IITM Research Park

Technical Specification for Façade Works

Issue | March 2014

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1 General

This is a performance based specification for the façade glazing and cladding contract works of the project “IITM Research Park” at Chennai. This specification should be read along with tender documents covers the façade works contract. This particular specification shall be read in conjunction with all of the following:

- General architectural elevations and plans
- Setting out and general façade elevations
- Design Intent and facade tender drawings
- Relevant building structural drawings and all interface trades
- Contract Terms and Conditions

1.1 Project Brief and Team

The proposed office space development consists of four blocks of roughly G+ 11 floors. Following are project team appointed by the client.
Following are project team appointed by the client.

<table>
<thead>
<tr>
<th>Role</th>
<th>In-Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client / Owner</td>
<td>IITM Research Park</td>
</tr>
<tr>
<td>Architect</td>
<td>Architect Hafeez Contractor</td>
</tr>
<tr>
<td>Facade Consultant</td>
<td>BES Consultants Pvt Ltd</td>
</tr>
<tr>
<td>Project Manager</td>
<td>In-Charge Appointed by the client</td>
</tr>
</tbody>
</table>

1.2 Definitions and Abbreviations

<table>
<thead>
<tr>
<th>Expression</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager or superintending Officer</td>
<td>Representative appointed by developer or client</td>
</tr>
<tr>
<td>Contractor or Façade Contractor</td>
<td>The Contractor for the Works under this Contract</td>
</tr>
<tr>
<td>&quot;authorized&quot;&quot;, &quot;approval&quot;&quot;, &quot;approved&quot;&quot;, &quot;selected&quot;, &quot;directed&quot; and any similar words</td>
<td>direction of the client</td>
</tr>
<tr>
<td>&quot;allow&quot;</td>
<td>the cost of the item referred to is the responsibility of the Contractor</td>
</tr>
<tr>
<td>&quot;provide&quot;</td>
<td>supply and install</td>
</tr>
</tbody>
</table>

Common industry abbreviations may be used in this document, but are not necessarily confined to, the following:

- IS - Indian Standard
- BS - British Standard
- ASTM - American Society for Testing and Materials
- CP - Code of Practise
1.3 About this Specification

This is a performance Specification and the contract documents provide the design intent for the facade works that includes aluminium glazing and associated works for building exterior. The façade contractor is responsible to produce their own design that will fully comply with the specified requirements. The Specification together with the Architectural and façade tender drawings indicates the design intent and scope of the works. Together they illustrate the mandatory geometry of visible facade surfaces, define the performance parameters for the facade, provide minimum acceptable standards and establish a regime for verification of the design, fabrication and installation processes. All the technical tender documents including tender details and specifications outlined minimum compliance requirements; contractor shall not downgrade components sizes or reduce specification of materials in any form. The Contractor shall provide all items required for proper completion of the Contract Works without adjustment to the contract price. It shall be the Contractor’s responsibility to warrant all façade works under this contract to the building owner, and to ensure that all materials and work are entirely fit for their intended purpose.

1.4 Drawings and Technical Tender Documents

This Specification shall be read in conjunction with Contract Drawings prepared by Architect and Consultants of the project. Dimension on drawings are indicative only, façade contractor should verify the actual dimensions on site prior to produce shop drawings and fabrication drawings. Façade contractor should be brought to the attention of client, architects and consultants for any variations on site dimension. Thus façade contractor cannot claim any additional time or cost on this aspects

The Architectural Drawings:

- are schematic and do not purport to identify or solve completely the problems of thermal or structural movement, pressure equalization, vapour and sound barriers, fixings and anchorage, flatness and stability of facing, or moisture disposal.
- Do not purport to solve problems in the glass line associated with glass movement, pressure fracture or thermal shock.
- Indicate profile and configuration required together with relationship to structural frame and interior building elements.
- Contain details that suggest directions for solving some of the major design issues. The Contractor may use the intent of these details and develop them as he deems best.

Façade drawings:

- The Drawings provide an indicative solution for the Contract Works. The façade contractor shall assume responsibility for the design, procurement, fabrication and installation of all curtain wall and related elements in accordance with the Contract Documents to satisfy the performance requirements stated in this Specification.

1.5 Responsibilities

- The contractor shall take responsibility for the design, procurement, fabrication and installation of all façade elements in accordance with the contract documents to satisfy the performance requirements stated in this specification. It shall be the contractor’s responsibility to warrant the above to the client and to ensure that all materials and work are entirely fit for their intended purpose.
- This is a design and build contract and the contractors are deemed to have designed the system after verifying with all the component suppliers / manufactures that all products meet the intend architectural intent and performance parameters laid out by the façade consultant for both as component and the system at large right from design, fabrication,
assembly, packaging, hoisting, installing and in service condition which should be
guaranteed for the minimum years as stipulated in the contract both for components and
system as a whole. No extra time and cost implications shall be entertained whatsoever in
this regards.

