



**External Envelope:
Glass & Aluminium, Precast and
Stone Façade Elements**

**EMPLOYERS REQUIREMENTS
PERFORMANCE BASED SPECIFICATION**

Cathedral Square, Manchester

**Document No:
1139-BDA-XX-ZZ-SP-Y-0001-P02**

July 2025

**For
Domis**

**By
Billings Design Associates Ltd.**

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1 GENERAL

1.1 Introduction

Refer to Clause 1.4.3 for prescribed technical submissions required at tender.

Failure to provide required submissions will negatively affect scoring of tenderer.

Terms:

Architect: Reference to Architect is deemed to include all members of the Client's design team, including the façade consultant. The project architect shall coordinate with members of the design team for review of documentation and the project architect is the Client's Agent and representative.

Client: Reference to Client is deemed to include the Client, and all individuals performing the role of Client's Agent.

Contract Specification: The revision of this specification included in the main contractor's appointment.

Specialist Façade Sub-contractor: Reference to the Specialist Façade Sub-contractor and SFC is interchangeable. Definition of the roles and responsibilities of the SFC are set out in this Specification. Should the role be split among several specialist façade sub-contractors, each one individually shall be responsible for complying with this Specification. Any party who is carrying out any part of the Works is a Specialist Façade Sub-contractor.

The Development: The construction of Cathedral Square.

Design Documents: All drawings, technical submissions, catalogues, calculations, data sheets, sample record sheets, quality control records and other submissions issued by the SFC.

1.1.1 The Building

The project is a new building located in Manchester on a very restricted site. The structure is primarily a reinforced concrete frame construction.

1.1.2 The Works

It shall be the responsibility of the Specialist Façade Sub-contractors (referred to as the SFC) to procure all expertise, materials and services required to complete the stone, precast, metal and glass portions of the envelope of the development as identified in this document.

The Specialist Façade Sub-contractor shall ensure full compliance with the design intent and specification requirements. The Main Contractor shall be responsible for over-seeing the package and ensuring compliance but shall rely on the Specialist Façade Sub-contractor to deliver all requirements related to the facade packages. The Works include all glazing elements, external door systems, stone cladding, aluminium cladding, aluminium parapets, fascias, soffits, aluminium louvers, support steel & backing walls, and associated components. Refer to the Sub-contract preliminaries from the Main Contractor for guidance on what additional elements are to be included in the Specialist Façade Sub-contractor's package.

All applicable façade types shall include components to allow cleaning and maintenance as outlined in the consulting façade access and maintenance documentation.

Works include, but are not limited to, the following. Refer to the Sub-contract preliminaries and Architect's drawings for guidance on what elements are to be included in the specific Specialist Façade Sub-contractor's package:

1.1.2.1 Stone Cladding: EWS-254.

The Stone Cladding proposed is aesthetic reference is Granite with a honed finish. The selection process shall be arranged by the SFC in line with the recommendations set out in the Stone Federation document 'Selecting the Correct Stone', system is repeated on all locations. The stone sizes have been selected as indicated on the Architect's drawings.

All exposed upper surfaces shall be positively sloped, to mitigate against streaking and staining. The top edge of each stone shall be protected with a drip typically provided by aluminium pressing located at the bottom of curtain walling above the stone. The location and extent of the drip shall be defined by the SFC with advice from his geologist, we expect minimum 40mm.

The design intent is for the Stone Cladding construction to include closed sealant joints (6mm) and hidden fixings. Movement joints as required. The SFC shall be responsible for final selection of stone to achieve the required aesthetic and performance.

The handset stone fixings are required to be stainless-steel/aluminium fixings with fine threaded adjustment and locking screws as required to achieve fine adjustment. The stainless-steel/aluminium bracketry shall have thermal packers and where required including bi-metallic separators.

The number of brackets shall be minimised to ensure cold bridging is minimised. As shown on the Architects drawings the supporting backing wall to the stone is by way of Concrete upstand. The upstand should be fully weather sealed with suitable membrane (Class A2-s1,d0 to EN 13501). The build-up is to include a Vapour Barrier (Class A2-s1,d0 to EN 13501) closing to the interfacing primary structure and glazing system. All membranes shall be checked by the SFC for compatibility with interfacing constructions. Where required in the system it is the SFC's responsibility includes provision of cavity barriers throughout the stone façade zone.

The SFC shall include provision of external hydrophobic mineral fibre insulation to the stone cladding cavity zone, supported with stainless-steel and durable plastic fixings. The insulation thickness shall be determined by thermal calculations carried out by the SFC responsible for the stone cladding, taking into account all cold bridging, bracketry, and fixings. Note where insulation is subject to constant wetting Mineral wool isn't suitable, Fire Consultant to confirm acceptance of suitable resilient product and zone as would be expected on upstand on roof parapets.

Specialist Façade Contractor (SYLK) Scope proposal includes:

Insulation; Rockwool Rainscreen Duo-Slab FR-Class A1.

Membrane; Obex 0221FR Breather Membrane FR-Class A2-s1, d0.

Design:

1.1.2.2 Curtain Walling (Capped Stick System) + Alu Panels: EWS-203/204/ 206.

EWS-203: Anodised Finish to Architect intent (Natural Silver Anodised). Located between Level LG1 and Level 02, but typically from ground level to soffit around the tower element of the building. At Level 00 the system incorporates the Main access doors to the project, and comprises clear vision areas together with opaque insulated anodised aluminium panels.

Whilst at Level 01 the system integrates inward opening window/door vents (Schueco AWS 75SI+). with safety barriers formed by bolt on aluminium Julliette balconies constructed in railing arrangement and fixed mechanically fixed externally to the glazing frame. Finish to be PPC to Architects intent.

In the upper portion in the ceiling zone at level 01 the system incorporates whole house MVHR weathered penetrations by the SFC, including louvres/ incorporated behind the line of the perforated aluminium sheet to architect's design intent. These penetrations are to be completed by the SFC by the provision of an aluminium penetrating duct and louvre and 15mm x 15mm vermin mesh. Louvre to achieve BS EN 13030 weather rating A which allows a duct airflow of 120 l/s (to M&E Consultants requirements). The louvre's finish and colour is to match the perforated panel. Note the plenum connecting to the façade shall be designed to be positively drained out of façade. Where moisture penetrates the perimeter seal of the plenum the façade is to provide a drainage route to the external wet-zone. Note where the Specialist façade contractor design omits the interstitial louvre described herein they must demonstrate the robustness of the weathering line by exposing the rear of the duct after the project CWCT Performance Mock-up after the wet weather testing parts of the sequence B testing regime.

The system spans between retail and residential in some locations, particular attention is required to ensure fire and acoustic performance requirements are achieved in these locations, we would anticipate a split system at these junctions/interfaces.

The system incorporates the entrance doors to the project which shall be as set out in the Architect's drawings. Door heights to be limited to minimise operational loads. Allow for all external doors to be power assisted with associated drives and sensors. Where the SFC can demonstrate a particular door is operable as a manually operated door the power assistance may be omitted.

A revolving door shall be provided as indicated on the Architect's drawings. The aesthetic reference is Boon Edam Circleslide with laminated low iron glass. It shall be automated with the motor placed in the head, and a laminated glass top. It shall include all sensors as required for compliance with EN 16005. The revolving door shall have the capability of switching to manually operated or power assisted (JMA to confirm operation). The revolving door shall be sized to suit the occupancy of the building. The SFC shall include provision of a drained matwell. The revolving door shall include laminated glass curved night-shield.

EWS-204: Anodised Finish to Architect intent (Natural Silver Anodised). Located between Level 00 and Level 14 to the River Irwell Elevation forming the envelope to recessed balconies. This façade is dead-loaded onto the main slab using cantilevered brackets, allowing its thermal line to align with the thermal break of the thermally broken concrete balcony system. This ensures a resilient and continuous thermal line throughout the façade, the head is restrained at the underside of the slab of this single-span façade type. Where required the system to incorporate integrated horizontal louvres

EWS-206: Anodised Finish to Architect intent (Natural Silver Anodised). Located between Level 16 and Level 27 to the Tree House Elevation forming the envelope to stepping back balconies. The system integrates inward opening window/door vents (Aesthetic ref Schueco AWS 75SI+) and lift and slide doors (Aesthetic ref Schueco ASE 80.HI).

This façade type spans 2 storeys incorporating 2 separate levels of apartments (separate compartment's) between to balcony levels. Particular attention is required to ensure fire and acoustic performance requirements are achieved in these locations; we would anticipate a split system at these junctions/interfaces. The system incorporates inward opening vents with perforated anodised panels to the exterior provided containment within the apartments; barrier loads to be considered for the engineering of this element.

System General:

The curtain walling system is formed with a stick system curtain wall with 50/60mm wide profiles (Engineering dependent) with external caps that are maximum 30mm deep.

The system shall include perimeter thermal insulation and pressings to allow sealing to the adjacent precast and balcony edge. The SFC shall engineer the joint between interfacing elements and the glazing to achieve a rectangular seal between them, allowing differential movement between the two.

Structure and weathering:

The curtain wall is intended to span vertically with deadload applied to each slab at the base of each glazed opening. The curtain wall system shall include aluminium backing trays, insulation and membranes (outer weathering, and inner vapour barrier) closing vertically between aluminium transoms and slabs.

To either side of the curtain walling the SFC shall include provision of perimeter outer weathering membranes and inner vapour barrier membranes on aluminium supporting pressings. Where the gap to the primary structure is in excess of 100mm from the side of the mullion, it is intended to close the gap. Membranes and seals shall be checked by the SFC for each package to ensure they are compatible.

Fire & Acoustics:

The installation shall include mineral fibre insulation to the perimeter of each opening. It is intended that the fire stopping material shall be included within the slab edge and vertical wall construction as required by project Fire Consultant.

Glass:

The glass is argon filled double glazed units with a low 'e' coating to the cavity side of inner glass in order to achieve the required environmental/acoustic/thermal stress analysis/engineering performance, aesthetic reference Eclaz One II #5 to 'Domestic Zones' and COOL-LITE SKN 183II #4 to 'Non-Domestic Zones' (Architect to confirm Acceptance). Note thicknesses of the glazing panels will vary to achieve project performance requirements. The glazing shall include black warm edge spacers. The clear vision areas of glass are typically laminated outer with toughened inner, with not less than 1.52mm interlayer. The glass shall be mid-iron throughout, aesthetic reference St Gobain Planiclear.

Opacified IGUs & Panels

The curtain wall system shall include opacified panels. These shall be pre-fabricated insulated glazing units HST inner and outer panes.

Glass Types GL-04 & GL-05 Frit to face #4 inner (Colour to Architects intent).

Glass Types GL-06 Frit to face #4 and #2, outer frit patterned (Colour to Architects intent).

Refer to Novo Thermal model requirements for glazed areas:

(Doc Ref: P2305-NOV-ZZ-ZZ-RP-MEP-001 Part L Summary Report).

Domestic: U value = 1.30 Wm²/K (Average): G-Value = 0.61/0.59

Non-Domestic: U value = 1.30 Wm²/K (Average): G-Value = 0.61/0.59/0.36

Samples of all glass types to be provided by SFC for architect's acceptance. Sizes T.B.A.

Lighting: N/A.

Aluminium panels:

The SFC shall include provision of all pressed and extruded aluminium panels including parapets, rainscreens, soffits, cills, cappings, grills on the elevation, external and internal pressings to curtain walling.

The Works shall include all aluminium parapets. All parapets shall be formed from folded and welded 3mm aluminium PPC finished profiles. These shall incorporate folded flanges at joints, a silicone seal and internal inverted welded top-hat for secondary drainage. Parapets shall be reinforced by aluminium support profiles to allow maintenance loads to be applied. Below the aluminium shall be an outer breathable membrane over insulation, and an inner vapour barrier membrane below insulation, sealing the roofing system to adjacent facade system.

Parapets shall include non-ferrous thick aluminium plate with reinforced gussets to achieve the maintenance load required by rope access in accordance with IRATA requirements. Locations required to be maintained by rope access are as indicated in the façade access and maintenance report

The parapets shall be reinforced to take loading from IRATA trained rope access technicians. The parapet shall be engineered to allow walk-on loading. Rope loads should not apply to the parapet as operatives should use davits. For details refer to the façade access and maintenance documentation.

Specialist Façade Contractor (FK) Scope:

Schueco System AWS 60 SI Capped System.

Schueco ASE 80.HI Lift and Slide Doors System.

Schueco AWS 75 SI+ Window/Door System.

Schueco ADS 75 SI+ Door System.

Boon Edam Circleslide revolving door system.

Refer to FK Schedule Of Combustibility document 150-FKG-XX-XX-RP-X-1106.

1.1.2.3 Unitised Curtain Walling Capped: EWS-201 & EWS-207 (Aluminium Opaque)

The EWS-201 accounts for the majority of the unitised element on the project. Anodised Finish to Architect intent (Natural Silver Anodised). Typically installed in a stacked arrangement throughout the height of the building between Pre-Cast Concrete Panels. The joints width between the unitised and precast element will vary due to a combination of fabrication and build tolerance, this primary joint to the outside face of the system is to be formed by a wet seal, the second line of defence will be formed by way of Class B membrane connecting the unitised to the precast element. Internal of this there will be further membrane acting as a Vapour Control Layer. The system integrates inward opening window/door vents (Schueco AWS 75SI+). with safety barriers formed by bolt on aluminium Juliette balconies constructed in railing arrangement and fixed mechanically fixed externally to the glazing frame. Finish to be PPC to Architects intent.

In the upper portion in the ceiling zone at level 01 the system incorporates whole house MVHR weathered penetrations by the SFC, including louvres/ incorporated behind the line of the perforated aluminium sheet to architect's design intent. These penetrations are to be completed by the SFC by the provision of an aluminium penetrating duct and louvre and 15mm x 15mm vermin mesh. Louvre to achieve BS EN 13030 weather rating A which allows a duct airflow of 120 l/s (to M&E Consultants requirements). The louvre's finish and colour is to match the perforated panel. Note the plenum connecting to the façade shall be designed to be positively drained out of façade. Where moisture penetrates the perimeter seal of the plenum the façade is to provide a drainage route to the external wet-zone. Note where the Specialist façade contractor design omits the interstitial louvre described herein they must demonstrate the robustness of the weathering line by exposing the rear of the duct after the project CWCT Performance Mock-up after the wet weather testing parts of the sequence B testing regime.

Glass:

The glass is argon filled double glazed units with a low 'e' coating to the cavity side of inner glass in order to achieve the required environmental/acoustic/thermal stress analysis/engineering performance, aesthetic reference Eclaz One II #5 to 'Domestic Zones' and COOL-LITE SKN 183II #4 to 'Non-Domestic Zones' (Architect to confirm Acceptance). Note thicknesses of the glazing panels will vary to achieve project performance requirements. The glazing shall include black warm edge spacers. The clear vision areas of glass are typically laminated outer with toughened inner, with not less than 1.52mm interlayer. The glass shall be mid-iron throughout, aesthetic reference St Gobain Planiclear.

Opacified IGUs & Panels

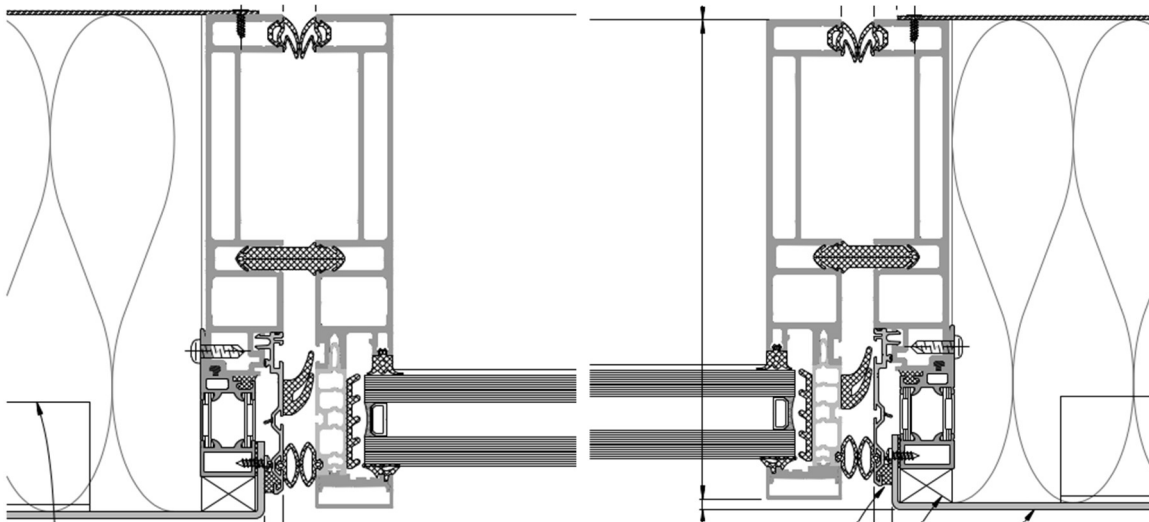
The curtain wall system shall include opacified panels. These shall be pre-fabricated insulated glazing units HST inner and outer panes.

Glass Types GL-04 & GL-05 Frit to face #4 inner (Colour to Architects intent).

Lighting: N/A.

Aluminium panels: As per EWS-201

The EWS-207 – Located predominantly on the River Irwell and Treehouse Elevations the System is as per EWS-201, however it is fully opacified by way of 3mm aluminium panel with stiffeners. Finish to Architect intent (Natural Silver Anodised). The thermal performance is as per opaque elements (0.17 W/m²K) which is not achieved in the depth of the unitised façade. Additional thermal performance to achieve compliance is achieved by the introduction of insulation between the dry lining and the unitised elements. Hygrothermal performance to be fully reviewed to ensure there is no risk of interstitial condensation in the through wall construction.



Above Vision Unitised & Opaque Units.

Specialist Façade Contractor (FK) Scope:

Schueco System UDC80 SI Capped System.

Schueco AWS 75 SI+ Window/Door System.

Refer to FK Schedule Of Combustibility document 150-FKG-XX-XX-RP-X-1106.

1.1.2.4 Unitised Curtain Walling SG: EWS-202 & EWS-205

EWS-202 is located to the Bridge Street Elevation. The system composed of clear vision and glazed zones of structurally bonded IGU's, aesthetic reference Schueco UDC 80 SI capped system. Unlike the capped system there are no requirements for plenums in the ceiling zones. The perimeter sealing to interfacing element will be as EWS-201. Anodised Finish to Architect intent (Anolok II Anodised)

Glass:

The glass is argon filled double glazed units with a low 'e' coating to the cavity side of inner glass in order to achieve the required environmental/acoustic/ thermal stress analysis/engineering performance, aesthetic reference Eclaz One II (Architect to confirm Acceptance). Note thicknesses of the glazing panels will vary to achieve project performance requirements. The glazing shall include and black warm edge spacers. The clear vision areas of glass are typically laminated outer with toughened inner, with not less than 1.52mm interlayer. The glass shall be mid-iron throughout, aesthetic reference St Gobain Planiclear.

Opacified IGUs incorporating fully sealed insulated back pan:

The curtain wall system shall include double glazed opacified IGU's incorporating mineral wool insulation and back pan to rear of system. These shall be pre-fabricated insulated glazing units, HST inner and outer panes.

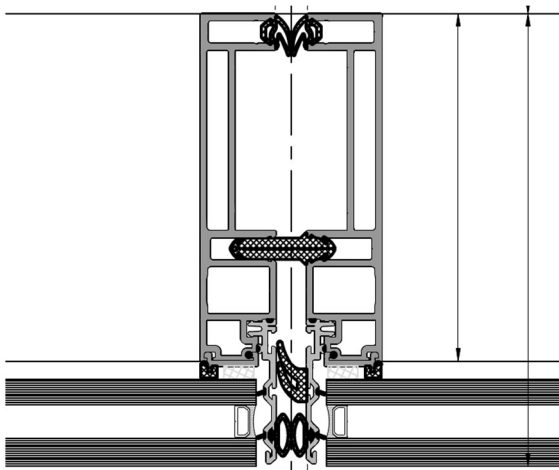
Glass Types GL-05 Frit to face #4 inner (Colour to Architects intent). Located Vertically between apartment compartment walls. (Note Fire rated wall behind)

Glass Types GL-06 Frit to face #4 inner (Colour to Architects intent). Located Horizontally between apartment compartment floors.

Samples of all glass types to be provided by SFC for architect's acceptance. Sizes T.B.A.

Lighting: N/A.

The EWS-205 as per EWS-202, located toward the bookends of the River Irwell balconies between levels 0 to 14. Note at each of the balconies the unitised element is performing only as barriers/wind breakers and are classed as attachments. They are not required to provide thermal/acoustic/solar control other performances as required by other façade elements forming part of the thermal line of the building. They are subject same other requirements including physical loads and Building Regulations requirements as a glazed balcony would, including Regulation 7(2). Compliance with these requirements must be demonstrated, laminated glass used elsewhere on the façade in not compliant for example, alternative must be proposed by the Specialist Façade Contractor after concluding a glass risk assessment. Non-Combustible Spacers will need to be proposed, typically stainless steel, no thermal requirements here for this element. Note Class A1 or A2-s1, d0 to be achieved for acceptance by the team including the project Fire Consultant.



W.I.P. Aluminium panels clear vision EWS-202

Specialist Façade Contractor (FK) Scope:

Schueco System UDC80 SI Bonded System.

Refer to FK Schedule Of Combustibility document 150-FKG-XX-XX-RP-X-1106.

1.1.2.5 Precast Façade: EWS-250/251/252/253.

EWS-250: This precast type forms the majority of the Precast panels on the project. The panels span over two floors to form a 'shingle' like effect, tapering inwards from bottom to top as per Architects design intent. They are circa 6500mm height by 1500mm width.

The precast panel is intended to be dead-loaded at its mid-span back to the floor slabs by a series of stainless-steel billets, and to have restraint points at the top and bottom as required by the pre-caster. Precast panels are required to correctly positioned with each other to ensure alignment.

Panel manufacturing (BS 8297) and installation tolerances shall be as specified herein.

The precast panels are required to have two finishes as required by the architects JMA (refer to drawings for location of finishes), Acid Etched and Polished.

Where required by the Architect JMA the panels/columns will have grooves cast-in 20mm deep and 40mm wide to agreed pattern supplied by JMA.

All bracketry and associated fixings shall be stainless steel. All cast-in channels and lifting eyes in panels shall be stainless steel.

The precast package includes factory application of mineral fibre insulation (minimum 80kg/m3) within the panels. This shall be installed using durable plastic and stainless-steel fixings. Where required by the consulting fire engineer, the SFC shall include fire stopping insulation. The SFC shall factory apply a self-adhesive breathable membrane which shall enclose all insulation and bond to the perimeter of the precast panel. The SFC shall select the membrane. Performance shall be equivalent to Wraptite, achieving Class B-s3, d0 or better in accordance with EN 13501

Part 1. The SFC providing the precast package shall employ the services of a building physics engineer who will carry out thermal calculations, condensation risk analysis and Frsi calculations, taking into account cold bridging at bracketry.

Prior to installation, the SFC shall provide to the main contractor cast-in channels for the main contractor to incorporate into the primary structure at locations and to tolerances set by the SFC.

During installation of precast panels, the SFC shall ensure they references the on-site gridlines and

setting-out levels at each floor. The SFC shall include thermal isolators at connections with the primary structure. He shall include stainless steel packers where required at deadload brackets.

During initial installation, the SFC shall install temporary seals which shall be removed when final

twin seals are being applied. All joints are required to have twin seals with a drained and ventilated cavity between the seals. The vent locations shall be located discretely to minimise their appearance on the elevations.

1.1.2.6 Aluminium Rainscreen and Parapet Cladding: EWS-256/350

Refer to the Architect's drawings for locations. The aesthetic reference to the main entrance area is Spanwall RF50 FR with extruded hollow profile vertical rails maximising spans to limit cold bridging. The support system shall incorporate gaskets and rubber isolators to prevent rattling. The joints on elevation, however should be limited to not exceed 15mm wherever possible. Joints to be sealed for improved thermal performance where required. Any sealant colour to be agreed with the Architect through provision of samples by the SFC.

The rainscreen system shall be formed from minimum 3mm aluminium sheet with folded and welded corners. Individual panels shall be fixed to vertical mullion profile rails that are fixed back to the primary structure. Where part of the thermal envelope, the number of brackets through the insulation shall be minimised to limit cold bridging. The rainscreen system shall be sealed at external joints (maximum 15mm), with localised vent holes to improve thermal performance. Cavity barriers shall be provided as required by the consulting fire engineer. Cavity barriers shall include intumescent strips mechanically fixed to the cavity barrier, and in-fill material in cassette panels in line with the cavity barrier system supplier's recommended details.

The SFC shall coordinate with the all-interfacing contractor to ensure the backing wall composition is included in the SFC's thermal and condensation risk calculations taking into account the actual locations and dimensions of all element in the backing wall build-up. The SFC shall be responsible for weather sealing of the backing wall. The outer surface of the backing shall be weather-sealed as required with a self-adhesive breathable membrane Class A2-s1-d0 to EN 13501. To the rear (room-side) of the light gauge steel backing wall others shall be required to provide the inner vapour barrier (assumed Class A2-s1-d0 to EN 13501) closing to the interfacing primary structure and glazing system perimeter membranes. All membranes provided by the SFC shall be checked by the SFC for compatibility with interfacing constructions, membranes, seals etc.

Parapets shall be provided to all locations as indicated in the Architect's drawings. These are formed in minimum 3mm PPC coated aluminium with folded joints as described in 2.3.4. ALL parapets shall be fully engineered to accommodate rope loads and maintenance personnel loads identified in the Façade Access and Maintenance Consultant's documentation. The parapets shall be engineered to transfer loads to the primary structure without applying loads to the vertical cladding below them. Where the SFC proposes reinforcing profiles, these may be thick welded aluminium or hot dip galvanised (ISO 1461) and duplex painted sections with stainless steel fixings. The SFC shall be responsible for ensuring coordination of loads from the parapets into the primary structure and agreeing these with the consulting structural engineer and façade access & maintenance consultant. Project specific load testing of aluminium parapets shall be carried out to demonstrate performance under the required rope loads.

EWS-256 is assigned to the parapet upstand on roofing areas and to back of house zone on the Tree House Hotel Elevation predominantly to levels 00 and 01. It is anticipated the finish is to be

PPC Class 2 (as per JMA requirements) with fixings visible at the joints. (Aesthetic reference Proteus SC Solid).

Specialist Façade Contractor (SYLK) Scope proposal includes:

Insulation; Rockwool Rainscreen Duo-Slab FR-Class A1.

Membrane; Obex 0221FR Breather Membrane FR-Class A2-s1, d0.

Proteus SC Solid 3mm, FR- A2-s1, d0 minimum.

Specialist Façade Contractor (FK) Scope:

Refer to FK Schedule Of Combustibility document 150-FKG-XX-XX-RP-X-1106.

EWS-256 is assigned to the mainly to the entrance soffit and cladding to concrete column, aesthetic reference is Spanwall RF50 FR system with concealed fixings. Note where used to clad columns insulation will typically not be required in the build-up.

Fire Rating - A2-s1, d0 minimum.

1.2 Design Responsibility

The Specialist Façade Sub-contractor (SFC) shall be wholly responsible for the selection of façade systems, materials and finishes to meet the performance requirements, the detailed design, design development, testing, engineering, logistics, delivery, coordination, supervision, installation and commissioning of the complete façade including, backing wall construction, steelwork (any steelwork required by the SFC which not identified by the consulting structural engineer at tender as being in the primary steel package), glazing, parapets, soffits and interfacing constructions.

The Architect's Drawings and this Contract Document are indicative of design intent and define the performance criteria, the approximate geometry of the exposed surfaces including joint positions, and detail the required principal materials and visible finishes.

The Specialist Façade Sub-contractor shall be responsible for developing and completing the design in accordance with the above and the other Contract Documents, taking into account any additional criteria which, with his specialist knowledge, he believes are relevant.

The Specialist Façade Sub-contractor can put forward alternatives for consideration by the Architect. Additionally, any suggested solutions described on the Architects Drawings or commented on the Specialist Façade Sub-contractor's drawings shall not in any way relieve the Specialist Façade Sub-contractor from his responsibility for the design and construction and installation of the whole of the Works taking into account all associated procurement, logistical and program requirements.

The SFC shall achieve Execution Class 2 in accordance with EN 1090 for all fabrication of relevant metal components of the facades and their associated bracketry (Elements which have a structural performance requirement).

Any acceptance, approval, instruction, or direction from the Architect, Client or Client's Agent shall not transfer liability for the performance of the Works in line with the specified performance

criteria away from the SFC. The SFC shall remain responsible for achieving the performance and design intent as identified in the tender and contract documents.

1.2.1 Design Responsibility, Electrical and Mechanical Componentry

The Mechanical, electrical and BMS Sub-contractor shall be responsible for providing power, settings and signals for operation of motorised elements where these are linked to the building management system/fire-board. However, the SFC shall be responsible for the design, supply, installation, commissioning and testing of all window/door/vent actuators, and coordination with the BMS.

Where identified in the Scope of Works, SFC is responsible to include within the façade package:

- a) Conduit with wiring routes agreed with the electrical contractor from motors to control boxes
- b) Backing support for lighting where applicable.
- c) Profiles and housing zones for installation of lights
- d) Installation of free-issue components where agreed in advance (does not include provision or connection of wiring).
- e) Sufficient access panels for lighting maintenance in agreed locations
- f) Electro-strike locks and mag-locks where required
- g) Door sensors and drives. Include minimum 1m tail from the façade frame-work to an agreed hidden location. Wiring to be hidden within facades, in conduit to allow future replacement.
- h) Support structure within the facade to accommodate camera brackets and other brackets for cameras etc as required.
- i) Backing structure to support signage. Signage to be provided by the Main Contractor.
- j) External weather stations, wind and rain sensors shall be provided as part of a separate package from the Main Contractor. However, control-boxes and wiring to control boxes from the motors shall be provided by the SFC.
- k) Provide control boxes for each motorised element as required for their safe operation. All control boxes with associated software, cable sizing and associated cabling containment specification for all site wiring associated with the system from control box to motor to be confirmed with the consulting electrical engineer and electrical contractor. All door drive, lock and sensor elements shall be commissioned by the SFC, and shall be agreed with the Employer's Representative and Consulting Electrical Engineers. The SFC shall coordinate via the Main Contractor with the specialist electrical and BMS contractors responsible for ensuring all such façade equipment is compatible and fully accessible through the Building Management System (BMS), being supplied by the Mechanical Sub-Contractors.
- l) Any software interfaces shall use commonly used open standards such as BACnet, KNX or Modbus and as agreed with the relevant interfacing packages as agreed with the consulting electrical engineer and appropriate electrical contractor. The Electrical Sub-Contractor shall be responsible for providing power supplies and for connecting to these.

- m) Provide battery back-up to all opening elements which are required to operate independent of the mains power in an emergency situation (example, powered fire escape doors). Battery back-up to be not less than 4 hours

The SFC shall work with the design team and interfacing contractors to develop fully integrated detailing of any external light fittings, intercoms, access control systems, cameras, dry-riser, wet-riser and service hatches provided that these requirements are identified in good time prior to manufacture. He shall give due consideration to access for loading and maintenance requirements.

1.3 Specialist Façade Sub-contractor's Role

The Specialist Façade Sub-contractor shall:

- a) Comply with all appropriate National, European and Local Government Regulations.
- b) Comply with all appropriate National and Local Government Regulations.
- c) Comply with submission and review protocols as required by Contract.
- d) Liaise with the Main Contractor and Architect and provide all information necessary to complete the Health & Safety File complying with the Health and Safety Regulations and health and safety procedures set out by the Main Contractor.
- e) Fully coordinate all design and installation solutions with interfacing contractors
- f) Use only recognised good practices and comply with the Contract Documents including this Specification, all relevant Irish, British and European Standards unless requirements conflict. If they do, the Architect shall be notified and shall make a decision as to which document takes precedence.
- g) Prepare a detailed design, procurement, mock-up, testing and installation programme for the execution of the Works, including the design development, testing, samples, prototypes and mock-ups, and submit it to the Architect within four weeks of the Award of Contract. The program shall include provision of submissions of drawings and technical documentation (the Design Documents). The program shall allow for re-submission and further re-submissions as required to finalise acceptance by the Architect and Client. Each submission shall allow minimum 10 working days for review by the Architect.
- h) Prepare a detailed drawing list, related to elevations showing locations of 2 and 3D drawings, and identify when in the programme these will be produced.
- i) Prepare a detailed list of all technical submittals. Each technical submittal to refer to the proposed product/material, its proposed performance, the relevant specification clause(s) to which it applies, and a project specific drawing illustrating the proposed location and use of the proposed material/product.
- j) Complete the Works that comply with the architectural design and the technical requirements of this Contract Document.
- k) Employ the services of a suitably experienced structural engineer, registered in Ireland, to carry out detailed audit of tolerances, design principles and deflections of interfacing structural elements, and to confirm coordination with the proposed primary structure, particularly with regard to suitability for attachment of the Specialist Façade Sub-

contractor's proposed Works. The SFC's structural engineer shall carry out detailed analysis of all of the SFC's components including finite element analysis where required. He shall carry out complete design of all façade types and associated structural connections. He shall attend site during installation of the façade on not less than 6 occasions and report on his findings, confirming compliance of the installed elements with his design intent. Any deviation from the agreed structural design shall be highlighted by the SFC's operatives and work stopped on that portion of the work until resolved by agreement with the SFC's engineer.

- l) Employ the services of an acoustic engineer to assess the performance of the proposed façade systems, including predicted performance in their installed condition to confirm compliance with the required external to internal performance and flanking performance from demise to demise (and demise to other spaces). Refer to Clients Acoustic Consultants documentation for performance requirements.
- m) Employ the services of a suitably qualified geologist/stone consultant (referred to hereafter as the 'Geologist') who is a member of the Stone Federation UK, or equivalent European body to select, test and certify suitability of the Specialist Façade Sub-contractor's selected stone for each intended location, orientation, fixing and exposure. The independent Geologist shall provide engineering calculations for each stone size, shape and thickness, indicating on diagrams/drawings the required restraint and deadload support fixings for each stone. The Geologist shall provide written confirmation of the selection, testing and approval procedure carried out and shall sign off the final stone selection, stone sizes, stone thickness', stone cutting for fixings, the stress in the stone and detailing as produced by the Specialist Façade Sub-contractor. He shall review and stamp approval of all drawings and calculations prior to issue to the design team confirming compliance with the Specification requirements. He shall visit site a minimum of 3 times to inspect the facade at quality control sample stage, mid-way through construction and 6 weeks prior to practical completion. He shall report on his findings confirming compliance with Specification requirements
- n) Employ the services of a suitably qualified design engineer experienced in the detail design and engineering of stone cladding. He shall review and stamp agreement of all drawings and calculations prior to issue to the design team confirming compliance with the Specification requirements. He shall visit site a minimum of 3 times to inspect the stone cladding at quality control sample stage, mid-way through construction and 6 weeks prior to practical completion. He shall attend impact testing to ensure the installed components are as per the engineered design. He shall report on his findings confirming compliance with Specification requirements.
- o) Provide trade literature, samples of finishes, components and elements of the Works to demonstrate the quality of design, material and workmanship, methods of fabrication and obtain acceptance from the Architect. Refer also to Clause 5.4.2 for minimum list of off-site quality control samples. On-site quality control samples are also required.
- p) Present proposals in drawn and written form and modify them as required by the Architect to complete the design intent and achieve compliant solutions. Drawn proposals, where required by the Architect, shall be in the form of 3D sketches, exploded where necessary, of all interfaces, corners, edges and features. These may be freehand for in-formal development of solutions prior to issuing formally in CAD form and Revit 3D

BIM format as required by the Contract. These sketches shall illustrate the proposals including the continuity of air and weather seals, vapour barrier, insulation, drainage routes and ventilation, allowance for movements, tolerances and fixings, and sequencing, shape and layering of elements at these locations. Note, the Specialist Façade Subcontractor (SFC) shall coordinate the design of his works with interfacing, external and internal trades.

- q) Attend regular meetings with the Architect to discuss and develop the detailed design and provide calculations, samples and other supporting evidence to corroborate it as necessary.
- r) Produce, and submit formally, design development drawings based on the compliant solutions, calculations and samples. As these are developed, ongoing checks shall be made to ensure that the principles adopted above are maintained. Drawings shall reference relevant technical documents (engineering, data sheets, test reports etc.)
- s) Prepare the necessary shop drawings for manufacture (not issued to the Architect for review) when and only when the design has been completed in compliance with this Contract Document for the system concerned.
- t) Drawings to be submitted in accordance with the procedures and formats required by Contract. Drawings shall include accurate representation of interfacing constructions and components. Drawings shall include imported information from interfacing packages wherever such information is available. The SFC shall be responsible for weather-proofing, thermal performance, clash detection and coordination at interfaces.
- u) Prepare thermal modelling (2D, full colour) of ALL systems and ALL interfaces and assemblies confirming location of air seal, dew point and U value. 3D thermal modelling shall be carried out where required at localised penetrations and bracketry. This shall include bracketry for stone-clad areas. Note, dew point to be demonstrated as being in a drained and ventilated zone. The SFC shall be required to obtain information regarding properties of interfacing constructions that his Works shall seal to. Calculations to take into account localised effects of brackets etc.
- v) Fabricate the specimens for off-site testing when and only when the necessary shop drawings have been completed.
- w) Provide samples, design development mock-ups, weather performance testing, acoustic assessment and quality control specimens (off-site and on-site) as required by this Contract Document.
- x) Test the specimens unless applicable test results are available and accepted by the Architect. Note, independent testing authorities to be used throughout.
- y) Carry out modifications to the design and construction of specimens and retest these in the event of failure during testing. Ensure any modifications to the design are incorporated into the design development drawings and shop drawings prior to manufacture of the Works for site.
- z) Proceed with fabrication when and only when the specimens have been tested successfully and acceptance to proceed is issued by the Client's Agent.
- aa) Proceed with installation of the Works only when the relevant drawings, engineering and technical submissions have achieved A Status.
- bb) Organise the delivery of components to the site so that the Works can be installed in proper sequence without omissions which would require modification of the design.

- cc) Ensure that all people engaged in the design, fabrication and installation of the Works are adequately trained, proficient and experienced.
- dd) Instruct all those engaged in the installation of the Works of the principles of its design, of any unusual details which might be overlooked and of the particular techniques to be used in its construction.
- ee) Ensure an up-to-date set of appropriate drawings, reports and calculations is available on site for the installation team at all times.
- ff) Provide on-site quality control samples and test these using an independent testing authority acceptable to the Architect at times suitable to allow inspection of all interior surfaces of the façade prior to covering up. Where covering up has occurred, the Specialist Façade Sub-contractor shall remove this prior to testing and re-instate it at his cost after testing. Note, the Specialist Façade Sub-contractor should program all testing to avoid this. Note, the Specialist Façade Sub-contractor shall provide all access required for inspection during the testing. Total linear meterage of hose testing to be as per Section 5.
- gg) Ensure that the Works are installed to the agreed standards set by the quality control samples. Supervise all on-site works and warrant that all site Works are as per the detail design provided by the SFC. Where proposing to deviate from the SFC's design, formally inform the Architect and gain acceptance prior to proceeding.
- hh) Protect the Works. Protection to include provision and maintenance of protection of surfaces including but not limited to glass, interfaces and all frames including thresholds and transoms. Maintain protection and remove build-up of dirt etc. Protection to include film protection on all aluminium, fire retardant sheeting up to 1.8m above floor. Include sheeting to room side of all punch window and curtain wall locations. Check the proper operation of all operable elements and carry out final presentation quality clean down (clean down in stages where required by the program). Commission all motorised elements. Commissioning to include twenty cycles of opening-closing of each motorised element using the appropriate signals from switches, BMS and Fire board as appropriate (one cycle is closed to open to closed again)
- ii) Provide a comprehensive maintenance manual and 'as-built' drawings at practical completion. Provide a draft version not less than 6 weeks prior to practical completion.
- jj) Employ the services of a suitably qualified and experienced document controller for the uploading and downloading of documentation in accordance with Contract protocols.

