true in proper alignment and relation to established lines and grids as shown on the Working Drawings. The erected system shall present true and accurate lines and flat planes. Deviations from lines, planes and verticality shall be limited to long wave formations of minimum 20mm length not exceeding 1000mm less rate of change and a maximum amplitude of 3mm. All the above shall be measured from a laser reference line.
- d. Joints between window units: The actual width of any joint shall not deviate from the nominal width by more than $\pm 2\text{mm}$ or 10% of the joint width whichever is the lesser. Any variation shall be equally distributed with no sudden changes. The misalignment between joints shall not exceed 2mm.
- e. Level: The works shall be within $\pm 2\text{mm}$ of the specified level. The cumulative slope between the same locations on any panel shall not exceed 1 in 1000.
- f. Plumbness: The works shall be erected such that no point on any panel is more than 3mm from its theoretical vertical/ diagonal plane. The cumulative slope between the same locations on any panel shall not exceed 1 in 1000. The vertical plane shall be within $\pm 2\text{mm}$ of the theoretical plane position.
- g. A method statement detailing proposals to achieve the specified tolerances shall be submitted with the Tender. This shall demonstrate a clear understanding of the construction programme, the effects of the building structure and construction method and the fabrication method of the panels.
- h. Sufficient analysis of the erection sequence shall be undertaken to ensure that the installation tolerances stated above shall be met to the satisfaction of the Architect.
- i. Dimensional Checking: Before work begins on Site the proposed method of dimensional setting-out and crosschecking with adjacent trades and elements to satisfy the accuracy requirements shall be submitted to the Architect. The checking of the setting-out or of any line or level by the Architect, or his representative, shall not in any way relieve the Contractor of his responsibility for the correctness thereof.
- j. Alternative Tolerances: Alternative tolerances to those specified may be permitted at the Architect's discretion, provided they are agreed in advance of manufacture of components.
- k. The Working Drawings shall provide for sufficient tolerance in manufacture of the works in order to accommodate manufacturing tolerances of interfacing elements.
- l. The tolerances stated herein shall be adhered to. No revisions to the tolerances to cater for inadequate control shall be permitted.

- m. Full details shall be submitted to the Architect for review of the proposed methods for achieving and constantly monitoring the fabrication tolerances during all stages of the work. Detailed records of the constant control and tolerances achieved shall be submitted to the Architect.
- n. The works, when installed, shall not be subject to warping or twisting and shall be strictly rigid, firm, free from vibration, knocking, rattles, squeaks and other noises when subject to the worst combination of environmental conditions and wind loads.
- o. All tolerances stated shall be measured and monitored at a mean temperature to be agreed with the Architect.