- As scope and performance documents, the drawings and specifications do not necessarily
  indicate or describe in detail all work required for the full performance and completion of
  the contract works. The contractor shall provide all items required for proper completion of
  the contract works
- The consultant or project manager is responsible for the review of the Contractor’s
  submissions and conducting representative inspections of the fabrication and installation
  process, to verify that the proposed design details and fabrications/installation process
  satisfactorily address the intent of the requirements of the contract
- Not with standing any comments made or omitted during that review process, the
  responsibility for the performance of the Contract works (design, manufacture & erection)
  remains entirely with the Contractor

1.6  Order of Precedence

In the event of any ambiguity with any clauses of various documents, following order of precedence
will be applicable.

1. Work Order
2. Letter of Intent
3. Clarification / conditions accepted in pre-bid meeting
4. Tender drawings
5. Special conditions of contract
6. General conditions of contract
7. Technical specification
8. Priced BOQ

1.7  Façade Schedule

Following are façade types included within this façade contract works, respective details and
drawings to be referred for more details.

<table>
<thead>
<tr>
<th>Façade Type</th>
<th>Location</th>
<th>Façade system</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW1</td>
<td>E1 &amp; E4</td>
<td>Untised Curtain wall System - Vision</td>
</tr>
<tr>
<td>CW1s</td>
<td>E1 &amp; E4</td>
<td>Untised Curtain wall System - Spandrel</td>
</tr>
<tr>
<td>CW1A</td>
<td>All Elevations</td>
<td>Untised Curtain wall System with Steel</td>
</tr>
<tr>
<td>CW2</td>
<td>All Elevations</td>
<td>Strip Curtain wall System</td>
</tr>
<tr>
<td>CL1</td>
<td>Refuge Floors</td>
<td>Metal Jali Screen</td>
</tr>
<tr>
<td>LV1</td>
<td>E1, E3 &amp; E4</td>
<td>Louvers</td>
</tr>
<tr>
<td>LV2</td>
<td>All Elevations</td>
<td>Louvers in front of glazing</td>
</tr>
<tr>
<td>CW3</td>
<td>Refuge Floors</td>
<td>Fire Rated Glazing</td>
</tr>
</tbody>
</table>
1.8 Scope of Façade Contract Works

In the context of these specifications the term Façade or facade system refers to Curtain Wall, windows, Cladding, Canopy, Skylight and aluminium glazing works, these terms may be used interchangeably and mean any component of the Contract Works.

The facade contract works covered in this specification shall include design, procurement, fabrication, and installation and hand over of the façade works as mentioned in the BOQ of this contract.

<table>
<thead>
<tr>
<th>Item</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Façade Systems (Typical and Non Typical)</td>
<td>• Brackets and other connections to the structural frame</td>
</tr>
<tr>
<td></td>
<td>• Expanding anchors (for post fixing) including testing to verify the installation</td>
</tr>
<tr>
<td></td>
<td>• Cast-in anchors / inserts</td>
</tr>
<tr>
<td></td>
<td>• Glazing</td>
</tr>
<tr>
<td></td>
<td>• Sound and thermal insulation materials as and when required</td>
</tr>
<tr>
<td></td>
<td>• Sealants, General flashings, gutters and copings</td>
</tr>
<tr>
<td></td>
<td>• Vapour barriers, Finishes, coatings, and surface treatments</td>
</tr>
<tr>
<td></td>
<td>• Smoke flashings and fire separation as and when required</td>
</tr>
<tr>
<td></td>
<td>• All fire safe/stop materials and the necessary galvanized sealed smoke stops associated with the system</td>
</tr>
<tr>
<td></td>
<td>• Fire access panels as required to comply with applicable codes</td>
</tr>
<tr>
<td></td>
<td>• Structural steel secondary framing and associated fireproofing (i.e. necessary support framing which has not been detailed on the Structural Engineers Drawings)</td>
</tr>
<tr>
<td></td>
<td>• Operable vents and hardware</td>
</tr>
<tr>
<td></td>
<td>• Penetrations for services</td>
</tr>
<tr>
<td></td>
<td>• All interior closures between exterior wall and finished columns, walls and floors</td>
</tr>
<tr>
<td></td>
<td>• Any and all supporting members required in the absence of building structure in order to complete the appearance of the curtain wall system as designed within the Architectural Drawings</td>
</tr>
<tr>
<td></td>
<td>• Visual Mock-up &amp; Performance Mock-up test</td>
</tr>
<tr>
<td></td>
<td>• Preparation of Maintenance Manuals</td>
</tr>
<tr>
<td></td>
<td>• Local statutory approval</td>
</tr>
<tr>
<td></td>
<td>• Penetration for signage</td>
</tr>
<tr>
<td></td>
<td>• Support for sign lighting &amp; penetrations for lighting conduit in canopy</td>
</tr>
<tr>
<td>Miscellaneous Works</td>
<td>• Preparation of the existing structure to receive the new works</td>
</tr>
<tr>
<td></td>
<td>• Provide and Installation of structural works</td>
</tr>
<tr>
<td></td>
<td>• Provision of temporary access, safety protection, hoardings etc.</td>
</tr>
<tr>
<td></td>
<td>• Protection of retained facade elements and external finishes.</td>
</tr>
<tr>
<td></td>
<td>• Protection of adjoining elements and finishes during works.</td>
</tr>
<tr>
<td></td>
<td>• Protection of all works during construction</td>
</tr>
<tr>
<td></td>
<td>• Survey and acceptance of building structure in interfaces with other building elements and connection points</td>
</tr>
<tr>
<td></td>
<td>• Cleaning of all Contract works during construction</td>
</tr>
<tr>
<td></td>
<td>• Provision of service crews and maintenance equipment during the Defects Liability Period.</td>
</tr>
<tr>
<td>Item</td>
<td>Details</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Submissions | • All authority submittals, approvals, permits, and payments of fees and charges  
• All calculations, shop drawings, samples and material certificates for inspection by the Engineer and the Consultants  
• Design certificates and producers Statements  
• Executed Warranty Deeds  
• Evidence of possession and maintenance of all appropriate insurance policies as required under the contract, including  
• Public liability (Contractor)  
• Professional Indemnity (Contractor’s designer)  
• Accident Compensation (Contractor)  
• Evidence of formulation and application of Quality Assurance plans. |
| Regulation | Façade contractor should take due care and diligence to comply with local government regulation in terms of design, fabricate and installation of contracted works. No extra claims in terms of cost and time will be allowed in order to comply with regulation, façade contractor should have considered all local regulation prior to award of the contract, cost of which will be included in the contract |