1.4 Submissions

1.4.1 Schedule of Submissions

Post tender and prior to appointment, the tenderer is required to issue a draft Schedule of Submissions for coordination and agreement with the Main Contractor. Maximum 4 weeks after contract award, the successful tenderer will be required to produce a coordinated Schedule of Submissions, including sample submissions. The Schedule of Submissions shall set out all of the documentation, test certificates, drawings, maintenance manuals, warranty certificates and samples referred to in this specification. The Schedule of Submissions shall list dates when the submissions shall be produced. The Schedule of Submissions shall be reviewed with the Main

Contractor and Architect and adjusted to suit the needs of all parties. As part of the Works, the Specialist Façade Sub-contractor shall provide the submissions and organise the inspections given in the Schedule of Submissions extracted from the Tender Specification, at the times indicated.

The Schedule of Submissions shall take account of the requirement for items to be submitted in good time for review, time for re-submission, review and acceptance. Failure to achieve acceptance of submitted documents shall not relieve the Specialist Façade Sub-contractor's obligations to achieve the requirements of the Contract Documents and the Contract Specification or meet the requirements of the contract program.

Provide a programme with the Schedule of Submissions which shows the proposed drawing list, date for issue and date for acceptance by the Architect for the entire SFC's Works.

The Architect reserves the right to amend the Specialist Façade Sub-contractor's Schedule of Submissions in order to ensure the satisfactory flow of information to other subcontractors or members of the project team irrespective of when information is needed by the Specialist Façade Sub-contractor for his own production programme.

The Architect reserves the right to reject ALL submissions which are received prior to agreement of a coordinated Schedule of Submissions.

1.4.1.1 Golden Thread

The SFC shall have in place a secure digital record of all decision making, engineering and detail design. He shall share this record of all decision making, engineering and detail design upon request. The SFC is to provide full disclosure of all detail design, materials and suppliers used in the design, manufacturing, fabrication and installation of their Works including all sub-consultants and sub-contractors.

1.4.2 Procedural Matters

The Specialist Façade Sub-contractor shall assemble the submissions as required in accordance with the agreed Schedule of Submissions and submit them in accordance with the agreed protocols, to the Architect for review by the appropriate member of the Design Team. He shall simultaneously issue information digitally in PDF format to other members of the design team as directed by the Architect with associated issue sheets.

The SFC's Design Documents, include drawings, technical submissions, catalogues, engineering calculations, etc. as defined in this Specification. The SFC's Design Documents shall be submitted as per the procedure agreed with the Architect and as required by the contract documents. As a minimum, the SFC shall follow the requirements as set out below:

- a) The maximum number of Design Documents to be issued for review in any one period of 5 working days shall not exceed 20 except where agreed in advance in writing.
- b) Official review of documents shall be via a Web Platform.

- c) When Design Documents are uploaded on the Web Platform the SFC shall inform the Design Team via e-mail of the documents uploaded. The e-mail shall be sent when the documents have been accepted by the Web Platform document controller and are available for the Design Team to download and review. The e-mail shall include the issue sheet of the documents (including confirmation of revisions) uploaded.
- d) The Design Documents review period shall be 10 working days. Note, the days between Christmas Day and New-year's Day are not working days. The review period starts from the date of the individual document is accepted on the Web Platform for review by the Architect and the date of receipt of the SFC's e-mail confirming the same (as described at point a)). The review period does not start until the SFC's e-mail confirming availability of the documents on the Web Platform is received.
- e) The SFC's design drawings shall be submitted in a pack of drawings (hereinafter referred to as the "drawings pack") to allow the reviewer to understand the complete functionality of the system and area being designed. The detail drawings (1:5, 1:2, 1:1) part of the drawings pack shall form one submission and shall be submitted at the same time as partial elevation, vertical sections and plan sections indicating the locations of details. If the detail drawings are submitted in different days to the relevant sections and partial elevations, the reviewing period starts after the submission of the last drawing forming the drawing pack. The drawing pack shall always include elevations, plans and sections with details tagged to show where the details refer to. Each detail drawing shall include a schedule on the drawing with reference to technical submissions for relevant engineering calculations, and associated technical submissions associated with that drawing. The SFC shall take into account the status of any drawing is subject to the close-out of any and all technical submittals.
- f) Technical submittals shall include the specific data sheets of the product proposed. If the product information is mentioned in a catalogue, the proposed product shall be marked-up in the catalogue.
- g) Comments containing questions on Design Documents shall be responded by the SFC by insertion of responding notes on the Design Documents when updated. Ignoring comments or lack of adequate response is to be avoided. The SFC shall discuss with the DesignTeam any comments he does not understand or cannot close out prior to re-issue of the relevant Design Document.
- h) Design Documents for each joint of structural silicone bonding shall include:
 - calculations of the proposed size of silicone confirmed by the structural silicone manufacturer
 - confirmation of compatibility of the silicone in contact or adjacent to other materials confirmed by the structural silicone manufacturer
- i) Design Documents for each joint of weather seal and membranes shall include:

- confirmation of compatibility of the seal in contact or adjacent to other materials confirmed by the sealant manufacturer
- j) Design documents of Fire Compartment details shall include:
 - confirmation from the Firestop / Cavity Barrier manufacturer that the product as shown in the SFC details complies with the Firestop / Cavity barrier manufacturer instructions and recommendations to achieve the required performance.
 - acceptance of the detail by the Consulting Fire Engineer employed in the project.
- k) **Design documents MUST be at A Status prior to INSTALLATION of the relevant Works on-site. It is the responsibility of the SFC to ensure site operatives have the correct documentation closing out all comments prior to installation.**

The naming of documents and recording of this process shall be in accordance with the requirements of the Contract Documents and Contract protocols.

The protocol shall include the following information on each issue sheet of every set of drawings, every technical submission and every sample (failure to provide the required information will result in rejection of the submission):

Drawings:

Heading:	SFC to fill in:	
Submittal reference number		
Submittal Date		
Submittal title (including relevant façade type)		
Confirm the proposals in the submission are in compliance with the BDA Specification and associated documentation.		
Confirm the proposals in the submission are in compliance with the architectural design intent as illustrated in the Architect's drawings.		
All changes from the previous submittal have been clouded and clearly indicated		
All comments have been incorporated. Where comments have not been incorporated, the drawing includes a note confirming reasoning why a comment could not be incorporated.		
Schedule all related technical submittals which accompany these drawings: Structural calculations Thermal calculations Glass engineering (incl. thermal stress) Acoustic assessment (incl. flanking)		

Test reports (incl. impact)		
Fire risk assessment		

The Technical and Sample Submittal schedules shall set out submissions per façade type against the principle façade performance criteria set out in Section 4 of this specification (Structural, Thermal, Acoustics, Fire, Weathertightness). See Appendix A, BCAR Requirements for reference schedule. The submissions shall be issued as a single complete document with clear concise information. Where product brochures or data are issued as part of a submittal, they shall be clearly marked up, identifying the specific product proposed. The submissions shall issued in line with the design programme ensuring the all relevant information is issued for a complete review by the Design Team.

Technical Submittals:

Heading:	SFC to fill in:	
Submittal reference number		
Submittal Date		
Submittal title (including relevant façade type)		
State relevant clause(s) from BDA Specification		
Confirm the proposals in the submission are in compliance with the BDA Specification and associated documentation.		
Illustrate the location on the SFC's drawings where the proposed Technical Submittal applies.		
All changes from the previous submittal have been clouded and clearly indicated		
All comments have been incorporated. Where comments have not been incorporated, the submission includes a note confirming reasoning why a comment could not be incorporated.		

Sample Submittals:

Heading:	SFC to fill in:	
Submittal reference number		
Submittal Date		
Submittal title (including relevant façade type and reason for issue)		
State relevant clause(s) from BDA Specification		
Confirm the proposals in the submission are in compliance with the BDA		

Specification and associated documentation.			
Illustrate the location on the SFC's drawings where the proposed sample applies.			
All changes from the previous submittal have been clouded and clearly indicated on the associated submittal sheet			
All comments have been incorporated. Where comments have not been incorporated, the submission includes a note confirming reasoning why a comment could not be incorporated.			

It is intended that the Architect, shall provide the following status to reviewed documents, drawings and samples taking into account comments from other members of the design team:

A: Accepted.

Permission to proceed as drawn/written (no changes permitted). Re-submit for Construction. Note, where A status is given, it does not alter the SFC's responsibility for ensuring all engineering, calculations, and coordination have been completed.

B: Accepted with comments.

Provide responses to ALL comments, incorporate all changes, and proceed with manufacture only where comments are being addressed to the satisfaction of the Architect. Permission to proceed with manufacture is not given where comments are ignored or not addressed. Re-submit for review prior to installation. Note, where B status is given, it does not alter the SFC's responsibility for ensuring all engineering, calculations, and coordination have been completed. B Status is not sufficient for proceeding with installation. Works that are installed when any relevant Design Document is at B status are automatically rejected.

C: Rejected.

Incorporate all comments and re-submit prior to proceeding. Re-submit for review. C Status is not sufficient for proceeding with manufacture. Works that are fabricated when any relevant Design Document is at C status are automatically rejected.

D: Not for review.

Applicable where an individual member of the design team is not required to review.

Where the on-line portal requires individual members of the design team to all provide separate status, the lowest status provided by any individual of the design team shall be deemed as the formal status of that submission.

Re-submitted B and C status Design Documents with changes not clearly clouded shall not be reviewed and may be rejected. The Specialist Façade Sub-contractor shall not be permitted to claim delay or cost where this occurs. The Architect shall reserve the right to down-grade from B

status to C status, any submission that has repeatedly not incorporated all comments to the satisfaction of all parties. As stated in this Specification comments on submissions do not relieve the Specialist Façade Sub-contractor of his responsibility to achieve the requirements of this specification and other contract documents including compliance with the agreed program for the project.

When Works are ready for inspection and/or testing, the Specialist Façade Sub-contractor shall submit these to the Architect for review by the appropriate member of the Design Team. The notification and recording of this process shall be in accordance with the requirements of the Contract Documents.

Drawings must show any requirements for builder's work in connection with the Specialist Façade Sub-contractor's installation. These drawings for the builder's-works are to be carried out by the Specialist Façade Sub-contractor within this sub-contract to allow the Main Contractor to carry out the required work on site in good time for coordination with the facade. The Design Team's comments will relate only to general performance, aesthetic and overall functional matters, not to the detailed design and construction components which is to remain the complete and sole responsibility of the Specialist Façade Sub-contractor.

The Design team's consideration of drawings and other technical submissions submitted by the Specialist Façade Sub-contractor shall not in any way relieve the Specialist Façade Sub-contractor from his responsibility in respect of the suitability of, accuracy of and programming of all such drawings and technical submissions, nor from his responsibility to provide elements suitable in dimensions for the location in which they are to be installed. The Design Team shall be entitled to rely upon the Specialist Façade Sub-contractor's submissions with regard to the accuracy of their information.

The Design Team's consideration of the Specialist Façade Sub-contractor's submissions shall not relieve the Specialist Façade Sub-contractor from his responsibility for rectifying errors or for supplying components and materials to the full satisfaction of the Design Team. Any modification required is to be re-submitted within one week of receipt of the design team's comments or as otherwise agreed on the drawing schedule.

The details shown on the BDA and Architect's drawings are indicative of the Architectural requirements. The method of achieving the construction is the responsibility of the Specialist Façade Sub-contractor, provided that it conforms to this specification and associated appearance. Where a quality control sample exceeds (is better than) the requirements of the Contract Specification, it shall become the minimum standard that all relevant Works shall achieve.

1.4.3 Compliant Tenders, Tender Submissions

TENDER SUBMISSION HEADINGS ARE REQUIRED TO FOLLOW THE HEADINGS a, b, c, d... AS NOTED BELOW FOR EASE OF REFERENCE AND SCORING.

It will be a requirement of the Contract that the successful Tenderer shall comply with this Contract Document without any qualifications. Tenderers must, therefore present (in written form) any concerns they have at the mid-tender interviews and finally at tender submission. The tenderer is invited to visit the site and review it during the tender period in order to familiarise himself with the development. Tender submissions shall be in A4 and A3 format.

1.4.3.1 Aluminium, Glazing.

Each Tenderer shall:

- a) Provide a table of ALL Specification clause headings from this document. Against each clause heading confirm complying or not-complying. Where not-complying, provide a clarification. Where issuing a clarification, state clearly the proposed deviation from the Specification. Any clauses not listed, the SFC is deemed to be complying. Any 'clarifications' or deviations from Specification not identified in this table shall be ignored and do not form part of the tender.
- b) Return a full set of the relevant Architect's elevation, section and detail drawings marked up in colour indicating the Tenderer's understanding of his scope of work. Note, interfaces are deemed to be part of the Specialist Façade Sub-contractor's work. Clearly indicate any work necessary for the full completion of the Works which has not been included for in his Tender, which will involve works to be carried out and costs to be incurred by the Main Contractor. Any such work not specifically described in the Tender return, shall be deemed to have been included for in the Tender. This includes secondary support-work and interfacing constructions.
- c) Provide 1:20 vertical section and 1:5 project specific vertical and horizontal sectional details of each principal wall type. Include details of proposed curtain wall system, perimeter cill/gutter, external doors and atrium double height curtain wall systems.
- d) Provide catalogue information of proposed doors
- e) Provide weather performance test reports for curtain walling and door systems where available. Where not available, confirm project specific testing will be carried out.
- f) Provide confirmation that U values specified by the consulting mechanical engineers shall be achieved.
- g) Provide confirmation that the acoustic performance specified by the consulting acoustic engineer shall be achieved.
- h) Provide confirmation that the Access Maintenance Strategy specified by the consulting façade access and maintenance consultant shall be achieved.
- i) Provide details of proposed independent testing authority for materials and finishes testing
- j) Provide details of the proposed independent testing authority for weather performance testing (off-site and on-site).
- k) Provide an outline program for the design, prototyping, testing, construction and installation of the Works.
- l) Provide confirmation of the tenderer's proposed glass products for each façade type on the building with associated data sheets identifying G value, light transmission, internal and external reflectivity and thermal performance. Include confirmation warm edge spacers are proposed. NOTE: glass thickness will not be assessed at this time.

- m) Provide a schedule of warranty periods for each of the components contained in the Works (see Specified schedule).
- n) Provide proof of Professional Indemnity Insurance stating insurance broker and policy terms, confirming sufficient cover for work in Ireland in line with Client requirements.

Any submissions omitted from the tender return will be marked as zero. If the tenderer achieves the position of preferred bidder any missing submissions must be provided prior to commencement of the Works.

Post tender, prior to contract signature the tenderer shall be required to agree with the Architect and Main Contractor, his precise scope of work and final Contract Specification as well as contract program. No further amendment or omission from the agreed scope and Contract Specification shall be permitted during the contract works without written acceptance from the Client.

1.4.3.2 Stone Facades.

Each Tenderer shall:

- o) Provide a table of ALL Specification clause headings from this document. Against each clause heading confirm complying or not-complying. Where not-complying, provide a clarification. Where issuing a clarification, state clearly the proposed deviation from the Specification or state 'not applicable'. Any clauses not listed, the SFC is deemed to be complying. Any 'clarifications' or deviations from Specification not identified in this table shall be ignored and do not form part of the tender.
- p) Return a full set of the relevant Architect's elevation, section and detail drawings marked up in colour indicating the Tenderer's understanding of his scope of work. Note, the steelwork, insulation and cavity barriers, fire collars and bracketry behind stone facades are deemed to be part of the Specialist Facade Sub-contractor's work. Clearly indicate any work necessary for the full completion of the Works which has not been included for in his Tender, which will involve works to be carried out and costs to be incurred by the Main Contractor. Any such work not specifically described in the Tender return, shall be deemed to have been included for in the Tender. This includes secondary support-work and interfacing constructions.
- q) Provide 1:20 vertical section and 1:5 project specific vertical and horizontal sectional details of each principal facade type including stone fins and columns. Include details of proposed stone support systems and associated bracketry.
- r) Provide catalogue information of proposed restraint fixings
- s) Provide confirmation that U values specified by the consulting mechanical engineers shall be achieved taking into account thermal bridging at bracketry.
- t) Provide confirmation that the Access Maintenance Strategy specified by the consulting façade access and maintenance consultant shall be achieved.
- u) Provide details of proposed geologist
- v) Provide details of the proposed independent testing authority for impact performance testing (off-site).
- w) Provide an outline program for the design, prototyping, testing, construction and installation of the Works.

- x) Provide technical details and material testing reports for the proposed stone materials in accordance with Table 3 of EN 1469 and associated independent Geologist's statement confirming suitability of the proposed stone types for the project. Stone test reports to include the following:
 - a. Petrography EN 12407 (max 10 years old)
 - b. Flexural Strength (wet and dry) EN 12372 (max 2 years old & every 2 years for 10 years)
 - c. Breaking load at dowel hole EN 13364 (max 12 months old using project thickness. Where proposing an alternative restraint method, provide relevant alternative testing)
 - d. Water absorption EN13755 (max 2 years old & every 2 years for 10 years)
 - e. Density and porosity EN 1936 (max 2 years old & every 2 years for 10 years)
 - f. Freeze thaw resistance EN12371 (max 10 years old)
- y) Provide a schedule of warranty periods for each of the components contained in the Works (see Specified schedule).
- z) Provide proof of Professional Indemnity Insurance stating insurance broker and policy terms, confirming sufficient cover for work in Ireland in line with Client requirements.

Any submissions omitted from the tender return will be marked as zero. If the tenderer achieves the position of preferred bidder any missing submissions must be provided prior to commencement of the Works.

Post tender, prior to contract signature the tenderer shall be required to agree with the Architect and Main Contractor, his precise scope of work and final Contract Specification as well as contract program. No further amendment or omission from the agreed scope and Contract Specification shall be permitted during the contract works without written acceptance from the Client

2 THE TECHNICAL SCOPE OF WORK

To be read in conjunction with the Contract Documents and design intent drawings for clarity.

2.1 Nature of this Specification

This is an Employers Requirements Performance Based Specification.

2.2 Design Team Documentation

Refer to:

- a) Planning conditions
- b) Architect's drawings and associated documentation
- c) Fire Engineer's report and Fire design drawings
- d) Structural Specification, Drawings and Movement/Tolerance Report
- e) QS information and preliminaries
- f) M & E reports (free area calculations, thermal performance, internal conditions, control strategy, Part L compliance, NZEB requirements, etc.)
- g) Acoustic Engineer's Report
- h) LEED Consultants Documentation
- i) Access and Maintenance Consultants Documentation
- j) Security and Asset Management Documentation

2.3 Design Requirements

Set out below are the requirements that the Specialist Façade Sub-contractor shall follow when designing the Works. The Specialist Façade Sub-contractor shall be responsible for ensuring he has obtained the required status on submissions and carried out all calculations and design work required prior to ordering and manufacture in order to prevent abortive and/or non-specification compliant work.

All submissions shall be provided in the English language. Where documentation has been provided to the Specialist Façade Sub-contractor in another language, an official translation certified by the translating authority shall be provided to the Architect.

2.3.1 General Requirements

The Specialist Façade Sub-contractor shall be responsible for the design, provision and installation of all interfacing constructions required to provide an air, vapour and water seal to the building. This shall include, but is not limited to, interface sealing membranes, external weathering membranes (breathable) and internal vapour barriers with associated supports. The vapour barrier is to be on the warm side of all insulation and no condensation shall be permitted to form beyond this point. Note, this includes ALL interfaces with this package. Specialist Façade Sub-contractors proposing to 'dress in' membranes provided by the Main Contractor shall be rejected. Interfaces shall result in complex folded pressings being required to provide a fully weathered closure of the assembly. The Specialist Façade Sub-contractor shall allow for site measuring and detailed resolution of these areas. The SFC shall allow for both in terms of cost and time.

- a) Site applied sealant shall not be acceptable as part of the primary sealing system unless shown and accepted on Status A SFC's drawings.

- b) The air/vapour barrier shall be designed to resist the full wind load. Membranes shall be selected and designed in accordance with Section '6.12 Vapour Control Layers Interface Sealing Membranes and Breather Membranes' of this Specification.
- c) All fixings are to be hidden from view wherever possible. Any visible fixings are to be allen-head type or turned 'pig-nose' type. External visible fixings, accessible at ground level shall be security type requiring special tools to remove them.
- d) No site grinding or welding of components shall be permitted.
- e) Any slots in bracketry positioned in line with the direction of wind load or perpendicular to the façade face shall be locked either by serrations or incorporation of a site drilled locking screw. Reliance on friction grip bolts shall not be permitted.
- f) Company logos or names shall not be visible on the completed works except where expressly agreed in advance with the Architect and where required as part of CE Marking or compliance with harmonised EN Standards.
- g) The Works shall incorporate all horizontal and vertical fire stops where interfacing directly with the primary structure (vertical fire stopping at dry-lining partition walls shall be provided by the associated dry-lining specialist contractor).
- h) The Works shall include all horizontal and vertical cavity barriers, and fire collars as required to achieve the required fire performance as required by the consulting fire engineer.
- i) The Works shall achieve the required acoustic attenuation at floor slab edges and walls. This detail shall achieve the flanking transmission attenuation required by the Consulting Acoustic Engineer.
- j) Façade and secondary structure weights, deflections, point loadings into the primary structure and coordinated integration of structural movements and tolerances shall be submitted to the Project Structural Engineer as soon as possible after appointment for acceptance and coordination with other Works.
- k) Motorised opening vents shall incorporate encoded motors.
- l) The Specialist Façade Sub-contractor shall allow for provision of all steel he requires that is not already indicated on the structural engineer's drawings as being part of the primary structure package. Should additional steel support or bracketry be required, the Specialist Façade Sub-contractor shall allow for these within his Works. Where the SFC is fixing to intumescent painted or fire-protected steel, he shall allow for provision of steel brackets corrosion protected, intumescent painted in line with the requirements of the intumescent paint system supplier's requirements, the structural steel engineer's requirements and the consulting fire engineer's requirements.
- m) The Specialist Façade Sub-contractor shall include provision of all internal aluminium pressings identified by the Architect at solid panels, spandrel, at floor, ceiling, and wall interfaces. These shall be formed in minimum 2mm aluminium up to 300mm span or 3mm where larger, with slave joints and invisible fixings.
- n) The SFC shall allow for provision of thermally broken holes through façade panels in locations as agreed with the Architect. These holes shall allow provision of over-flow pipes by the Main Contractor, penetrating the facades, and projecting outside the façade line for drainage. Sealing around these pipes shall be the responsibility of the SFC. Over-flow pipe locations to be as set out on the Architect's drawings.

- o) Materials that form, penetrate through and/or are outside the vapour barrier shall be non-ferrous except where identified on the design intent drawings where hot-rolled galvanised steel with duplex paint finish shall be permitted. The use of pre-galvanised sheet thinner than 1.5mm in any areas shall not be permitted. All galvanising shall be external grade suitable for exposure to the external environment even where used internally (see Corus guidelines for external grade pre-galvanised sheet).

2.3.2 Curtain Wall Glazing Systems

These systems shall: -

- a) Be CE Marked. To that end they shall have full weather performance testing documentation for its proposed use (e.g. roof glazing to be tested as a roof, not a wall) prior to going into manufacture
- b) be designed as pressure equalised
- c) incorporate a secondary drainage system behind the weathering seals, that drains to the outside
- d) allow complete drainage of water from rebates to outside
- e) allow ventilation of the edges of the insulated glazing units, panes and panels.
- f) incorporate an internal air seal and vapour control layer that shall also act as second line of defence against water ingress (secondary gasket).
- g) eliminate standing water on/or around the edge of insulated glazing units, panes and panels.
- h) provide the following when all tolerances are accommodated and the most onerous combination of movements occur (including wind sway):
 - sufficient edge cover on all insulated glazing units, panes and panels to maintain weathering and structural performance around their perimeter.
 - clearance to edges of all glass panes or panels of at least 2 mm everywhere around their perimeter
- i) incorporate isolation devices to minimise thermal bridging.
- j) be capable of being re-glazed from outside of the building.
- k) be sealed with gaskets at joints between mullions and transoms with a step in depth of drainage chamber to promote free drainage into the mullion in a stick system. Be sealed with gaskets at panel perimeters providing two lines of defence in all locations
- l) provide discrete mechanical retention to aluminium transom/mullion profiles and cover caps.
- m) At the bottom of stick curtain walling provide notched mullion cut-outs behind the mullion drainage ports allowing water to drain forward and below the membrane top edge which shall run continuously fixed to transoms and behind the mullion drainage profile, providing a 100% air and water seal. Reliance on proprietary drainage spouts mounted in the mullion profile shall not be accepted.
- n) At the top of each curtain wall incorporate sealant of the mullion drainage channels to provide continuous seal at the inner gasket line.

- o) motorised opening vents shall be integrated into the system as required with hidden wiring and shall be designed to achieve the required free area defined by the Consulting Mechanical Engineer.
- p) Include test reports regarding the geometric free areas for the size and operation of opening vents to provide the required free air supply specified by the Consultant Mechanical Engineer. Note, the curtain walling system supplier to provide written confirmation (project specific) to the Specialist Façade Sub-contractor, confirming the required free area is achieved with the proposed vent size and opening.
- q) Include fire stopping, smoke and acoustic seals between slab edge and the back of the curtain walling system where it passes the slab edge.
- r) Include perimeter fire stopping to prevent fire spread into adjacent cavities in accordance with the consulting fire engineer's requirements.
- s) Include mineral fibre packing to assist fire stopping within all mullions and transoms where they pass a fire-stop.
- t) Insert acoustic attenuation within mullions where required by calculation and design to meet the performance requirements.
- u) Where frames are mitred, mitred corners to windows insert frames, opening vents, and mitred systems are to be additionally sealed at these mitred corners with a two-part structural adhesive and pumped with compatible sealant, allowed to cure fully prior to transportation. Reliance on small-joint sealant alone at mitre connections is not accepted.
- v) All curtain walling to allow for coordination to allow installation by the Main Contractor of blinds boxes onto the rear of the glazing systems.

2.3.3 Systems with Structural Silicone Glazing

These systems shall (in addition to the points noted above in 2.3.1 and 2.3.2):

- a) provide the following when all tolerances are accommodated and the most onerous combination of movements occur (including wind sway):
- b) sufficient edge cover on all insulated glazing units, panes and panels to maintain weathering and structural performance around their perimeter without over-stressing the structural silicone connections. Structural calculations and tests required to prove this.
- c) Clearance to edges of all glass panes or panels of at least 2mm everywhere around their perimeter.
- d) be capable of being re-glazed from outside of the building without relying on the use of site applied structural silicone.
- e) incorporate bottom edge support to vertical panes of both panes of insulated glazing units, and panels that prevent the gravity loads of the glass and panels being supported by the structural silicone seals alone
- f) be covered by project specific calculation and sign-off by the structural silicone manufacturer confirming compliance with his load restrictions, compatibility of components and quality control procedures.
- g) incorporate black coloured spacers within insulated glazing and triple glazed units.

- h) be covered by full QA documentation in line with the structural sealant manufacturer's guidelines including future maintenance and inspection requirements. The above documentation shall be reviewed and signed off by the structural sealant manufacturer prior to practical completion.
- i) Avoid reliance of structural bonding to painted surfaces. Structural silicone bonding shall be limited to anodised aluminium and stainless-steel surfaces only.

2.3.4 Pressed Metal Cladding, Rainscreen, including Parapets, Soffits and Interfaces.

SOLID ALUMINIUM –

These systems shall have (in addition to the points noted above in 2.3.1): -

- a) Aluminium panels minimum 3mm thick with concealed fixings. Aluminium sheet to be stretched to minimise rolling tolerances. Note, rolling tolerances set by EN 485-4 shall not be acceptable in the finished installation. Tighter tolerances as specified shall be achieved. Stiffening shall be provided as required to achieve the required panel surface flatness and architectural aesthetic.
- b) Where an individual panel is more than 2.0m² surface area, it shall be reinforced for flatness and to limit deflections to those specified.
- c) Include ALL parapets jointed to suit the curtain walling, 3mm aluminium, with inverted welded U-shaped drainage profiles and hidden fixings throughout. Welded or structural silicone bonded end-caps to be included. The insulation shall be resistant to moisture, suitable for use under an aluminium capping, supported on a continuous surface of ISM supported by 2mm aluminium pressings spanning between the façade and primary structure. This inner membrane shall interface and seal to the roofing vapour control and weatherproofing layer to the rear of the upstand.
- d) Soffits (solid panels) to be minimum 3mm thick aluminium, flat panels, Coloured anodized finish, to include hidden fixings, hidden stiffening elements if required, perimeter profiles and joints aligned with adjacent curtain walling and brick/stone (confirm applicable setting out reference) setting out. All to include associated membranes where required (e.g. penetrations), bracketry, fixings, insulation and drainage systems. Insulation to be fixed to the structure, wrapping all beams.
- e) Cavity closers at corners, copings and across the body of the façade at minimum 12m centres together with sufficient openings in the external face of the screen to allow external wind pressure to act on and pressure equalise the air in the screen cavity.
- f) The facility to replace damaged or broken elements without removing more than 5 adjacent panels
- g) Fully controlled drainage route for water from horizontal joints into vertical recessed profiles. Bracketry to incorporate thermal isolation.
- h) Openings in the panels sufficient to ventilate the cavity, and allow water which may accumulate in the cavity to drain to the outside.
- i) Protection from standing water to insulation at horizontal locations e.g. copings and roofs
- j) Dark faced insulation where it will be visible. Insulation to be mechanically fixed with stainless steel and durable plastic fixings. Reliance on adhesive shall not be permitted.

- Insulation to be external grade, certified by the insulation manufacturer as suitable for rainscreen cladding.
- k) Fire and smoke cavity barriers (combined) as required by the Building Regulations and Consulting Fire Engineer extending across the cavity. Cavity barriers and their respective components to have a design life of not less than 60 years. To incorporate stainless steel restraint clips and fixings for durability. Where used, (if permitted by the consulting fire engineer) open state cavity barriers to be installed such that the cavity to be closed is within 20mm of the back of the external metal panel unless required otherwise by the consulting fire engineer or fire authorities. Include intumescent strip as part of the open-state cavity barrier system to close cavity in event of hot gasses entering the cavity.
 - l) A continuous cavity tray laid to fall, sealed to the supporting structure/vapour barrier, above soffit-to-wall interfaces and glazing opes, so that any water is drained to the outside. Interface locations to provide an outer ISM weathering membrane and inner vapour seal membrane.
 - m) Anti-drumming features shall be applied to all parapets to mitigate against noise generated in heavy rain. Anti-rattle features shall be applied to all panels and parapets to mitigate against noise generated in high winds and to minimise wear on fixings and bracketry. Anti lift-off features (locking screws and alike) shall be included to prevent wind driven or unlawful lift-off of the panels.
 - n) Full engineering calculations shall be required for each backing structure, panel type, bracket and fixing type taking into account maintenance loads, snow and wind loads. Note the backing structure shall be engineered to take the full design wind load uniformly and from point loads applied by the brackets from the outer skin.
 - o) All folded corners are to be tightly formed and welded. See image below for aesthetic reference.
 - p) Incorporate pressed aluminium, welded collars for fitting of penetrations through the system maintaining all seals etc.
 - q) To include expanded aluminium insect mesh at base details (minimum 0.7mm thick), closing between panels and backing wall to prevent entry of vermin.



Figure 1 Rainscreen panel corner quality. Aesthetic Reference, Central Bank, Dublin

2.3.5 Stone System

These systems shall have (in addition to the points noted above in 2.3.1 and 2.3.4):-

- a) The Specialist Facade Sub-contractor shall be responsible for the design, provision and installation of all interfacing constructions required to provide an air, vapour and water seal to the building. This shall include, but is not limited to the outer stone, sealant joints, wet-seals, SS bracketry, duplex painted hot dip galvanised steel support structure, insulation, cavity barriers, fire collars, self-adhesive breather membrane, cement particle board with weather-sealed board to board joints, inner light-gauge steel liner-wall with insulation, and inner vapour barrier. The vapour barrier is to be on the warm side of all insulation and no condensation shall be permitted to form beyond this point. Note, this includes ALL interfaces. Specialist Facade Sub-contractors proposing to 'dress in' membranes provided by the Main Contractor shall be rejected. Interfaces shall result in complex welded pressings being required to provide a fully weathered closure of the assembly. The Specialist Facade Sub-contractor shall allow for site measuring and detailed resolution of these areas.
- b) All stone of a particular type shall be supplied from one bed in one quarry and from one batch or sequential batches from sequential blocks in order to maintain continuity of colour, hue, and visual quality. The Architect shall be the sole arbiter regarding acceptability of variations where they occur on stone panels. It is the responsibility of the Specialist Facade Sub-contractor to provide samples of the FULL extent of colour and feature variation to be expected on site prior to manufacturing of the Works. Thickness of stone shall be calculated in accordance with BS 8298. In all cases natural stone shall not be less than 40mm thick.
- c) All insulation is to be A1 or A2 rated in accordance with EN 13501. Thickness to be calculated by the SFC to achieve the required thermal performance taking into account cold-bridging at brackets and fixings. Where insulation must be locally reduced in thickness, high performance insulation shall be provided to match the overall performance of the surrounding insulation. Thermal calculations shall take into account any reductions in insulation. Thermal calculations shall include condensation risk calculations and assessment of cold-bridging in all typical details including columns and beam interfaces with the building's thermal envelope. 3D thermal modelling to be carried out at bracket penetrations.
- d) Site applied stone to stone joints shall be sealant in line with the architectural design intent.
- e) All seals shall be accessible for inspection/replacement.
- f) The air/ vapour barrier shall be designed to resist the full wind load.
- g) Ventilated cavity openings, where larger than 12mm, shall have expanded stainless steel bird mesh (max hole size, 6mm dia.)
- h) Horizontal and vertical cavity barriers, and fire collars shall be provided as required by the Building Regulations and in accordance with the consultant fire engineer's requirements closing between the cladding (stone) and structure, including internal walls. Refer to the Granted Fire Safety Certificate drawings and Consultant Fire Engineer's information for clarity. Note, fire stopping shall be provided around all curtain walling and window

- interfaces preventing fire break-through into adjacent cavities. (refer to Fire Consultants report)
- i) Note, cavity barriers incorporating stainless steel restraint pins shall be required to extend to close to the back of all external rainscreen panels in a fire situation. Cavity barriers shall be fire-tested in line with the requirements of the consulting fire engineer. If fire test certification is not currently available to the satisfaction of the consulting fire engineer, allow for provision of alternative solutions which are in line with the consulting fire engineer's requirements. This is required for intumescent seals, cavity barrier systems, and fire collar systems. In all cases the product must be installed in compliance with the Building Regulations Technical Guidance Documents. Systems incorporating intumescent strips may be proposed but must be to the same service life as the surrounding cladding and be part of a proprietary tested cavity barrier system.
 - j) Fire collars shall be provided, with stainless steel fixings and external casings, fixed to the stone cladding support framework and intumescent sealed to the adjacent cavity barrier in accordance with the requirements of the consulting fire engineer.
 - k) All fixings are to be hidden from view wherever possible. Visible dowels in stone joints shall not be accepted. All bracketry and fixings to be coloured to match the Architect's requirements where there is a risk of being seen through stone joints.
 - l) Any visible fixings are to be Allen-head type or turned 'pig-nose' type. External visible fixings, accessible at ground level shall be security type requiring special tools to remove them.
 - m) No site grinding or welding of components shall be permitted except where expressly agreed in the SFC's technical submissions and drawings.
 - n) Any slots in bracketry positioned in line with the direction of wind load or perpendicular to the cladding face shall be locked either by serrations or incorporation of a site drilled locking screw. Reliance on friction grip bolts shall not be permitted.
 - o) Company logos or names shall not be visible on the completed works.
 - p) The works shall incorporate all horizontal and vertical acoustic attenuation at floor slab edges where the facade system seals to the slab edge and internal walls. This detail shall achieve the flanking transmission attenuation required by the Consulting Acoustic Engineer, not less than the figures specified here-in.
 - q) Façade and secondary structure weights, deflections, point loadings into the primary structure and coordinated integration of structural movements and tolerances shall be submitted to the Project Structural Engineer as soon as possible after appointment for acceptance and agreement with other Works.
 - r) The Specialist Façade Sub-contractor providing the stone cladding package shall allow for provision of all steel he requires that is not already indicated on the structural engineer's drawings as being part of the Primary Steel package. Should additional secondary steel support or bracketry be required, the Specialist Façade Sub-contractor shall allow for these within his Works.
 - s) As a rule, any damaged stone panels shall be replaced with new. At the Architect's discretion, minor repairs may be permitted subject to sample acceptance and confirmation of maintenance of warranty and design life comparable with the panel. Repairs on any one location and on any one panel shall not exceed 10mm x 10mm or equivalent surface area.

- t) The Specialist Facade Sub-contractor shall allow for penetrations as required by the Main Contractor. He shall seal the inner lining wall around these and cut stone to suit, providing a neat 6mm joint at the interface.
- u) the facility to replace damaged or broken elements without removing more than 5 adjacent panels
- v) include openings and cavity trays in the stone sufficient to ventilate the cavity, and allow water which may accumulate in the cavity to drain to the outside.
- w) include protection from standing water to insulation at horizontal locations eg copings
- x) provide a minimum of 30mm air gap between the internal face of the external stone panel and the cavity face of the insulation.
- y) dark faced insulation where it will be visible.
- z) fixing system to ensure that there can be no accidental or unlawful removal of facade panels.
- aa) Include thermal isolation at bracketry fixings
- bb) Include bi-metallic separation where required at dissimilar metals and at metal to concrete interfaces
- cc) Follow the guidelines of the Stone Federation
- dd) Use only CE Marked products designed for their respective use.

2.3.6 Louvres

Louvres are intended to be storm louvres to achieve the required performance and aesthetic. All louvers intended to provide weather protection and allow transfer of air to mechanical plant shall be single or double-bank Class A3 for water penetration and coefficient of discharge when tested in accordance with EN 13030 at 2.4m/sec face velocity. Louvres shall be vertical or horizontal orientation as identified on the Architect's drawings.

These shall be extruded aluminium type incorporating expanded aluminium or stainless-steel wire (as tested) bird mesh with a combined free area not less than that required by the Consulting Mechanical Engineer.

In the design of louvre screens the Specialist Facade Sub-contractor shall take into account the natural frequency of the louvers and ensure failure fatigue loading of fixings is prevented. Louvres to have intermediate support behind the blades to limit spans. All backing structures including fixings shall have a PPC matt black finish. Interfaces with mechanical plant shall incorporate connection details agreed with the mechanical contractor allowing drainage of all water that may enter the duct through the louvers. Refer to the Mechanical Engineer's documentation for air flow rate of air intakes.

2.3.7 Manually Operated Windows

- a) To be compliant with harmonised standard EN 14351-1 and this Specification.
- b) To be side-hung, inward opening (refer to Architect's drawings). Stainless steel limiting devices as JMA operational requirements with adjustable friction control are required.
- c) Windows to incorporate limiting devices to initially restrict them to opening 100mm clear opening at transom.