1.9 Interfacing Trades

The Contractor shall ensure that Contract Works carried out under this specification are fully interfaced and co-ordinated with the following existing elements of the building:

• Lighting and electrical  
• Lightning Protection  
• Façade lighting  
• Gutters/Drainage  
• Mechanical Services  
• Electrical Services  
• Fire Services  
• Security Systems  
• Internal finishes i.e. walls, ceilings and floors.  
• External works and paving  
• Building Maintenance and Cleaning System

1.10 Warranties

Contractor to submit a written warranty executed by the suppliers / manufacturer agreed to repair or replace components of the façade systems that fail in materials or workmanship within the specified warranty period. Failures include but are not limited to structural, weather performance, durability and finishes. The warranty period for the façade systems shall be ten (10) years after the end of the twelve (12) months defects liability period. The system warranty shall include all materials and labour. All costs and expenses out of, or in connection with, the obligation herein shall be solely borne by façade contractor and manufacturers.
1.11 Site Co-ordination

Façade contractor is responsible for any site co-ordination issues related to façade works and advice builder or client for sequences of work that may affect façade works. Sequence of any major critical works should be identified in the drawings and need to be co-ordinated in advance to avoid any potential problems or delays or re-working at site. Critical areas such as internal plaster or render at aluminium sub-frame should be highlighted to the civil contractor at the early stage.

1.12 Critical Inspections

Following are critical inspections to be completed by Façade consultant and requires approval prior to proceed; the façade contractor should lead and organise for these inspections to be completed at appropriate timeframes as noted in table below.

<table>
<thead>
<tr>
<th>Stages</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection to Aluminium Extruder</td>
<td>During trial runs prior to actual production, upon review and approval of successful trial section actual production to proceed.</td>
</tr>
<tr>
<td>Inspection to Paint Application</td>
<td>During 1st batch of paint application, upon approval further work to proceed</td>
</tr>
<tr>
<td>Inspection to Glass Processor</td>
<td>During 1st batch glass production, upon approval further work to proceed</td>
</tr>
<tr>
<td>Inspection to Façade Contractor Factory</td>
<td>During 1st batch fabrication, upon approval further work to proceed</td>
</tr>
</tbody>
</table>
2 Facade System Requirements

The design principles set out in this specification should be followed in the planning, design and construction of various facade systems

2.1 General Principles

All façade systems and joints to be pressure equalised weather proofed unless noted otherwise incorporating the following features:

1. A rain screen: This prevents the majority of water entering joints.
2. An air seal: Design this for the full wind load. This allows the effective pressurisation of the cavity. Design the system so that water penetrating the cavity does not reach the air seal.
3. A cavity between the rain screen and air seal. This cavity to be:
   a. Sufficiently ventilated and bounded by baffles, seals etc so that there is no air pressure difference across the rain screen
   b. Drained so that any water entering the cavity flows to outside

2.2 Unitised Curtain Wall Glazing System

System to comply with following basic features and design requirements

<table>
<thead>
<tr>
<th>Features</th>
<th>Design Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Horizontal joints or stack joint to consist of an upper sill section sitting inside a lower gutter head.</td>
<td>1. Continuous air seals, sub-sills and sub-heads to slab at top and base and sides of the system. Insulation to be added where the air seal flashing faced into air conditioned spaces.</td>
</tr>
<tr>
<td>2. Stack joint (head and sill) aluminium sections to have interlocking metal legs with gaskets, similarly mullion section to have interlocking metal legs with gaskets to form as a split mullion section.</td>
<td>2. Split mullions, stack joints, intermediate mullions and spandrel zones that comply with Pressure Equalized design principle</td>
</tr>
<tr>
<td>3. The perimeter section of panels consist of:</td>
<td>3. Stack joints to use interlocked split (head and sill) aluminium sections, stack head sections to have drainage provision at each panel head.</td>
</tr>
<tr>
<td>a. Male mullion (with metal legs for interlocking)</td>
<td>4. Interlocked Spilt mullions and stack joints that accommodate tolerances and differential movements between adjoining panels due to thermal effects and buildings movements.</td>
</tr>
<tr>
<td>b. Female mullion</td>
<td>5. Gutter splices at panel head (between panels) featuring aluminium splice sections and are fully sealed, gutter splices to use extruded aluminium profiles.</td>
</tr>
<tr>
<td>c. Gutter Head – at top of panel (with metal legs for interlocking)</td>
<td>6. Dead loads supported directly on male and female mullions through hook curtain wall support system.</td>
</tr>
<tr>
<td>d. Sill section – at foot of panel.</td>
<td>7. Corner panels that are either L shaped or feature a split corner mullion.</td>
</tr>
<tr>
<td>4. The base of the curtain wall shall be terminated by a sub sill, the top by a subhead</td>
<td>8. Split mullions designed on the basis that loads are distributed in proportion to their stiffness.</td>
</tr>
<tr>
<td></td>
<td>10. Internal flanges are unstable unless the design features restraints to local building.</td>
</tr>
</tbody>
</table>
### Features

<table>
<thead>
<tr>
<th>Bracket</th>
<th>Design Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11. The extruded mullion is to be reinforced by steel inserts in areas where there are structural requirements. Calculations to be submitted to demonstrate the adequacy of this reinforcement.</td>
</tr>
<tr>
<td></td>
<td>12. All terminations of jambs and head to be provided with metal flashing as air seal</td>
</tr>
</tbody>
</table>

#### 2.2.1 Operable Hardware

Provide a full hardware schedule confirmation for all windows and doors as per the Architect’s schedule. Use the proprietary specific product as per material list referred in the appendix of this specification. Contractor shall get all necessary approvals from architect and facade consultant for hardware make and type.

#### 2.3 Steel Metal Railing / Balustrades

The external metal railing will meet the following minimum requirements.

- a. To follow structural design criteria mentioned on specification
- b. Steel finish to be consistent.
- c. Any welding to be done at shop, all weld to finish to grind and smooth
- d. To have continuous top rail firmly fixed to permanent structure
- e. To have vertical metal post at specified intervals, anchored to RC structure with base plates. All fixings to penetrate into RC structure and not to rely upon fixing on floor finish / screed.

#### 2.4 Aluminium Louvers

Louvers within façade cladding / glazing to be/have:

- a. Free area as required by the project M&E engineer. Integral rain traps and non-ferrous bird/insect mesh.
- b. Louver blades to be extruded aluminium of acceptable profile, minimum wall thickness to be 1.5 mm however contractor to check that thickness of section is adequate to achieve flatness requirements.
- c. Each blade to be fixed to perimeter frame without any visible exposed fixing
- d. Louvre profiles shapes are as per architectural requirements.

#### 2.5 Façade Interfaces

Air seals to be continuous through interfaces and located in dry and drained positions.

- a. Flashings, vents and weep holes to be provided to maintain Pressure Equalisation principles and to prevent collection or ponding of water in cavities.
- b. The effects of differential movement to be considered as the development of details.
- c. Any continuous vertical or horizontal cavities to be divided of length greater than 20m
- d. Cavities to be divided vertically at corners between different planes of the building
2.6 Fire Rated Doors / Glazing

a. Fire access doors / panels shall be designed to comply with applicable codes,
b. The glazing detail shall be designed to integrate effectively into adjacent curtain wall system / structure and provide weather proofing,
c. Architectural elevation / plans indicate the location of fire rated doors / panels and time duration under performance for all fire rated doors
d. All frames shall use Structural steel grade
e. Glazing system overall integrity to be maintained for the specified period.

2.7 Copings and Parapets

a. Copings to be designed for expected maintenance loads and on particular point loads from people and rope access.
b. Coping should be provided with stiffeners wherever the width of flashing greater than 250mm wide unsupported or as per structural requirements.
c. Secondary drainage to be provided to joints in panels of less than 45° slope.
d. Flashings to be provided under copings to complete air seal to the main roof structure.
# 3 Codes and Standards

Following but not limited relevant codes are applicable. Indian standards shall be applicable wherever relevant current codes of practises are available.