- d) Per window there shall be at least one operated safety limiting device per opening side. Safety limiting devices shall re-engage automatically when the window is closed.
- e) Where top-hung windows are used, friction stay hinges shall hold the window open against the weight of window at any opening angle between 15 and 30 degrees.
- f) Incorporate EPDM perimeter gaskets providing minimum two lines of defence against water ingress.
- g) Shall not disengage from its supports under any of the relevant specified loads when open or closed. Refer to Clause 4.5.4 for applicable loads
- h) Shall not be capable of removal from the surrounding area of the cladding under any of the relevant specified loads, when closed.
- i) To be provided with locking and security mechanisms in accordance with the Architect's, Security Consultant's and consulting mechanical engineer's requirements, and with 2 No. keys for each lock. Additionally, all windows to be provided with suitable integrated (hidden) stainless steel multi-point locking mechanisms operated by a single handle.
- j) Ironmongery and window locations/sizes shall be as specified by the Architect.
- k) Finishes and jointing shall be matching with the surrounding cladding as agreed with the Architect.
- l) Opening windows shall be designed to operate for their full warranty period (12 years) without dropping, or deforming out of square. The opening elements and their supporting framework shall be designed to resist torsion loads induced by opening to prevent dropping of the free edge. Specialist Façade Sub-contractor to provide details of maintenance required to achieve the durability and performance noted in this Specification

2.3.8 Manually Operated Doors

- a) To be side hung (doors), opening to 90° inwards / outwards (refer to Architect's drawings). Stainless steel limiting devices with adjustable friction control are required and shall be capable of being undone only by authorized personnel. Door hinges to be colour matched pencil type to suit the door colour (block hinges should be avoided).
- b) Shall not disengage from its supports under any of the relevant specified loads when open or closed.
- c) To be provided with locking and security mechanisms in accordance with the Architect's and consulting mechanical and electrical engineer's requirements. Additionally, all doors to be provided with suitable integrated (hidden) locking mechanisms.
- d) External entrance/exit doors shall include mortice locks to eventually be on the Client's master keyed system. All doors shall be provided with temporary eurocylinder locks for construction stage. It is intended the final locks shall be fitted by the Main Contractor.
- e) External entrance/exit doors to be fitted with hidden intruder alarm sensors and wired for easy connection by the Main Contractor to the Building Management System via the SFC's control box.
- f) All doors to be fitted with adjustable stainless steel door closers in all locations. Closers to have stainless steel arms. Projecting arms shall be rejected except where applicable loads require these. Casings for these closers shall match Cathedral Squares except

where expressly agreed with the Architect otherwise. Door closers to include a 'hold-open' position.

- g) Ironmongery and door locations/sizes shall be as specified by the Architect. All handle ironmongery to be *contrasting colour to JMA requirements*.
- h) Finishes and jointing shall be matching with the surrounding facade as agreed with the Architect.
- i) Incorporate two lines of continuous gasket as defence against water ingress, including stepped threshold at base (maximum 15mm step).
- j) Refer to the Architect's schedule for the requirements of each specific door
- k) All doors to have reed switches integrated into frames hidden from view with associated wiring. (Fixing as per JMA requirements or by Electrical Contractor face fixed to door.)
- l) Stainless steel overhead closer mechanisms shall be incorporated on all external doors. The spring strength class on all closers to be sized in accordance with the door dimensions and in accordance with the tested strengths in EN 1154. All overhead closer mechanisms to be cam action and incorporate a back check function, delayed action on closing and cushioned limiting stay functions. All closer mechanisms must be CE Marked, have Certifire certification and must be supplied with a Torque/ Force profile curve.
- m) All manually operated doors unless specifically noted otherwise for functionality purposes, or if subject to fire escape routes, to be inward opening to prevent risk of wind damage to door or surrounding facade or safety risk.
- n) Where doors are required to open outwards the hardware and connection detailing shall be capable of withstanding wind speeds up to 13m/s (acting both as a sudden closing or opening force) as a minimum in the open condition.
- o) Opening doors shall be designed to operate for their full warranty period (12 years) without dropping, flexing or deforming out of square assuming regular maintenance is carried out. The opening elements and their supporting framework shall be designed to resist torsion loads induced by opening to prevent dropping of the free edge. Specialist Façade Sub-contractor to provide details of maintenance required to achieve the durability and performance noted in this specification.
- p) All ironmongery required to act as panic exit hardware is to be designed and tested in accordance with the requirements of BS EN 1125 – Building Hardware / Panic Exit Devices Operated by a Horizontal Bar/ Requirements and Test Methods. Vertical espagnolette rods to be integrated, hidden within door frames. Horizontal push-bars to be aluminium or stainless steel.

2.3.9 Motorised Doors

- a) Comply with all local and national Regulations including disability directives and associated guidelines.
- b) Provide full replacement warranty period of 12 years from date of practical completion (excluding motors and ironmongery which should have a 2 year warranty).
- c) Shall not disengage from its frame under any of the relevant specified loads when open or closed
- d) shall not be capable of removal from the surrounding areas of the façade under any of the relevant specified loads, when closed.

- e) Where doors are not operating as a fire escape route, external powered doors shall include mortice locks to eventually be on the Client's master keyed system. All doors shall be provided with temporary eurocylinder locks for construction stage. It is intended the final locks shall be fitted by the Main Contractor. The intention is these shall be interlinked with the motors to ensure the locks do not damage the motors or prevent safe operation of the doors.
- f) Where accessible, shall be fitted with hidden intruder alarms and wired for easy connection by the Main Contractor to the Building Management System via the SFC's control box.
- g) Be tested for weather performance and durability as identified in this document (provide reports)
- h) All powered doors (all types) are to be designed in accordance with EN 16005: Powered pedestrian doors. Safety in use of power pedestrian doors.
- i) Door leaf widths and heights are to be minimised where possible to reduce loading on mechanisms
- j) All companies who install, and individuals who install, automatic door hardware must be full members of ADSA.
- k) Opening doors shall be designed to operate for their full warranty period (12 years) without dropping, flexing or deforming out of square. Motors are permitted to be changed during this time. The moving elements and their supporting framework shall be designed to resist loads induced by opening. Specialist Facade Sub-contractor to provide details of maintenance required to achieve the durability and performance noted in this specification.
- l) Motorised doors shall have integrated, hidden wiring. Installation of these elements includes individual commissioning and site testing to ensure full operation. Site testing to include not less than 20 cycles of opening and closing.
- m) All motorised opening elements, including motorised entrance doors shall be designed to fail safe release upon signal from the building management system/fire board UNLESS SPECIFICALLY PROGRAMMED OTHERWISE UNDER THE INSTRUCTION OF THE CLIENT.
Note, winter-garden doors are currently not envisaged to be connected to the BMS.
- n) The SFC shall include provision of battery back-up for all powered doors. Back-up shall be for not less than 4 hours.

3 TECHNICAL PROCEDURES

3.1 Sources of Information

The SFC shall be responsible to ensure that the façade systems will, as a minimum, be in accordance and comply with, the requirements of all relevant standards and codes of practice where they exist:

Local Authorities and Building Regulations, Codes of Practice, English Standards, Fire and Safety Regulations.

All relevant Standards, Codes of Practice relevant to the Works for this contract. (This includes relevant BS, EN and ISO).

The standards and Technical Notes of the Centre for Window and Cladding Technology (CWCT).

Where standards and codes of practice are quoted within this document, all parts of that that standard shall be considered.

Where standards are quoted within this document, the most recent version of that standard (and associated parts) shall be utilised, unless otherwise stated within this document.

Where conflict exists between relevant documents the SFC shall highlight the anomaly and propose which document will be followed with the agreement of the Architect. In the case of disagreement, the more onerous requirement shall apply.

3.1.1 British and EN Standards (all references to 'ISO' mean 'EN ISO')

Note, the schedule of standards noted below is not intended to be restrictive and is only a guide as to the applicable standards:

Access and ergonomics	BS 8300
Acoustic performance	ISO 171, ISO 10140, ISO 10848, ISO 16283
Aluminium structures	EN 1999
Aluminium extruded sections	BS 1161, BS EN 515, BS EN 755, BS EN 14024
Aluminium plate, sheet and strip	BS EN 485, BS EN 573
Anodising aluminium	BS 3987, Qualinod 25 microns.
Anodising tests	BS EN ISO 3210, & BS EN ISO 8251
Barriers in and about buildings	EN 1991, BS 6180
Bi-metallic corrosion	PD 6484
Carbon steel angles	BS EN 10056-1 and 2
Carbon steel beams joists and channels	BS EN 10365; BS EN 10210-2
Carbon steel bolts and nuts	BS EN 24032, BS EN ISO 4033, BS EN ISO 4034
Carbon steel hollow sections	BS EN 10210
Carbon steel washers	ISO 898-7
Continuously hot dipped zinc coating	BS EN 10346, BS EN 10143,
Doors/windows, weather performance	EN 14351, EN 1026, EN 1027, EN 12211, EN 12207

Doors/windows, mechanical tests	EN 14351, EN 12046-2, EN 1192, EN 12217, EN 947, EN 948, En 949, EN 950
Doors/windows, cyclic tests	EN 14351, EN 1191, En 12400
Insulated glazed units	EN 1279
Dynamic water test	BS EN 13050 (if not used. See AAMA 501.1-05)
Durability	BS 7543
Fire	BS 9999, BS 476: Parts 6, 7, 20-24 BS 9991
Gaskets	ISO 37(S2)
Glass	BS 952, BS EN 572
Glazing for buildings	BS 6262
Hot dip galvanising	BS EN ISO 1461
Hot rolled steel	BS EN 10025
Impact performance	BS 6206, EN 12600, EN 13830, EN 14019
Laminated glass	BS EN 14449
Lightning protection	BS EN 62305-3, BS 7430, BS 7671
Liquid organic coatings (pvf2)	BS 4842, EN 12488
Loading for buildings	EN 1991 (with local annex)
Non-loadbearing vertical enclosures	BS 8200
Polyester powder coating on aluminium	Qualicoat
Polyester powder coating on galvanised steel	Qualisteelcoat
Quality assurance systems	BS EN ISO 9001
Pre-cast concrete	BS 8297
Protective coating of iron & steel structures against corrosion	BS EN ISO 12944: Parts 1-8
Rain gauges	BS 7843-3
Sampling procedures	BS 6001-1
Sealants (non-structural)	BS 6213, BS EN ISO 11600, BS 6093
Sills and copings	BS 5642: Parts 1 & 2
Slip Resistance, Pendulum test	BS EN 7976
Sound insulation and measurement	BS EN ISO 10140, BS EN ISO 16283, BS EN ISO 717-1 & 2
Stainless steel	BS EN 10029, BS EN 10048, BS EN 10088, BS ISO 9445-1,
Steel plate, sheet and strip	BS EN 10021, BS EN 10139
Steel preparation	BS 7079, ISO 8501, ISO 8502, ISO 8503, ISO 8504
Steel tubes	BS EN ISO 10296-1, EN 10297
Structural fixings in concrete	BS 5080: Parts 1 & 2, EN 1992-4
Structural sealant	BS EN 13022. ETAG 002
Structural use of aluminium	BS EN 1999-1:2007 (+A2:2013)
Structural use of glass	prEN 13474, EN 16612
Structural use of steel	BS EN 1993-1 & 2
Stainless steel fasteners	BS EN ISO 3506-1 & -2
Testing of aluminium welds	BS EN ISO 4136, BS EN ISO 5173:2010+A1:2011, BS EN ISO 9017, BS EN ISO 9017, EN ISO 17639
Testing of welders	BS EN ISO 9606
Welding consumables	BS EN ISO 14341, BS EN ISO 2560, BS EN ISO 14171, ISO 18275, BS EN ISO 17632,

Welding of stainless steel	BS EN ISO 3581, BS EN ISO 14343 ISO 201940-23
Welding procedures	BS EN ISO 15614, BS EN 1011-1, 2, -3 & -4,
Window safety, door safety	EN 14351, BS 8213: Part 1
Workmanship on building sites	BS 8000: Parts 7 & 16
Zinc rich paints	BS 4652
Code of Practice for the use of rope access methods for industrial purposes	BS 7985:2002, IRATA
Powered pedestrian doors. Safety in use of power pedestrian doors. Requirements and test methods	EN 16005
Door hardware	EN 14351, BS EN 1125, BS EN 179, EN 13637, BS EN 14846,
Stone.	BS 8298, <u>BS 8221-1:2000</u> , <u>BS 8221-2:2000</u> , <u>BS EN 413-1</u> , BS EN 1469:2015, <u>BS EN 1936</u> , BS EN 12371, <u>BS EN 12407</u> , <u>BS EN 12440</u> , <u>BS EN 12670</u> , <u>BS EN 13161</u> , <u>BS EN 13364</u> , <u>BS EN 13373</u> , <u>BS EN 13755</u> , BS EN 12059.

3.1.2 Other National Standards

High performance organic coatings (PVDF)	AAMA 2604, AAMA 2605
Elastomeric cellular pre-formed gaskets	ASTM C 509
Test method for dry film thickness	ASTM D 1400
Load resistance of glass	ASTM E 1300
Dynamic testing of facades	AAMA 501.1-05
Vertical inter-storey movement	AAMA 501.7-11

3.1.3 Local and National Codes and Planning Permission Conditions

General Requirements (not exhaustive):

Client Brief.

Requirements of the purchaser/developer insurance (guarantee) scheme.

Key Design Team guidance:

- 1) Fire Strategy
- 2) Acoustic Report(s)
- 3) Risk register
- 4) Façade Access and Maintenance Report
- 5) Energy Performance / Carbon Emissions/Part L compliance
- 6) Site Survey
- 7) MEP Performance documentation for MEP coordination including, but not limited to thermal, heat gain, acoustic, drainage and HVAC
- 8) Structural Performance Reports for coordination of structural elements including slab edge deflections
- 9) BREEAM or LEED accreditation (refer to relevant report).

Building Regulations:

Requirements of Building Control and Fire Officer.

The latest editions of the Building Regulations in place at the time of permission for Planning.

Approved Documents

3.1.4 Guides, Reports and Codes of Practice

American Welding Society BCSA & SCI	Recommended practices for stud welding. National Structural Steelwork Specification for Building Construction 5th Edition.
British Board of Agrément BSRIA	Methods of assessment and testing. Technical Memorandum TN10/98- Air leakage of office buildings.
Building Research Establishment	Information Paper 2/82 Ergonomic requirements for windows and doors. BR 135
Centre for Window and Cladding	Guide to the design of thermally improved glazing frames. Standard and guide to good practice for curtain walling. Standard for Walls with Ventilated Rainscreens. Standard for Systemised Building Envelopes. Technical Notes.
CIRIA	Book B5-Rainscreen cladding: A guide to design principles and practice.
CIRIA	C632 - Guidance on glazing at height Special publication 87-Wall Technology. Technical note 107-Design for Movement in buildings.
Council for Aluminium in Buildings	A guide for thermal assessment of aluminium windows. A guide for thermal assessment of aluminium curtain walls.
European Organisation for Technical Approvals	Document 002; Structural sealant glazing systems. European Blue Guide to Product Marking
J.M.Davies	Lightweight Sandwich Construction.
N. Cook	The designer's guide to wind loading of building structures.
Secretary of State	Process guidance note PG6/23.
The Steel Construction Institute	Concise guide to the structural design of stainless-steel SCI 123. Design of stainless-steel fixings and ancillary components SCI 119.

	Curtain wall connections to steel frames SCIP 101.
	Architects Guide to Stainless Steel SCIP 179.
Industrial Rope Access Trade Association (www.irata.org)	Guidelines on the use of rope access methods for industrial purposes (and other publications)
TRAV (Technische Regeln für die Verwendung von absturzsichernden Verglasungen)	Technical rules for the use of glazing
Stone Federation of Great Britain	Selecting the Correct Stone (2014) How to select a Stone Professional Guide to BS8298 The Natural Stone Resource Book Guide to Best Practice on the Repair and Maintenance of Internal and External Masonry Surfaces
National House Building Council (NHBC)	Standards, including and not limited to the documents for curtain walling and cladding (Chapter 6.9).

4 PERFORMANCE REQUIREMENTS

4.1 Principle of Design Intent

4.1.1 The Building

The building is required to provide safe, dry, temperate and comfortable conditions under all extremes of weather that can be reasonably anticipated. Its walls and roofs are expected to withstand the deleterious and degrading effects of radiation from the sun, weathering, atmospheric pollution, vermin, fungi and other growths for the required service life described herein without maintenance in excess of routine cleaning and minor repairs.

4.1.2 The Works

The Works shall withstand or accommodate the stresses and movements induced by changes in temperature, building settlement and other physical and chemical changes. It shall have a resistance to combustion and fire spread appropriate to each part and shall prevent casual and unlawful entry into the building. It must be possible to clean and maintain and replace all elements of the Works.

The Works are required to include suitable allowances for construction tolerances, cambers, estimated deflections, relative deflections and the long-term movements associated with the settlement of the foundations, or any other movements of the structure as identified by the Consulting Structural Engineer. It is the responsibility of the SFC to ensure he is fully informed regarding the structural behaviour of the building.

The Specialist Façade Sub-contractor shall ensure that he has allowed for all hardware, brackets, channel fixings etc. He will be responsible for obtaining the necessary approvals from the Statutory Authorities.

4.2 General Principles of Performance

The Works shall perform at the levels set out herein as a minimum.

4.3 Design Life

The Building has a design life of 60 years in accordance with BS 7543. Service life of individual parts of the Works shall be as set out in Table 1.

Materials and components which under normal service conditions cannot meet the specified service life, i.e. “replaceable elements”, as defined in BS 7543, shall be identified by the SFC. Details shall be provided together with methods of replacement, in accordance with the Schedule of Submissions.

Materials and components that under normal service conditions will meet the service life of the facade without loss of performance below those specified in this specification, but require servicing and maintenance to do so, ie “maintainable items”, as defined in BS7543, shall be identified by the SFC. He shall provide comprehensive recommendations for the servicing and maintenance of them in accordance with the Schedule of Submissions.

All structural fixings, frames, brackets, angles, or other load bearing components of the façade Works shall remain in position and meet structural stresses and loadings for the period of the estimated service life. These are “maintainable elements” as defined in BS 7543.

4.4 Warranties / Guarantees / Insurance

The Specialist Façade Sub-contractor shall provide evidence of Professional Indemnity Insurance and Collateral Warranty as requested by the Client. PI insurance to be not less than €6,500,000 in the annual aggregate for a period of not less than 12 years from date of practical completion. PI insurance to be in place for a period of not less than 12 years from date of practical completion. Warranties from the Specialist Façade Sub-contractor are required for the system and its components including interfaces and installation.

The Specialist Façade Sub-contractor shall provide the information in the form of a table with headings as below, in accordance with the Schedule of Submissions and Tender Submissions requirements.

Item	Required Manufacturer's Warranty (years)	Estimated Service Life (max. Years)	Category of Design Life BS7543 table 1.	Anticipated maintenance requirements
Frames (Alu. and Steel)	12	35	replaceable	Inspect annually. Clean min. every 6 months
Frames (timber)	12	25	replaceable	Inspect annually and carry out repairs as required to minimise degradation. Clean min. every 6 months. Detailed inspection, repair and re-paint every 5 years. Carry out localised opening up, inspect for any hidden rot, carry out repairs/replacement, re-seal joints as required every 5 years.
Gaskets	12	25	replaceable	Inspect annually. Clean min. every 6 months
Wet Seals	12	20	replaceable	Inspect annually. Carry out repairs and replacement as required during service life
Finishes (PPC/Anodised)	12	25	replaceable	Inspect annually. Clean min. every 6 months
Insulated Glazing Units	12	25	replaceable	Inspect annually. Clean min. every 6 months
Motors	2	10	short-term	Inspect & service every 6 months.
Ironmongery	2	10	short-term	Inspect & service every 6 months.
Brackets and fixings	12	60	maintainable	Inspect every 5 years. (spot-check)
Structural Silicone	12	25	replaceable	Inspect annually. Clean where exposed min. every 6 months
membranes	12	35	replaceable	Inspect every 5 years. (spot-check)
Stone panels	12	60	maintainable	Inspect annually. Clean min. every 6 months

Table 1, Table of Warranties

This specification and any warranties required shall be construed and interpreted in accordance with English Law and shall be subject to the English Courts only. Estimated Service Life is not a guarantee or warranty and should not be interpreted by any party as such. The Service Life of any component cannot be guaranteed beyond the Warranty Period. The Service Life shall be greatly dependent upon the care and maintenance of the Works. The building owner shall be required to carry out, or contract the Main Contractor to carry out, service life planning in accordance with ISO 15686 to maximise the Service Life of his asset.

Where reference is made in this specification to any EN, British Standard, Board of Agreement Certificate or Code of Practice, it shall be construed as reference to such publication in the form in which it is in force at the date of the specification.

The Specialist Façade Sub-contractor shall provide a warranty with the Maintenance Manual to replace any part of system which fails in material or workmanship. Failure of materials or workmanship includes but is not limited to, excessive water leakage or air infiltration, excessive deflections, interstitial condensation, faulty operation, delamination of laminated elements beyond specified limits, adhesive or cohesive bond failure, deterioration or discoloration of finish in excess of normal previously identified and agreed weathering, and cracking. Each warranty and material guarantee shall take into account the surrounding external environment C3 as described in EN ISO 12944.

The Specialist Façade Sub-contractor shall provide a warranty with the Maintenance Manual to cover the costs of access, dismantling, removing, making new parts, making good to adjacent/surrounding surfaces, finishing and refixing to match existing.

The SFC's warranty will be treated as being in place as long as regular maintenance, yearly visual inspections and five-year detailed inspections by the user are undertaken unless more frequent inspections or maintenance are described in the maintenance manual or the product literature available online. The Architect must be informed in writing of any aspect of the construction which may not meet this requirement and his written acceptance granted for any relaxation.

4.4.1 Copyright and Ownership

The Architect retains copyright for the outline design of the building. The Specialist Façade Sub-contractor shall indemnify and hold harmless the Client and Design Team against all liabilities, losses, costs and expenses which the Client and/or Design Team may suffer if the designs provided by the Specialist Façade Sub-contractor or any of the Design Documents infringe any letters patent, trade mark or any other rights of a third party protected by law.

4.5 Applied Loads

4.5.1 General

The Works shall transmit the design loads as specified below to the building structure via the points of attachment as designed and built, with an adequate margin of safety appropriate to each material and product. As required by the appropriate Codes of Practice, the various load cases and combinations of load cases acting together shall be considered.

4.5.2 Gravity

The Works shall support its self weight and transmit this weight safely back to the supporting structure without overloading or permanently displacing any of its components.

4.5.3 Wind

The building is located in Manchester. The SFC shall calculate the wind loads on the facades using EN 1991 (with UK National Annex). The Specialist Façade Sub-contractor shall calculate the wind loads to be carried by the various parts of the Works taking into account funnelling and other site-specific environmental conditions as well as applicable external, internal and local pressure coefficients. He shall submit detailed calculations for review by the Architect, as soon as possible after award of contract prior to going into manufacture of the Works. The Works shall support these wind loads and transmit them safely back to the supporting structure without overloading or permanently deforming any of its components.

Calculations shall be carried out by a suitably qualified structural engineer. Structural calculations shall be completed, submitted and achieve A status prior to manufacture.

All, cantilevered elements and screens subject to external conditions from both sides are to be engineered in accordance with EN 1991 (including the UK National Annex). Wind resistance: safety

When tested at both positive and negative applications of the design wind loads, multiplied by a factor of 1.5, there shall be no permanent damage to framing members panels or anchors. Framing members shall not be buckled. Panels, assemblies and decorative capping pieces shall remain securely held and gaskets shall not be displaced.

Permanent deformation to framing members shall not exceed 1/500 of the span measured between points of attachment to the structure after loading.

4.5.4 Impact

The Works shall satisfy the requirements of Harmonised Standard EN 14019 and CWCT TN75 and TN76 as set out in Section 5 of this Specification. The glazing and cladding shall be impact tested with loads as defined in TN75 (for residential facades facing onto balconies, see exposure Category C in Table 3).

The resultant classification shall be:

Class for Safety Performance: 'Negligible Risk' (Table 01 TN75)

Class for Serviceability Performance: 1 (Table 2 TN75)

Project specific impact testing shall be required on a representative sample of the facade including stone cladding and glass constructed precisely as proposed for the Works to demonstrate the performance noted above. Testing shall be carried out by an independent testing authority. The test shall be coordinated and agreed with the Consulting Façade Access and Maintenance

4.5.5 Accidental loading

The Works shall sustain safely and without damage, a static load of 500 N applied horizontally through a square of 100mm side on any part of Cathedral Squarework, glass, or solid surface.

4.5.6 Barrier Loads

Barrier loads shall be applied as defined by the Architect, set out in BS 6180. Barrier loads shall be not less than those identified below:

- a) Bedrooms, laboratories, offices: Location A
- b) Corridors: Location B
- c) Restaurants/cafes/retail: Location B/D
- d) Emergency Escape routes: Location C
- e) External screens/balustrades at ground level protecting against a fall: Location E

The facade shall be designed to sustain safely each of the following static horizontal loads (derived from BS6180:2011) acting separately:

Location		Horizontal uniformly distributed load (KN/m)	Uniformly distributed load applied to infill (KN/m2)	Point load (100mm x 100mm) to infill (KN)
A	Residential/office areas. Areas not susceptible to overcrowding	0.74	1.0	0.5
B	Areas where people may congregate (restaurants, bars) with fixed seating or tables.	1.5	1.5	1.5
C	Areas susceptible to overcrowding	3.0	1.5	1.5
D	Retail areas	1.5	1.5	1.5
E	Areas susceptible to overcrowding. Assembly areas, footways or pavements greater than 3 m wide adjacent to sunken areas.	3.0	1.5	1.5
F	Other areas (minimum requirement)	0.74	1.0	0.5

Table 2, Loadings

Note: assemblies where glass is retained on point fixings and are required to achieve the loadings noted above shall be tested physically to demonstrate compliance with the requirements. Structural calculations shall be required in addition to the testing.

4.5.7 Access and Maintenance

Any gutters, parapets, cills or sloped and near horizontal surfaces in the Works may be used for maintenance and occasional access by design or not, and therefore shall sustain safely and without damage each of the following loads.

A uniformly distributed load of 0.9 kN/m², and a concentrated load of 1.2kN acting on a 125 mm x 125 mm square contact area applied repeatedly anywhere on the finished surface, applied separately. Note, this loading capacity is required in all areas whether they are intended for access or not.

The structures shall be engineered by the SFC with loads applied in accordance with EN1991 (including the UK National Annex). Loads to include (but not limited to) live-load, wind, and super-imposed dead-load (decking, furniture, snow).

The edge of all cills, however, shall accommodate the loads identified above and any other loads identified by the façade access and maintenance consultant.

4.5.8 Snow / Ice

The Works shall sustain any loads created by snow and/or ice and shall transmit these loads back to the supporting structure safely without overloading or permanently deforming any of its components. Snow load shall be calculated in accordance with EN 1991 (including the UK National Annex). Calculations for review by the Architect shall be provided in accordance with the Schedule of Submissions.

4.5.9 Temporary Conditions

The Works shall be designed by the SFC to sustain any temporary loading that may arise from lifting, storing, transporting, hoisting and installing them, or any other works, which will induce stresses greater than those which will be induced when the Works are completed.

4.6 Movement and Deflection

4.6.1 Accommodation of Movement Generally

The Works shall accommodate the movements noted below without any reduction in the performance below the minimum levels required herein.

- a) Deflections due to design dead loads and live loads.
- b) Deflections under repeated cycles of the design wind loads.
- c) Changes in dimension and shape arising from building movements, including settlement, shrinkage, elastic shortening, floor beam deflections, creep, wind sway, twisting and racking and thermal and moisture movement.
- d) Due to movement of any joint in the supporting structure or building frame.

The Specialist Façade Sub-contractor shall provide estimates of nominal, minimum and maximum joint widths accounting for tolerances and movements at all movement joints and shall confirm to the Architect that the joints shown on their Design Intent Drawings will accommodate them.

4.6.2 Accommodation of Building Movement

The Works shall accommodate the following movements without any reduction in the performance below the minimum levels required herein.

- a) Sway of the building
- b) Reduction in storey height under live and super-imposed dead loading
- c) Reduction in storey height due to creep/shrinkage
- d) Differential settlement of one foundation relative to the next one
- e) Differential beam deflection between adjacent floors due to imposed and super-imposed dead load on one floor only
- f) Differential beam deflection between adjacent floors due to creep
- g) Differential structural movement at designated movement joints

The works shall accommodate the movements as specified in the Structural Engineer's documentation without any reduction in the performance below the minimum levels specified herein. It is the responsibility of the Specialist Façade Sub-contractor to ensure he obtains all information required from the consultant structural engineer to complete his design.

4.6.3 Facade Deflection Limits

Under the action of the most onerous combination of loads, deflections of the facade shall not exceed the values given below. The deflection shall be recovered fully when the loads are removed:

- a) Framing members generally - at both positive and negative applications of the peak out of plane load, the maximum horizontal deflection shall not exceed:

$H \leq 3000\text{mm},$	maximum deflection: $H/200\text{mm}$
$3000\text{mm} < H < 7500,$	maximum deflection: $5\text{mm} + H/300$
$7500\text{mm} \leq H.$	maximum deflection: $H/250$

where H is the span of the member measured between points of attachment to the building.
- b) Framing members supporting four-edge supported vertical insulated glazing units - at both positive and negative applications of the peak out of plane load, the maximum horizontal deflection shall not exceed $1/175$ of the length measured along the unit edge, or 25 mm, whichever is the lesser, or more restrictive limits if set by the unit manufacturer.
- c) All glazing - at both positive and negative applications of the peak out of plane barrier-load, the maximum perpendicular deflection shall not exceed 25mm at level 1.1m above FFL under imposed barrier load cases.
- d) Allowable deflections for balustrades (glass or other) - at both positive and negative applications of the peak out of plane load, the maximum perpendicular deflection shall not exceed $L/65$ or 25 mm whichever is the lesser, measured from the point of support to the top edge of the balustrade.
- e) IGUs two and four edge supported - at both positive and negative applications, the maximum out of plane deflection shall not exceed $1/100$ or 50mm of the effective span of the panel measured between points of attachment. The IGU manufacturer shall confirm the deflections align with their requirements for edge sealing and warranties. For small sized glass panes, the IGU's visually consistent with the adjacent glazing.

- f) The downward vertical deflection of framing members that support the weight of glazed panels or other elements shall not exceed $1/500$ of the length measured along the glass edge or 3mm, whichever is the lesser. This includes all glazing.
- g) The horizontal deflection of louvres shall not exceed $1/200$ or 15mm, whichever is the lesser when subjected to both positive and negative applications of the peak out of plane load.
- h) The vertical deflection of cantilever structures at application of the maximum calculated load shall not exceed $1/350$ or 15mm, whichever is the lesser when subjected to both positive and negative applications of the peak out of plane live-load (including wind and snow).
- i) The horizontal deflection of cantilever structures at application of the maximum calculated load shall not exceed $1/350$ or 20mm, whichever is the lesser when subjected to both positive and negative applications of the peak out of plane load.
- j) The deviation of nominally flat sheet due to oil-canning or similar local bow shall not exceed 2mm per metre up to maximum 4mm per length of sheet.
- k) Panels (metal) generally - at both positive and negative applications of the peak out of plane load, the maximum horizontal deflection shall not exceed $1/350$ of the longest span of the panel measured between points of attachment to the building/framing, or 15mm, whichever is the lesser. Lesser figures shall be used where recommended by the panel manufacturer.

4.6.4 Accommodation of Thermal Movement

The Works shall accommodate changes in dimension resulting from changes in temperature in any of its parts, its supporting framework and bracketry without any reduction in the performance below the minimum levels required herein.

The surface temperature ranges shall be calculated and shall be taken as being not less than the following:

- a. External surface temperatures
- b. Heavyweight materials, light colour: -20°C to +50°C
- c. Heavyweight materials, dark colour: -20°C to +65°C
- d. Lightweight insulated materials, light colour: -25°C to +60°C
- e. Lightweight insulated materials, dark colour: -25°C to +80°C
- f. Uncoated glass -25°C to +50°C

4.6.5 Accommodation of Moisture Movement

The Works shall accommodate the following movements without any reduction in the specified performance:

- a) Due to changes in the moisture content of its components, and wetting due to rain.
- b) Expansion of absorbed or retained moisture due to freezing.
- c) Due to changes in the moisture content of the supporting structure and interfacing construction.

4.7 Weathertightness

4.7.1 Interfacing Construction

The weathering principles incorporated within the Works and interfacing with adjacent elements of work shall be compatible with the weathering principles adopted by the adjacent elements of work. It is the responsibility of the Specialist Façade Sub-contractor to coordinate his work with adjacent trades, with the assistance of the Main Contractor, to ensure the provision of a durable weather-proof interface incorporating a minimum of two lines of defence and insulation. The design life of interfaces shall be similar to surrounding works.

The Specialist Façade Sub-contractor shall be the lead Specialist Façade Sub-contractor and shall coordinate his works with interfacing following trades while providing a fully sealed, insulated and durable closure to the primary structure or interfacing weathering system ensuring it is fully air sealed with a minimum of two lines of defence against air and water ingress. To this end, the glazing Specialist Façade Sub-contractor shall provide minimum 300mm collar of not less than 0.7mm thick Interfacing Sealing Membrane (ISM) bonded and sealed to the interfacing construction around all openings. Reliance on provision by the Main Contractor of membranes sealing to the window/curtain-wall frame shall not be accepted.

Interfacing Sealing Membranes are required to provide a weather-proof seal between the SFC's Works and the adjacent construction (approximately 200mm perimeter zone on elevation). Interfacing Sealing Membrane (ISM) shall be compliant with EN 13984, tested to EN 1928, 2kPa for 24 hours, achieving NO LEAKAGE. Breather membranes are not suitable as Interfacing Sealing Membranes. Where interfacing with breather membranes, the ISM shall be project specific tested for compatibility with the breather membrane for durability of bond and seal without being detrimental to either membrane. Confirmation from each membrane supplier required to be provided by the SFC.

ISMs shall achieve fire rating not less than B-s3, d0 in accordance with EN 13501-1

The Specialist Façade Sub-contractor shall be responsible for coordinating and agreeing compatibility of all interfacing details and ensuring the correct combination of materials are used.

4.7.2 Air Permeability

The Works shall be designed to limit air flow, from the exterior surface to the interior surface through any of its joints, to the air leakage rates specified below (in controlled test environments), when it is subjected to wind induced pressures or suctions across the cladding:

- a) Through opening elements to not more than Classification as Class 4 minimum. Classification to EN 12207.
- b) Through the fixed glazing and opaque cladding to not more than 1.5 cu m/ hr per square metre of fixed glazing and opaque cladding when tested at 600Pa.
- c) Between the glazing and openings in the structure to not more than 1.5 cu m/hr per metre length of the outside perimeter of the glazing frames when tested at 600Pa

- d) And to not more than q cu m/hr per metre length or per square metre, as measured above, under a pressure or suction of p Pa, where q = the air leakage rate given above multiplied by the pressure or suction p divided by 600 (test pressure) to the power of $2/3$.
- e) There shall be no region of concentrated air flow through the Works as a whole or at any interfaces.

4.7.3 Water Penetration Resistance

The Works including all joints between it and other elements of work, shall effectively prevent leakage of water into the interior of the building from the outer face of the assembly, under the action of wind pressure kinetic energy, gravity, surface tension, or capillary action. It shall also prevent water entering into those parts of the façade that would be adversely affected by the presence of water.

All joints within the Works shall maintain their watertightness under the loads and movements specified herein.

The drainage of water along edge seals of insulated glazing units is not permitted unless written confirmation is provided by the unit manufacturer stating that the design life, required service life and warranty, of the unit is unaffected.

4.7.4 Rainwater disposal

The Works shall accommodate the anticipated rainfall with sufficient numbers of outlets to allow for outlet blockage between maintenance inspections. The design shall allow for the provision of visible warning pipes and overflow outlets for all concealed gutters. The Specialist Façade Sub-contractor shall allow for integration of overflow outlets through the facade from roof areas where indicated on the Architect’s drawings or MEP Consultant’s drainage drawings.

4.8 Thermal Performance

The Works shall provide overall U-values equal or better than those required by the Consulting Mechanical Engineers for the façade types

Building	Façade Type	Weighted u-value (W/m2K)
All	Unitised/Stick Curtain Wall/Window Clear Vision and Glass Spandrel Zones.	1.3
All	All solid walls including opaque aluminium panels within the unitised system or stick system.	0.17

NOTE: To achieve the required performance, the SFC shall be required to select systems with extremely good thermal performance through frames. Detailed analysis should be carried out by the SFC at Tender to ensure the correct system is proposed so as to avoid abortive work later.

Data shall be submitted at Tender confirming that the Works meet the required performance. Detailed calculations prepared by the Specialist Façade Sub-contractor incorporating edge effects and frame effects, shall be submitted to the Architect for review during the design development stage.

4.8.1 Assessing Thermal Performance, Calculation

The heat transferred through thermally complex systems shall be assessed by 2-dimensional numerical analysis. 3D thermal analysis shall be carried out at complex junctions and penetrations only where 2D calculations have failed to illustrate the required conditions. The software shall be validated against benchmarks in line with the following:

- a) BRE, document BR 443
- b) EN ISO 10077-1:2010-05: Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 1: General (ISO 10077-1:2006 + Cor. 1:2009); EN ISO 10077-1:2006 + AC 2009
- c) EN ISO 10077-2:2010-06: Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 2: Numerical method for frames (ISO/DIS 10077-2:2012); EN ISO 10077-2:2012
- d) EN ISO 6946:2008-04: Building components and building elements - Thermal resistance and thermal transmittance - Calculation method (ISO 6946:2007); EN ISO 6946:2007
- e) EN ISO 12631: 2013-01: Thermal performance of curtain walling. Calculation of thermal transmittance; EN ISO 12631:2012
- f) EN 673: 2003-06: Glass in building - Determination of thermal transmittance (U value) – Calculation method (including Amendment A1:2000 + Amendment A2:2002)
- g) EN ISO 10211:2008-04: Thermal bridges in building construction – Heat flows and surface temperatures, detailed calculations.
- h) EN ISO 13788:2001-11: Hygrothermal performance of building components and building elements. Internal surface temperature to avoid critical surface humidity and interstitial condensation. Calculation methods
- i) BS 5250:2011: Code of practice for control of condensation in buildings

The results of the assessment shall be summarised as thermal transmittance (U-values) for the central and perimeter zone of each relevant facade type. Overall U values for each relevant facade type shall be calculated as a weighted average of constituent areas, with the weighting method defined.

The calculation method shall take into account the internal and external surface heat transfer resistances. These resistances and the parameters which affect them shall be quoted. The method shall take into account the effects of any air spaces, porous materials, and the thermal interaction between elements of the facade. Guidelines for the calculation method are laid out in the CWCT Guide to the Design of Thermally Improved Glazing Frames.

Thermal bridging calculations for all façade types, including parapets, must be carried out on all key junctions to achieve the Y value target of 0.05 W/m²K. All calculations must be carried out in line with ISO 10211:2007 “Thermal bridges in building construction -- Heat flows and surface temperatures -- Detailed calculations”.

Before any detail is accepted the output report for the proposed detail must be submitted as part of the technical submittal process and the suitably qualified thermal modeller must provide the following reports:

- j) Psi output report from the certified modelling software
- k) fRsi output report from the certified modelling software

With reference to interfaces, the SFC shall ensure accurate modelling of interface constructions showing all components. The SFC shall comply with diagram A shown below, taken from CWCT Technical Note 110.

- 40 The figure below shows a comparison of the internal surface temperatures of a window jamb detail calculated including the window frame (as per BS EN ISO 10211) and calculated replacing the frame with an adiabatic element (modelled as per BR 497).

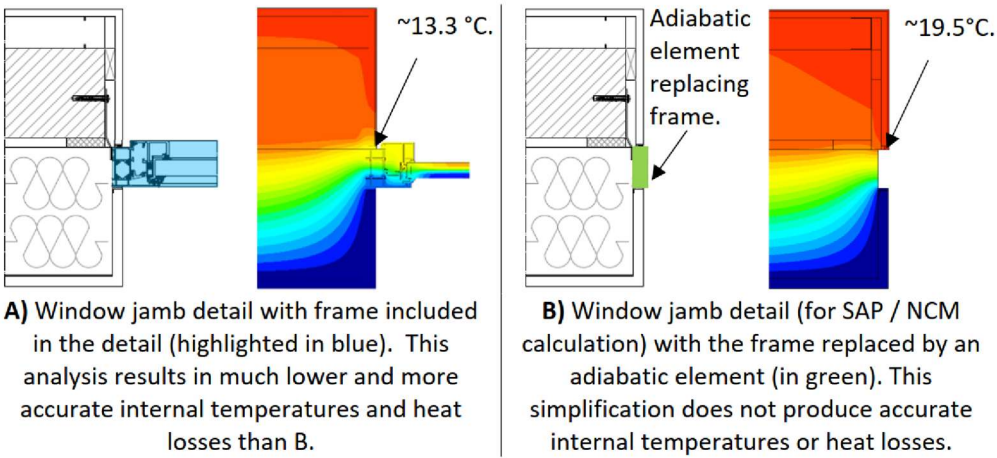


Figure B1 – Example jamb detail with window frame (left) and adiabatic element for SAP (right)

4.8.2 Solar Control

Body tinted glass shall not be accepted.

Solar control data shall be submitted to the Consultant Mechanical Engineer confirming that the proposed glazing will meet the performance criteria set out by the consulting mechanical engineer. Required performance shall be no lower than the figures noted below:

IGU’s Elevations:

Visible light transmission	>68%*
External visible light reflectance	15%max.
Internal visible light reflectance	15%max.
Total Solar Energy Transmission (solar factor, EN410)	Varies*

Note * – Refer to the Mechanical Engineer for all G-value and Light transmission requirements.
Novo Requirements G-Values: Domestic = Varies: Non-Domestic = Varies: See P2305-NOV-ZZ-ZZ-RP-MEP-001 Part L Summary Report, Novo to confirm acceptance.

Note: Glass to have NEUTRAL grey/blue colouring with minimal effect on colour of light entering the space. In all cases the Colour Index RD65 shall not be lower than 90.

It is understood that the coated glass noted above would have a long lead time. Therefore, the Specialist Façade Sub-contractor is required to urgently confirm his proposed glass type and to submit the samples noted in this specification as soon as possible after contract award. It is the Specialist Façade Sub-contractor's responsibility to ensure his selected glass achieves all of the performance criteria required by the contract documents.

4.8.3 Condensation

The Works shall include thermal breaks. Condensation shall not form on or behind the building side of the vapour barrier, or on surfaces or in areas which compromise the performance of the Works. The Specialist Façade Sub-contractor shall assess the risk of surface or interstitial condensation forming, based on the worst-case environmental conditions as specified below. The Specialist Façade Sub-contractor shall confirm these values with the Mechanical Engineer prior to carrying out his calculations. Dew-point calculations prepared by the Specialist Façade Sub-contractor, shall be submitted to the Architect for review.

Note, the figures shown below are approximately based on calculations for mechanical plant design. The SFC is required to submit his own calculations, based on local environmental conditions. Information shall be obtained by the Specialist Façade Sub-contractor from the Meteorological Office and consulting Mechanical Engineers.

External conditions minimum criteria:

- Location & weather file used – Manchester
- Peak temperatures – to be as defined by the consulting MEP engineer
- Peak humidity's – to be as defined by the consulting MEP engineer

Internal conditions, design criteria to be not less than those agreed with the Consulting Mechanical Engineers, and not less than the following:

General areas (winter): +21°C (-4°C) Relative Humidity Percentage will vary for Domestic and Non-Domestic zones. Refer to the consulting mechanical engineer's documentation for further detail regarding predicted humidity and operating temperatures. (See Guidance from CWCT TN110). Note, the building is not humidity controlled.

The SFC shall provide calculations indicating where condensation is likely to form in the systems the Specialist Façade Sub-contractor proposes. The Specialist Façade Sub-contractor shall design his systems to ensure no condensation shall form on the room side of the vapour barrier. This is to include interfaces. Particular attention is required to prevent condensation forming inside the building where any support members protrude through the vapour barrier.

Type of building	Condensation ^c	Mould ^c
Dwellings; residential buildings; schools	0.65 ^a	0.75
Storage buildings	0.30	0.50
Office, retail premises	0.50	0.65
Sports halls, kitchens, canteens; buildings heated with un-flued gas heaters	0.80 ^b	0.90 ^b
Buildings with high humidity, e.g., swimming pools, laundries, breweries	0.90 ^b	0.90 ^b

Table 4: CWCT Recommended critical temperature factors for different building types

4.9 Acoustic Performance

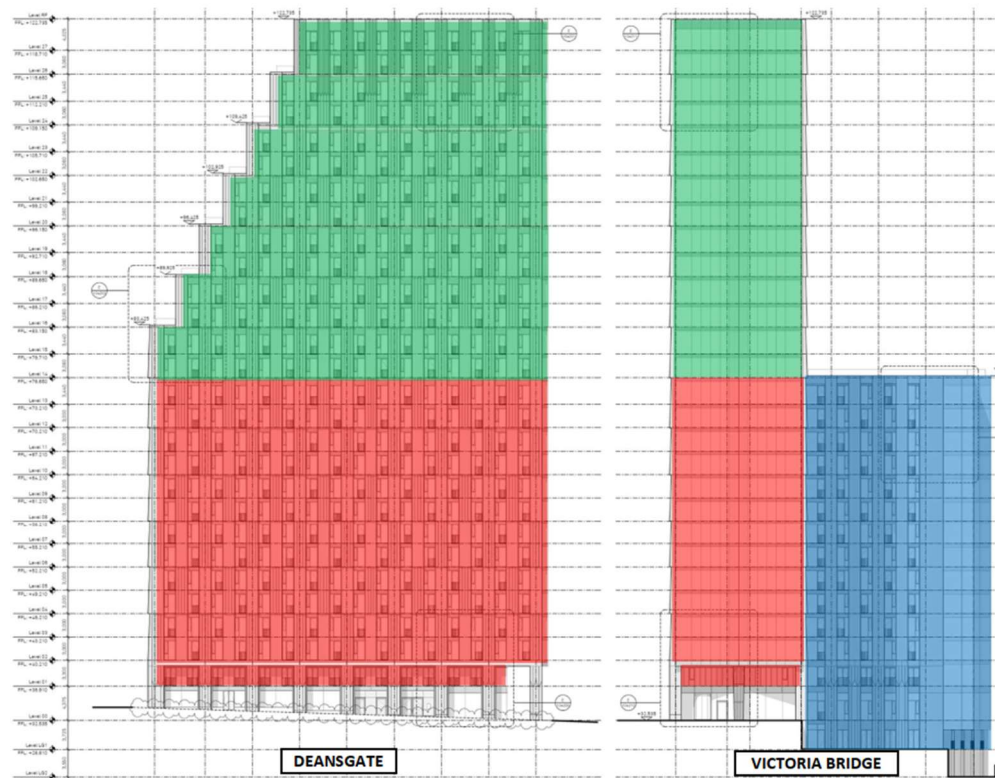
The Specialist Façade Sub-contractor shall take into account the acoustic performance criteria set out by the Consulting Acoustic Engineers (Jameson Acoustics), who have produced reports for the building. The SFC shall take into account extremely onerous acoustic performance criteria prescribed for the façade systems which may result in bespoke solutions being required for glazing composition, interfaces and vents. Acoustic performance shall also take into account penetrations through the façade systems of vents. The SFC shall ensure an adequate acoustic seal is achieved between the spigot duct-work which he provides and the interfacing duct-work provided by the Main Contractor.

4.9.1 Airborne and Structure borne Sound Insulation

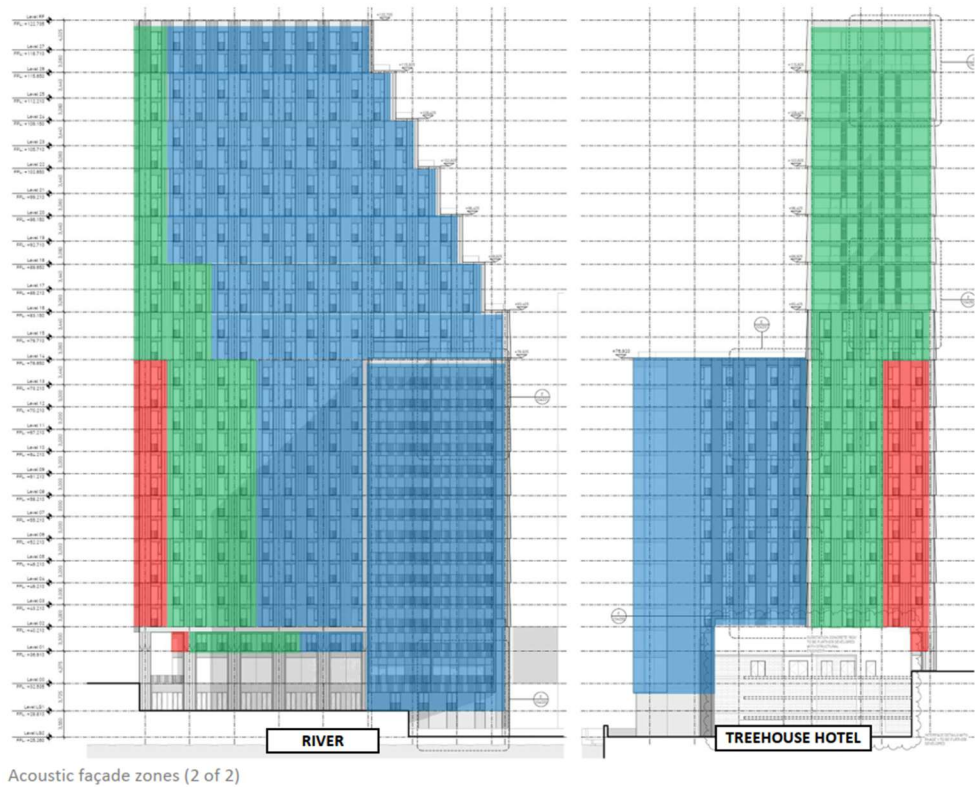
The SFC shall employ the services of a suitably qualified acoustic consultant to verify the performance of the proposed façade systems confirming compliance with the Requirements as set out by the Acoustic Engineer. All façade systems shall be tested in accordance with EN ISO 10140-2:2010. All ventilators shall be tested in accordance with EN 20140-10:1992.

Acoustic performance of completed systems shall be based on no trickle ventilation being required. The internal supply and return ductwork will be designed by the Mechanical Sub-contractor to comply with the acoustic requirements, see below from Jameson Acoustics.

Zone (ref. Figures below)	Minimum Sound Reduction, R (dB) at OBCF (Hz)							Weighted $R_w + C_{tr}$ (dB)
	63	125	250	500	1k	2k	4k	
Red	26	28	34	40	43	46	46	38
Green	24	25	31	37	40	43	43	35
Blue	22	23	27	34	38	40	40	32



Acoustic façade zones (1 of 2)



4.9.2 Flanking transmission:

Floor to floor flanking transmission: The system shall provide a weighted standardised flanking level difference as specified by acoustic engineer.

Room to Room (limited to demise-to-demise performance) flanking transmission (see plan locations): The system shall provide a weighted standardised flanking level difference as specified by acoustic engineer, see below from Jameson Acoustics.

Type	Location	Minimum Sound Flanking Performance $D_{nf,w} + C_{tr}$ (dB)
Vertical	Apartment <> Apartment	53
	Commercial Unit <> Apartment	53
	Apartment <> Reception/Lounge	53
	Apartment <> BOH (e.g. parcel room)	53
Horizontal	Apartment <> Apartment	53

4.9.3 Demonstration of Acoustic Performance

The SFC shall provide technical submittals prepared by his consulting acoustic engineer for review by the Client’s consulting acoustic engineer. Where the submittals do not provide sufficient information the Specialist Façade Sub-contractor shall arrange an independent testing authority to carry out testing and provide technical submissions as required by the project consulting acoustic engineer.

4.9.4 Seals

The standard of all sealing of the Works (inclusive of gaskets and membrane seals) shall ensure no reduction in sound insulation performance for its service life.

Gaskets and seals used to achieve the required weather and air flow resistance shall be selected to accommodate fully the range of dimensional tolerances associated with fabrication, installation and movement in situ of the Works sufficient to maintain the acoustic performance required herein. Materials for gaskets and seals shall be capable of maintaining their elastic qualities, dimensions and resistance to physical or chemical attack.

Seals to be used on opening glazing or panels shall be fully continuous. The closure mechanism shall ensure even and adequate compression consistent with maintaining the full acoustic performance.

The Specialist Façade Sub-contractor shall provide details and samples of acoustic seals in accordance with the Schedule of Submissions.

4.10 Noise

The Works shall eliminate creaking, rattling, whistling and any other noises due to the effects of thermal and structural movement and wind and air movement. The surveying of such noises, and their assessment and remedy shall be the responsibility of the SFC. The Client's consulting acoustic engineer shall be the sole arbiter regarding resolution of disputes where they arise.

The noise output from motors during normal operation shall not exceed 45dB(Laeq)

The SFC shall carry out a analysis to validate external components and brise soleil do not generate unwanted noise as a result of wind.

4.11 Fire Performance

4.11.1 General

Materials shall be classified to EN 13501-1: Fire Classification of Construction Products and Building Elements. If certification is not currently available project specific testing in line with EN 13501 may be acceptable. The Works, including junctions with other works, and fire breaks that may be incorporated to meet the performance requirements, shall not be composed of materials that readily support combustion and add significantly to the fire load or give off toxic fumes. The Specialist Façade Sub-contractor shall be responsible for ensuring he is aware of, and incorporates, the requirements of the Building Regulations and consulting fire engineer. He shall include fire stopping at interfaces with openings, internal party walls and floor edges at compartment wall and floor locations.

He shall include fire stopping at interfaces with openings, internal partition walls and floor edges in line with the building regulation and the requirements of the Fire Strategy Report that has been prepared by the Consulting Fire Engineer.

Fire rated glazing systems including frames and fixing details shall be fully tested to confirm suitability for the proposed installation. It is envisaged there shall be no fire rated glazing required.

All insulation on buildings shall be mineral fibre insulation achieving Class A1 in accordance with EN 13501-1.

The façade elements shall comply with CIBSE, Technical Note, Technical note: the UK government ban on combustible materials in high-rise residential buildings.

Where BBA certification is not available, similar certification acceptable to Building Control shall be provided. Dual-density insulation shall be used where exposed to a rainscreen environment.

Where required, Fire rated glazing systems including in-fill material, frames, interfaces and fixing details shall be fully tested to confirm suitability for the proposed installation.

4.11.2 Material combustibility

Materials, including insulation, shall be Class A2-s1, d0 or better in accordance with BS EN 13501 classification of construction products and building elements, Part 1 – Classification using fire tests. Technical Guidance Document B is unclear regarding the allowable combustibility of materials. Therefore, where appropriate, the SFC shall generally follow the guidance contained in the document titled 'Technical guidance for interpretation in relation to the external walls and specified attachments of Relevant Buildings in England Revision 2' produced by the CWCT and SFE. The document can be downloaded from the relevant website:

<https://www.cwct.co.uk/pages/cwct-sfe-fire-guidance>. (Revision 02)

The SFC shall produce a full schedule of all materials proposed in the Works, with coloured detail drawings indicating where each material is used. The technical submission shall include all relevant data sheets for the proposed materials, including fire-performance of each. He shall issue this for review and agreement with the Consulting Fire Engineer.

Membranes, except where exemption has been agreed in advance with the consulting fire engineer, shall be Class B-s3, d0 or better in accordance with BS EN 13501 Part 1, classification of construction products and building elements, Part 1 – Classification using fire tests where possible.

4.11.3 Fire and smoke stopping

The Works shall comply with the requirements of the consulting fire engineer and Technical Guidance Document B, BS 9999, and EN 13501. The scope and conditions of where fire stops and cavity barriers are to be provided by the SFC shall be as per the scope agreed with the consulting fire engineer and per marked-up drawings (contract).

The Specialist Façade Sub-contractor shall be responsible for ensuring that any gaps between the Works and the edges of the structural frame are fire stopped where required.

The fire rating between compartment floors and walls shall be as identified on the Consulting Fire Engineer's documentation and Architect's drawings.

The Specialist Façade Sub-contractor shall be responsible for obtaining acceptance for the fire performance of his Works from the consulting fire engineer prior to ordering and manufacture.

All fire stopping and cavity barriers at slab edges and wall interfaces shall include smoke stopping which shall provide an air seal. These seals shall have EN test certification. Air tight Horizontal and vertical smoke fire stops/smoke seals shall be provided as required by the Building Regulations and in accordance with the consultant fire engineer's requirements, closing between the facade (glass line) and structure, including internal demise line walls, providing insulation and integrity. Refer to the Consultant Fire Engineer's information for clarity. Note, fire stopping shall be provided around all opes, rainscreen, curtain walling preventing fire break-through into adjacent cavities.

The cavity barriers to rain screen systems will be mineral fibre incorporating stainless steel restraint clips and perimeter intumescent strip in accordance with the Fire Engineer's requirements. The design gap between the insulation and inner face of rainscreen will not exceed 25mm. These shall incorporate stainless steel fire-collars with intumescent cores wrapping drainage pipes. These shall be intumescent sealed to the horizontal cavity barriers. Vertical cavity barriers shall be installed to be hard up against the back of the rainscreen.

4.12 Lightning Protection

The Works shall meet the requirements of EN 62305:2006, parts 1 to 4 inclusive, BS EN 7430, BS 7671 and also the latest Edition of the Institute of Electrical Engineers Regulations. The Works shall take into account the requirements of the consulting electrical engineer.

The Specialist Façade Sub-contractor shall co-ordinate as necessary with contractor responsible for the main lightning protection systems for the building and shall agree appropriate connection points with him for review by the Architect.

On-site Equipotential Testing shall be carried out by the Main Contractor to confirm compliance with the consulting electrical engineer's requirements and integration of the façade into the lightning protection of the building.

The Specialist Façade Sub-contractor shall allow for inclusion of fixings and fixing points for electrical connection to the building lightning control system by the Main Contractor.

4.13 Brackets and Fixings

The Specialist Façade Sub-contractor shall be responsible for the design of all fixings supporting and/or restraining the Works. He shall assume all concrete is 'cracked'. He shall co-ordinate as necessary all the interfacing elements of work to the satisfaction of the Architect and consulting structural engineer. Prior to installation he shall provide details with supporting calculations of his design for every type of fixing together with the loading on those fixings, proving compliance with the requirements of the Building Regulations Technical Guidance Document A to the Architect for review.

All anchors and supports shall be designed, fabricated and installed in full compliance with the performance criteria specified without distress to any component or assembly or panel joint

integrity. The general requirement for torquing of bolts shall be highlighted on the Specialist Façade Sub-contractor's drawings and tightening torque values to be clearly stated.

All fixings outside or through the vapour barrier shall be stainless steel. All brackets outside the vapour barrier shall be stainless steel or aluminium.

Any devices indicated on the Contract Drawings are schematic only and do not necessarily represent the type shape or profile.

The design of the fixings shall allow for the following:

- a. All movements and dimensional changes that may occur in the building due to thermal changes, deflections, settlement and creep.
- b. All movements and dimensional changes that may occur to the facade itself.
- c. Constructional inaccuracies of the supporting structure, within tolerances as defined by the consulting structural engineer. The SFC shall report any areas where he finds the primary structure is outside the consulting structural engineer's specified tolerances.
- d. Adjustments by small increments in and out, up and down and side to side in the position of the facade supports to accommodate the full variations in the underlying construction.
- e. Shimming required accommodating local variations only in construction tolerances. The maximum allowable shim dimension shall be stated in the Specialist Façade Sub-contractor's drawings.
- f. Any reduction in safe working loads in fixings due to their spacing, location in areas of tension, near edges or proximity to cast in inserts/existing fixings, or thickness of shims.
- g. Where post drilled or site fixings are used for connections to the external structural steel frame, the integrity of the steel corrosion protection system shall not be compromised.
- h. Where slots are located in line with wind loads or perpendicular to the façade plane to provide tolerance only (not movement), these shall be mechanically locked against movement. Reliance on friction alone shall not be permitted.

Calculations submitted to the Architect shall show the extent of movements and tolerances, which have been allowed for in the design of fixings.

Bolts, screws and nuts used for fixings the facade to the structure shall be of adequate strength for their purpose. The Specialist Façade Sub-contractor shall state in his calculation the factor of safety he will achieve. Nuts shall be fully tightened after adjustment to prevent loosening due to movements and/or vibrations.

The design of brackets for site drilled fixings shall allow for the possibility of reinforcement being encountered and the fixing position being moved as a result of this event occurring. No reinforcement shall be cut.

The Specialist Façade Sub-contractor shall demonstrate to the Architect that the use of all proprietary fixings installed have been reviewed by his structural engineer with regard to the fixing manufacturer's requirements and shall, prior to the installation, submit his structural engineer's calculations including relevant fixing manufacturer's documentation confirming that the details proposed by the Specialist Façade Sub-contractor are appropriate for their intended use.

4.14 Locked in Stresses

The Specialist Façade Sub-contractor shall avoid in his design and detailing of fixings, the introduction of locked-in stresses that may be detrimental to the performance or aesthetic of the Works during the service life.

The stresses that are referred to are those that can develop in an individual panel, if the various fixings that secure that panel in position are so rigid that they do not allow for thermal or other movement in that panel.

Such rigidity and resistance shall be avoided by the careful positioning of fixings and preventing slots, which are intended to allow for movements, becoming filled.

4.15 Vibration

The brackets and all fixings shall be designed so that there will be no risk of loosening due to the effects of vibrations, or to the cyclic effects of load, deflections and thermal movement.

4.16 Corrosion

The Specialist Façade Sub-contractor shall select and install each material so that it is, and will remain compatible with the other materials around it within its range of influence for the service life of the Works. The SFC shall determine the corrosive risk of the environments within and external to the Works. Reference shall be made to EN ISO 14713 parts 1 to 3, and EN 10169. As described in BS EN ISO 12944, the environment is C3 (urban).

He shall ensure that adequate measures shall be taken to prevent bimetallic corrosion between dissimilar metals. To this end, attention is drawn to publication PD 6484 'Commentary on corrosion at bimetallic contacts and its alleviation'.

Where different metallic materials are used, separators shall be fitted to eliminate the risk of corrosion.

All aluminium or galvanised steel components in direct contact with, but not totally encased in, cementitious surfaces shall be isolated with thin dense PVC or EPDM isolation packs. The use of bituminous paint shall not be accepted.

The SFC shall ensure there is no exposed galvanised sheet or mill finish aluminium visible in the completed Works when viewed from inside or outside except where agreed in advance with the Architect.

4.17 Infestation

Materials used in the Works shall not be attacked or infested by micro-organisms, fungi, insects or other vermin. The Specialist Façade Sub-contractor shall incorporate components to prevent infestation in the Works. All facades shall incorporate expanded aluminium or woven stainless steel wire mesh, max. 2mm grid, 0.6mm wire at base details, louvres and at penetrations.

4.18 Security

Ironmongery, where incorporated into the Works shall hold their respective doors in their intended position. They shall withstand the specified design wind load and shall not deflect, drop, or compromise the overall performance of their respective windows or doors for the service life, subject only to routine maintenance and minor repairs.

All openable glazing assemblies accessible from ground level shall achieve Resistance Class (RC) 2 in accordance with EN 1627. Glass which is accessible from ground level shall achieve P2A when tested in accordance with EN 356.

4.19 Anti-Graffiti

The Specialist Façade Sub-contractor is required to recommend suitable graffiti removal materials and procedures for all of his works.

5 TESTING & MOCK-UPS

5.1 General

5.1.1 Introduction

It is intended a project specific off-site structural or weather performance testing should be required for the project. Test reports must be provided by the Specialist Façade Sub-contractor or project specific testing shall be required.

Project specific impact testing shall be required

Acoustic testing/desk studies shall be provided as required by the consulting acoustic engineers.

Fire testing of materials shall be provided in accordance with EN 13501 requirements if not already tested.

The Specialist Façade Sub-contractor shall demonstrate to the Architect, at times set out in the Schedule of Submissions that the performance requirements of this specification can be met by:

Where possible, provide full test reports of:

- a) The weathering performance of the proposed systems
- b) The cyclic test results of proposed door systems
- c) The structural performance testing of proposed systems
- d) Weather performance test result of a completed installation utilising a similar system and of similar size and geometry.
- e) Building movement testing
- f) External and internal impact testing (for CE Marking, CWCT TN75/76, rope access and BMU impacts as appropriate.
- g) BMU pullout testing (where Building Maintenance Units are used)
- h) Performance testing of ventilation grills, and louvres (ref. EN 13030 and EN 13141 where applicable)
- i) Producing structural and calculations for all proposed components and assemblies as set out in the Schedule of Submissions.
- j) Submitting detailed design drawings, recognising the requirements of the Contract Documents.
- k) Submitting samples for setting of quality control levels
- l) Construction of mock-ups as described in the Contract Documents.
- m) Carrying out Weather/structural/fire/acoustic Performance Testing on Facades Types where suitable test reports are not available or acceptable to the Design Team
- n) Carrying out all other performance testing as set out in this document
- o) Construction of on-site quality control samples and independent site hose testing and air infiltration testing of these samples including completed weathering interfaces with other packages.
- p) Testing of materials, finishes, fixings and components as set out in this document.

Should the Architect deem any of the information unsatisfactory, the Specialist Façade Sub-contractor shall be required to weather performance test other areas at his own cost and with no effect on the program.

Representatives from the Design Team shall be given the opportunity to witness all tests. The Specialist Façade Sub-contractor shall identify all testing, on his programme for the Works. The Specialist Façade Sub-contractor shall give the Architect fifteen working day's notice of any tests.

5.1.2 Testing authority

Testing shall be conducted by an Independent Testing Authority (or authorities) identified by the Specialist Façade Sub-contractor and agreed with the Architect.

Either the testing facilities of the Independent Testing Authority or those of the Specialist Façade Sub-contractor may be used, but in either case, the calibration of the equipment, and the witnessing, reporting and certification of the results shall be by the Independent Testing Authority. The Specialist Façade Sub-contractor shall submit details of the proposed Independent Testing Authority with his Tender.

The appropriate National Authority shall have accredited the Independent Testing Authority.

All measurement devices used in the tests shall be calibrated to National Standards and shall have current calibration certificates available for inspection by the Architect.

5.2 Weather / Structural Performance Testing

5.2.1 General

Off-site weather performance testing of all curtain wall systems shall be required unless up-to-date weather performance testing results are submitted and accepted by the design team. The tests must be comparable in panel orientation, retention systems, member spans/deflections and loads that would be expected in a job specific test for this project. Weather performance test reports shall include full details of the tests carried out with associated detail drawings and photographs demonstrating identical construction to the proposed system for the Works.

Weather performance test reports shall include full details of tests carried out with associated detail drawings and colour photographs, all fully legible. Photocopied versions shall be rejected. Existing test reports (where proposed) for curtain walling shall not be less than two floors in height and three panels in width. Test reports must be official copies in English language in accordance with CWCT or applicable CE Certification standard sequence and include hose testing of the specimen within the testing sequence in accordance with CWCT standard hose test method or similar agreed method. If the proposed test reports are not accepted, project specific off-site tests will be required as noted below. Note: on-site tests are always required.

Where project specific tests are required, full test procedures and detail drawings shall be submitted for review in good time in order to allow comment and amendment and acceptance prior to testing as noted below:

5.2.2 Test Specimens

The test specimens shall be designed and constructed using the same methods, materials and sequence as for the Works. The techniques, skills and quality control used for the installation of the test specimen shall be those that are to be used for the installation of the Works.

The test specimens shall be of sufficient size to establish that all elements of the facades in the specified test area are capable of complying with the specified performance criteria. For testing of curtain walls, the test shall be not less than 2 panels high and 3 panels wide

The Specialist Façade Sub-contractor, in consultation with the Testing Authority, shall provide drawings, showing the size and arrangements of the specimen to be tested including details of the test box. The Specialist Façade Sub-contractor shall also provide assembly drawings, details and method statement, and calculations, of the test specimen. These shall be reviewed, revised as necessary, and agreed with the Architect prior to construction of the test specimen.

The above information shall include details of all jointing, fixing techniques, materials used, type, number and size of drainage/ventilation apertures, and section properties of framing members, strength of concrete, fixings etc. The Specialist Façade Sub-contractor shall co-ordinate all the interfacing elements of work included in the test specimen.

The specimen shall also be used to review proposed assembly and erection methods. If the Architect requires it, the Specialist Façade Sub-contractor shall video record and photograph the test specimen during erection.

Any defects in the test specimen shall be corrected to the satisfaction of the Architect and the modifications shall be incorporated into the remainder of the Works. All defects and modifications shall be recorded by the testing authority and included in the test report.

The test specimens shall be mounted in the test rigs with the conditions of attachment and supports structurally equivalent to those in the Works. The structure supporting the test specimen shall be equivalent in stiffness to that in the building. The Specialist Façade Sub-contractor shall detail the interface between the test chamber and the specimen so that the test chamber and its seal to the test specimen does not influence the results of the test.

Should there be a failure during testing this shall be recorded on marked-up test-rig drawings. Retesting shall only occur when the Design Team and Specialist Façade Sub-contractor have agreed the required amendments. Should the test rig fail 3 official tests it shall be dismantled and rebuilt at the SFC's cost, and re-tested until passed. Should the test rig need to be rebuilt, costs associated with attendance of the design team may be off-set against the SFC's contract value.

5.2.2.1 Stick/Unitised System Curtain Walling (to CE Certification Standards).

To include stacking joint detail (mullion to mullion connection)

Curtain Wall: Harmonised Standard EN 13830			
Characteristic	Test and classification	note	Minimum Classification
Wind resistance	EN 12179 EN 13116	Calculate xxxx wind load (P1) in accordance with EN 1991 as specified.	E xxxx Deflection maximum 1/200 or 15mm, whichever is the lesser

Watertightness	EN 12155 EN 12154	Watertightness to be not less than $\frac{1}{4}$ the positive wind load.	R7 (600Pa) No leaks!
Watertightness Dynamic	EN 13050	Calculate pressure as per EN 13050 Section 8: $P_{max} = 3 P_{min} = 0,375 \times P_{design}$ where P_{design} is the maximum wind pressure (negative or positive)	Pressure as calculated. No leaks!
Watertightness Hose test	CWCT Test Method 09, and TN 102	Test representative length of horizontal and vertical joints, not less than total 25% of test mock-up linear meterage. 220kPa (+/- 20kPa) water pressure	Without air pressure No leaks!
Air permeability	EN 12153 EN 12152	Reference air permeability at 100 Pa ($m^3/(h \cdot m^2)$ or $m^3/(h \cdot m)$)	Class A4
Fire resistance test (floor interface where passing in front of a floor fire-stop)	EN 1364-4	Existing fire-test detailing to be used or allow for project specific fire-testing. Note, mullion spacing and structural floor build-up is a factor and must be as per the test.	Internal, or internal and external test, and test duration to be as specified by the consulting fire engineer.

5.2.2.2 Doors (manually operated, residential)

Characteristic	Test and classification	note	Minimum Classification
Wind resistance	EN 12211 EN 12210	Calculate xxxx wind load (P_1) in accordance with EN 1991 as specified.	E xxxx Deflection Class 'C'
Watertightness	EN 1027 EN 12208	Watertightness to be not less than $\frac{1}{4}$ the positive wind load.	7A (non-shielded)
Watertightness Spray-bar test	CWCT Test Method 10, and TN 102	Test linear meterage of all joints.	Without air pressure No leaks!
Air permeability	EN 1026 EN 12207	Reference air permeability at 100 Pa ($m^3/(h \cdot m^2)$ or $m^3/(h \cdot m)$)	Class 4
Ventilation	EN 13141-1	Each opening where doors are used for make-up air	Confirm compliance with areas specified by the MEP Consultant
Operating forces	EN 12046-2	Manually operated door	Class 1

	EN 12217		
Mechanical strength	EN 947 EN 1192	Each door type	Class 3
Impact resistance	EN 13049 EN 13049	Each door type	Class 2 internal Class 2 external
Resistance to repeated opening and closing	EN 1191 EN 12400	Each door type	Class 3 (20,000 cycles)

5.2.2.3 Doors (all non-residential types) (manually operated) (to CE Certification Standards)

Typical Doors:			
Characteristic	Test and classification	note	Minimum Classification
Wind resistance	EN 12211 EN 12210	Calculate xxxx wind load (P1) in accordance with EN 1991 as specified.	E xxxx Deflection Class 'C'
Watertightness	EN 1027 EN 12208	Watertightness to be not less than ¼ the positive wind load.	7A (non-shielded)
Watertightness Spray-bar test	CWCT Test Method 10, and TN 102	Test linear meterage of all joints.	Without air pressure No leaks!
Air permeability	EN 1026 EN 12207	Reference air permeability at 100 Pa (m ³ /(h · m ²) or m ³ /(h · m))	Class 4
Ventilation	EN 13141-1	Each opening where doors are used for make-up air	Confirm compliance with areas specified by the MEP Consultant
Operating forces	EN 12046-2 EN 12217	Manually operated door	Class 1
Mechanical strength	EN 947 EN 1192	Each door type	Class 3
Impact resistance	EN 13049 EN 13049	Each door type	Class 2 internal Class 2 external
Resistance to repeated opening and closing	EN 1191 EN 12400	Each door type	Class 6 (200,000 cycles)

5.2.2.4 Windows (fixed and manually operated opening, residential)

Characteristic	Test and classification	note	Minimum Classification
Wind resistance	EN 12211 EN 12210	Calculate xxxx wind load (P1) in accordance with EN 1991 as specified.	E xxxx Deflection Class 'C'
Watertightness	EN 1027 EN 12208	Watertightness to be not less than ¼ the positive wind load.	9A (non-shielded)
Watertightness Hose test	CWCT Test Method 09, and TN 102	Test linear meterage of all joints. 220kPa (+/-20kPa) water pressure. Exclude trickle-vent in louvres.	Without air pressure No leaks!
Air permeability	EN 1026 EN 12207	Reference air permeability at 100 Pa (m ³ /(h · m ²) or m ³ /(h · m))	Class 4
Ventilation *	EN 13141-1	Each opening and trickle vent	Confirm compliance with areas specified by the MEP Consultant
Operating forces *	EN 12046-1 EN 13115	Manually operated vent	Class 1
Resistance to static torsion *	EN 14609 EN 13115	Each opening vent type	Class 3
Racking *	EN 14608 EN 13115	Each opening vent type	Class 3
Loadbearing capacity of safety devices (restrictors) *	EN 14609 EN 14351	Manually operated vent	350N
Impact resistance	EN 13049 EN 13049	All areas including louvre panels	Class 2 internal Class 4 external
Resistance to repeated opening and closing *	EN 1191 EN 12400	Each opening vent type	Class 2

‘*’ Tests applicable to opening sections only. All other tests apply to opening and fixed sections.

5.2.2.5 Automatic Opening Natural Smoke and Heat Exhaust Ventilators

Testing sequence to be carried out in accordance with EN 12101-2 (2003) A.1 and a test report created in accordance with A.2.

Assume all smoke vents are dual-purpose as defined in EN 12101-2 (2003) clause 7.1.3.

Essential Characteristic	Requirement Clause in EN 12101-2 (2003 Harmonised standard)	Note	Minimum Required Performance
Nominal activation conditions/sensitivity	4.1 initiation device		Class 'b' electrical signal
	4.2 opening mechanism		Electric drive with protected power supply
Response delay	7.1.2 opening time		Maximum 60 seconds to open. Stay open without external energy supply.
Reliability	7.1.1 opening and closing	For smoke vent only	Re 1000
	7.1.3 opening and closing	For dual purpose ventilator open to its normal comfort position when tested under no load	10 000 times in accordance with annex C prior to testing the same ventilator under EN 12101-2 (2003) clause 7.1.1 and 7.1.2
	7.4 wind load	Calculate in accordance with EN 1991 as specified	WL 3000
Effectiveness of hot gas extraction	6	Test in accordance with Annex B as Figure B.1 does not allow 'simple assessment procedure'	Confirm aerodynamic free area is as required by the GFSC.
Aerodynamic free area	6	Test in accordance with Annex B as Figure B.1 does not allow 'simple assessment procedure'	Confirm aerodynamic free area is as required by the GFSC.
Performance under fire conditions	7.5 resistance to heat	Test in accordance with Annex G. Achieve not less than 300 degrees C.	B 300
Fire resistance. Mechanical stability	7.5		Maximum 10% reduction in throat area when tested in accordance with Annex G.
	7.2.1.1 snow load	Not applicable	

Ability to open under environmental conditions	7.2.1.2 Side wind	Test in accordance with Annex D. Most unfavourable wind direction	Wind not less than 10m/sec (equivalent pressure)
	7.2.2 Opening under load	Test in accordance with Annex D.	Open within 60 seconds and stay open
	7.3 low temperature	No test required as noted in 7.3.1, 7.3.2.	T(00)
Reaction to fire	7.5.2.1	Vent temperature prior to operation. Agree with consulting fire engineer if higher performance is required.	B 300
Smoke vent, weather performance requirements:			
Wind resistance	EN 12211 EN 12210	Calculate xxxx wind load (P1) in accordance with EN 1991 as specified.	E xxxx Deflection Class 'C'
Watertightness	EN 1027 EN 12208	Watertightness to be not less than ¼ the positive wind load.	9A (non-shielded)
Watertightness Hose test	CWCT Test Method 09, and TN 102	Test linear meterage of all joints. 220kPa (+/-20kPa) water pressure	Without air pressure No leaks!
Air permeability	EN 1026 EN 12207	Reference air permeability at 100 Pa (m ³ /(h · m ²) or m ³ /(h · m))	Class 4
Ventilation	EN 13141-1	Each opening	Confirm compliance with areas specified by the MEP Consultant

5.2.2.6 Revolving Doors

a. *Air permeability

Max 5.1L/Sec/m² @ 75Pa

*Ref ASHRAE 90.1

(BOON EDAM REVOLVING DOOR MANUFACTURER TO PROVIDE DATA)

5.2.3 Testing Procedure and Sequence, Curtain Walling

The test specimen shall be subjected to tests for air permeability, water leakage, stacking joint movement and resistance to wind loads.

Tests stipulated by this document to which the test specimen shall be subject, shall be undertaken according to sequence set out in The Centre for Window and Cladding Technology, Test Methods for Curtain Walling amended as noted.