<table>
<thead>
<tr>
<th>Title</th>
<th>Details</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design Load</strong></td>
<td>Wind Load</td>
<td>• IS 875(Part 3):1987-Code of practice for wind loads</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• BS EN 1991-1-1:2002-Action on structures General actions densities, self-weight imposed loads for structures</td>
</tr>
</tbody>
</table>
| **Aluminium Design** | Structural design of aluminium extrusion | • BS 8118 : Structural Use of Aluminum  
|               |                                | • BS 1999-1-4:2007                                                  |
|               |                                | • BS 1999-1-3:2007                                                  |
|               |                                | • IS 8147 : Code of Practice for Use of Aluminum Alloys in structures |
| **Structural Aluminium** | Aluminium Extruded sections | • BS 1161 Specification for aluminium alloy sections for structural purposes  
|               |                                | • BS EN 12020 -Pts. 1 Aluminium and aluminium alloys. Extruded precision profiles in alloys EN AW-6060 and EN AW-6063. Technical conditions for inspection and delivery &  
|               |                                | • BS EN 12020 -Pts.2 Aluminium and aluminium alloys. Extruded precision profiles in alloys EN AW-6060 and EN AW-6063. Tolerances on dimensions and form |
| **Structural Aluminium** | Aluminium plate sheet & strip | • BS EN 573 Pts. 1 to 3-  
|               |                                | 1. Aluminium and aluminium alloys. Chemical Composition and form of wrought products Numerical designation system  
|               |                                | 2. Aluminium and aluminium alloys. Chemical Composition and form of wrought products. Chemical symbol based designation system  
|               |                                | 3. Aluminium and aluminium alloys. Chemical Composition and form of wrought products. Chemical composition and form of products  
<p>|               |                                | • BS 4873- 2009-Aluminium alloy windows and door sets. Specification |
| <strong>Glass Design</strong> | Structural design              | ASTM E1300 : Glass in Buildings                                      |
|               | General                        | BS 6262 : Code of Practice for glazing for buildings                |</p>
<table>
<thead>
<tr>
<th>Title</th>
<th>Details</th>
<th>Code</th>
</tr>
</thead>
</table>
| **Structural steel Design** | steel structural design in general building constructions               | • IS 800-1984 Code of practice for general construction in steel  
• IS 801-1975 Code of practice for use of cold form light gauge steel structural members in general building construction  
• BS EN 1993-1-5:2006-Design of steel structures. Plated structural elements  
• BS EN 1993-1-10:2005-Design of steel structures. Material toughness and through thickness properties |
| Hot Rolled steel comply with the requirements of                  |                                                                                                                                    | • IS 800-1984 Code of practice for general construction in steel  
• IS 2062-1999 Specification -Steel for general structural purposes  
• BS EN 10025-1:2004 -Hot rolled products of structural steel. General Technical delivery conditions  
| **Structural steel**   | Cold formed steel conform to                                            | • IS 801-1975 Code of practice for use of cold form light gauge steel structural members in general building construction  
• BS EN 10327:2004  
• Continuously hot-dip coated strip and sheet of low carbon steels for cold forming. Technical delivery conditions  
• BS EN 10143:2006  
• Continuously hot-dip coated steel sheet and strip. Tolerances on dimensions & shape  
• BS EN 10346:2009  
• Continuously hot-dip coated steel flat products. Technical delivery conditions |
| Hot dip Galvanisation comply with                                 |                                                                                                                                    | • IS 4759- 1996 This standard specifies the requirements This standard specifies the requirements for Zinc coating applied by hot dip for Zinc coating applied by hot dip galvanizing on Iron and steel products. galvanizing on Iron and steel products  
• BS EN ISO 1461:2009  
• Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods |
| **Fire Rated Glazing**  | Material, Installation, Service                                        | • EN 1634 -1: 2008  
• 2hr fire rated                                                                                                                                 |
4 Performance Requirements

The facade works shall be designed and installed to satisfy, as a minimum, the following criteria:

4.1 Design Life

All façade elements and components are to be designed for the following minimum design life.

4.1.1 Structural

The design of structural components shall be based upon a 50-year design life.

4.1.2 Durability

The durability design life of the façade, with reasonable routine maintenance is 25 years. Glazing materials, stone-glass laminate panels, double glazed units and paint finishes may require replacement after 20 years. The performance of the façade systems will be covered under warranty for 10 years. Suppliers of the glass, panel systems and sealants will be required to supply warranties direct to the client for supply and installation for 10 years.

4.2 Structural Adequacy

Any façade system is to be structurally adequate to resist the loads that it will experience over its structural design life. Following to be read in conjunction with allowable deflection limits as specified in the following section:

4.2.1 Dead loads

All systems are to support and transfer their own self-weight and other associated dead loads to the main building structure. The contractor will be required to identify, design, coordinate and supply all necessary sub-frames and secondary structure.

4.2.2 Wind loads

All facade systems are to be designed in accordance with the IS 875 Part 3, following are minimum wind pressures.

<table>
<thead>
<tr>
<th>Typical (+/-)</th>
<th>Building Corner (+/-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7 kPa</td>
<td>1.5 kPa</td>
</tr>
</tbody>
</table>

For other areas and non-typical locations, design pressures to be calculated as per Indian Standard IS 875 and appropriate pressure coefficients with basic wind speed 50 m/s with terrain category 2. Dynamic response to wind effects and associated loads, deflections and vibrations are to be considered for all elements of the façade.

4.2.3 Live loads

- Canopy and skylights with access only for maintenance: 0.75kPa
- Accidental human point load on sunshade and fins: 0.75KN most critical direction
- Horizontal barrier loads for Glazings/cladding of all occupied spaces: 0.36kN/m @ +1m above Floor Finish Level.

Large panels forming horizontal surfaces should be designed for multiple concentrated loads of 2.25 kN concentrated at any critical location.
4.2.4 Maintenance loads

All trafficable / glazings including parapet copings shall make allowance for maintenance loadings. This will include person loadings, point loads and indirect loads from rope access. Following maintenance loads (Gondola) to be considered as minimum compliance.