The testing sequence shall be:

- a. Air permeability/draughts. @ 600Pa
- b. Watertightness – static. @ 600Pa
- c. Wind resistance – serviceability.
- d. Repeat air permeability/draughts.
- e. Repeat watertightness – static.
- f. Watertightness – dynamic.
- g. Hose test (all joints).
- h. Wind resistance – safety.
- i. Inspect and record.
- j. Inspect and record during dismantle (photographic record required)

No tests shall be carried out unless all previous tests in the sequence have been passed to the satisfaction of the Independent Testing Authority. In addition the specimen shall be thoroughly checked from inside the test box prior to each test to ensure that there is no water on the inside face of the specimen. If any modifications are made to the test specimen, including dismantling and re-assembly, the Architect or the Independent Testing Authority, can request that the sequence shall begin again at the first test.

5.2.4 Air Permeability Test

The specimen shall be tested to determine the air infiltration per unit area for fixed panels and per unit joint length for opening lights and junctions between interfacing elements of work.

A check for regions of concentrated air leakage shall be made during the air permeability test. The Testing Authority on a drawing of the specimen shall mark-up regions so identified, with a note of any remedial work that was carried out to eliminate the problem.

Testing shall be carried out in accordance with the requirements of the CWCT Test Methods for Curtain Walling.

5.2.5 Watertightness Tests

The following test methods shall be employed for assessing the resistance to water penetration:

Static test method.

Dynamic test method

Hose test method

Testing for (a) and (c) shall be carried out in accordance with the requirements of Test Methods for Curtain Walling.

The Dynamic Test Method shall be carried out to ENV 13050 with a dynamic pressure of 600 Pa.

5.2.6 Wind Resistance Tests

The following test shall be employed for assessing wind resistance:

- (a) Wind resistance - serviceability.
- (b) Wind resistance - safety.

Testing shall be carried out in accordance with the requirements of the CWCT Test Methods for Curtain Walling.

5.2.7 Erection and Dismantling

The Independent Testing Authority shall witness the installation and dismantling of the test specimen. He shall record any variations to the details and method statements on a set of the test specimen assembly drawings prepared beforehand by the Specialist Façade Sub-contractor. He shall also record the extent of water penetration into the system together with any other evidence of damage or displacement revealed during the dismantling.

The Specialist Façade Sub-contractor shall ensure that any adjustments, additions or changes made to the test specimen to achieve the performance required are included on his drawings prior to any site installation being carried out.

5.2.8 Reporting

The test report shall be prepared by the Independent Testing Authority and submitted to the Architect for review. The report shall contain the information as described in the CWCT Standard for Curtain Walling. It shall include records of all pre-tests and any remedial actions that are carried out prior to the official test. It shall include photographic record of construction and dismantling and record any deviations from the detail drawings. The test report shall include the detail drawings of precisely what is tested.

5.3 Stone testing and Monitoring

The Specialist Facade Sub-contractor shall employ the services of a suitably qualified Independent Geologist or Stone Specialist (referred to as the Independent Geologist) as his advisor regarding the suitability, performance and testing of the stone cladding within the Works package. The Independent Geologist shall review the specification requirements and advise the Specialist Facade Sub-contractor on what tests are required based on the selected stone types and detailing. These shall be generally in accordance with CWCT recommendations.

The Independent Geologist shall visit the quarry for each selected stone on at least one occasion to set the quality control samples for the works and witness all project specific testing.

The Independent Geologist shall review the Specialist Facade Sub-contractor's drawings confirming compliance with the specification requirements prior to issue of these to the Design Team. The independent geologist shall confirm in writing that all stone bracketry and stone detailing has been checked by him and that the stone shall not be stressed in excess of allowable limits in any of the proposed conditions.

The characteristic values and properties of the stone are to be stated/confirmed by the Independent Geologist confirming their suitability for their intended installation on site for review and acceptance by the Architect. These shall include the following information with associated test reports which shall not be more than 12 months old for retention fixings, and not older than 5 years or EN 1469 (whichever is the shorter period) :

- Petrography EN 12047
- Flexural Strength EN 12372
- Breaking load at dowel hole EN 13364 (or as applicable for fixing proposed)
- Water absorption EN13755, EN1925
- Compressive Strength EN 1926 (if stacking stones)
- Density and porosity EN 1936
- Salt crystallisation EN12370 (2020)
- Frost resistance EN12371
- Thermal shock resistance EN14066
- Water vapour permeability ISO 10456, EN ISO 12572

The above information shall be provided at tender. Test reports shall be independently verified by the Geologist. The Quarry shall be required to confirm to the Specialist Facade Sub-contractor that the properties of the stone currently being quarried match the performance figures achieved in the test reports and that the test results for the last 10 years remain constant. If the results are not consistent, allow for additional project specific testing as required to ensure durability and suitability of the proposed stone.

5.3.1 Approval Testing

These tests are carried out post tender but prior to commencing fabrication of the stone. They are intended to check that the stone quarried or stockpiled for this project is of the technical quality expected by the Specialist Facade Sub-contractor's consulting Geologist. Reporting of these tests shall be in line with the requirements of EN 1469 Table 5.

Specimens for testing below are the minimum to be taken from 2 randomly selected blocks (selected by the Specialist Facade Sub-contractor's independent Geologist) of each stone type that will be used on the project.

- Petrography EN 12047
- Visual appearance
- Flexural Strength EN 12372
- Breaking load at dowel hole EN 13364 (or as applicable for fixing proposed)
- Water absorption EN13755, EN1925
- Density and porosity EN 1936
- Salt crystallisation EN12370

5.3.1.1 Acceptance

For each location an average value is to be computed for each group of tested samples. The result of all samples tested within each group is to be used in determining the average value, except if any specimen gives a value of 20% or more below/above the average, it shall be reported, and the significance of that result shall be reviewed with the Architect.

5.3.2 Production control tests

The production control testing protocol shall be reviewed and confirmed by the SFC's Geologist. It shall then be issued to the Architect for acceptance. Each block shall be numbered. Each slab shall be numbered. Traceability of stone shall be demonstrated in the production control testing protocol.

The frequency of production control testing shall be as set out below:

First block up to twelfth block: every third block

Thirteenth block up to fiftieth block: every tenth block

Fifty-first block up to one hundredth block: every twentieth block

Beyond one hundredth block: Every fiftieth block

As a minimum, the following testing shall be carried out per block which is selected for testing:

1. Density, and Porosity (BS EN 1936) - 6 No. specimens taken from each block
2. Water absorption (BS EN 13755) - 6 No. specimens from each block
3. The back face of 10% of the cut to size pieces shall be visually inspected for cracks by wetting the back face with water.

These production control tests shall be in accordance with EN1469. The Specialist Façade Contractor shall be responsible for ensuring his Independent Geologist agrees with all testing procedures. The tests shall be carried out at an independent testing laboratory certified in accordance with EN standards for carrying out such testing.

5.3.2.1 Acceptance of Production Control Tests

The stone(s) shall be deemed to satisfy the performance requirements if, in the written opinion of the Specialist Façade Sub-contractor's Independent Geologist, the results of the production control testing demonstrate;

- a) Consistency with the Approval Testing results.
- b) Technical performance in excess of the requirements given in this Specification.

The Specialist Façade Sub-contractor shall reject all the stones represented by specimens which fail to satisfy the performance requirements.

5.3.2.2 Visual inspection

The Specialist Facade Sub-contractor shall make a standing arrangement for the Architect to inspect at regular intervals any stone element he chooses at the following stages.

- a) After gang sawing and prior to further processing.
- b) After initial processing and cutting to size.
- c) After edge labours and surface finishing.

5.3.3 Impact testing

Impact testing shall be carried out as set out in Clause 5.12.2 of this Specification. For each type of stone exposed to Category B and E, a section of wall shall be constructed using the proposed fixing method to a backing structure of similar structural performance to that expected on site, all constructed by the stone contractor. Impact testing shall be carried out by the independent testing authority in accordance with BS 8298, impacting three times each on the following locations:

- The centre of the stone with the largest area
- The centre of the stone with the largest aspect ratio (the ratio of the long side to the short side)
- The centre of the longest horizontal edge
- Centre of false joint (worst case)
- The centre of the longest vertical edge
- Three number four-way junctions

5.4 Design development mock-ups

5.4.1 Glazing & Aluminium Systems

Design development mock-ups have been agreed as hand-samples where required. These mock-ups may be replaced with technical submissions where agreed. Design development mock-ups are required to develop the contractor's detailed processes to achieve the required design intent. All sample panels shall be to dimensions as set out below, manufactured precisely as proposed for the Works (including all edge finishing etc):

- a. Vision glass for selection of coating regarding colour and reflectivity with proposed glass thickness and composition (600 x 600mm)
- b. Spandrel glass including range of colours (provide not less than 3 options for selection by the Architect) (600 x 600mm)
- c. Aluminium Extrusions with proposed finish
- d. Parapet including support bracketry and folded welded joint (600mm length)
- e. Ironmongery (samples of each proposed component)
- f. Louvres on main facade and associated framing, etc. (600mm x 600mm)
- g. Hand-samples as agreed with the Architect

5.4.2 Stone

Design development mock-ups are required to develop the contractor's detailed processes to achieve the required design intent. All sample panels shall be minimum 600mm x 600mm manufactured precisely as proposed for the Works (including all edge finishing etc):

- a) Full size natural stone samples with proposed options for anti-graffiti coating/treatments, including all supporting product literature. Allow for anti-graffiti coating to all stone up to 4m above ground floor level.
- b) Stone to stone sealant joint samples to select colours (minimum sample wall size 2m x 2m). To include at least one unfilled, stepped movement joint (see architectural intent for movement joint at each floor).
- c) Pre-acceptance samples of all types of stone materials as agreed 600mm x 600mm or full size for selection of the final stone type (bed) and finish.
- d) Range samples of stone (minimum 12 pieces per stone type and finish, full size) for agreement of the acceptable range.
- e) Liquid membrane application to reinforced concrete backing wall, with sample membrane bandage at day-joints.
- f) Impact test mock-up (see Section 5 testing requirements of this Specification)
- g) Materials testing samples as required
- h) Various samples of each type of fastening device and anchor proposed.
- i) Stone fin with backing structure, sealant joints, and interface with glazing.

5.5 Off-site Visual Mock-Up

Not used

5.6 Off-site Quality Control Samples & Technical Mock-Up

5.6.1 General

Off-site quality control samples shall be provided in order to ensure the quality of the proposed Works carried out by the Specialist Façade Sub-contractor. Failure to provide quality control samples and achieve acceptance from the Contract Administrator may result in rejection of installed Works.

It is intended that initial hand-samples shall be provided prior to ordering the full quality control mock-ups. These shall include profiles, glazing, ironmongery, spandrel panels, floor grills etc..

5.6.2 Quality Control Prototype

A full size Quality Control Prototype shall be provided. Proof of concept for installation and adjustment of the façade and precast assembly with integrated gutter, downpipes and glazing interfaces. To be constructed from materials and finishes to accurately replicate the on-site condition. Demonstration to illustrate transport and installation of the façade panels and precast. To include demonstration of adjustment during installation of the glazing and precast cladding system. To include installation of cavity barriers and membrane interfaces to the glazing. The

Quality control prototype to remain in-situ off-site for the duration of the installation of the Works to allow comparison with the site installation. The quality control prototype CANNOT form part of the Works on-site.

The quality control prototype shall include flat insulated glazing units with correct coatings, edge polishing, fritting, lamination, and spacer bars etc for each type. Include samples of any.

The quality control prototype shall be formally, presented for review. Only when the quality control prototype has been accepted by the Architect and Design Team shall the SFC commence production for the Works.

Figure 2 Quality control prototype scope

5.6.3 List of Off-Site Quality Control Samples Required (minimum)

The following items form the minimum quality control samples (including minimum sizes) required to be provided by the Specialist Façade Sub-contractor and accepted by the design team as soon as possible during Specialist Façade Sub-contractor design development. Off-site quality control samples shall be provided in Manchester adjacent to the site. Where agreed in advance, the quality control parts may be incorporated into the final Works on-site:

- 1) Sample of each proposed finish as applied to sheet metal and extruded aluminium as called up in Clause 7.2.6. These shall be used for comparison with the finishes provided to site.
- 2) Samples of all ironmongery
- 3) Samples of all materials and finishes as agreed with the Architect.
- 4) Parapet with weathering joint
- 5) Quality control samples of completed insulated units shall be provided (1m x 1m) for viewing with a reflected blue-sky to assess the degree of visible anisotropy.

5.7 On-site Quality Control Samples

5.7.1 General

The Specialist Façade Sub-contractor shall erect the first area of each type of the Works not exceeding one structural bay width by one floor height (maximum 20m²) and offer these to the Architect as on-site quality control samples. He shall present the areas in stages as each layer of material is added.

The standard of workmanship for the Works shall be to an agreed standard established by the construction of the off-site and on-site Quality Control Samples. The Architect shall review and comment on the On-site Quality Control Samples. Should the Specialist Façade Sub-contractor wish to continue with installation of any of the Works before the Architect has reviewed and commented on the On-site Quality Control Samples, he shall do so at his own risk. The Architect may require parts of the sample to be dismantled to allow inspection of concealed details. Upon acceptance, the on-site control samples shall remain as part of the installed permanent Works.

The Architect shall reject workmanship that falls below the accepted standard and shall require the Specialist Façade Sub-contractor to remove it and re-install it to the acceptable standard.

Prior to construction a programme that details these areas shall be agreed with Architect. The programme shall identify when they will be inspected and hose tested (see Site Hose Tests below).

The Architect may wish to inspect items that will be concealed in the final works, prior to covering up, and this programme should identify such intermediate inspections.

5.7.2 Site Hose Tests

As part of the review of each of the On-Site Quality Control Samples, site hose tests shall be arranged by the Specialist Façade Sub-contractor and shall be carried out by the Independent Testing Authority. They shall be carried out on all On-Site Quality Control Samples on dates to be agreed with the Architect ALL PRIOR TO INSTALLATION OF INTERNAL FINISHES. Other areas, randomly selected by the Architect shall also be hose tested as the Works proceed covering each facades type. The SFC shall allow for testing minimum 10% linear metres of joints measured in accordance with the CWCT standard covering all façade types and areas by the Independent Testing Authority for randomly selected areas which include interfaces with other works. Tests shall be conducted, witnessed and reported in accordance with the requirements contained in this Contract Document BY THE INDEPENDENT TESTING AUTHORITY.

Where the performance criteria specified in this document are not met, the construction shall be opened up, the cause identified, remedial work carried out and the area re-tested. Any remedial work shall be agreed with the Architect before it is carried out. This procedure shall be continued until the Works meet the performance criteria. The Specialist Façade Sub-contractor shall then ensure that any modifications are incorporated into all similar areas of the Works. Furthermore, where the performance criteria are not met, the Architect shall determine the need for additional testing at the Specialist Façade Sub-contractor's expense up to 100% of the Works.

Prior to hose testing beginning, the Specialist Façade Sub-contractor shall submit a hose testing schedule with associated elevations marked up indicating the proposed test areas and associated measured linear meterage of joints in line with the Specification requirements. The Architect may alter the location of tests.

5.7.3 Hose Testing/Spray-bar Testing

Hose and spray-bar tests shall be carried out in accordance with the specified procedure in the Section 9 of CWCT Standard Test Methods for Building Envelopes (December 2005) by the independent testing authority. Testing to be on 5% of each façade system (5% of sliding doors, 5% of each opening window type, 5% of each hinged door type, 5% of each fixed glazing type, 5% of perimeter interfaces around glazing systems, etc) achieving overall test of 5% of area of facade. Locations for tests to be agreed in advance with the Architect. Tests to be spread out over the duration of the Works, as agreed with the Architect to align with their project planning.

The order in which the joints in the Works will be tested shall be agreed between the Architect, the Independent Testing Authority and the Specialist Facade Sub-contractor.

The Independent Testing Authority shall check for leaks at the test area and at the floor below the test area inside the building. Internal finishes shall be omitted in the test areas in order to

allow clear view of any areas where leakage may occur. Test areas and areas adjacent to the test area shall be continuously monitored for not less than to 30 minutes after all testing has been completed. If no leak is detected in that time, the area shall be deemed to have passed.

5.7.4 Localised Testing, Combined Air and Water Testing

During installation, the Specialist Façade Sub-contractor shall commission an independent testing authority agreed with the Architect to carry out a minimum of one site tests of the installed glazed windows in accordance with the procedures in AAMA 502-12 "Voluntary Specification for Field Testing of Storefronts, Curtain Walls and Sloped Glazing Systems". The test area is to encompass a minimum of 1 complete glazed opening including all perimeter joints and junctions prior to proceeding with further installation. Should one fail, an additional test shall be carried out on that elevation. If there are two failures, an additional two areas shall be tested. If there are more than two failed tests, all openings shall be tested.

Testing:

- Conduct tests for air infiltration at an air pressure difference of 300Pa. Maximum allowable rate of air infiltration to be as defined by AAMA 502.
- Conduct tests for water penetration at an air pressure difference equal to 300Pa. There is to be no water leakage at this pressure difference.

5.7.5 Reporting

The reports shall contain the information listed under the following headings:

- a. Date of test, and of report.
- b. Identification of the areas tested on as-built elevation drawings. Plan and vertical section details of the area tested to be provided also. Detailed photographic record of all tested areas and testing apparatus.
- c. A note of the weather conditions particularly wind strength and direction at the time of test.
- d. The duration of the test with at statement of how water was applied, where the test started, how it was progressed and where it finished.
- e. A statement that the test carried out was in accordance with the standards referred to in this document, or a full description of any deviation from the standards previously agreed by the Architect.
- f. A statement that the test was successful, or alternatively, a note of any leakage through and/or directly below the area being tested, together with an indication of the severity of leakage.
- g. Name and author of report.
- h. Name and address of Independent Testing Authority that conducted tests, and the requester of the tests.
- i. Signature of person responsible for supervision of tests and list of official observers.
- j. Copy of valid calibration certificates for the testing apparatus.

5.8 Tests to Fixings

5.8.1 General

In order to demonstrate that his proposed fixings are adequate, the Specialist Façade Sub-contractor shall provide all the necessary test data, project specific calculations and technical literature in accordance with the Schedule of Submissions. He shall incorporate an auditable method of recording the quality control testing noted below.

5.8.2 Site inspections of fixings

As the Works proceed, the Specialist Façade Sub-contractor shall carry out inspections to check that:

The fixings as detailed on the Specialist Façade Sub-contractor's installation drawings have been installed.

Every facade fixing to structure is the right size and is in the right place and has been correctly tightened using a calibrated torque wrench.

Fixings do not restrain any intended movement and generate locked-up stresses.

All anchor bolts to be torque tested and sprayed confirming quality control testing.

5.8.3 Quality Control Testing of Bolts Embedded in Concrete/Blockwork

As the Works are installed, the Specialist Façade Sub-contractor shall carry out tests on bolts forming part of the Works at each floor level. Testing shall be broadly in line with the procedures set out in Construction Fixings Association Guidance Note: Procedure for Site Testing Construction Fixings - 2023 for non-destructive quality control inspection and testing of installed fixings. Minimum 5% of all fixings to be load tested as follows:

The bolts shall be loaded to a minimum load of 1.0 times the design load acting on the bolt. The Independent Testing Authority shall record any horizontal displacement.

If any bolts show a displacement of more than 0.1 mm this shall be brought to the attention of the Architect and project structural engineer. Further testing may be required, or additional fixings may be required at the Specialist Façade Sub-contractor's cost.

5.9 Materials Testing

Materials testing shall be carried out in accordance with the requirements of this Contract Document.

5.10 Finishes Testing

Finishes testing shall be carried out in accordance with the requirements of this Contract Document.

5.11 Barrier, and Load Testing

5.11.1 General

Barrier loads shall be applied as defined by the Architect, set out in BS 6180. An external balustrade to an individual residence shall be tested to 0.74kN/m line load and associated other loads. An external balustrade to a private terrace shall be tested to 1.5kN/m line load and associated other loads. An external balustrade to a public space shall be tested to 3.0kN/m line load and associated other loads.

Barrier load tests shall be applied as defined by the Architect, set out in BS 6180. Barrier loads shall be not less than those identified below:

- | | |
|--|--------------|
| f) Bedrooms, laboratories, offices: | Location A |
| g) Corridors: | Location B |
| h) Restaurants/cafes/retail: | Location B/D |
| i) Emergency Escape routes: | Location C |
| j) External screens/balustrades at ground level protecting against a fall: | Location E |

An external balustrade to a private terrace shall be project specific load tested to 1.5kN/m line load and associated other loads.

Note: assemblies where glass is retained on point fixings and are required to achieve the loadings noted above shall be tested physically to demonstrate compliance with the requirements. Structural calculations shall be required in addition to the testing.

5.11.2 Loading for Maintenance Access

The SFC shall carry out project specific load tests on projecting horizontal feature profiles and parapets where loads are identified as part of the façade access and maintenance. Loads shall be as identified in Clause 4.5.8 unless agreed otherwise with the consulting façade access and maintenance consultant. Testing for maintenance access shall be as set out in 5.11.1 and 5.12 unless agreed otherwise with the façade access and maintenance consultant.

5.12 Impact Testing

Impact testing shall be carried out in accordance with this specification to demonstrate compliance with this Contract Document unless valid comparative test certification is provided.

5.12.1 Impact Testing for CE Certification

Façade type	Impact zone	Ref. Standard	Exposure category	Performance
Unitised/Stick Facades	Internal	BS EN 14019	B	Class I4
	External	BS EN 14019	E	Class E4
Windows	Internal	BS EN 13049	4	Class 4
	External	BS EN 13049	4	Class 4

5.12.2 Impact Testing to CWCT TN75/76

The Specialist Façade Sub-contractor shall demonstrate that the rainscreen cladding, stone, aluminium and glazing shall satisfy the requirements of CWCT Technical Note No. 75 ‘Impact performance of building envelopes’. Where vertical projecting features exceeding more than 100mm from the face of glass exist, these shall be impacted at 45 degrees.

Impact tests to be carried out on a representative sample of the Specialist Façade Sub-contractor’s works. The minimum impact values shall be as per table 4 and 5 of CWCT TN75 categories B and E as defined in CWCT TN75 Table 3.

Class for Safety Performance: ‘Low Risk’ (Table 01 TN75)

Class for Serviceability Performance: 2 (Table 02 TN75)

CWCT TN 75 and description		Soft Body Impacts		Hard Body Impacts**	
		CWCT TN75	Joules	CWCT TN75	Joules
B	Areas within 1.5m of ground, terrace, etc.	Serviceability	120	Serviceability	10
		Safety	500	Safety	10
E	Areas more than 1.5m above ground or terrace.	Serviceability	120	Serviceability	6
		Safety	350	Safety	10

** Hard-body impacts shall not apply to stone cladding

5.12.3 Impact Testing, Façade Access and Maintenance

Impact tests and loads shall be carried out as defined by the façade access and maintenance consultant.

Where Building Maintenance Units are required on a project, the actual unit with applicable buffering shall be used in all testing.

Where vertical projecting features exceeding more than 100mm from the face of glass exist, these shall be impacted at 45 degrees.

5.13 Louvre and MVHR Vent Testing

All proprietary louvres shall achieve Class A3 for water penetration and coefficient of discharge when tested in accordance with EN 13030 at 2.4m/sec face velocity.

Where non-standard slot-vents or untested louvres are proposed, these shall be project specific tested to achieve equivalent to Class A3 for water penetration and coefficient of discharge when tested in accordance with EN 13030 at 2.4m/sec face velocity. These shall be tested to EN13141

including representative length of duct internally. Locations of pressure taps to be agreed with the consulting mechanical engineer.

5.14 Equipotential Testing

Refer to the requirements outlined in Section 8 of the CWCT Standard for systemised building envelopes Part 8. Equipotential bonding shall be provided to ensure that the various exposed conductive parts and extraneous conductive parts as defined by BS 7671 shall be at a substantially equal potential. The testing shall be carried out by an independent testing authority agreed with the Architect. A report shall be provided to the Architect in accordance with Clause 8.15 of CWCT “Standard for Systemised Building Envelopes” Part 8. For equipotential testing, the independent authority may be the project electrical contractor responsible for lightning protection of the building.

5.15 Air Tightness Test and Thermal Inspection

During installation, the Specialist Façade Sub-contractor shall assist the Main contractor in demonstrating the air leakage characteristics of the building. The test shall be undertaken by an accredited specialist agreed with the Architect, in accordance with the procedure set out by the ATTMA arranged by the Main Contractor.

Main Contractor to commission whole building air tightness testing in accordance with the following standards:

- ISO 9972:2015 ‘Determination of air permeability of buildings. Fan pressurisation method
- Test Procedure/equipment and analysis software as per EN ISO 9972:2015
- Approved Documents Part L Domestic (SAP) and Non-Domestic (SBEM).

Required performance (exfiltration):

Non-Domestic = 3.0m³/m²/hr@50Pa.

Non-Domestic = 2.5m³/m²/hr@50Pa.

(Figures as per SAP and SBEM assessment by Novo).

In the event of the test demonstrating an air leakage in excess of the specified rate, the testing authority shall investigate possible sources of excessive air leakage. The Specialist Façade Sub-contractor shall allow for opening up locally to assist in this investigation. If it is found that the Specialist Façade Sub-contractor’s works is deemed to be the source of the excessive air leakage the Specialist Façade Sub-contractor shall locate and identify all unplanned leakage paths and submit to the Architect for review, his proposals for remedial works. This shall include all necessary uncovering and making good of concealed elements of the fabric. The Specialist Façade Sub-contractor shall assist the Main contractor in re-testing the building to demonstrate that the air leakage rate is within the limits specified above, after these measures have been undertaken.

Air leakage will be deemed to be satisfactory when total leakage for the building volume being tested is within the value specified above and that such leakage paths that remain are evenly distributed around the enclosing envelope. Concentrations of air leakage, which may have an

adverse effect upon local environmental conditions within the zone of the building in which they occur as judged by the Architect, will not be acceptable.

It is envisaged that Thermographic inspection of the façade will be carried out. Should this demonstrate any defects in the performance of the façade the Specialist Façade Sub-contractor shall be required to rectify these defects at his own cost with no provision for additional time.

6 MATERIALS

6.1 General

6.1.1 Compliance with Standards

Unless otherwise described, all materials shall conform to the appropriate current European or British Standard Specifications. The Specialist Façade Sub-contractor shall provide the Architect, on request, with guarantees, or certificates of conformity, from the prime material manufacturers and suppliers proving that the materials to be used do in fact conform to such specifications.

6.1.2 Sources of Materials

In accordance with the schedule of submissions, immediately after contract award (within 5 weeks) the Specialist Façade Sub-contractor shall commence provision for the Architect's review a complete list of the proposed materials and their sources. He shall also provide documents from the sources as evidence of their ability to carry out the tasks expected of them, and written confirmation that the materials they are supplying are suitable and appropriate for their intended use and will satisfy this Contract Document.

The Specialist Façade Sub-contractor shall obtain the total quantity of each material from the same manufacturer. Materials shall be procured in single batches or sequential batches wherever possible to minimise variation between parts.

The Specialist Façade Sub-contractor shall obtain materials from established and reputable manufacturers, particularly those who are prepared to assist him with the design process, through to the fabrication and final installation on site.

6.1.3 Identification of materials

All principal materials delivered to the factory or site shall bear the manufacturer's name, brand name or any other data that may be required to verify the exact nature of the material and relate it to the requirements of this Contract Document. Where applicable, the material shall bear the Works test certificates, Trade Mark, and CE Mark. Test certificates shall include, whenever applicable, the location in the Works or the delivery or batch which the sample represents.

6.1.4 Compatibility of materials

The Specialist Façade Sub-contractor shall select and install each material so that it is, and will remain, compatible with the other materials around it and within its range of influence for the service life of the Works. The SFC shall carry out compatibility testing as per Clause 4.7.1.

6.1.5 Unspecified materials

As part of his submissions after appointment, the Specialist Façade Sub-contractor shall submit a list of all materials he proposes to use that are not specifically described in this Contract Document. These materials shall conform to the general requirements specified herein.

Unspecified materials shall be subject to review by the Architect.

6.1.6 Deleterious materials

Materials shall be selected by reference to the good practice guide "Good Practice in the Selection of Materials" available from the British Council of Offices (BCO) and the British Property Federation (BFP).

6.2 Aluminium Components

6.2.1 Extrusions

All extruded aluminium for framing members shall have the chemical composition and temper appropriate for its function, exposure and applied finish. They shall comply with BS EN 755, BS 1161, and BS EN 515, EN1999-1:2007, EN 755-9, EN 754, and EN 12020.

Design shall comply with BS 8118. The extrusions shall have the webs, walls, and flanges of sufficient thickness to satisfy all structural requirements and eliminate permanent distortion of elements in the finished Works.

6.2.2 Sheet, Strip and Plate

Sheets for hidden flashings shall not be less than 2mm thick. Sheets for all components exposed to view or to impact including copings, panels and visible closures shall not be less than 3mm, and shall have the chemical composition and temper appropriate for its function. They shall comply with BS EN 485 and BS EN 573.

Sheets for anodising shall be Novelis J57S alloy or equivalent to achieve uniformity of appearance.

6.2.3 Aluminium Welding and Consumables

Consumables shall be stored, handled and used in accordance with manufacturers' recommendations. They shall comply with applicable EN and ISO standards. Where welding panels which will be anodised, welding rods for welding of aluminium shall be selected in an alloy to minimise the visible appearance of the completed welds.

6.2.4 Bonded Aluminium Panels

Bonded (ACM) panels are not permitted to be included in the façade Works.

6.3 Steel Components

6.3.1 Stainless Steel

6.3.1.1 Plate, sheet and strip

Sheet material is proposed as minimum 2mm thick with surface roughness not exceeding 0.4 microns (Ra).

Stainless steel in profile, plate, sheet and strip shall comply with BS EN 10029, BS EN 10048, BS EN ISO 9445 and BS EN 10088 as appropriate..

Unless noted otherwise, grade 1.44xx (formerly 316L) shall be used for visible components, in all other circumstances grade 1.43xx (formerly 304) may be used.

6.3.1.2 Fixings and fasteners

Fixings and fasteners shall comply with BS EN ISO 3506-1 and BS EN ISO 3506-2.

Unless noted otherwise, grade A4 shall be used for visible fasteners, in all other circumstances grade A2 shall be used.

The fastener property class shall be selected by the Specialist Facade Sub-contractor so as to meet the performance criteria specified herein.

6.3.1.3 Sections

Stainless steel sections shall comply with BS EN 10088-3.

6.3.1.4 Welding consumables

Welding consumables shall comply with BS EN ISO 14343 and/or BS EN ISO 3581 as appropriate.

6.3.2 Mild Steel

6.3.2.1 Generally

The use of mild steel shall only be permitted where the component is readily accessible for regular inspection and maintenance. Any locations proposed to be highlighted to the Architect for review and acceptance.

Where used, it shall be one of the following:

- a. Hot rolled steel complying with the requirements of BS EN 10025.
- b. Hot rolled sections to EN 10365, BS EN 10210-2 and BS EN 10021, tubes to BS EN 10296-1&2; EN10297 and angles to BS EN 10056-1. .
- c. Cold formed pre-galvanised steel sections to BS EN 10346, BS EN 10327, BS EN 10143
- d. Steel sheet to BS EN ISO 9445.
- e. Ordinary bolts and nuts to BS EN ISO 4032, BS EN ISO 4033, BS EN 24034.
- f. All plain and tapered washers to BS 4320, Form E.

6.3.3 Hot dip galvanising

Hot dip galvanising to be in accordance with BS EN ISO 1461. Where mild steel sections or fabrications are hot dip galvanised the following additional specification shall apply. The use of coil coated galvanised sheet shall not be permitted where condensation or water may be present.

Mild steel shall have a carbon equivalent (calculated by the IIW formula) equal to or less than 0.43%

All welding procedures and welding procedure specifications shall be limited to a maximum carbon equivalent of 0.43%.

6.3.4 Welding Procedures and Consumables

Consumables shall be stored, handled and used in accordance with the manufacturers' recommendations.

Consumables for use in metal arc welding shall comply with ISO 18275, BS EN ISO 2560, BS EN ISO 14341 , BS EN ISO 14171 or BS EN ISO 17632 as appropriate.

6.4 Glass

6.4.1 General

All glass shall be mid-iron (aesthetic reference St Gobain Planiclear) unless otherwise specified.

Glass shall comply with the provisions of BS EN 572 and BS 952. Where coated, glass shall comply with EN 1096. Where laminated, glass shall comply with Harmonised Standard EN 14449 (all parts). Laminated glass with stone shall be tested to EN 14449 (all parts).

The thickness and dimensions of glass shown on the Architects Drawings are not prescribed thickness or dimensions.

The Specialist Facade Sub-contractor shall calculate the glass thickness, using the recommendations prEN16612, 'structural use of glass in buildings' and EN 1991(including the IRL National Annex) and validated proprietary design methods to meet the structural, environmental, acoustic and safety requirements.

All visible edges of glass shall be fully polished with ARRISSED EDGES (reference EN12150 Figure 6d), reference ISO 12543-5 clause 5.3.4, Figure 8, for laminated glass). ALL NON-VISIBLE EDGES SHALL BE SMOOTH GROUND WITH NO BLANK SPOTS (reference EN12150 Figure 6c), reference ISO 12543-5 clause 5.3.3, Figure 7 for laminated glass). Samples of proposed edge finishing shall be provided prior to manufacturing of the works.

6.4.2 Visual Acceptance Criteria

IN ALL INSULATED UNITS, THE OUTER GLASS SHALL BE STIFFER THAN THE INNER GLASS TO MITIGATE AGAINST 'PILLOWING'.

The glass shall be without significant edge faults (including feathered edges, shells or other imperfections) and free from bubbles, inclusions, cracks ripping dimples or other defects within allowable parameters as specified. Distortion shall be kept to an absolute minimum and no local defects producing irregular reflections beyond those permitted within agreed parameters shall be allowed.

The quality of all glass off the float line shall be assessed for optical and visual faults as described in BS EN 572-2. Spot faults shall not be worse than category C. There shall be no linear/extended faults. For optical faults, acceptance levels shall be as described.

Visual acceptance criteria for as-installed insulated glazing shall be gauged against the guideline prepared by the Technical Advisory Board of the Institute of Glazing Trade for Glazing Technology and Window Manufacture, Hadamar (IGH, Hadamar) shall be used to assess the visual quality of insulating glass units except that this specification shall be used to assess roller wave and bow for toughened/heat strengthened glass and this specification shall be used to assess anisotropy in heat strengthened and toughened glass, not the criteria found in the guideline. The glass shall be assessed in both transmission and reflection with a maximum viewing angle of 30° between the normal to the surface of the glass and the position of the observer.

A sample not less than 900mm x 900mm for each composition shall be provided, prior to start on site, of the final quality of the finished glass. This is to demonstrate the quality of glass, spacer bar, carrier frame and insulated glazing unit edge seals. The samples shall be to a standard agreed by the Architect. The accepted samples shall be kept protected by the Specialist Facade Sub-contractor as a control sample on site for review against installed glass if the quality of the installed glass is in question. As a rule, repair of damaged glass shall not be permitted. It shall be replaced with new. Very small individual repairs may be permitted where quality control

samples of the proposed repair is agreed in advance with the Architect, and where the repair itself is formally accepted by the Architect.

6.4.3 Safety and Thermal Stresses

The SFC shall carry out thermal stress analysis on all glass compositions including fully toughened, heat-strengthened and annealed glass. Thermal stress analysis shall be carried out in accordance with French standard NF DTU 39/3. The Specialist Façade Sub-contractor shall ensure that no glass or glazing combination develops stresses that may lead to damage of glass, glazing materials, components and/or framing systems.

He shall take into account shading stresses that might occur from adjacent components and buildings including shading devices. The Specialist Façade Sub-contractor shall agree with the Architect the allowable specification of mechanical properties for internal blinds to all elevations where appropriate which do not form part of this package. This is in order that the warranty provided by the glass manufacturer takes into account the likely stress from these blinds.

All glass shall be cut to accurate sizes and delivered to site in the required sizes. No on-site cutting or nipping shall be allowed. The glass shall be clearly marked to show its intended final position and orientation.

6.4.4 Toughened Glass

ALL glass that is intended to be fully toughened shall be traceable from the float-line to the position on the building and vice-versa. Each individual piece of glass shall be traceable to its heat-soak test and associated batch of panels tested at the same time. The SFC shall demonstrate the tracking of glass during detail design.

THE USE OF FULLY TOUGHENED GLASS IS TO BE AVOIDED WHEREVER POSSIBLE TO MITIGATE THE RISK OF SPONTANEOUS BREAKAGE. MONOLITHIC FULLY TOUGHENED GLASS SHALL NOT BE USED IN ANY LOCATION WHERE IT MAY FALL AND CAUSE INJURY.

The Specialist Façade Sub-contractor must satisfy himself that glass toughening requirements are satisfactory to meet wind or other loads anticipated in the Works. The prime manufacturer of the toughened glass shall be made aware of its intended use in the construction. Any drilling and notching is to be done with the agreement of the prime manufacturer of toughened glass and prior to the toughening being carried out. All toughened glass shall be tempered on a roller hearth furnace eliminating tong marks and shall conform to BS 6206 Class A.

All toughened glass shall be heat soak tested in accordance with EN14179-1 & 2 (achieving classification 1(c)1 to EN 12600) and should convert Nickel Sulphide inclusions greater than 40 µm in diameter from the alpha to the beta phase so that the glass will fracture in the test. After the test the probability of failure in service should be less than 1 in 400 tonnes.

The manufacturer shall, at the request of the Architect, show by statistical analysis of test data that the probability of failure is not greater than the value quoted above.

Edge dip is taken as the measurement taken within 200mm of the edge of the glass.

The glass shall conform to the following requirements in the horizontal toughening process when measured with a Strainoptics digital micrometer:

Flat glass, vision and spandrel units:

- (i) Maximum Bow (deviation from intended line) - 0.2%
- (ii) Roller Wave - 0.15 mm max depth (over 300mm)
- (iii) Edge dip - 0.25 mm maximum

All glass edge working shall be fully polished where visible in balustrades, and flat ground with no blank spots, with a small arris (refer to EN12150, figure 6c) in all other locations. Corners shall be dubbed on balustrades. Small shells and/or chips shall be ground out prior to toughening.

Maximum chip/shell diameter shall not exceed 3mm, and there shall not be more than four randomly placed chip/shells in any single pane of glass.

6.4.4.1 Heat soak testing

The manufacturer shall, provide the following during the Works:

- a) Each individual glass pane to be stamped with UV ink prior to heat-soak testing, with the date and batch number of heat soak testing directly adjacent to the glass stamp. A HST Checkmarker® ink or equivalent shall be used to ensure all glass is processed as specified: (<http://www.boraident.de/index.php?pid=41&state=page&action=default>)
- b) The marking shall be positioned to allow inspection with UV light after installation. Any fully toughened glass found without this marking shall be rejected.
- c) Record of heat soak testing of each batch
- d) Record to provide time versus temperature record for each batch
- e) Calibration certificates for thermocouples and oven relevant to each batch. Calibration to be not more than 12 months old.
- f) Record of any breakages that occur during heat soak testing.
- g) All breakages on site that may have been due to NiS inclusions shall be sent for analysis by digital microscope by Glass Technology Services UK or equivalent independent laboratory. Records shall be maintained of all such breakages and associated reports. These shall be provided to the Architect.

6.4.5 Heat Strengthened Glass

All heat strengthened glass shall be tempered on a roller hearth furnace eliminating tong marks.