- BMU restraint points: 1.50kN (in any direction)
- BMU impact loads: In accordance with requirements of the equipment supplier.

4.3 Structural Serviceability

4.3.1 General Requirements

Any facade system shall be serviceable under the loads it is likely to experience. It shall not deflect beyond the following serviceability limits. Basic design wind pressures to be used for deflection checks:

- Water must not pond on any part of the window system.
- All framing members are to recover fully from the above deflections when the loads are removed.
- Surfaces (all materials) that are horizontal or inclined at less than 15° from horizontal must not deflect by more than L/360.
### Allowable Limits

Following are allowable serviceability deflection limits

<table>
<thead>
<tr>
<th>Elements</th>
<th>Loadings</th>
<th>Allowable Deflection Limits</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Out of plane</td>
<td>In Plane</td>
</tr>
<tr>
<td>Steel Frames and support structures</td>
<td>Dead load (self wt.) - General</td>
<td>L/240 or 20mm max</td>
<td>L/1000 or 5mm max.</td>
</tr>
<tr>
<td></td>
<td>Dead load (self wt.) – Visually exposed edge conditions</td>
<td>L/500 or 10mm max</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Live Load</td>
<td>L/360 or 20mm max</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wind load</td>
<td>L/240 or 20mm max</td>
<td>L/1000 or 5mm max.</td>
</tr>
<tr>
<td>Aluminium Frames and support structures</td>
<td>Dead load (self wt.) - General</td>
<td>L/175 or 20mm max</td>
<td>L/1000 or 5mm max.</td>
</tr>
<tr>
<td></td>
<td>Dead load (self wt.) – Visually exposed edge conditions</td>
<td>L/500 or 10mm max</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Live Load</td>
<td>L/360 or 20mm max</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wind load</td>
<td>L/175 or 20mm max</td>
<td>L/1000 or 5mm max.</td>
</tr>
<tr>
<td>Glass</td>
<td>Dead load (self wt.) - General</td>
<td>L/175 or 20mm max</td>
<td>Max. Allowable mid span deflection</td>
</tr>
<tr>
<td></td>
<td>Dead load (self wt.) – Visually exposed edge conditions</td>
<td>L/360 or 10mm max</td>
<td>Exposed edge deflection limits are subject to architect’s and consultant’s approval.</td>
</tr>
<tr>
<td></td>
<td>Live Load</td>
<td>L/90 or 25mm max</td>
<td>Human impact load, line loads are applicable as per International standard BS 6180 or equivalent IS</td>
</tr>
<tr>
<td></td>
<td>Wind load</td>
<td>L/90 or 25mm max</td>
<td></td>
</tr>
<tr>
<td>Metal Sheet/ cladding</td>
<td>Dead Load - General</td>
<td>L/180 or 20mm max</td>
<td>L/500</td>
</tr>
<tr>
<td></td>
<td>- Exposed Edge</td>
<td>L/360 or 8mm max</td>
<td>L/1000</td>
</tr>
<tr>
<td></td>
<td>Live Load</td>
<td>L/90 or 25mm max</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wind Load</td>
<td>L/90 or 25mm max</td>
<td>L/1000 or 5mm max.</td>
</tr>
</tbody>
</table>
4.3.3 Verification Methods

Acceptable evidence of adequacy may be provided by:

- Calculation
- Testing / demonstration – small prototypes, mock-ups and in-situ testing

Where the calculation will not be adequate to demonstrate the strength then façade contractor should carry out testing as instructed by consultant.

4.4 Environmental Conditions

Following are to be considered as minimum environmental requirements for any facade systems

**Interior**
- With air-conditioning
  - Temperature Range: 20°C±2°C
  - Relative Humidity: 50%±10%
- Without air-conditioning
  - Temperature Range: 16°C to 40°C
  - Relative Humidity: 90%±10%

**Exterior**
- Temperature Range Ambient: 16 °C to 50 °C
- Surface Allowance: 16°C to 80°C

4.5 Finished Tolerances of Façade Systems

The façade systems (external and internal) shall be true to line and level.

**a. Manufacturing**
   i). linear dimensions + 2 mm
   ii). squareness (diagonal) + 3 mm
   iii). flatness + 0.5 mm in 300 mm length

**b. Assembly/Installation**
   i). linear dimensions + 2 mm
   ii). level + 2 mm
   iii). position at floor or ceiling + 2mm from grid
   iv). plumb + height/500 or < 5mm between floors and ceiling.
   v). steps in-plane + 2 mm
   vi). steps out of plane + 1 mm
   vii). Joint widths ± 2 mm

The tolerances given for assembly/installation are deemed to include manufacturing tolerances. The above tolerances are not cumulative to total number of floors.
4.6 Thermal Effects

The façade system shall accommodate all expected thermal effects and movements in service. The following normal operating temperatures are assumed but need to be verified at the completion of M&E design.