The glass shall conform to the following requirements in the horizontal toughening process when measured with a Strainoptics digital micrometer or equivalent gauge:

Flat glass:

- a. Maximum Bow - 0.15%
- b. Roller Wave - 0.12 mm max depth
- c. Edge dip - 0.25 mm maximum

Edge working shall be as per fully toughened glass above. Raw cut edges that are only dressed will not be accepted. Small shells and/or chips shall be ground out prior to toughening. Maximum chip/shell diameter shall not exceed 2 mm, and there shall not be more than four randomly placed chip/shells in any single pane of glass.

The surface compressive stress shall be demonstrated by non-destructive testing to be between 24MPa and 69MPa during random testing of glass pieces during manufacture (not less than 1% of glass to be tested). Records of non-destructive testing to be provided during the Works.

6.4.6 Anisotropy

The appearance of anisotropy or "Leopard Spots", a multi-coloured pattern, is known to be associated with toughened or heat strengthened glass under certain polarised lighting conditions. The factors that cause anisotropy shall be minimised where possible by ensuring uniform treatment of the glass surface. All heat-treated glass shall be measured for iridescence (anisotropy) during processing with an Anisotropy Scanner at the toughening line. Records shall be kept of scanner results.

Quality control samples of completed insulated units shall be provided (1m x 1m) for viewing with a reflected blue-sky to assess the degree of visible anisotropy. They should be viewed in a location close to the project site with similar environmental conditions. Assessment shall be carried out in accordance with Fachverband Konstruktiver Glasbau e. V. Technical Note FKG 01/2019, The visual quality of glass in building – anisotropies in heat treated flat glass.

6.4.7 Laminated Glass

Laminated glass shall comply with EN 14449 achieving Class 1(b)1 to EN 12600. Where the edge of laminate glass is to be exposed, the interlayer material must be shown to be resistant to the effects of moisture absorption, including clouding and delamination. Any delamination that exceeds 15mm from the edge of the glass in non-visible locations, and 8mm from the edge of the glass in visible locations shall be deemed failed and shall be replaced under warranty by the SFC. All laminated glass shall conform to EN12600 (1B1). Where laminated glass is used on the outside of an insulated glazing unit, and the glass edge is exposed the perimeter of the glass shall be carefully considered to minimise the risk of de-lamination that may occur. Maximum delamination during the warranty period shall be 8mm from the edge on visible edges, and 15mm on non-visible edges.

All annealed laminated glass shall be edge worked pre-lamination (smooth-ground to ISO 12543-5 Figure 7, arrised) to ensure even dispersion of self weight when glass is installed in vertical position. Edge finishing shall be to a quality suitable to prevent thermal stress cracking and not less than Specified.

All laminated glass panels shall have a single 'control' edge where maximum displacement between panels shall be 1mm. Maximum displacement on other edges shall be 2mm. This shall be indicated by a removable sticker on the glass during transport and installation. The control edge shall be flush with no step in glass lites to ensure even spread of load.

Laminated glass shall be manufactured using vacuum bagging and autoclave where required as a structural fin element, to achieve a durable product with minimal risk of de-lamination.

The guideline prepared by the Technical Advisory Board of the Institute of Glazing Trade for Glazing Technology and Window Manufacture, Hadamar (IGH, Hadamar) shall be used to assess the visual quality of laminated safety glass. The glass shall be assessed in both transmission and reflection with a maximum viewing angle of 30° between the normal to the surface of the laminated glass and the position of the observer.

6.4.8 Low emissivity coating (including solar control coatings)

Low emissivity coating, if required to achieve the performance criteria specified, shall be positioned on surfaces 2 or 3. It shall be nominally neutral in colour and uniform in tone, hue, colour, texture, pattern and opacity and shall provide a consistent appearance to the glazed units. The emissivity shall be less than 0.2.

Coatings shall be edge deleted in accordance with the coating manufacturer's instructions and this Specification.

6.4.8.1 Colour control

Coatings, in combination with the glass to which they are adhered, shall be uniform in appearance. Where there is a dispute, measurements shall be carried out at the SFC cost using a portable sphere spectrophotometer (X-Rite SP62 or equivalent). The Architect shall select the areas for measurement including the reference panels. Measurements shall be captured in L*a*b* colour values. Delta values shall be ascertained measuring between the 'reference' panel location and the target location. The difference between panels in question and the reference panels shall be represented as a Delta value for each of the L*a*b* colour values and shall be maximum 1.5 for each except where an alternative performance figure has been agreed in advance with the Architect.

Measurement procedures shall be carried out in accordance with the European Association of Flat Glass Manufacturers "Code of practice for in-situ measurement and evaluation of the colour of coated glass used in façade" and EN 1096-1.

The image below is an example of unacceptable colour variation:



Figure 3 Unacceptable colour variation

6.4.8.2 Ceramic Ink Application

Ceramic ink shall be applied to areas of heat-treated glass as indicated on the Contract Documents using the silk screen or digital print process (for patterns) or roll-on (for 100% coverage, spandrel panels). All pigment for one job shall be from one source in one or consecutive batches.

Samples shall be submitted prior to mass-manufacture for review by the Architect. Colour variation shall be as above. All ink application and toughening/heat-strengthening of glass shall be carried out in one location (flat and curved).

Where frit pattern is to be applied to curved glass, the processes of application and baking for flat and glass shall be identical (note this may require double-baking of flat glass to achieve look-alike appearance).

The ceramic ink shall be fused to the surface of the glass during the heat treatment process and be permanent and durable and shall be resistant during the design life of the Works to:

- attack from mechanical damage or abrasion, during normal use and maintenance as specified by this Contract Document.
- weathering, fading, or discolouration due to attack from climatic conditions, UV or atmospheric pollutants.

6.5 Stone

The preferred stone aesthetically selected by the Architect is:

- a) Granite Honed.

6.5.1 General

The Specialist Façade Sub-contractor will be responsible for selecting a stone that meets the specified performance and visual criteria. The Specialist Façade Sub-contractor is to provide proposals for the stones together with any alternatives he may consider appropriate.

Stonework shall generally be designed in accordance with the requirements of BS 8298:2020 Code of Practice for Design and Installation of Natural Stone Cladding and Lining. Final stone and finish selection shall be made by the Architect following sample reviews of the stone proposed by the SFC in accordance with section 5 of this specification.

6.5.2 Source

For each stone type, each surface finish, and each cut (as listed above), the SFC shall submit before signing the contract at least one reference building and 4 visual samples, each a minimum of 400mm square, which are indicative of the visual appearance that is typical of the proposed stone. These samples shall be retained by the Architect and compared against the range samples.

In the case of stone that requires 'seasoning' before it can be used, the SFC shall clearly state how this process is carried out and what the time implications are for the supply of the stone for the project.

Each stone type is to be sourced from a single actively working quarry possessing sufficient reserves under development or available from stock to meet the project's requirements. Before ordering the chosen stone the SFC shall submit an agreement in writing with the quarry owner which will commit the latter to produce the chosen stone in the quantity and quality required by the Contract Documents and at the times required by the programme of the Works.

6.5.3 Range Samples

As soon as possible after award of Contract, the Specialist Façade Sub-contractor shall arrange for a suitable number slabs of the accepted stone types at the thickness proposed for the stone cladding, to be cut from three randomly selected blocks taken from current workings at the quarry, from which the visual range for the project can be defined. Sufficient slabs shall be provided to include all the features which, in the opinion of the stone supplier, are likely to occur in the stone and therefore should be considered in determining the acceptable visual range. These slabs shall then have the specified finish applied and shall be set up in the quarry with a neutral background and orientated facing east or west to enable viewing in shadow or sunlight. Features not represented on these slabs shall not be included in stone supplied for the project.

The Architect shall then visit the quarry (flights and accommodation to be at the cost of the Specialist Façade Sub-contractor), view the finished slabs and agree an acceptable range of colour, veining, blemishes and other relevant visual criteria with the SFC. These samples shall also be viewed both wet and dry. Features considered unacceptable shall be clearly marked on the slabs. At the same time the Architect and the SFC shall agree the steps that shall be taken to ensure the correct tonal distribution of stones in the Cladding.

The SFC shall then arrange for 3 sets of sufficient range samples, of minimum sample dimensions shall be the larger of the average size of piece for the project, or 0.6m x 0.6m for each stone type

to be cut from the accepted slabs, so that three sets of range samples can be provided. All relevant features and characteristics shall be included in each set of range samples such that each set fully illustrates the agreed range. The design team shall reject those features shown in the reference samples which they deem to be unsuitable on visual or technical grounds. One set of range samples shall be set up in the SFC's fabrication yard, one set shall be set up on site, and one set shall be at the stone quarry, all to the satisfaction of the Architect. The remaining slabs marked with unacceptable features shall be set up in the SFC's yard.

The SFC shall use these range samples to assess the visual quality of the stones processed during the fabrication and installation of the Cladding. He shall immediately notify the Design Team of any variations outside the agreed range.

6.5.4 Requirements at the quarry

All stone for each stone type shall be cut from a designated part of the quarry that exhibits consistent mechanical and aesthetic properties.

The extraction of the stone shall be undertaken by experienced and competent quarrymen and they shall use only those techniques and practices which will not impair the performance of the finished product.

Individual blocks shall be given a unique reference number at the quarry indicating the location from which they were removed from the quarry face. A record shall be kept of the date on which individual blocks were numbered.

Should the character of the stone change during the progress of extraction from the quarry, the SFC shall immediately inform the Architect so that an alternative location of working can be agreed. Under no circumstances shall the SFC obtain stone from another quarry or another part of his nominated quarry without the prior agreement of the Architect.

In the case of stone that requires 'seasoning' the SFC shall ensure that sufficient time has been allowed under suitable storage conditions for the stone to achieve maximum strength and durability.

6.6 Gaskets

Gaskets and seals used to achieve the required weather and airtightness shall be selected to fully accommodate the range of dimensional tolerances associated with fabrication and installation of the Works. They shall be formed with materials capable of maintaining their elastic qualities, dimensions and resistance to physical and chemical attack sufficient to maintain the full performance during the design life. Gaskets providing the water and air seals shall be formed into complete frames with factory formed injection moulded vulcanised corner joints.

Gaskets shall be free from contact and migration stain and shall be compatible with all substrate, sealant and finishes with which they are likely to come into contact. The gaskets shall be free of mould flash.

The Specialist Facade Sub-contractor shall comply with the manufacturer's recommendations for specific conditions of use wherever a range of hardness or compressibility is available for a

product. All materials must be compatible with substrate, sealants, finishes and other materials in joint systems.

6.7 Insulation

Thermal insulation shall be inert, durable, rot and vermin resistant, CFC and HCFC free, shall not support mould fungal or bacteria growth and shall provide the specified performance for the service life of the Works. Due allowance shall be made for the reduced performance of insulation due to the effects of moisture and ageing.

Thermal insulation shall be sufficiently robust and cohesive to allow it to be removed and replaced in service without loss of material or performance. It shall not be injurious to human health when being properly installed, when in service and when being removed or replaced.

Insulation materials and any associated adhesives shall be non-combustible or of limited combustibility as specified here-in. Insulation shall be manufactured from external grade mineral wool fibre or equivalent accepted by the Design Team. Where used in a rainscreen, it shall be rigid, and shall not be degraded by the presence of water on its surface.

All insulation within curtain wall systems shall be mineral fibre, not less than 80kg/m³ with a Green Guide rating of A+ or A manufactured in accordance with EN 13162.

Insulation material, contained within curtain walling shall have performance equivalent to not worse than A2-s1,d0 in accordance with EN 13501.

It shall be the responsibility of the SFC to ensure all proposed insulation materials and associated fixings are acceptable to the local authorities and Consulting Fire Engineer.

6.8 Setting Blocks

Setting blocks shall be non-metallic, inert material of an appropriate Shore A hardness. Carbon compounds for fillers and durability agents shall not leach out over time and cause staining.

6.9 Sealant (non-structural)

In general, sealant shall be selected and applied in accordance with the guidelines contained in BS 6213 and BS EN ISO 11600. Sealant shall be:

- a. Silicone sealant
- b. One- or two-part polysulphide sealant
- c. As proposed by the Specialist Facade Sub-contractor to the appropriate British or European Standard, subject to written confirmation being provided by the manufacturer that his product is being used in appropriate manner in an appropriate situation.

Backing rods shall be closed cell polyethylene foam. When closed cell sections are used non-gassed produced shall be selected.

The colour of visible sealant used shall be as agreed with the architect and selected from manufacturers full range, include for colour matching sealant.

6.10 Materials used for Flashings

Flashings shall maintain their performance and properties for the expected service life of the product. They shall resist the deleterious effects of water, agreed cleaning agents, temperature variations expected from the specified temperature ranges, gaseous pollutants (including ozone), weak acids deriving from gaseous pollutants dissolved in water and UV radiation to which they may be exposed during installation and in service.

Flashings shall have appropriate water vapour permeability. The water transmission properties of the material and the complete construction shall preclude the inward passage of liquid water, but permit the release to outside over time of harmful condensation and other trapped water.

Flashings shall have the necessary mechanical properties to withstand installation and specified design loads.

Visible flashings shall be anodised or polyester powder coated aluminium to match adjacent finishes, minimum 3mm thick with folded corners and folded ends.

6.11 Timber

No timber shall be permitted in the façade package.

6.12 Vapour Control Layers Interface Sealing Membranes and Breather Membranes

6.12.1 General

Vapour control layers, interface sealing membranes and breather membranes shall maintain their performance and properties for the expected service life of the facade. They shall resist the deleterious effects of water vapour, temperature variations expected from the specified temperature ranges, gaseous pollutants (including ozone), weak acids deriving from gaseous pollutants dissolved in water and UV radiation to which they may be exposed during installation and in service.

Where flexible membranes are used, they shall comply with Harmonised Standard EN 13984. Data sheets shall follow the sample data sheet indicated below (Table 1 of EN 13984):

Table 1 — Compliance criteria for initial type testing (1 of 2)							
Property	Product type			Parameter	Clause in this document	Test method	Compliance criteria (where required)
	A	B	V				
Water vapour transmission	*	*	*	MDV	5.10	EN 1931	Within declared tolerance of the MDV
Water tightness to liquid water	*		*	Watertight at 2 kPa	5.5	EN 1928	Pass
Reaction to fire	*	*	*	Euroclass	5.12	EN 13501-1 (see Note in 5.12)	Classification
Tensile properties							
- unreinforced sheets	*	*	*	MLV	5.11	EN 12311-2	Greater than or equal to MLV
- reinforced sheets	*	*	*	MLV	5.11	EN 13859-1	
Durability of water vapour resistance against ageing	*	*	*	Not more than ± 50% change	5.7.1	EN 1296 evaluation testing according to EN 1931	Pass

Figure 4 Flexible membrane. Relevant Standards for data to be provided by the SFC

The vapour control layer shall have a vapour resistance greater than the sum of the vapour resistances of the materials used on the cold side of the vapour control layer. The vapour transmission properties of the material and the complete construction shall preclude the inward passage of liquid water, but permit the release to the outside in the form of water vapour over time, of harmful condensation and other trapped water.

Membrane waterproofing systems shall have independent certification of design and performance prepared in accordance with EN Standards and CE certification. The membrane material shall be agreed with the consulting fire engineer.

All membranes shall achieve a minimum classification of European Class B-s3, d0 to EN 13501.

Where an inner vapour barrier and outer weathering/breather, membrane are present in the same wall construction, the vapour barrier shall have a lower permeability than the outer membranes. Where flexible membranes are connected together or to other systems they shall be continuously sealed with overlap orientated to naturally drain and positively bonded. Where fixed to the interfacing structure they shall be similarly continuously sealed and bonded.

Membranes shall not be permitted to free-span more than 50mm in any location. Membranes shall be laid to falls in all locations to prevent standing water and encourage drainage to outside.

Interfacing Sealing Membranes (ISM) are required to provide a weather-proof seal between the SFC's Works and the adjacent construction (approximately 200mm perimeter zone on elevation and full cover of all parapets sealing to interfacing roofing membranes). Breather membranes are not suitable as Interfacing Sealing Membranes. Where interfacing with other membranes, the ISM shall be project specific tested for compatibility with the other membrane for durability of bond and seal without being detrimental to either membrane. Confirmation from each membrane supplier, including the interfacing membrane, required to be provided by the SFC.

6.12.2 Vapour barriers

The material used as a vapour barrier shall be, galvanised steel (where it is warm side of all insulation), stainless steel, aluminium or membrane as noted below:

- a. Proprietary flame-retardant membrane system (including any proposed tapes) compatible with interfacing constructions. The membrane system shall be tested and classified to achieve not less than European Class B-s3, d0.
- b. Membrane compliant with EN 13984, tested to EN 1928, 2kPa for 24 hours, achieving NO LEAKAGE
- c. Where adhesive paste is used, it shall be part of the fire classification of the membrane system. It should be applied to the substrate so that when spread to an even layer it provides a continuous surface for bonding to the full area behind the membrane. Paste adhesive and sealant shall be included in any area where a membrane is penetrated.

- d. Bond widths from membrane to membrane to be in accordance with the manufacturer's instructions, and not less than 30mm (wider where recommended by the manufacturer) taking into account the substrate the membrane is applied onto.
- e. Compatible sealant shall be applied by the SFC in all locations where vapour barriers are penetrated.

Where sheet metal vapour barrier is interfacing with a fire-stop it shall be galvanised steel not less than 1.5mm thick or stainless steel not less than 1.5mm thick.

Where aluminium is used, it shall be not less than 2mm thick.

6.12.3 Interface Sealing Membranes

The material used as ISM shall be, a membrane as noted below:-

- a. Proprietary flame retardant membrane system (including any paste sealants) compatible with interfacing constructions. The membrane system shall be tested and classified to achieve not less than European Class B-s3, d0.
- b. Membrane compliant with EN 13984, tested to EN 1928, 2kPa for 24 hours, achieving NO LEAKAGE
- c. Where adhesive paste is used, it shall be part of the fire classification of the membrane system. It should be applied to the substrate so that when spread to an even layer it provides a continuous surface for bonding to the full area behind the membrane. Paste adhesive and sealant shall be included in any area where a membrane is penetrated.
- d. Bond widths from membrane to membrane to be in accordance with the manufacturer's instructions, and not less than 30mm (wider where recommended by the manufacturer) taking into account the substrate the membrane is applied onto.
- e. Pre-moulded corners to be used to maximise weather performance.
- f. Edges to be lapped to encourage water to cascade to outside and avoid attack of exposed edges.
- g. All exposed edges of membranes to be coated in an adhesive paste to form a perfect seal.
- h. Compatible sealant shall be applied by the SFC in all locations where membranes are penetrated.

6.12.4 Breather membranes

Breather membranes shall be vapour resistant to less than 0.6MNs/g (0.12 Sd) when tested in accordance with BS EN ISO 12572 using the set of conditions C and using five test specimens and shall be capable of resisting water penetration in the anticipated exposure.

The material used as breather membrane shall be, a membrane as noted below:-

- a. Proprietary flame-retardant membrane system (including any paste sealants) compatible with interfacing constructions. The membrane system shall be tested and classified to

achieve not less than European Class B-s3, d0. Breather membrane shall be self-adhesive so that it bonded to the surface where installed.

- b. Membrane compliant with EN 13859 Part 2, tested to EN 1928 method A, achieve not worse than W1 (aged and un-aged).
- c. Where adhesive paste is used, it shall be part of the fire classification of the membrane system. It should be applied to the substrate so that when spread to an even layer it provides a continuous surface for bonding to the full area behind the membrane. Paste adhesive and sealant shall be included in any area where a membrane is penetrated.
- d. Bond widths from membrane to membrane to be in accordance with the manufacturer's instructions, and not less than 30mm (wider where recommended by the manufacturer) taking into account the substrate the membrane is applied onto.
- e. Pre-moulded corners to be used to maximise weather performance.
- f. Edges to be lapped to encourage water to cascade to outside and avoid attack of exposed edges.
- g. Compatible sealant shall be applied by the SFC in all locations where breather membranes are penetrated.

6.13 Cement Particle Board

Cement particle board shall be manufactured in accordance with BS EN 12647:2012 + A1 2016, suitable for exposed environment.

The panel shall satisfy the requirements of Category A, Class 3 to BS EN 12467. Panel thickness shall be not less than 12mm and shall be selected in line with the Specified requirements. The panel shall be through-colour type with cut edges and outer surface matching. All panels shall have an integrated translucent top-coat.

Note, it is recommended not less than 12mm thick panels are provided for resistance to impact from rope access technicians during maintenance and inspection. Final thickness is to be selected by the SFC based on engineering and testing performance.

Cement particle board shall be CE marked in accordance with BS EN 12467:2012. The manufacturer's Declaration of Performance shall meet or exceed the following criteria:

- a) Mechanical resistance Category A, Class 3 (Modulus of Rupture, 8MPa minimum)
- b) Density 1200kg/m³ minimum.
- c) Water permeability Pass
- d) Dimensional variations Pass
- e) Durability against warm water Pass
- f) Durability against soak/dry Pass
- g) Durability against freeze/thaw Pass
- h) Durability against heat/rain Pass
- i) Fire classification (EN13501) A1 minimum.

Boards shall be supported, fixed and jointed, allowing for movement and deflection, strictly in accordance with the manufacturer's instructions. Fixings shall be as recommended by the board manufacturer to limit stress at fixing holes.

7 FINISHES

The SFC shall employ the services of an independent finishes specialist to ensure compatibility of finishes and to agree all quality control procedures prior to application of finishes for the Works. The independent specialist shall visit each finishing facility (including galvanising) to review quality control procedures and confirm compatibility of proposed processes and finishes to meet the requirements of this Specification. Prior to application of ANY finishes, the independent specialist shall provide a report on the proposed applicators confirming compliance with the specification and expert opinion on their suitability for providing the required finishes.

All finishes applicators (including galvanising) shall be ISO 9001 certified and independently audited.

7.1 Stainless Steel Finishes

Stainless steel shall be supplied with finishes to both sheet, cast and rolled components, all grade 1.44xx (316L) as minimum except where used in highly corrosive environments, where Duplex stainless steel shall be used (areas such as chlorine rich environments).

Generally all visible surfaces in stainless steel materials shall be as defined by samples provided by the Specialist Facade Sub-contractor. Finish as specified with maximum surface roughness of 0.4 microns (Ra)(aesthetic reference equivalent to 4N by Outokompu). The direction of the texturing shall be the same in any continuous run of panels and shall be vertical when installed. The stainless steel finish selected shall not discolour during its design life when subjected to normal atmospheric conditions.

Samples are to be submitted for acceptance by the Architect prior to manufacture.

Surface roughness (measured transversely across the grain) shall not exceed 0.4 microns in any areas exposed to external air where stainless steel components are visible.

With the exception of hidden welds, welds shall be fully finished, butt welds shall be finished to a maximum 4mm arris unless otherwise advised, to the above finishes standard.

All stainless steel shall be passivated and chemical cleaned by a specialist stainless steel cleaning contractor appointed by the Specialist Facade Sub-contractor upon installation prior to hand-over.

7.2 Polyester Powder Coating

7.2.1 General

Polyester powder coating on aluminium shall comply with the requirements of Qualicoat where applied to aluminium. They shall comply with the requirements of EN13438 or Qualisteelcoat where applied to galvanised steel.

The external PPC system and applicator shall be certified 'Durable' Class 2 in accordance with Qualicoat requirements. The internal PPC system and applicator shall be certified Class 1 in accordance with Qualicoat requirements.

The Specialist Facade Sub-contractor shall inform the coating applicator where the profiles are intended to be exposed to a corrosive environment. The Applicator shall adjust coating parameters beyond the requirements of the above standards where, in his expert opinion, he

feels it is required to deal with the environment and achieve the required life-cycle durability and warranty.

The coating shall be carried out by an applicator nominated by the Specialist Façade Sub-contractor, approved by the polyester powder manufacturer and agreed by the Architect. The same, single powder coating applicator shall be used for the duration of the Works. If the Specialist Façade Sub-contractor elects to use more than one ppc applicator, all requirements noted here-in are to be duplicated.

7.2.2 Colour

The coating finish colour and gloss levels shall be as per the Architect's requirements.

A colour match is defined within BS 2015 as "paints are said to match if under certain conditions of illumination and viewing, no significant differences in their colour, can be detected". The Architect shall be the sole arbiter regarding what is understood by 'significant' and what can be 'detected' where measured colour variations are outside the manufacturer's guidelines or agreed range demonstrated by range samples. He shall be the sole arbiter regarding acceptance of variations in colour, gloss and hue where they are outside the specified and agreed parameters.

7.2.2.1 Colour measurement

When compared under natural diffuse daylight as described in ISO 3668: 2001, the finish on all visible surfaces shall match the accepted reference samples noted in 7.2.6 below.

Measurements shall be captured in L*a*b* colour values. Delta values shall be ascertained measuring between the 'reference' panel location and the target location. The difference between locations shall be recorded and represented as a Delta value for each of the L*a*b* colour values.

Quality control samples shall be measured prior to going into mass manufacture, by the Specialist Façade Sub-contractor's independent paint inspector. Report of target colour (CIELab) and agreed permissible deviation (L, a, and b) to be issued for agreement prior to mass manufacture of the Works. Periodic measuring by the coating applicator shall also be carried out to the same standards. Confirmation of colour control within the agreed parameters to be provided for each batch of coated material.

7.2.3 Service Life

The minimum functional and aesthetic service life as defined in BS7543 shall not be less than 25 years.

7.2.4 Significant surfaces

All visible surfaces and other surfaces exposed to the external environmental conditions shall be deemed to be significant surfaces. These shall include any drained and ventilated cavities and pressure equalisation chambers.

The Specialist Façade Sub-contractor shall note all significant surfaces on his drawings and provide the Architect with written confirmation from the powder coating applicator that full coverage in accordance with this specification is achieved.

Visible un-coated surfaces shall not be accepted.

7.2.5 Fabrication requirements

Fabrications shall be from pre-finished or finished machine lengths at the recommendation of the powder coating applicator. The Specialist Façade Sub-contractor shall state in his Tender, which he has used. Specialist Façade Sub-Contractor (SFC) shall execute and optimise the detailed design of the curtain wall systems to minimise visibility of exposed areas of un-surface treated metal due to machining or cutting, or unsealed crevices open to the exterior. Optimisation may include provision of end-caps, mitred joints or other means as agreed with the Architect during detailed design development to minimise the visibility of external exposed un-treated aluminium. Any area where coating is carried out after machining, satisfactory jiggling points shall be arranged between the Specialist Façade Sub-contractor and the powder coating applicator. Where necessary, drain holes shall be provided. Two sample joints shall be submitted to the Architect for acceptance, prior to fabrication.

All welds, burrs and other edge machining shall be ground smooth to the requirements of the powder coating applicator prior to coating.

The Specialist Façade Sub-contractor shall ensure uniformity of colour, texture and gloss, on the completed elevations, between adjacent panels and/or components within the accepted Status A control samples. He shall agree with the powder coating applicator, a sequence for coating the various elements in consistent batches. Particular attention shall be paid to small components such as any exposed fixings, plates, snap on cover plates and the like.

7.2.6 Control Samples

Colour control limits shall be submitted during detail design. Prior to the commencement of the powder coating, the Specialist Façade Sub-contractor shall, in conjunction with the Applicator, submit to the Architect for acceptance, the following samples showing the variations in colour and texture:

- a. 5 No. extrusions, typical for the works, each 1200mm long showing the lower and upper range limits.
- b. 5 No. sheets, typical for the works, but each not less than 1200mm x 1200mm showing the lower and upper range limits.

These shall be submitted with associated data sheets confirming the measured colour variations.

Once accepted and given Status A, the Specialist Façade Sub-contractor shall label and sign each sample in five separate locations and arrange for the samples to cut into five equal sizes. The samples shall then be distributed as follows:

1. The Main Contractor
2. The Architect (2 No. samples)
3. The powder coating applicator

4. The Independent Inspector

The respective parties shall keep these for the duration of the Works. The Architect shall use these samples to agree or otherwise any disputed finishes.

7.2.7 Performance Criteria for the Powder Coating

Prior to the commencement of production the powder applicator shall provide a copy of the powder manufacturers certificate confirming that the powder coating complies with the minimum performance requirements stipulated in the relevant Qualicoat Class. In the case of weathering tests, unless otherwise agreed with the Architect; the powder coating shall meet the requirements of both the artificial and natural weathering tests.

7.2.8 Acceptance testing

7.2.8.1 Third party inspection

The Specialist Facade Sub-contractor shall make provision for the independent inspector to attend site to measure colours, and to attend the PPC facility to carry out an initial review of quality control procedures of the ppc coating facility and their ability to match the required colours. In addition to this, allow for a minimum of three acceptance inspections to be conducted by the independent inspection authority per ppc processing facility. The independent inspection authority shall be experienced in the assessment of powder coated aluminium finishes. The Specialist Facade Sub-contractor shall provide details of the proposed independent inspection authority at the time of tender to the Architect for review. If, for whatever reason, third party inspection is not implemented as specified, the Architect shall instruct an independent inspection authority to carry out the specified inspections and shall make a financial adjustment to the Sub-contract sum to cover the costs involved.

In the case of dispute between the powder coating applicator's test results and those of the independent inspection authority, the results of the independent inspection authority shall take precedence. In the event of dispute regarding the acceptability of the colour match, the Architect shall be the sole arbiter.

7.2.8.2 Sampling procedures

Sampling procedures and plans shall comply with BS6001:Part 1 (ISO2859/2) for general inspection Level 2, AGL = 1% on each colour and finish used in the Works. These inspections must be carried out in the powder coating plant prior to fabrication.

7.2.8.3 Testing requirements

Unless specified otherwise, all inspections and tests on the finished coating shall comply with the minimum requirements of the relevant Qualicoat Class.

7.2.8.4 Applicators' certificates

The Specialist Facade Sub-contractor shall provide the Architect with certificates which state that the finish complies with the requirements of this specification.

The Architect prior to the receipt of the Applicator's Certification cannot sign certificates of practical completion, or any other documentation accepting responsibility.

7.2.9 Temporary Protection

Provision of temporary protection shall be limited to that agreed in the Contract with the Main Contractor.

Protective coverings, where applied, shall be resistant to all weathers and be removed from areas inaccessible after installation. They shall be partially removable and replaceable for access to fixing points during installation and/or subsequent site operations.

Any protective tapes used in direct contact with the coating shall be a low tack, self-adhesive type in white or any colour lighter than the coating to be covered. It shall be applied and removed in accordance with the recommendations of the powder manufacturer guidelines.

Protective tapes shall not be kept in contact with coated surfaces for longer than 6 months.

Particular attention shall be paid to any wet applied weathering sealant. The covering shall allow for protection to the sealant during curing and shall not compromise the sealant's long term performance in any way.

Should the protective covering need to remain in place following installation, the Specialist Facade Sub-contractor shall, in conjunction with the Architect agree a programme for monthly inspections and make good/replace the coverings as may be required.

7.2.10 Remedial Works

As a rule, remedial works to polyester powder coated aluminium external surfaces shall not be permitted. Where rectification is permitted to internal surfaces, full frame elements shall be coated. Spot repairs shall not be permitted in any circumstances. Site rectification of damage shall be subject to the acceptance of the Architect and shall only be permitted subject to the submission and acceptance of a specification and method statement endorsed by the powder manufacturer. The rectification of damage shall not invalidate the coating warranty.

All remedial works shall be subject to trials and rejections and shall be at the discretion of the Architect. The Architect shall keep accepted trial samples as control samples. Repair record sheets including elevations indicating coated locations shall be logged by the Specialist Facade Sub-contractor and submitted to the Architect on completion of the works together with the coating Warranty documents.

7.2.11 Maintenance

The Specialist Facade Sub-contractor shall provide comprehensive instructions for the maintenance of the coating. He shall ensure that the recommendations have been endorsed by the powder manufacturer and that, when applied as specified, they shall fulfil the requirements of the coating Warranty.

The recommendations shall include, but not be limited to the following:

- a. Frequency of washing
- b. Solutions/detergents to be used and recommended dilution levels
- c. Type of cleaning materials

- d. Recommendations (if any) for deep cleaning processes (including solutions/compounds etc.) and their frequency

7.3 Anodising Aluminium

7.3.1 General

Anodic oxidation of wrought aluminium shall comply with the minimum requirements of BS3987.

The anodising shall be carried out by an Anodiser subject to the acceptance of the Architect. The same Anodiser shall be used for the duration of the Works. The Anodiser shall operate an ISO 9001 approved quality assurance system.

7.3.2 Materials

Materials shall comply with Appendix C of BS 3987. Sheet material shall be Novellis J57S or equivalent grade.

7.3.3 Significant surfaces

All visible surfaces and other surfaces exposed to the external environmental conditions shall be deemed to be significant surfaces. These shall include any drained and ventilated cavities and pressure equalisation chambers.

The Anodiser shall note all significant surfaces on his drawings and provide the Architect with written confirmation from the Anodiser that full coverage is achieved.

7.3.4 Fabrication Requirements

Fabrications shall be from pre-finished or finished machine lengths. The Specialist Façade Sub-contractor shall state in his Tender, which he has used. Specialist Façade Sub-Contractor (SFC) shall execute and optimise the detailed design of the curtain wall systems to minimise visibility of exposed areas of un-surface treated metal due to machining or cutting, or unsealed crevices open to the exterior. Optimisation may include provision of end-caps, use of profiles anodised after cutting, mitred joints or other means as agreed with the Architect during detailed design development to minimise the visibility of external exposed un-treated aluminium. Any area where coating is carried out after machining, satisfactory jigging points shall be arranged between the Specialist Façade Sub-contractor and the Anodiser. Where necessary, drain holes shall be provided.

The anodic finish is intended to be coloured as indicated on the Architect's drawings.

7.3.5 Control Samples

Prior to commencement of the anodic coating, the Anodiser, shall submit to the Architect for acceptance, the following samples FOR EACH COLOUR showing the variations in colour and texture:

- a. 5 No. extrusions, typical for the Works, each 1200mm long processed in separate batches. These are specifically to define the range.
- b. 5 No. sheets, typical for the Works, but each not less than 1200mm x 500mm, processed in separate batches. These are specifically to define the range.

- c. The SFC shall submit quality control samples of every extrusion for review to demonstrate it is within the agreed range and to demonstrate any draw-lines and weld lines. Visibility of draw-lines and weld-lines shall be minimised.

The CIELab readings for colour and reflectivity of the range samples shall be provided with the samples and associated technical data sheets. Once accepted and given Status A by the Architect, the Anodiser shall label and sign each sample in five separate locations and arrange for the samples to be cut into five equal sized pieces. The sample pieces shall then be distributed as follows:

- The Main Contractor
- The Architect (2 pieces)
- The Anodiser
- The Independent Inspector

The respective parties shall keep them for the duration of the Works. The Architect shall use these samples to agree or otherwise any disputed finishes.

7.3.6 Acceptance testing

7.3.6.1 Third party inspection

The anodizer shall make provision for the cost of a minimum of three acceptance inspections per anodising facility to be conducted by an independent inspection authority.

In the case of dispute between the anodizer's results and those of the independent inspection authority, the results of the independent inspection authority shall take precedence.

7.3.6.2 Sampling procedure

Sampling procedures and plans shall comply with BS 6001: Part 1 (ISO 2859/2), for general inspection Level 2, AQL = 1%. These inspections must be carried out at the finishing plant prior to fabrication.

7.3.6.3 Visual appearance

The visual appearance of anodised aluminium shall comply with the requirements of BS3987.

The Quality control samples noted above shall be measured prior to going into mass manufacture, by the Specialist Façade Sub-contractor's independent inspector. Report of target specular gloss and colour (CIELab) and agreed permissible deviation as achieved in the range samples noted above (L, a, and b) to be issued for agreement prior to mass manufacture of the Works. Periodic measuring by the anodiser shall also be carried out to the same standards. Confirmation of colour control within the agreed parameters to be provided for each batch of anodised material.

7.3.6.4 Sealing Quality

Sealing of the anodic coating shall comply with BS 3897.

The adequacy of the seal for production purposes shall be assessed in accordance with BS 6161: Part 6.

7.3.6.5 Surface abrasion resistance

Surface abrasion resistance shall comply with BS 3987. In cases of dispute, the surface abrasion resistance shall be assessed using the method described in BS EN ISO 12373: Part 9. A minimum of 8 No. samples per colour shall be selected at random from the batch of material suspected of low surface abrasion resistance. Anodic oxide films produced in sulphuric acid electrolytes shall have a wear index of not greater than 1.4.

7.3.6.6 Certification

Inspection certificates demonstrating that all relevant tests required by BS 3987 and this specification have been carried out and that the anodic finish complies with the minimum requirements in all respects, shall be submitted on request, to the Architect for review.

7.3.7 Temporary protection

All metal surfaces are vulnerable to damage during handling and installation or by subsequent site operations. These shall be fully protected for the duration of the Works.

Protective coverings shall be resistant to all weathers. Prior to installation, they shall be removed from areas inaccessible after installation. Where necessary, they shall be partially removable and replaceable for access to fixing points during installation and/or subsequent site operations. Any protective tapes used in direct contact with the coating shall be low tack, self-adhesive type in white or any colour lighter than the coating to be covered. It shall be applied and removed in accordance with the recommendations of the anodiser's guidelines.

7.4 Steelwork Corrosion Protection – Galvanising

The SFC shall inform the galvaniser of the proposed finishes to be applied after galvanising. The selected galvaniser shall be one with experience in galvanising prior to powder coating and shall amend his procedures accordingly to ensure adhesion and durability of the completed finish.

Mild steel components shall be hot-dip galvanised after forming and drilling in accordance with BS EN 1461. The cutting, drilling or working of galvanised components shall not be permitted. Drilling may be permitted where suitable corrosion protection and prevention of rusting can be proven.

The galvaniser shall control dipping rates, temperatures, lifting methods and stacking procedures to ensure distortion, discolouration is minimised, and cracking due to differential expansion is avoided.

All galvanised components shall be subject to the following inspections to ensure freedom from distortion, discolouration, cracking and other imperfections.

- a. 100% visual inspection
- b. Magnetic particle inspection of critical areas agreed with the independent coatings expert.

All inspections shall be recorded.

Any cracked components shall be rejected.

Cut ends or surface working to pre-galvanised sheet steel or any damage to galvanising (hot-dipped or otherwise) shall be repaired with zinc rich paint complying with BS4652.

Galvanising coating to measure not less than 75 microns.

Refer to duplex painted galvanised steel below for all steelwork which is exposed to the external environment.

7.5 Steelwork Corrosion Protection – Paint

Note, paint finish shall only be applied to components that can be proven are not suitable for galvanising.

7.5.1 General

Painting shall follow the requirements of The National Structural Steelwork Specification for Building Construction (NSSSBC) Protective Treatment and Consulting Engineers (refer to relevant documentation). A single source complete paint system shall be used following requirements from ISO 12944 parts 1-8. Surface treatment prior to painting shall be in accordance with BS 7079: Part A1 Two-part epoxy primer shall be applied prior to top-coat and finishing coat.

The painting of the steel elements shall be carried out by an applicator approved by the paint manufacturer. The aesthetic paint finish shall be in accordance with the architectural intent. A complete method statement shall be submitted by the SFC specialist applicator to the Main Contractor for review. The method statement shall describe preparation, coating process and quality control throughout the project including on-site finishing.

Aesthetic and performance reference: AkzoNobel Interthane 870 curtain walling mullions to Leadenhall Building lobby, London.

Aesthetic and performance reference: AkzoNobel Interfine 979 (Acrylic Polysiloxane).

7.5.2 Primers

The paint system primer will comprise two-part epoxy paint finish.

Colours of the primer will be a light grey, red oxide or off white. The colour of the undercoat will be dependent upon the colour of finish chosen by the architect.

As part of the quality control procedures during paint application, primer coats, and build-up coats shall vary in colour and be different to the final desired finish. Each coat is required to be high-contrast to the previous and following layer. This will assist in ensuring each coat is fully applied and that the final paint build-up is evenly achieved on all surfaces.

Where enhanced surface quality finish is applied, compatible fillers shall be applied to the steel surface. The filler material shall be part of the paint system which shall include compatibility and adhesion with all layers to ensure a durable consistent finish.

7.5.3 Finishes

Finish coats may include acrylic urethane or acrylic polysiloxane.

The combined coating and finish will be applied to a thickness that will achieve a C4 Exterior environment as defined under BS EN ISO 12944 and Iso 9223

Abrasion resistance measure approximately 88mg weight loss per 1000 cycles using CS17 wheels and 1KG loading as per ASTM D4060.

7.6 Duplex Paint Systems onto Galvanised Steel

All galvanised steel which is exposed to the external environment shall be painted creating a Duplex system. The selected paint system shall be devised specifically for application onto galvanised steel applied by a specialist applicator with not less than 10 years experience in the application of duplex paint systems (paint application to galvanised steel). Surface preparation of the galvanised steel shall be precisely in line with the manufacturer's instructions and the recommendations/guidelines of the UK Galvaniser's Association.

Surface preparation of galvanised steel options to be followed (or equivalent):

- a. Apply T-Wash (or proprietary equivalent). This is a chemical treatment using a formula of phosphoric acid, ethyl cellulose, methylated spirit, water, and copper carbonate. The process changes the colour of the galvanised surface making inspection and quality control more reliable than other solutions.
- b. Etch primer. It can be difficult to ensure the etch primer has fully reacted with the galvanised surface. This is noted as being less suitable than T Wash or Sweep Blasting for new galvanised surfaces.
- c. Sweep Blasting. Fine copper slag, J blast or carborundum powder may be used with a blast pressure no greater than 2.7bar. Distance of nozzle to surface shall be determined by the applicator based on the applicator's recommendations. Angular iron blasting grit must not be used under any circumstances. Avoid damage to thick galvanised coatings. The resultant surface should have the minimum of zinc oxide removed and present a slightly rough surface for paint application. Sweep blasting should be combined with chemical preparation (1 or 2 above). Prior to painting, all surfaces shall be clear of contamination and moisture that may reduce the adhesion and durability of the final finish. The service life of the completed corrosion protection system shall not be less than 35 years from date of Practical Completion.
- d. Performance and composition reference is Corus paint system E11 (hot-dip galvanise to ISO 1461, Mordant wash, epoxy primer (40microns), high build epoxy MIO (100 microns), recoatable polyurethane finish (60microns). Paint system reference is Akzo Nobel Interthane 870.

8 STRUCTURAL SILICONE GLAZING

8.1 General

The structural silicone glazing shall be carried out by a specialist applicator nominated by the Specialist Facade Sub-contractor and shall be subject to the acceptance of the Architect. Site applied structural silicone shall be avoided. Structural silicone shall apply to anodised aluminium. Application to painted finishes to be avoided. The same specialist applicator shall be used for the duration of the Works. The specialist applicator shall operate a quality assurance system based on ISO 9001. Where structural silicone glazing includes insulated glazing units, the same sealant manufacturer shall provide the structural sealant and the sealant for the insulated glazed unit vapour seals and weather seals.

Structural silicone glazing systems shall meet the performance criteria specified elsewhere in this Contract Document. Verification of performance of the structural sealant shall follow the requirements of the European Organisation for Technical Approvals (ETAG) document 002.

The structural sealant manufacturer shall establish the structural silicone seal dimensions. Guidance on the method of calculation is given in clause 5.1.4.7 in ETAG 002. The need for any mechanical devices in addition to the structural seals holding the glazing shall be established with the Building Control Officer prior to commencement of detailed design by the Specialist Facade Sub-contractor. Guidance on the design of mechanical devices should they be required is given in clause 5.1.4.3 in ETAG 002.

Where insulated glazing units are used as part of the structural silicone glazing, the structural sealant manufacturer shall provide the design of the hermetic seal of the insulated glazed units. Guidance on the design of the hermetic seal is given in section 12 in EN 13022-2.

The design of the structural silicone glazing system shall permit removal and replacement of individual assemblies from the building without affecting adjacent assemblies or supporting framework. The design of the system shall prevent standing water on or adjacent to the structural silicone seals.

Generally all structural silicone glazing shall be carried out off site in factory controlled conditions. On-site structural silicone glazing shall only be permitted in special circumstances and shall be subject to the acceptance of the Architect. Structural silicone application on-site shall be permitted during the construction period subject to the appropriate quality and safety control procedures.

8.2 Materials

Structural silicone sealant shall be supplied from manufacturers who provide a full detailed design and testing service and a warranty for the design of the sealant joint and the material. The material for the whole of the Works shall be supplied from one manufacturer only.

The sealant manufacturer shall provide verification of performance in the form of current test reports or ETA certificates and shall confirm in writing the suitability of the proposed structural sealant for use in structural sealant applications. The verification shall demonstrate that the

structural sealant meets the requirements of ETAG 002. For factory glazing, two component silicones shall be used.

Surfaces to which the structural silicone sealant shall be bonded shall be those described in clause 2.1 in ETAG 002. The sealant shall be compatible with all the materials in direct contact with it, and shall adhere properly to the bonding surfaces on each side of the structural joint.

8.3 Testing

8.3.1 Pre Production Testing and Reviews

The Specialist Facade Sub-contractor through the specialist applicator shall arrange for the structural sealant manufacturer to provide a written structural silicone glazing manual and written confirmation of material testing to be carried out on a project specific basis. The written confirmation and manual shall be submitted to the Architect for review in accordance with the Schedule of Submissions.

The Specialist Facade Sub-contractor shall arrange for samples of all the surfaces to which the structural sealant is to be bonded, to be sent to the sealant manufacturer for adhesion testing. Testing shall be based on the tests described in section 5.1.4 in ETAG 002, where applicable. The Specialist Facade Sub-contractor shall also provide the sealant manufacturer with appropriate technical data from the manufacturers/suppliers of the bonding surfaces, on the durability of the bonding surfaces. The Architect may request meetings between the Specialist Facade Sub-contractor, the sealant applicator, the sealant manufacturer and the bonding surface suppliers to establish that all the relevant technical data has been exchanged and has been clearly understood by all parties.

The Specialist Facade Sub-contractor shall arrange for samples of all other materials in contact with the structural silicone seals to be sent to the sealant manufacturer for compatibility testing. Testing shall be based on the tests described in section 5.1.4 in ETAG 002.

The Specialist Facade Sub-contractor through the sealant manufacturer shall provide the Architect with copies of letters from the sealant manufacturer confirming that he has carried out the adhesion and compatibility tests and found them to be satisfactory. He shall also provide the Architect with copies of letters from the sealant manufacturer confirming that he has checked and approved the Specialist Facade Sub-contractor's structural silicone design and detail drawings. He shall also supply copies of the production-testing regime that the sealant manufacturer requires the Specialist Facade Sub-contractor and structural sealant applicator to carry out in order that the sealant manufacturer can provide a warranty. Guidance on testing regimes is given in Table 10 in ETAG 002.

The Specialist Facade Sub-contractor shall inform the sealant manufacturer of any changes physical or chemical in bonding surface materials and contact materials that may affect the performance of the structural silicone seals. When changes occur, he shall instruct the sealant manufacturer to carry out further adhesion tests and compatibility tests as necessary.

8.3.2 Production Testing

During production the Specialist Facade Sub-contractor shall arrange for the sealant applicator to carry out the production testing required by the sealant manufacturer in order that the sealant manufacturer can provide a warranty. For two-part structural sealant, production testing shall

include glass or butterfly tests, snap tests and mixing ratio measurements. For all structural sealant, adhesion testing shall be carried out using the peel adhesion or the H-piece method.

The Specialist Façade Sub-contractor shall arrange for randomly selected units that have achieved proper cure and adhesion to be de-glazed to check cohesion, adhesion and filling of joints if these are concealed.

The Specialist Façade Sub-contractor shall arrange for the sealant manufacturer to make regular factory inspections to ensure that the production-testing regime is being properly carried out and correctly recorded the project logbook. The sealant manufacturer's records of these inspections together with any non-conformity reports shall be made available to the Architect for review should he request them.

NOTE: Production testing shall include the random selection of individual panels and de-glazing of these for inspection of the quality of structural sealant. In particular, this test is required to demonstrate the structural silicone is free of voids. The SFC shall provide a photographic record and associated report regarding each test. Where voids are discovered, the SFC shall immediately inform the structural silicone supplier and the Architect for direction on how to proceed. Not less than 5 panels shall be selected randomly during manufacture.

8.3.3 Warranty

The sealant manufacturer shall provide a warranty for the structural sealant. Where structural silicone glazing includes insulated glazing units the warranty shall include the hermetic and weather seals in the insulated glazing units.

The warranty shall list the drawings, calculations and details that have been accepted and the production testing that has been carried out.

8.4 Fabrication

8.4.1 Assembly

Generally, structural silicone glazing shall be assembled in a factory with a controlled environment. Sealant shall not be applied, when the temperature is below 14 degC, or above 35 degC, or when the relative humidity is above 85%. Tighter controls may be applied by the structural sealant applicator in line with his quality control procedures. A thermometer and RH instrument shall be adjacent to the ssg application zone and these values shall be measured AND RECORDED minimum 6 times per 24 hour day at equal intervals. The area where panels are stored for curing of structural sealant shall be similarly controlled. Records of temperature and humidity shall be issued on a daily basis during manufacture. Prior to commencement of manufacture, sufficient time shall be allowed for component temperatures to approximate to those of the assembly area in order to avoid the formation of condensation on the contact surfaces.

Assembly shall proceed in accordance with the drawings and method statements prepared by the Specialist Façade Sub-contractor in conjunction with the sealant applicator and the sealant manufacturer and accepted by the Architect. All the components shall comply with the requirements of this Contract Document.

8.4.2 Preparation of bonding surfaces

All bonding surfaces shall be cleaned and primed in accordance with the sealant manufacturer's application specification. A minimum time shall be allowed between cleaning and priming and the application of the structural seal. This time shall be agreed with the sealant manufacturer but shall not be more than 4 hours.

8.4.3 Seal Production

For two-part sealant, glass or butterfly tests, snap time tests and mixing ratio tests shall be carried out in accordance with the sealant manufacturer's requirements. The results of these tests shall be recorded in the project log book as soon as they have been completed

Prior to application of structural sealant, the components shall be set in place and suitably supported to avoid induced stresses being introduced in the seals after curing and following installation on site. Masking tape, spacers and or backing rods shall be installed as required.

Sealant shall be applied to the joint cavity in one continuous operation using a gun or pump and applying a positive pressure sufficient to fill the whole joint without entrapment of any air bubbles and tool the sealant with a light pressure immediately after application.

Following application of the sealant units can either be moved immediately to a storage area before any curing has taken place and left there suitably supported and without any further movement until sufficiently cured and adhesion is fully developed, or left for the same period in the place they were sealed.

Units stored for curing shall be kept under cover and shall not be exposed to direct sunlight, temperatures in excess of 30 deg C or relative humidity in excess of 85%.

8.4.4 Factory Production Control

Notwithstanding the quality assurance requirements of this Contract Document, the Specialist Facade Sub-contractor shall set up factory production control procedures with the sealant applicator and sealant manufacturer specific to the fabrication of the structural silicone glazing assemblies. Guidance on the procedures to be followed can be found in ETAG 002 sub-sections 8.3.2.4 and 8.3.2.5.

Information to be submitted to the Architect for acceptance prior to mass manufacture shall include:

- a) Documentation of the sealant manufacturer's requirements for the particular substrates of the construction including joint sizes, limitations, requirements for mixing, cleaning, surface preparation, priming, testing and application.
- b) Written confirmation from the sealant manufacturer that the sealant manufacturer has reviewed all sealant details and tested the contact surfaces and finds them suitable to use with the proposed sealant. The written confirmation shall also confirm that the sealant will not stain the surfaces to which the sealant will be applied. This written confirmation on suitability, adhesion and staining shall be accompanied by test results on production substrates performed in accordance with the procedures noted herein.
- c) The sealant manufacturer's calculations for structural sealant joint sizes determined from the design wind pressure and panel size using the procedures described herein.

- d) Details of test methods to check adhesion are to be provided and agreed with the Architect.
- e) Glazing procedures including, cleaning, priming (if necessary), gunning, tooling, handling after glazing and curing.
- f) Silicone batch logging procedures to record all batches and their expiry dates, used including batch manufacture, date and arrival date of each batch at the fabrication works. Similar logging procedures are required for solvents and primers.
- g) Details of testing carried out to ensure continued high quality of silicone being used on a weekly or batch basis whichever is the least.
- h) Details of substrate testing carried out on a daily basis to ensure continued high quality of and consistency of silicone adhesion to the substrate.
- i) Frame logging at time of assembly which shall include identifying every panel by a unique number. The position of each panel on the building shall be recorded on a set of elevation drawings prepared by the Specialist Façade Sub-contractor. The glazing record for each panel shall include silicone type, batch reference and date, curing time, date of application, glazier's name, and temperature and humidity measured inside the factory at a nominated time each day.
- j) Details of procedures to deal with non-conformities. The procedure shall provide for the identification of all frames of unacceptable quality and their re-glaze or rejection. When non-conformity is established as a result of a random de-glaze, then the sealant manufacturer shall call for further de-glazing of Cathedral Squares glazed on the same day and using the same silicone batch as the rejected frame.
- k) On completion of the project the Specialist Façade Sub-contractor shall provide to the Architect sets of Quality Management Records and logbook. A copy of the Quality Management Records and logbook shall be included in the Operations and Maintenance manual as a record of the as-built works.

8.5 Transport and Storage

Generally, the requirements for transport and storage shall be as described elsewhere in this Contract document.

Units shall not be moved before the agreed cure time and full adhesion has been achieved. Orientation of panels during storage and transport shall be as agreed with the structural silicone supplier.

8.6 Installation

The Specialist Façade Sub-contractor shall provide for the Architect's acceptance, installation drawings showing where each structural glazing assembly is located. He shall provide for the Architect's acceptance a detailed method statement for lifting and fixing the assemblies to the façade structure, procedures for accurate alignment and installation of weather seals. The method statement shall identify procedures for ensuring that weather seals do not block drainage holes, surfaces for weather seals are properly prepared prior to sealing. It shall also

ensure that any mechanical supports and setting blocks for glass self weight are properly located and design shear stresses in the structural silicone seals are not exceeded.

Experienced and properly trained operatives with normal levels of skill shall carry out the installation. Details of their training shall be made available on request for the Architect to review.

8.7 Maintenance

The Specialist Facade Sub-contractor shall document an ongoing inspection/maintenance programme for the structural silicone and list suitable independent inspection authorities to carry out these inspection works. This shall include acceptable cleaning agents based on the tests described in ETAG 002 sub-section 5.1.4.2.4, frequency of cleaning and cleaning methods to be used.

Details of the frequency of inspections, not less than once every 5 years, the number and location of panels to be inspected at each inspection, the features of the assemblies that should be inspected and tested and the pass/fail criteria. Procedures for dealing with assemblies that do not meet the acceptance criteria shall be described. The Specialist Facade Sub-contractor shall provide inspection forms for the Building Owner to pass on to the independent inspection authority as required. The form shall state the full procedures for the inspection. The independent inspection authority shall be required to produce a report based on its findings and recommendations for any remedial works, and shall submit his report to the Building Owner.

Note, it will be the responsibility of the Specialist Facade Sub-contractor to put the above procedures in place at a time not less than 6 weeks prior to practical completion. However, it will be the responsibility of the Building Owner to ensure the described inspections and maintenance procedures are carried out.

9 QUALITY CONTROL

9.1 Quality Plan

This section sets out the minimum requirements for the production of a Quality Plan for the Works. Much of the necessary documentation should already exist as part of the Specialist Facade Sub-contractor's standard procedures and shall be supplemented where necessary by project specific procedures.

As required by the Schedule of Submissions an outline Quality Plan and a project specific Quality Plan shall be produced by the Specialist Facade Sub-contractor following the principles and guidelines of BS EN ISO 9001 to demonstrate how quality management will be implemented from award of Contract through to Contract Completion.

The SFC shall implement a Inspection Plan and an Inspection Notification Framework (INF, i.e. Quality Control Benchmark Plan) in accordance with the requirements as outlined in Appendix A. The Inspection Plan shall be project and system specific. The SFC shall include all notes / comments from the design review process to their INF and Inspection Plan.

9.2 Quality Control Procedures

The Specialist Facade Sub-contractor shall develop inspection procedures, check lists and audits for monitoring the Works at the various stages.

A clear system shall be implemented to track information flow and check that work is being designed and installed to the most up-to-date revisions of specifications, drawings, interface drawings and this Contract Document.

The documented procedures shall cover but shall not necessarily be limited to the following:

5. Names and CV's of the Quality Manager and his team
6. Quality assessment
7. List of design development drawings required and the rate at which they will be produced.
8. Inspection procedures to be adopted in checking the Works
9. Stages at which checklists will be used and samples of those checklists
10. Statements on works procedures on the correct use of materials and components, both off site and on site.
11. List of product information with latest revisions.
12. Sub-contractors appointed by the Specialist Facade Sub-contractor that are involved in the Works.
13. The SFC's quality systems and details of their checklists.
14. Design, procurement, material checking, fabrication, storage, handling, transport and protection requirements.
15. Procedure for checking compliance with the Contract Documents and with accepted good practice.
16. Procedure for registering and reporting non-compliance.
17. Procedure for ensuring that non-compliance do not recur.

18. Calibration records of measuring equipment.
19. Certification that the Works are considered by the Specialist Facade Sub-contractor to be complete and are ready for inspection by the Architect.
20. Checklist register to ensure that all items have been inspected by the Specialist Facade Sub-contractor and non-compliance discharged.
21. Protection of work in progress and work completed, including primary brackets, seals and fire stops.
22. Compliance with the requirements of the Health & Safety Regulations.

During fabrication, checklists shall include inspection requirements for all components and finishes that cannot be inspected at later stages in manufacture, assembly, or erection of components.

During erection, checklists shall include such items as survey spot checks of primary brackets, condition of components and assemblies and finishes, joint cleaning, backer rod and sealant installation, and fire stopping. Completed quality checklists shall accompany the components at all stages of production up to the final erection on site and be available for inspection at any stage.

The Specialist Facade Sub-contractor shall keep full records of all quality management documents for a period not less than twelve years from Practical Completion. Copies of the quality management documents shall be included in the Operations and Maintenance manual as a record of the as-built works. Detailed method statements as referred to in this Contract Document shall be required before the work commences.

10 FABRICATION

10.1 General

As required by the Schedule of Submissions, the Specialist Facade Sub-contractor shall prepare general arrangement, component and assembly drawings and method statements and shall submit them to the Architect for review. The drawing review procedure is described in the Contract Documents. The Works shall be fabricated in accordance with these drawings and method statements, modified as necessary to meet the requirements of the Contract Documents. The Specialist Facade Sub-contractor's fabrication team shall be involved with the design development.

Materials delivered to the Specialist Facade Sub-contractor's works shall have supporting documentation verifying compliance with this Contract Document.

Methods used in the fabrication shall be selected to achieve the specified performance. Methods used shall be based upon the use of suitable equipment and experienced operatives.

The assembly of components shall be carried out in a factory environment to the extent that it is possible to do this.

Components shall be checked by the Specialist Facade Sub-contractor for compliance with drawings and method statements that have been reviewed by the Architect, prior to assembly in accordance with his quality procedures.

No modification or adaptation of the reviewed drawings and method statements shall be undertaken without the written consent of the Architect. All changes shall be recorded on a master set of documents and shall be included in the Operations and Maintenance manual as a record of the as-built works.

10.2 Stone processing

10.2.1 General

All cutting finishing and edge labours shall be carried out by personnel skilled in the trade, using modern, well-maintained equipment. Stones shall be formed to the required shapes without flaws and defects.

Every precaution shall be taken to ensure that the stone is not subjected to excessive heat generated by any grinding, shaping, drilling or polishing processes. Suitable lubricants shall be used where appropriate to dissipate or reduce the heat generated and shall not cause staining.

Drilling shall be undertaken without the use of percussive tools (both off-site and on-site). Only diamond or tungsten tipped bits shall be used, together with appropriate cooling methods and drill speeds. All drilling shall be carried out in the factory using jigs.

Exposed surfaces and edges shall be thoroughly cleaned of all rust stains, iron particles and cutting fluids.

The Specialist Facade Sub-contractor shall satisfy himself that the dimensions of stone as specified and as shown on the Contract Documents will provide adequate strength to maintain the structural integrity of the individual elements and units at all stages during production,

fabrication and erection. If in the Specialist Facade Sub-contractor's opinion, the prescribed size is insufficient, he shall make this known to the Architect at the time of Tender.

The Specialist Facade Sub-contractor shall supply and maintain all equipment, fit for its intended purpose and capable of achieving the tolerances prescribed.

10.2.2 Off-Site Design and Processing

All stone cladding thicknesses, and processing for fixings shall be prepared off site and under strict manufacturing and quality control conditions using machinery and tools that will ensure that cracks in the stone do not result from the process. Manufacture of these shall be made in accordance with the current edition of BS 8298 and any deviation from these must first be identified to the Architect.

Any stone cladding fixing methodology, shall be calculated, designed and fixed by the Specialist Facade Sub-contractor in accordance with the recommendations found within BS 8298 and any deviation from these must first be identified to the independent Geologist and Architect for acceptance. The backing structure must be capable of supporting the stone cladding under full design loadings (wind, dead, barrier, maintenance, etc). The SSS shall submit calculations illustrating locations and quantities of loads applied to the backing structure by the stone cladding for acceptance by the project consulting Structural Engineer.

The size and thickness of the stone elements, location and size of the cut-outs shall be designed to comply with the current BS 8298: 2020. Any deviation to the sizes and or thickness shall be proven via published calculations and testing. A location mark is to be placed upon each stone and in co-ordination with assembly drawings.

10.2.3 On-Site Stone Processing

Should site cutting be required the SSS shall advise all parties and provide detailed method statements for acceptance prior to carrying out any work. No site working of stone shall be permitted on scaffolding without prior agreement of the Architect.

Site cutting and any other on-site machining of stone pieces shall be subject to the same quality control and cutting procedures as off-site (SSS to allow for suitable machinery to match off-site machining processes on site and avoid the use of percussive tools). Machining processes to be covered by a method statement. The method statement shall be endorsed by the consulting independent Geologist and submitted for acceptance by the Architect.

10.3 Assembly

10.3.1 Framework

Grinding, cutting and shaping of metals shall be carried out using tools which will not contaminate them with particles which could stain or corrode them.

Joints shall be accurately formed without lipping or offsets in visible surfaces unless designed otherwise. Other joints shall be rigidly secured to prevent all but designed movement, unless shown otherwise.

Metals shall be welded in accordance with the relevant standards using methods to avoid distortion. The type, size and spacing of welds shall be shown on drawings and reviewed by the Architect, prior to fabrication.

Welds shall be fully bonded throughout their length without holes, inclusions, cracks or porosity so that the long term performance is not compromised and the welds are strong enough for the design requirements. The welds shall be ground smooth and flush with the adjoining surfaces where visible or impinging on other work. Site welding shall not be carried out. The completed welded construction shall be finished to prevent corrosion. All welds shall be cleaned as necessary to ensure the durability of the connections.

10.3.2 Mild Steel for Hot Dip Galvanising

Mild steel cut or shaped by either flame cutting or Plasma cutting shall be to procedures agreed by the Architect. These procedures shall demonstrate that the surface hardness is less than 270 Hv10. Random inspection of the steel shall be required to ensure that the hardness level is not exceeded. Alternatively, all cut edges shall be surface dressed to remove hardened material.

All welding procedures and welding procedure specifications shall limit the hardness in the weld, parent metal or heat affected zone to less than 270 Hv 10.

Following pickling operations, the steel shall be held at more than 100 deg C to ensure a uniform temperature, either prior to, or after fluxing.

10.3.3 Cutting, Drilling and Milling

Arc cutting and acetylene gas cutting shall not be used.

Pressing and folding

The folding and forming of aluminium sheet shall be carried out over dies or mandrels with the minimum radii recommended by the Aluminium Federation in such publications as The Properties of Aluminium and Its Alloys and The Designer's Guide to rolled Aluminium, Part 2. Trial bends shall be made on scrap material of the alloy, temper and thickness being used to ensure that it is not cracked, torn, unevenly stretched or separated at grain boundaries.

10.3.4 Welding of Aluminium

Welding procedures shall comply with BS EN 288-4.

Welders shall be certified to BS EN 287.

Welding shall comply with BS EN 1011-4.

Welding shall be tested in accordance with BS 3451, BS EN 895, BS EN 910.

All stud welding shall be by the capacitor discharge process on freshly cleaned, degreased and oxide-free base metal shielded with argon gas, 99.95% pure, in accordance with Recommended Practice for Stud Welding by the American Welding Society.

10.3.5 Welding of Steels

Welding procedures shall comply with BS EN 288-3.

Welders shall be certified to BS EN 287.

Welding of carbon manganese steels shall comply with BS EN 1011-2.

Welding of stainless steels shall comply with BS EN 1011-3.

Testing of welds shall comply with the National Structural Steelwork Specification, 3rd Edition.

10.4 Sealant Application

10.4.1 Sealant Application (Non-Structural)

Sealant shall be applied to clean surfaces, primed as necessary, in accordance with the manufacturer's recommendations and procedures following adhesion and application tests. Conditions of application and cure shall be conducive to producing satisfactory results and avoid undue stress in uncured material.

Quality control adhesion tests shall be carried out throughout the period of manufacture to monitor the effectiveness of the material and application techniques.

Sealant shall be applied over bond breakers/backer rods, set into the joint to control the depth of sealant and to prevent three-sided adhesion.

Backing rods shall be selected and used strictly in accordance with the sealant manufacturers' recommendations.

10.4.2 Sealant Application (Structural)

Structural sealant requirements are described elsewhere in this Contract Document.

10.5 Glass

10.5.1 Preparing Panes of Glass

Annealed glass panes, including those for insulated glazing units, shall be cut to size in the factory by scoring to produce clean cut edges.

The edges of all panes and insulated glazing units shall be inspected during processing and before and after installation in their frames. Any edges with defects likely to initiate cracks in service including feather (shark's teeth) or whisker (serration's) deeper than half the thickness' of the pane, vents (flake chips) greater than 4mm across, or impact damage shall not be incorporated in the Works.

10.5.2 Preparing Insulated Glazed Units

All insulated glazing is to be hermetically sealed insulated units to comply with EN 1279 (all parts) and have a predicted design life of at least 25 years. The insulating glass unit manufacturer shall be registered to ISO 9001 and hold a Kite Mark licence or equivalent for all of its units (CE marking). He shall be independently audited for compliance with EN1279 (all relevant parts). The Specialist Façade Sub-contractor shall prepare a detailed technical submission for all IGU types, which shall included data sheets of selected components, EN 1279 certs and test reports for their proposed composition.

The spacers separating the panes of glass shall have a black finish and shall have adequate rigidity for their purpose (including during the manufacturing, transport and installation stages). They shall be specifically designed to accommodate the seal and contain desiccant, allowing both to operate at maximum efficiency. Warm edge technology spacers shall be used to achieve the required U values.

All bent edge spacers shall be limited to a maximum three joints in any one assembly. Spacer pieces shall not be less than 200mm in length. Joints shall not be allowed within 50mm of any corner.

- a) The solar control coating (where applicable) shall be uniformly edge deleted or masked to ensure it does not overlap the primary polyisobutylene seal completely covering it. A minimum of 2mm of primary seal shall be in direct contact with the un-coated glass at all times around the perimeter of the glass.
- b) Particular care shall be taken where the perimeter primary and secondary seals are exposed (visible). In this case it is required that NO coating residue is visible beyond that which is agreed on quality control samples. This shall be recorded on quality control samples prior to going into mass manufacture.

The units shall have and a secondary two-part structural silicone seal extending around the perimeter of the insulated glazing units.

All breather/feeder tubes shall be nipped closed.

The units shall not employ edge tape. The edges shall be finished in a way which permits visual inspection of the glass edge, edge seals and the positions of the spacers.

Safety glass shall be marked in accordance with the requirements of BS 6262-4 and applicable Harmonised Standards. Marking shall be legible when read from inside. They shall be located in the bottom left hand corner of the insulated glazed units when viewed from the inside to the outside. Inner and outer lites shall be labelled to indicate construction of each (including annealed glass, ie. All safety glass to have appropriate markings including laminated annealed). Prior to going into mass-manufacture, the Specialist Façade Sub-contractor shall provide samples of glass with proposed stamps. These shall include UV ink marking of heat soak tested glass.

Spacer bars shall follow the line of the perimeter of the glass with equal dimension on all sides or as shown on the Specialist Façade Sub-contractor's drawings, all within agreed tolerances. Spacer bars shall have the following straightness:

±1.5 mm on length of spacer

10.6 Gaskets

Gaskets shall be jointed as per the relevant system hand-book and applicable weather performance test reports. Gaskets shall not be jointed by bonding with adhesive and are not accepted as a substitute for moulded frame gaskets if the tested system used vulcanised ring gaskets. In the event that adhesive bonded joints are required to be formed, this shall be brought to the attention of the Architect for review before such work is carried out.

All gasket frames should be normally manufactured to a small but predetermined oversize tolerance, to ensure that when seated into position, the lineal lengths and corners of the gaskets are in slight compression.

Gaskets shall be installed in accordance with the manufacturer's recommendations and utilising the correct tools.

10.7 Fabrication Tolerances

10.7.1 Framework, including Louvres and Brise Soleil

The maximum allowable tolerances for all framework shall be:

±1.0 mm on length on profiles

±1.0 mm on straightness of profiles

±1.0 mm on straightness of carrier frames

10.7.2 Metal Panels including Parapets

The maximum allowable tolerances for metal panels shall be as follows:

	Type	Tolerance
a)	Width or Length	0.8 mm up to 1200 mm 1.6 mm from 1200 mm to 3660 mm.
b)	Squareness	3 mm difference of diagonals for panels up to 1200 mm. (up to 1000 mm width). 4 mm difference of diagonals for panels from 1200 mm to 3000 mm (up to 1500 mm width).
c)	Camber	0.8 mm up to 1200 mm 1.6 mm from 1200 mm to 3660 mm.
d)	Panel Local Bow:	0.1% of panel minimum dimension in width and length up to 2.0 mm maximum deviation from a 1m straight edge.
e)	Panel Local Bow:	0.1% of panel minimum dimension in width and length up to 6.0 mm maximum deviation from a straight edge

The Specialist Facade Sub-contractor shall submit a full size quality control sample of each metal panel size prior to mass manufacture to set the maximum allowable tolerances. Quality control samples that fail to meet the design intent to the satisfaction of the Architect or fail to achieve the tolerances specified shall be rejected and additional samples shall be provided. Samples shall be presented in the required orientation to best demonstrate how it will appear in the Works. The Subcontractor shall ensure all components are measured and that those measurements are

recorded in an auditable manner confirming compliance with the tolerances specified and achieved by the quality control samples.

10.7.3 Glazing

The allowable tolerances on individual panes of glass shall be:

±2.0 mm on height and width

±1.0 mm on straightness of edges

Maximum overall bow measured edge to edge (deviation from design curve or flat surface) (Total) - (L/500 measured along the internal surface of the glass, and design curve template) up to a maximum of 5mm.

The maximum allowable tolerances on flat insulated glazing units shall be those given in this Specification and EN1279.

10.7.4 Frames Bonded to Glazing (including spacer bars)

The sizes of an assembled frame shall be within ± 1mm from the work sizes and the maximum difference between the diagonals of the assembled frame shall be 4mm.

For flush joints formed by mechanical means, any in-plane deviation shall be within the tolerance limits set by the extrusion tolerances given in EN 573, EN 755 and EN 12020.

10.7.5 Stone

The allowable tolerances on individual stone pieces shall be:

- ±1.0 mm on height and width
- ±1.0 mm on straightness of edges
- 2.0 mm differential on length of diagonals
- 2.0 mm on thickness.

Note, stone pieces to be machined on rear surface at reveals and interfaces in order to ensure control of dimensions. Thickness tolerances shall be eliminated where required by CNC machining.

10.8 Material Protection Prior to Site.

Materials, assembled units, elements of framing and all components shall be protected in such a manner that will prevent damage, distortion, uneven weathering or degradation under normal conditions of handling, storage and installation. Particular attention shall be given to the protection of edges, projecting features, corners and other vulnerable areas.

The Specialist Facade Sub-contractor shall allow for provision of tape fully covering all aluminium, glass and other finishes. The SFC shall be responsible for maintaining and replacing such protection as is deemed necessary. Any damaged materials shall be dealt with as identified in this Specification.

11 HANDLING & STORAGE

11.1 General

The Specialist Facade Sub-contractor shall provide a method statement detailing the proposed methods of storage and handling, including transportation. This shall clearly demonstrate that all possible steps have been taken to minimise the risk of damage to fabricated panels.

The method statement shall include:

- a) Details of manufacturer's requirements for the correct storage of materials and components, in the factory and on-site prior to erection, and protection at all times.
- b) Details of temporary support arrangements for the assemblies, both on and off site.
- c) Details of lifting arrangements (including structural calculations verifying structural adequacy for DGU elements such as spacer bars and primary seal between spacer bar and glass during lifting, storage, transportation and installation).
- d) Transportation arrangements

Materials, assembled units, elements of framing and all components of the permanent Works shall be protected and stored in such a manner that will prevent damage, distortion, uneven weathering or degradation.

All elements and components shall be clearly labelled for identification and traceability.

Inspection shall be undertaken in line with the agreed quality procedures for elements and components prior to their use. All damage shall be recorded and remedial procedures agreed with the Architect prior to incorporation into the Works.

12 INSTALLATION

12.1 General

12.1.1 Documents

As required by the Schedule of Submissions, the Specialist Façade Sub-contractor shall prepare installation drawings and method statements and shall submit them to the Architect for review. The drawing review procedure is described in the Contract Documents. The Works shall be installed in accordance with the reviewed drawings and method statements, modified as necessary to meet the requirements of the Contract Documents.

Methods used in the installation of the Works shall be selected to achieve the specified performance. The equipment and operatives employed in all stages of installation shall be appropriate to the methods adopted.

The method statement shall set out the Specialist Façade Sub-contractor's procedures including programme, sequence of erection, temporary works, dealing with adverse weather conditions, tools and plant, ancillary materials, labour, protection, co-ordination with other elements of work, and regular inspections. Installation drawings, method statements and quality control procedures shall be supplied to the site installation team. The Specialist Façade Sub-contractor shall co-ordinate between the site installation team and the works suppliers and his own designers and site staff so that all those parties are made aware of the important items to be checked during installation.

The installation drawings, method statements and procedures shall detail all the elements used to construct the Works and shall clearly describe all operations including the following:

- a) Setting out and control points.
- b) Cross reference to the identification of elements.
- c) Details of isolation and packing.
- d) All joints requiring sealant together with details of cleaning and, if required, priming of surfaces.
- e) Details of position, type and size of backing rods and bond-release tapes etc.
- f) The tolerances to be achieved in the location of elements and the alignment of joints.
- g) All fixings requiring specific torque
- h) Details of equipment necessary to lift elements and components onto the building and to hold, line and level them once they have been positioned on the building.
- i) Details of points that are susceptible to damage or should not be loaded during installation.
- j) Details of protection.
- k) Position of all hidden fixings.
- l) How all Health & Safety requirements are incorporated into the installation process.

No modification or adaptation of the agreed drawings and method statements shall be undertaken without the prior agreement of the Architect. All changes shall be recorded on a master set of documents and shall be included in the Operations and Maintenance manual as a record of the as-built works.

12.1.2 Site Work

The Specialist Facade Sub-contractor shall employ only competent experienced installers to carry out the Works. He shall provide and maintain records to demonstrate his employees experience and all related training.

The Works shall be installed to the dimensions indicated with the permissible deviations estimated by the Specialist Facade Sub-contractor and marked on his drawings. These permissible deviations shall be confirmed to the Architect by the Specialist Facade Sub-contractor during his detailed design development stage and be appropriate for the materials and methods employed to achieve the project requirements for appearance and fit as specified in the Contract Documents.

As installation proceeds, the Specialist Facade Sub-contractor shall check the work and shall record all non-compliance. Remedial proposals shall be reviewed and agreed with the Architect as soon as possible after the problem has been identified.

The Specialist Facade Sub-contractor shall not cut, drill or otherwise alter any work without review by the Architect.

12.1.3 On-site control Samples

The standard of workmanship for the Works shall be to the standard established by the reviewed off-site and on-site quality control samples. Until the Architect has accepted the control samples, the Specialist Facade Sub-contractor proceeds with further installation work at his own risk. Upon acceptance, the on-site control samples shall remain as part of the Works. The Architect shall reject all workmanship that falls below the accepted standard.

12.2 Tolerances

12.2.1 Building Frame Tolerances

The Specialist Facade Sub-contractor shall establish the anticipated tolerances for the building frame and shall allow for these tolerances in the design of fixings and components such that the Works are always within the tolerances specified herein.

The Specialist Facade Sub-contractor shall be responsible for obtaining any further tolerance information he may require having taken into account all criteria which in his specialist knowledge are relevant to the design and installation the Works.

The SFC shall ensure Cathedral Square contractor is informed regarding the permissible tolerances of cast-in fixings, plates and channels.

12.2.2 Site Survey

The main contractor shall be required to provide the SFC with survey information confirming the location of all primary structure elements including cast-in features for connection of the facades. The Specialist Facade Sub-contractor shall check the position of all elements of the building structure and other work that interfaces with the Works during the Specialist Facade Sub-contractor's detailed design development period to verify their compliance with the Contract Documents. He shall do this by undertaking a line and level survey of the preceding elements of work including the details of points of attachments for the primary brackets where appropriate. He shall do this as soon as possible and shall submit the results to the Architect without delay.

Should the Specialist Façade Sub-contractor find the preceding elements of work including any prepared fixing points to be outside the tolerances he anticipated and allowed for, he shall inform and review with the Architect his proposed remedial action.

The SFC shall allow for site survey of cast-in elements that he has free-issued to Cathedral Square contractor for inclusion in the primary frame. Survey shall be during incorporation into the structure and after pouring of the concrete. He shall report to the Main Contractor any cast-ins that are outside agreed tolerances and agree remediation measures prior to installation of façade elements.

12.2.3 Accuracy of erection

The Works shall be installed to the following permitted deviations (non-accumulative):

- (a) Line: ± 2 mm in any one storey height, or structural bay width.
- (b) Level: ± 2 mm in any one structural bay.
- (c) Plumb: ± 2 mm in any one storey height.
- (d) Plane: ± 2 mm in any one storey height or structural bay width.

Intersection: 3mm in alignment in any direction between any two adjoining panels, at a 2-way/4-way intersection of panels.

12.2.4 Accuracy of Junctions Between Components

Joints between components shall be constructed to the following permitted deviations:

Within the length of any joint (including in line continuations across transverse joints) the greatest width shall not exceed the least width by more than 25%. Any variation shall be evenly distributed with no sudden changes.

The offset end elevation between nominally in-line edges across a transverse joint shall be not more than 20% of the width of the transverse joint.

The offset in plan or section between flat faces of adjacent panels across any joint shall not be more than 20% of the width of the joint.