- Internal temp range (with AC operational) 22 ± 2°C
- Internal temp range (AC off) 18 – 35°C
- External temp. range (ambient) 15°C min; 50°C max
- External temp. range (ambient) 75°C max

4.7 Weather proofing

Each façade system is required to be waterproof under the normal environmental conditions expected over its design life. A pressure equalised and drained joint approach is to be adopted for curtain walls and windows should be pressure equalised with drained seals. The location of drainage holes shall be aesthetically pleasing and subject to review and acceptance by the Architect. Wall cladding will generally be rain screen systems with impermeable back-up walls. Face sealed approach can only be adopted with the consent of the client team.

Sealants shall be kept to a minimum and be used principally as air seals. Sealants shall be used for the weather seals only where a leak will not occur if the seal fails. More detailed description of waterproofing system is defined in the appendix-A.

Water shall run off all exposed surfaces without ponding and with measures to minimise staining. Water shall not pond within the systems, cladding or canopies unless its evaporation within 24 hours can be assured.

Acceptable evidence of waterproofing may be provided by:

- Off-site testing of a representative prototype – The tender will require full sized mock-ups to be conducted of each unique curtain wall suite.
- On-site testing of representative sections of completed installation
- Previous test report on a similar system under similar circumstances

4.8 Air Infiltration

Air infiltration limits for typical level glazing systems to be as per performance test criteria specified in this specification. Following are applicable for all other façade systems.

A complete air seal shall be provided. The facade shall not leak air excessively nor give rise to noise as a result of wind movements around the facade or within cavities.

Air infiltration limits (allowable air leakage) shall be as follows:

- For fixed sashes: Leakage< 1.0 l/s/m² under 300 Pa differential pressures
- For operable sashes: Leakage< 0.5 l/s/m length of seal under 300 Pa differential pressures

Mechanical Services to confirm this is in accordance with their design assumptions.

For operable elements criteria specified for performance testing to be followed.

4.9 Thermal Performance

The facade system shall have an appropriate level of insulation to prevent excessive heat or cold transfer to the building. The complete building envelope shall comply with any available local requirements. Vapour barriers shall be located to prevent interstitial condensation and condensation build-up on visible surfaces. If condensation is permitted to occur within cavities then provision will be made for adequate drainage.
For performance of the total envelope reference should be made to the performance criteria set for the internal environment.

The following are indicative minimum thermal properties, but this will supersede with glass performance specification if specified separately by façade consultant / Architect.

Maximum ‘U’ values shall be (European U-value):
- Glass Vision Areas Single glazed 5.7 W/m²K (max)
- Glass Vision –Double glazed 2.0 W/m²K (max)
- Spandrel Areas (complete construction) 0.6 W/m²K (max)

Acceptable evidence of adequacy shall be provided by calculation.

4.10 Acoustic Performance

The design, construction and installation of facade shall be such as to minimise the generation of noise due to relative movement between facade and structure. Proper treatment should be provided to eliminate cracking noise caused by not only by thermal expansion and contraction of metal parts but also by deflection main structure.

The complete facade system shall provide sufficient attenuation of the external acoustic environment to achieve the client’s required internal noise levels.

4.10.1 Noise

The design, construction and installation of facade shall be such as to minimise the generation of noise due to relative movement between facade and structure. Proper treatment should be provided to eliminate cracking noise caused by not only by thermal expansion and contraction of metal parts but also by deflection of the main structure. Drumming, creaking, rattling, whistling and any other noises generated from the glazing / cladding system shall not be audible to occupants.

4.11 Fire

The facade shall be constructed from non-combustible components. Façade systems and respect details are required to provide smoke separation between floors and incorporate fire-stopping materials as per the details and to comply with any local statutory requirements.

4.11.1 Fire Access Panels

Fire access panels shall consist of breakable glass i.e. Non-laminated, with or custom designed removable or open able panels. Where used all toughened or tempered glass to be heat soaked, but its use is to be avoided and heat strengthened or annealed glass where appropriate. Internal and external access to the Fire Access Panel shall comply with the requirements of the local authority requirements. The bottom of the fire access panels to be no more than 900mm from the internal floor level.

4.12 Building Structure

The building structure is indicated in the Structural drawings of the existing and available from the Contractor for inspection. All façade systems are to be designed for the following minimum compliance with respect to the main building structure.
4.12.1 Building Movements

Any type of facade system and associated works shall accommodate the following building movements as minimum criteria. Any forces resulting from support structure movements, thermal effects, building sway etc. to be accommodated.

The following parameters, to be specified by the Structural Engineer and references should be made to their Structural Movement Report. In general the following should be allowed for in the facade design in the absence of any more detailed information:

- Inter Storey drift - H/500
- Column shortening - 1mm/floor-
- Differential edge beam/cantilever deflection (1/360 & 1/180 respectively)
- Imposed dead load (façade system + others) max 25mm.
- Live load deflection limit for beams and cantilevers (1/360 & 1/180 respectively)

4.12.2 Construction Tolerances for Building

The facade shall accommodate the following tolerances on the structural elements: However it is noted that the contractor is also responsible for surveying and accommodating the actual tolerances of building structure.