12.3 Fixings

ALL fixings shall be locked to prevent loosening over time. Reliance on torque alone shall not be permitted.

Fixings including primary fixings to the building structure shall be installed in accordance with the fixing manufacturer's recommendations and required procedures, where necessary following site trials and tests. The details of primary fixings including the following shall be checked and recorded:

- (a) Type of proprietary fixings, their size and location
- (b) Embedment, spacing and edge distances
- (c) Torque levels

- (d) Locking washers or nuts and engagement of serrated washers.
- (e) Isolation of dissimilar metals and of mill finish aluminium from cementitious material in wet environment.
- (f) Whether the fixing was tested or not. If tested, results of test.

For all bolt assemblies the strength grade combination of bolts/nuts/washers shall be as prescribed or recommended in the relevant British Standard.

The Specialist Façade Sub-contractor shall secure all nuts used in connections to prevent loosening during the life of the Building.

The length of bolt shall be such that at least one clear thread shows above the nut after tightening, and at least one thread plus the thread run out shall be clear between the nut and the unthreaded shank of the bolt.

Where site drilling, cutting, grinding etc is carried out all swarf shall be removed and all surfaces left clean.

12.4 Glass

12.4.1 General

Glazing shall be carried out in accordance with manufacturer's recommendations, which shall take into account the recommendations of the Glass and Glazing Federation, and the requirements of BS 6262, and BS 8000-7.

Setting blocks and anti-walk devices shall be installed in accordance with the requirements of BS 6262, modified where noted in this specification.

It is envisaged that large panels of glass will be gravity supported in locations outside those described in BS 6262. The Specialist Façade Sub-contractor shall provide calculations to justify the support conditions.

No grinding or welding shall be permitted within 10m of unprotected glass.

12.5 Gaskets

Gaskets shall be installed as described elsewhere in this Contract Document.

12.6 Insulation

Insulation shall be installed as shown on the Specialist Façade Sub-contractor's drawings in accordance with manufacturers' recommendations. It shall be held in place by non-ferrous fixings mechanically attached to the supporting components. Installations relying upon adhesives only shall not be permitted except where specifically agreed in advance. Where mechanical fixings pass through waterproof membranes or vapour barriers, they shall be properly sealed to the waterproof membranes or vapour barriers.

The method of attachment to the supporting components shall be selected to eliminate the risk of bulging, sagging, delamination or detachment of the insulation. It shall be installed so that there are no gaps or lips between individual pieces of insulation or between insulation and any penetrations through the insulation.

12.7 Waterproofing Membranes

Membranes shall be fixed mechanically and with adhesives to the backing components. They shall be formed into shapes compatible with the building interfaces. They shall be sealed at all joints, and fixing penetrations.

The closures of junctions shall be formed of the membrane, on its own for narrow gaps (50mm and less) and in combination with aluminium alloy sheet for wider gaps where support is required to prevent flapping under wind loading.

All joints between membranes shall be made by gluing and clamping them together where they are supported by a firm substrate and by gluing, vulcanising, solvent welding or heat welding them together where they are unsupported along the line of the joint.

Aprons and collars around windows and glazed walls shall be made completely continuous by gluing, vulcanising, solvent welding or heat welding the joints between their various segments.

The membranes shall be attached to the supporting components by sealing and clamping them to the supporting components. The clamps shall be sufficiently stiff and shall be fixed with fasteners sufficiently close together to maintain a complete seal and sufficiently strong to resist any design wind load on the barrier.

In all cases membranes shall be laid up in a manner to ensure natural drainage preventing ponding and preventing top edges of membrane from being exposed.

12.8 Finishes

Surface areas likely to be damaged during installation or by other Contractors shall be fully protected until completion of all work in the area of the installation. If during installation any damage does occur, this shall be rectified by the Specialist Façade Sub-contractor, progressively and shall not be allowed to accumulate. The Specialist Façade Sub-contractor shall report all damage and these reports together with the Specialist Façade Sub-contractor's proposals for rectification, shall be submitted to the Architect for review.

Where significant surface damage occurs to cosmetic clip-on components, such components shall be removed and renewed.

12.9 Protection and Cleaning

Protection from the following trades or operations shall provide specific protection from the anticipated hazards. In particular vulnerable coated surfaces, glass, metal edges, corners and features shall be protected internally and externally.

He shall include provision of protective sheeting or similar robust covering to glass and metal to full height above finished floor. The Specialist Façade Sub-contractor shall be responsible for maintaining and replacing such protection as is deemed necessary (not less than noted above) for the duration of the project until hand-over to the Main Contractor. At hand-over, he shall remove all protection, clean down and present the Works for inspection. Any damaged materials shall be dealt with as identified in this Specification.

Unless agreed otherwise protection should remain in place until all work potentially damaging to the components or their finish has been undertaken.

Materials used for temporary protection shall be compatible with the surface and finishes. They shall be removed without detriment to the finish and the component suppliers and finishers shall approve methods for removal.

Removal of protection and cleaning of the Works shall be carried out on completion unless agreed otherwise.

12.10 Visual acceptance criteria (installed Works)

Viewing shall be for maximum 2 minutes per panel in natural light excluding direct sun-light:

12.10.1 Visual Acceptance Criteria (glazing)

- a) When viewed at 1m from the finished glazing (excluding frames) and at any angle or direction from perpendicular, through to 30 degrees from the façade face for 20 seconds per m2 in diffuse light: -
- b) Apply Hadamar criteria for visible scratches, chips, white scars and sleeks.
- c) Apply Hadamar criteria for visible bubbles, ripples, pimples and inclusions.
- d) Optical distortion in excess of that demonstrated in off-site quality control mock-ups and samples shall not be accepted. If no samples were submitted, the Specialist Facade Sub-contractor shall ensure no optical distortion occurs.
- e) Rollerwave and edge-dip to be within specified limits.
- f) Colour of glass panels shall be uniform across an entire elevation and across a single panel, within agreed parameters.
- g) Visible dessicant or any other intended features within the gap between glass panes shall result in rejection.
- h) Defects within enamelled glass shall be within the criteria set out by Bulversband Flachglas 'Guideline for assessing the visual quality of enamelled glass' (Bulletin 015/2013).

12.10.2 Visual acceptance criteria (metal)

When viewed from outside, at 1m from the finished opaque metal cladding (including soffits) broadly in accordance with CWCT TN36 and TN34 at any angle or direction from perpendicular, through to 30 degrees from the cladding face for 20 seconds per m2 in diffuse light:-

- a) Visible scratches shall be deemed unacceptable.
- b) Visible bubbles, ripples, pimples and inclusions shall be deemed unacceptable.
- c) The panel surface shall appear flat from edge to edge in all conditions including direct sunlight. At 15 degrees Celsius surface and air temperature in a shaded location the panel surface shall be measured and confirmed to deviate less than 2mm from a straight edge. Straight edge to be minimum 1.5m long held up against the panel surface.
- d) Surface deformation such as oil-canning shall not result in visible rippling or bowing of the panel. Panel retention systems and stiffener application shall be designed to minimise this phenomenon and prevent locking in of stresses (see off-site quality control samples for initial quality assurance)

- e) Colour, hue, and gloss level of panels shall be uniform across an entire elevation and across a single panel/profile within agreed parameters.

12.11 Stone

12.11.1 General

Stone installation shall be carried out in accordance with manufacturer's recommendations, which shall take into account the requirements of this Specification. Note, these exceed the minimum requirements set by the Stone Federation.

No grinding or welding shall be permitted within 10m of unprotected stone.

12.11.2 Visual acceptance criteria

When viewed at 2m from the finished stone installation and at any angle or direction up to 45 degrees from perpendicular to the stone surface:

- a) Visible discolouration, scratches, notches, scars and chips shall be deemed unacceptable.
- b) Visible voids and inclusions beyond those agreed during sample acceptance shall be deemed unacceptable.
- c) Visible scratches and sleeks shall be deemed unacceptable.
- d) Colour shall be uniform within agreed tolerances set by off-site samples. Batch mixing shall ensure even spread of features, preventing 'bunching' of similar panel types.
- e) Joints to be even and straight. Sealant filling to be uniform in appearance. Movement joints to be uniform.

The Architect shall be the sole arbiter regarding the acceptability of any items listed above.

13 MAINTENANCE

13.1 Operations and Maintenance Manual

The Specialist Facade Sub-contractor shall produce an Operations and Maintenance manual for the Works. A draft copy of the proposed manual shall be submitted to the Architect not less than six weeks before the programmed date for Completion. The manual shall be developed in parallel with the design and shall include, but not be limited to, the following information:

- a) The name, address and telephone number of each firm and/or Contractor involved in the supply or fabrication of materials, components, assemblies and finishes.
- b) A clear and concise description of the construction used to form the various elements within the Works. It shall be set out in chapters dealing with each element in turn. Its contents shall be comprehensively tabulated and its text cross-referenced. It shall be illustrated with sketches and Trade Literature and shall refer to the 'as-built' drawings.
- c) Copies of material, components and finishes certification and test reports as required by the Contract Documents.
- d) A method statement showing the means of access to all parts of the Works with recommended safe loading for regular maintenance.

- e) A method statement covering the procedures for replacement of damaged or otherwise defective materials or components, and materials and components that have a design life less than the design life of the Works and will therefore require replacement during its life. Provide confirmation of the proposed glass replacement strategy for each part of the Works. Include detailed recommendations of access strategies and lifting methodology including proposed machinery, working platforms and safety systems. To include detailed structural calculations and loading requirements.
- f) Quality management record sheets including records of repairs to coatings.
- g) Recommendations and procedures for inspections, routine maintenance, lubrication, cleaning, suitable cleaning agents and painting.
- h) A full set of as-built construction drawings, updated to include any changes made up to the time of completion.
- i) The terms and conditions of any Warranties. Note that all Warranties for finishes shall be valid for periods of one year between cleaning.

Following hand over of the Building at Completion, the Specialist Façade Sub-contractor shall allow for providing an experienced member of staff to familiarise the Facilities Manager of the Building with the use of, and information contained within, the Operations and Maintenance manual.

13.2 Maintenance and Defect Records

During the defects liability period (12 months from date of Practical Completion) if any defects in the Works are identified, the Specialist Façade Sub-contractor shall be responsible for rectifying these. If a defect is identified during this time, the SFC shall start and maintain an auditable Defects Register. The Defects register shall include, but is not limited to, the following information:

- a) Reference numbers for ease of tracking each defect
- b) Identification of the location of the defect, clearly indicated on A3 drawing giving grid referenced plan, section and elevation
- c) Identification of type of defect (eg. failure of handle, leak, glass breakage etc.)
- d) Date that defect was detected.
- e) Dates of inspections of the defect and reports of findings (one per inspection)
- f) Formal proposal for rectification of the defect (multiple proposals to be recorded if initial proposal is not successful)
- g) Record of Client and Main Contractor formal acceptance of 'a'-'f' above (required prior to carrying out any remedial actions)
- h) Record of inspection of remedial action and confirmation that the action has been successful in resolving the defect. Note, this statement shall include confirmation that the warranty and insurances for the completed works as provided at Practical Completion has not been compromised by the remedial actions To be signed by the Specialist Façade Sub-contractor and Main Contractor, countersigned (if accepted) by the Client.

The Maintenance register shall include, but is not limited to, the following information:

- a) Schedule for regular maintenance with identification of what actions are to be undertaken at each interval.
- b) Sign-off sheet for regular maintenance confirming maintenance has been undertaken
- c) Identification of any un-planned maintenance that had to be undertaken (reference Defects Register number)

13.3 Access of Cleaning and Inspection

Refer to the access and maintenance consultant's report for details.

Access for cleaning are envisaged as follows:

- a) cherry picker
- b) long pole
- c) temporary platform
- d) rope access (IRATA)

Note, roof areas shall require man-safe systems installed by the Main Contractor to interface with the façade construction. The Specialist Facade Sub-contractor shall allow for interfacing constructions to allow safe maintenance of the facades and roof areas.

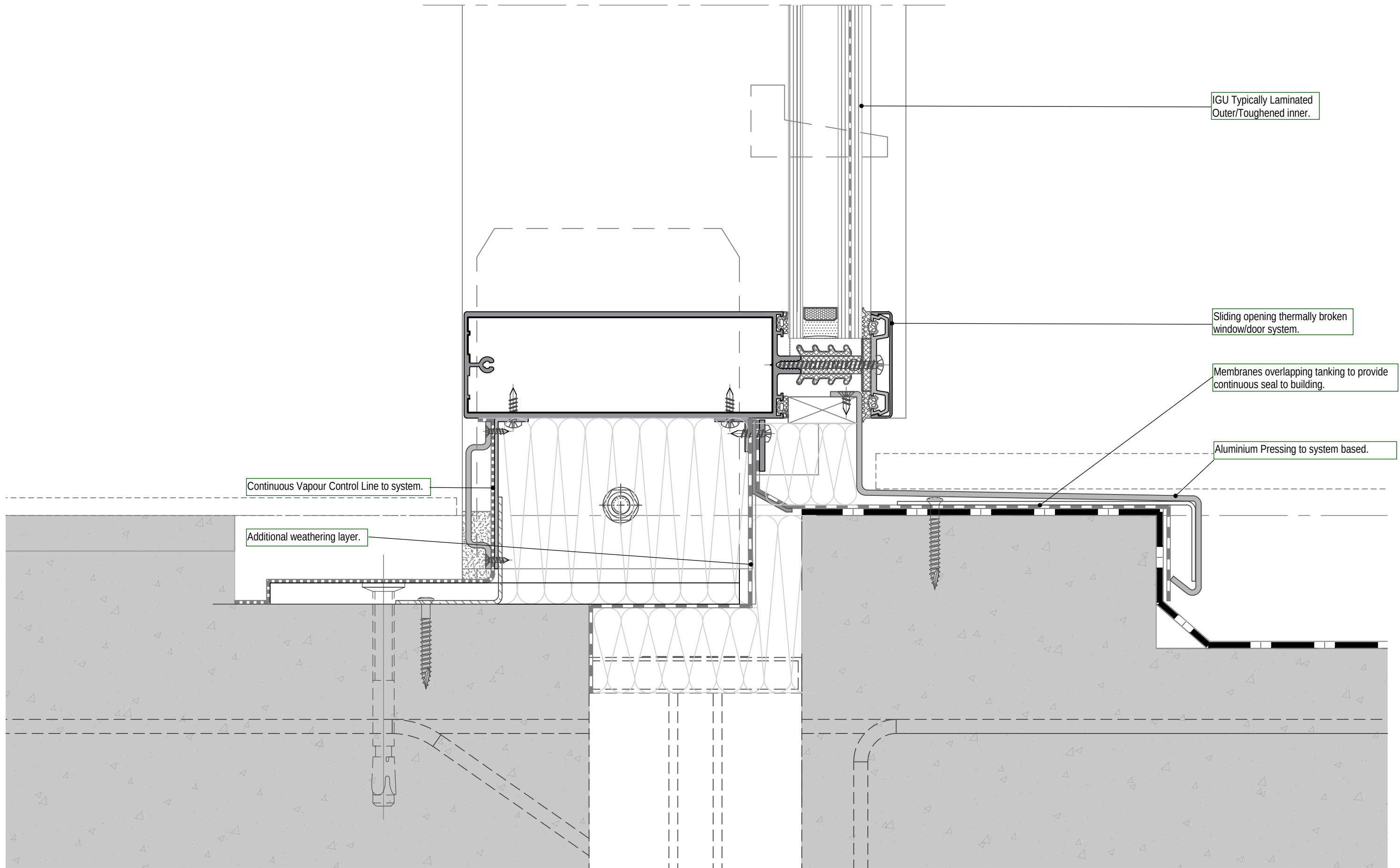
The Specialist Facade Sub-contractor in consultation with the Architect shall recommend methods and procedures to be utilised to allow inspection at the intervals stated in the Operations and Maintenance manual. This will allow systematic monitoring of the condition of the Works, assist in the prediction of the need for preventative maintenance and redecoration during the life of the Works, and inspection and testing of structural silicone glazing as required by this Contract Document. It shall be the responsibility of the building owner to monitor the condition of the building and commission maintenance and repairs as required. It is envisaged these will be carried out by the building owner in accordance with BS 8210 'Guide to Facilities Management' and in line with the recommendations of ISO 15686 series of standards for service life planning of buildings and constructed assets.

Yearly visual inspections and 5 yearly detailed inspections are recommended. Opening up is recommended every 10 years to spot-check hidden components including cavity barriers. Repairs and replacement of worn/aged components to be carried out in good time so as not to allow progressive damage. Cleaning of all visible components recommended not less than once per year. Lubrication of all moving parts recommended to be not less than twice per year. Operational testing of life-safety systems, including fire escape doors, to be as per applicable legislation and EN Standards. Operational testing of smoke vents to be as per applicable legislation and EN Standards. Records of maintenance, repairs and replacement to be maintained by the Client.

14 APPENDIX.

14.1 Typical System Details.

1. Typical Curtain Wall Base Detail.
2. Typical Curtain Wall Head Detail.
3. Typical Sliding Door Base Detail.
4. Typical Sliding Door Head Detail.
5. Typical Terrace Door Base Detail.
6. Typical Terrace Door Head Detail.
7. Typical Ground Floor Stone Base Detail.
8. Part Section DD - Typical First Floor Slab Edge Detail.
9. Part Section DD - Typical Second Floor Slab Edge Detail and Soffit Detail.
10. Typical Unitised Curtain Wall Slab Edge Detail.



IGU Typically Laminated
Outer/Toughened inner.

Sliding opening thermally broken
window/door system.

Membranes overlapping tanking to provide
continuous seal to building.

Aluminium Pressing to system based.

Continuous Vapour Control Line to system.

Additional weathering layer.

TYPICAL CURTAIN WALL BASE DETAIL

Scale: 1:5



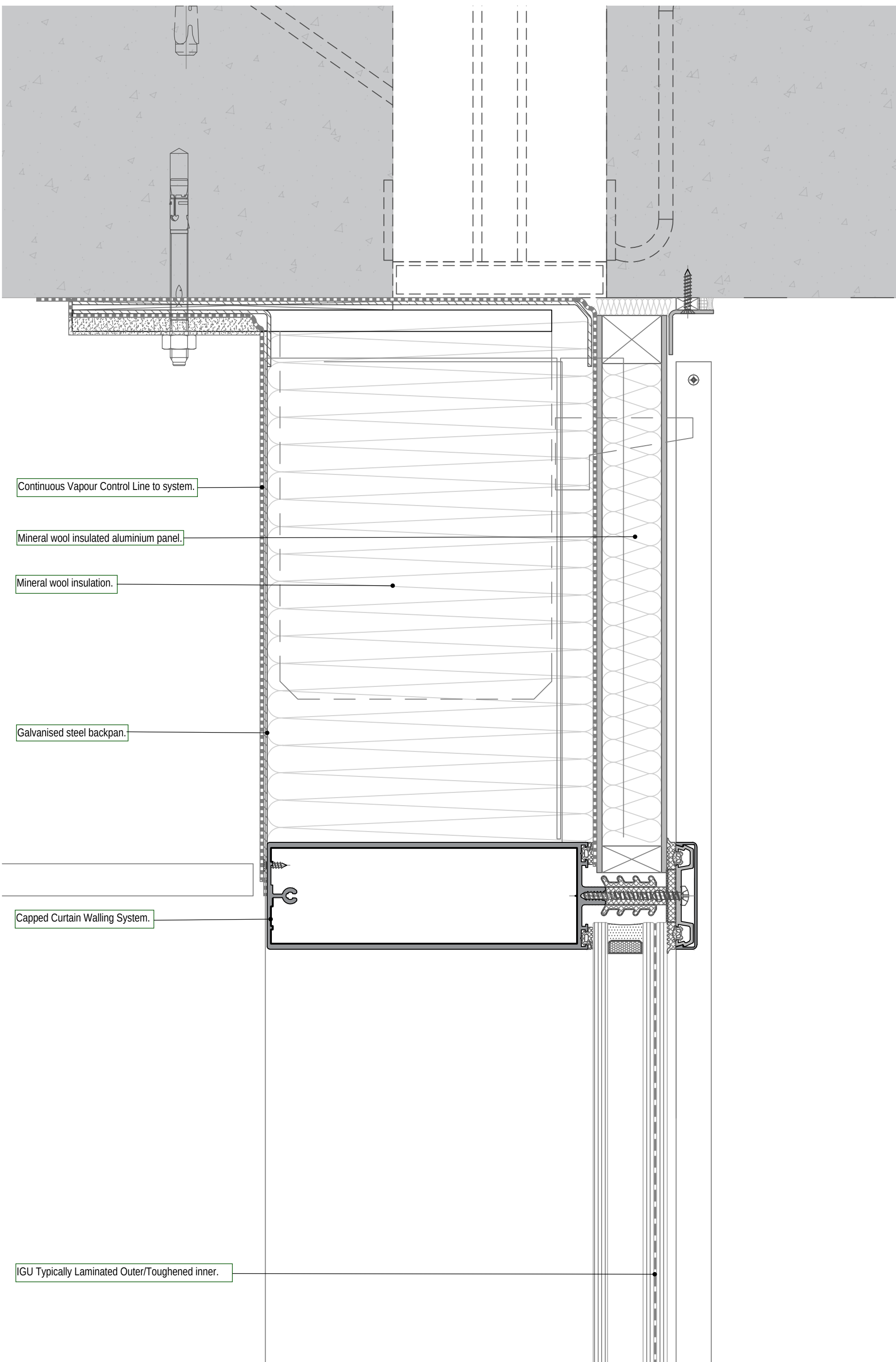
Billings Design Associates.
Façade Consultants.

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WS 4A DETAIL

DO NOT SCALE. ALL DIMENSIONS ARE INDICATIVE ONLY.
PLEASE REFER TO RELEVANT DRAWINGS FOR DIMENSIONS.

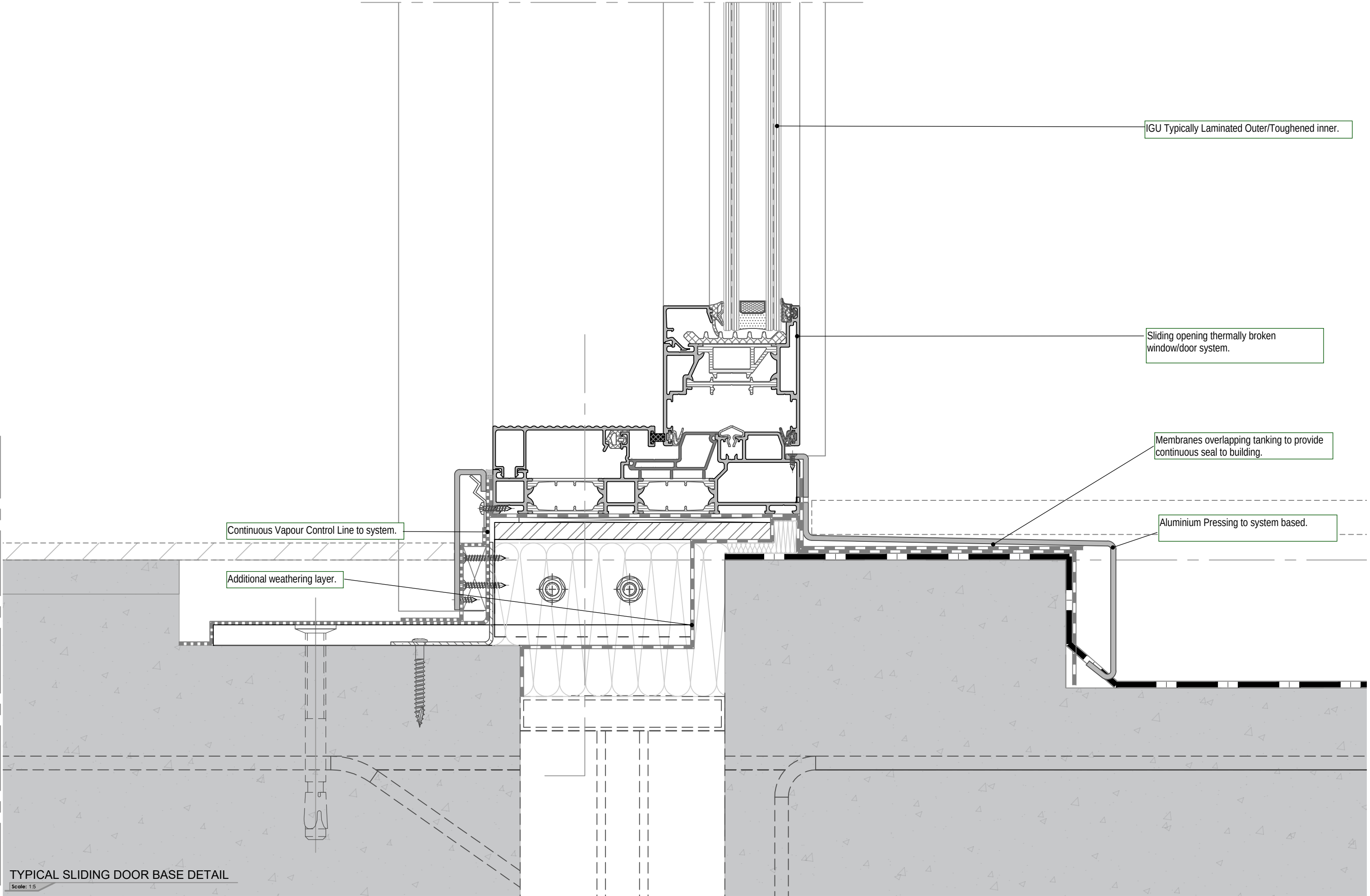
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PROJ.: 1139	PROJ.-SUB: -	AUTHOR: BDA	ZONE: XX	LEVEL: ZZ	FILE TYPE: DR	ROLE: Y	FILE NUMBER: TRS	PURPOSE: S0	REVISION: P01	



TYPICAL CURTAIN WALL SYSTEM HEAD DETAIL

Scale: 1:5

									
Billings Design Associates, Facade Consultants.									
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WS 4A DETAIL DO NOT SCALE. ALL DIMENSIONS ARE INDICATIVE ONLY. PLEASE REFER TO RELEVANT DRAWINGS FOR DIMENSIONS.									
ARCHITECT: Jon Matthews Architects						PROJECT: Cathedral Square		PROJ. NO.: 1139	
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PROJ.: 1139	PROJ.-SUB: -	AUTHOR: BDA	ZONE: XX	LEVEL: ZZ	FILE TYPE: DR	ROLE: Y	FILE NUMBER: TRS	PURPOSE: S0	REVISION: P01



TYPICAL SLIDING DOOR BASE DETAIL

Scale: 1:5

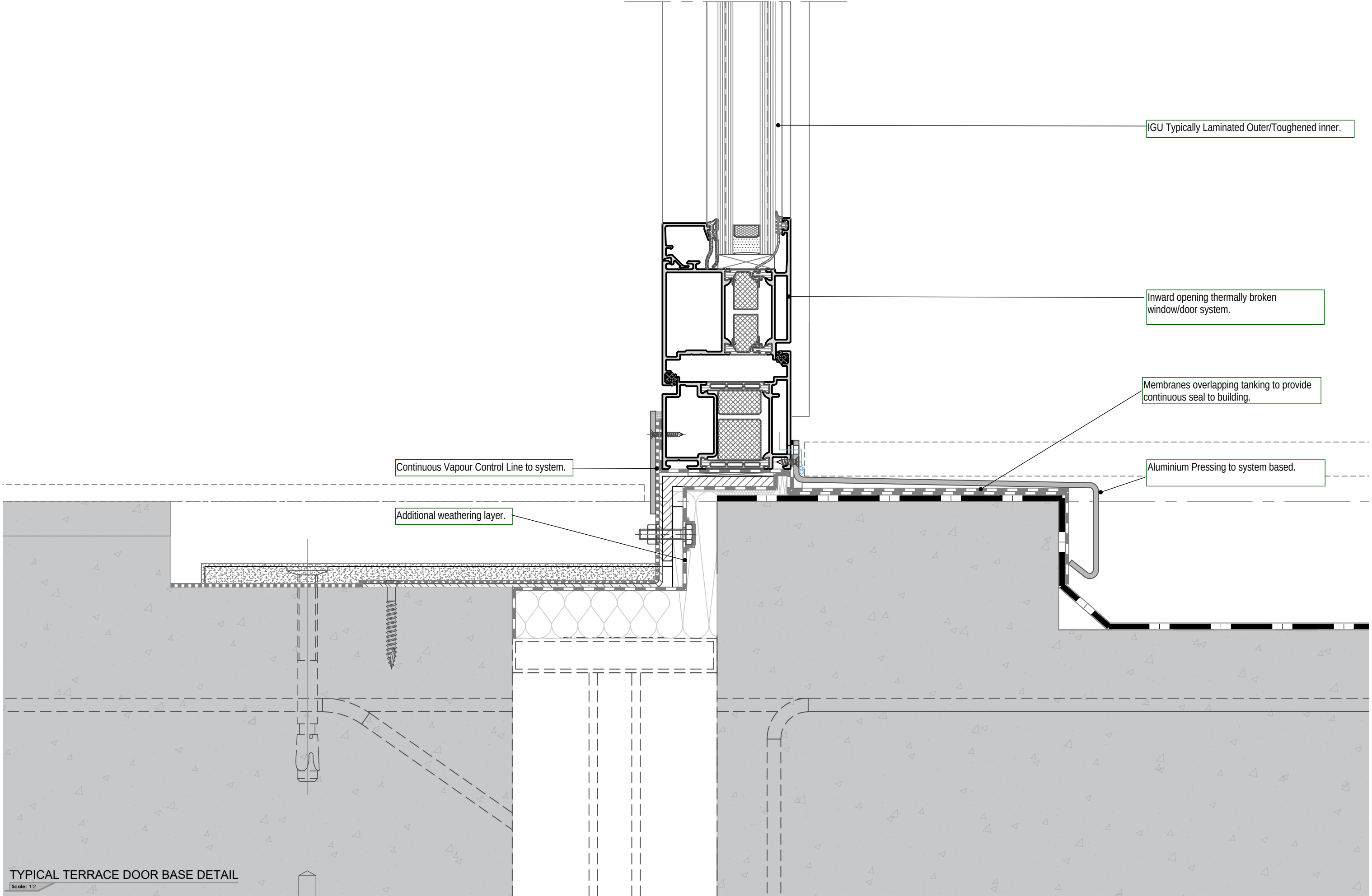
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WS 4A DETAIL

DO NOT SCALE. ALL DIMENSIONS ARE INDICATIVE ONLY.
PLEASE REFER TO RELEVANT DRAWINGS FOR DIMENSIONS.

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Scale: 1:5



TYPICAL TERRACE DOOR BASE DETAIL

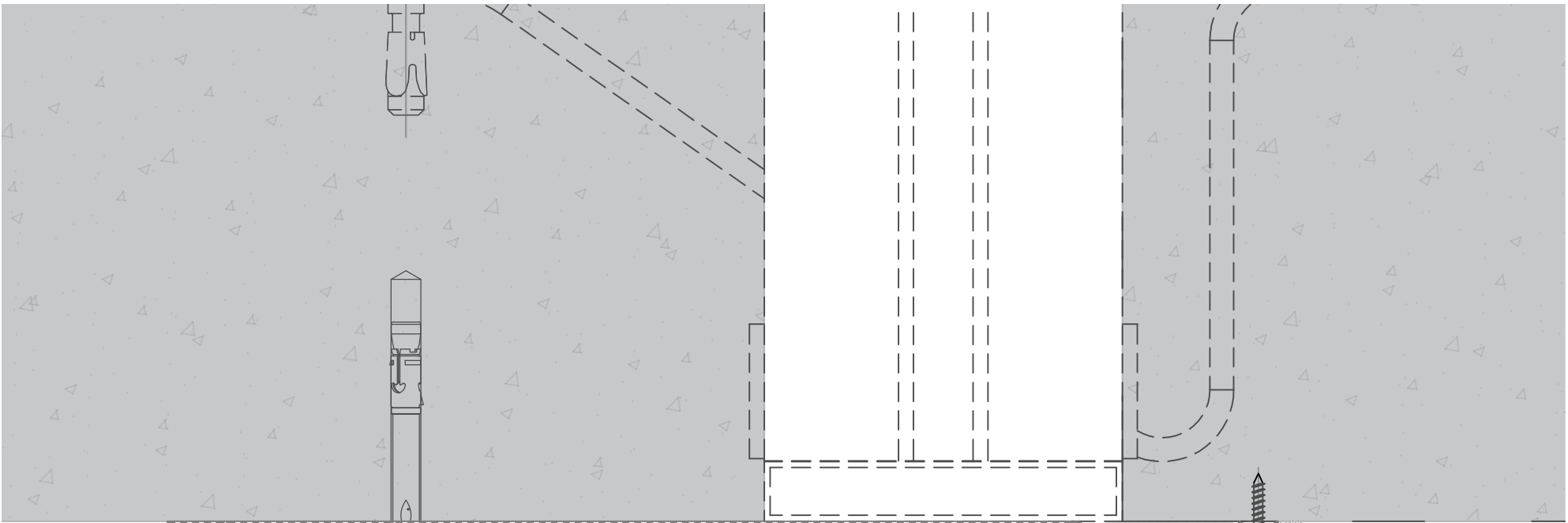
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WS 4A DETAIL

DO NOT SCALE. ALL DIMENSIONS ARE INDICATIVE ONLY.
PLEASE REFER TO RELEVANT DRAWINGS FOR DIMENSIONS.

ARCHITECT: Jon Matthews Architects					PROJECT: Cathedral Square					PROJ No.: 1139
DRAWING TITLE: Typical Balcony Detail - Door Base Detail					DATE: 02/05/25	SCALE: As noted	DRAWN: TL	CHECKED: ED		
PROJ.: 1139	PROJ.-SUB: -	AUTHOR: BDA	ZONE: XX	LEVEL: ZZ	FILE TYPE: DR	ROLE: Y	FILE NUMBER: TRS	PURPOSE: S0	REVISION: P01	



Continuous Vapour Control Line to system.

Mineral wool insulated aluminium panel.

Mineral wool insulation.

Galvanised steel backpan.

Capped Curtain Walling System.

Inward opening thermally broken window/door system.

IGU Typically Laminated Outer/Toughened inner.

TYPICAL TERRACE DOOR HEAD DETAIL

Scale: 1:2



Billings Design Associates.
Façade Consultants.

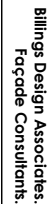
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WS 4A DETAIL

DO NOT SCALE. ALL DIMENSIONS ARE INDICATIVE ONLY.
PLEASE REFER TO RELEVANT DRAWINGS FOR DIMENSIONS.

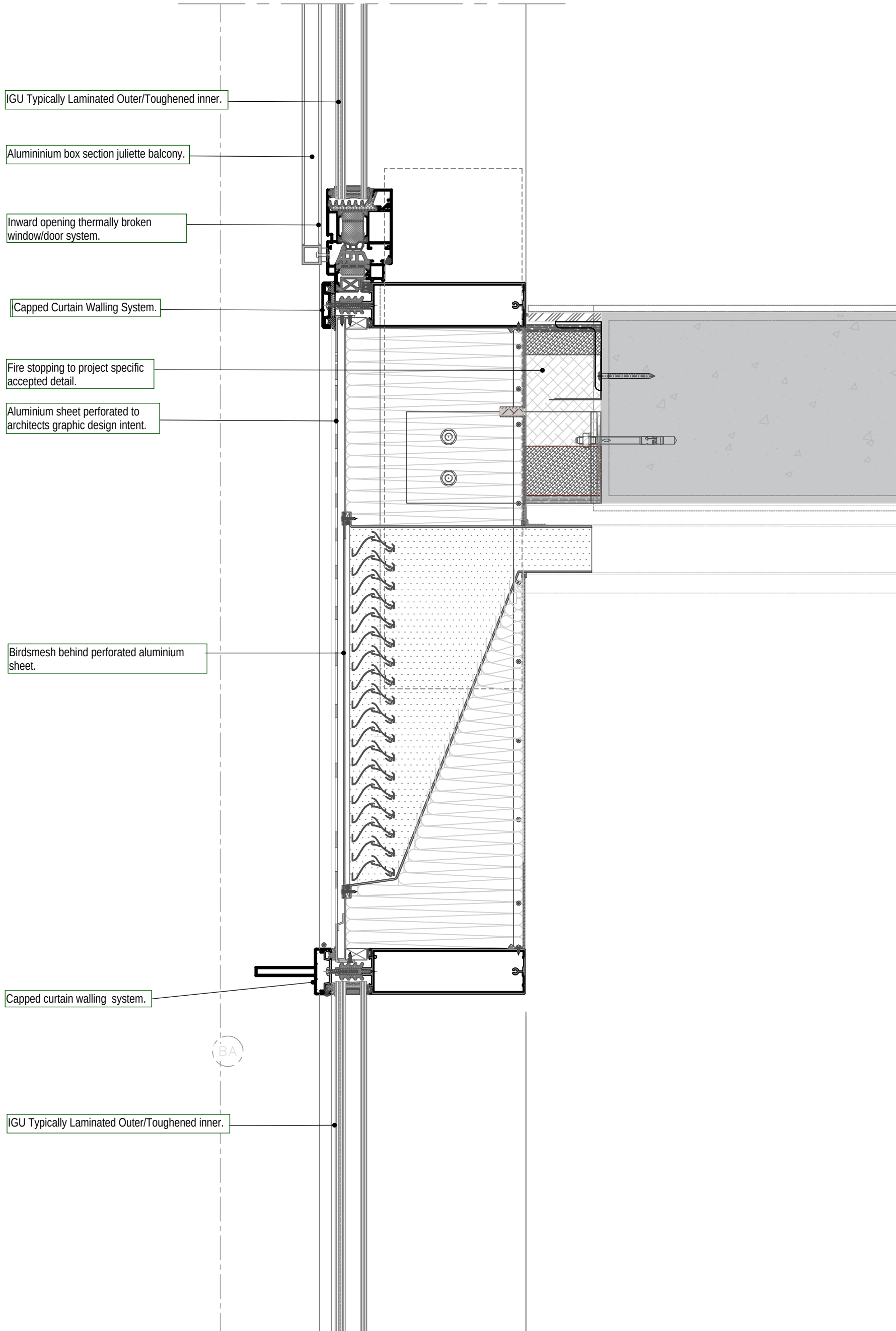
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DRAWING TITLE: Typical Balcony Detail - Door Head Detail				DATE: 02/05/25			
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LEVEL: ZZ				FILE NUMBER: TRS			
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				REVISION: P01			



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WS 4A DETAIL

ARCHITECT: Jon Matthews Architects										PROJECT: Cathedral Square			PROJ No: 1139				
DRAWING TITLE: PART SECTION D-D FF SLAB EDGE DETAIL																	
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												REVISION: P01					



PART SECTION D-D - FIRST FLOOR SLAB EDGE DETAIL

Scale: 1:5

IGU Typically Laminated Outer/Toughened inner.
Inward opening thermally broken window/door system.
Aluminium box section Juliette balcony.
Capped Unitised Curtain Walling System.
Pressing with weathering membrane behind.

Fire stopping to project specific accepted

Fire stopping to project specific accepted

PART SECTION D-D - SECOND FLOOR SLAB EDGE DETAIL

Scale: 1:5

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WS 4A DETAIL

DO NOT SCALE. ALL DIMENSIONS ARE INDICATIVE ONLY.
PLEASE REFER TO RELEVANT DRAWINGS FOR DIMENSIONS.

ARCHITECT: Jon Matthews Architects					PROJECT: Cathedral Square				PROJ No.: 1139	
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Scale: 1:5