<table>
<thead>
<tr>
<th>Building Elements</th>
<th>Levels</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>Slab edge in plan</td>
<td>+/- 20 mm</td>
</tr>
<tr>
<td></td>
<td>Slab Level in elevation</td>
<td>+/- 10 mm</td>
</tr>
<tr>
<td></td>
<td>Vertical</td>
<td>H/500</td>
</tr>
<tr>
<td></td>
<td>Column side face</td>
<td>+/- 12 mm</td>
</tr>
<tr>
<td>Finished Floor and Ceiling</td>
<td>Level</td>
<td>+/- 5 mm</td>
</tr>
<tr>
<td></td>
<td>Position from GL</td>
<td>+/- 5 mm</td>
</tr>
<tr>
<td>Wall Finishes</td>
<td>Position from GL</td>
<td>+/- 5 mm</td>
</tr>
<tr>
<td>External Finishes</td>
<td>Level</td>
<td>+/-20 mm</td>
</tr>
</tbody>
</table>

4.12.3 Attachment to the Building

Structural fixings shall be designed to resist dead loads, live loads, wind loads, and all building movements, individually and in combination. All fixings are to accommodate the worst combination of tolerances as listed previously.

Cast-in inserts are the preferred method of attachment to the new structural elements. Post-fixed anchors may only be used where cast-in anchors have been unintentionally omitted and with the approval of the Engineer. Location of post fixing anchors to be approved by the structural consultant, in order to avoid any drilling on pre-stress tendons or any other services within the structure. 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 cladding itself.

c. Constructional inaccuracies of the supporting structure.

d. Adjustments by small increments in and out, up and down and side to side in the position of the cladding 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 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. Calculations submitted to the Project Manager shall show the extent of movements that have been allowed for in the design of fixings.
i. Bolts, screws and nuts used for fixings the cladding to the structure shall be of adequate strength for their purpose. The Contractor shall state in his calculation the factor of safety achieved. Nuts shall be fully tightened after adjustment to prevent loosening due to movements and/or vibrations.
j. 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 Contractor shall demonstrate to the Project Manager that the use of all proprietary fixings installed have been reviewed and approved by the fixing manufacturer and shall, prior to the installation, submit the Manufacturer's written certification that the details proposed by the Contractor are appropriate for their intended use.

4.13 Locked-in stresses

The Contractor shall avoid in his design and detailing of the fixings, the introduction of locked-in stresses that may be detrimental to the performance 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.

4.14 Corrosion and Durability

The facade systems are to be detailed to minimise the risk of corrosion and deterioration of all elements. Weep holes, recesses and drip inducers are to be detailed to control rainwater runoff and minimise streaking.

4.14.1 Electrolytic & Bimetallic Isolation

Different (dissimilar) metals that are in direct contact and at risk of electrolytic and bimetallic corrosion shall be isolated from one another to prevent electrical connectivity and inter-metal corrosion between the metals.

4.15 Maintenance and Replacement Capacity

4.15.1 General Requirements

All glass panels for windows and doors to be replaceable from inside. Handling of glass to be from the inside and gondola will be used for site re-glazing. Similarly repairs and replacement for metal cladding shall be performed from the outside using all other elements and routine cleaning to be conducted with minimal disruption to building occupants.

Access to the outside of the facade shall be generally from the Gondola (Building Maintenance Unit). Intermediate restraint plugs for gondola shall be provided in the facade at various levels as
required by the local authority and Gondola supplier. Facade elements shall be designed such that effective maintenance and replacement of these elements can be carried out without damaging adjacent components.

Maintenance must be identified in terms of routine (e.g., Cleaning) and in terms of component, repairs/replacements. Each system shall be analysed to define the sequence under which components are likely to fail. On completion, provide four copies of the maintenance manual procedures for the satisfactory long-term care and regular maintenance of the various curtain wall and cladding system installations (and associated works), including: (These shall be provided by the Maintenance system supplier)

- An outline description of the installation and a detailed description of specific items with product names, types, serial numbers, etc.
- Recommend maintenance periods and planned preventive maintenance procedures.
- Copies of manufacturers’ warranties or guarantees, service manuals, brochures, recommendations, etc.
- Copies of test and approval certificates
- One original copy of each shop drawing, ‘AS BUILT DRAWING’, and the like relevant to the installation.
- A list of replacement parts recommended to be held on site, with the names of suppliers.
- Realignment and adjustment instructions where relevant.
- Procedures for dismantling and reassembling.
- Finishes and their architectural description.

Include in the manual, log book pages set up for recording the times of performance of the above procedures, sufficient in number to receive the entries for 10 years. Show examples of typical entries by recording any maintenance procedures (such as cleaning) performed during the contract and defects liability periods.

4.15.2 Provision for Cleaning

All façade systems are to have features and elements incorporated for cleaning and maintenance of facade systems.

4.16 Building Regulations and Standards

All façade components shall comply with the requirements of all national and local Government codes and regulations, in particular those relating to Building Construction.

The Contractor shall, as a minimum, comply with all the relevant regulations and with the current edition of the relevant Standards and Codes. Where conflicts arise between this specification and the Code or Standard listed below the more stringent requirement shall apply.
5 **Mock-ups – Testing and Visual**

Upon finalisation of design and before production design verification shall be completed with the help of mock-ups erected for visual and testing purposes.

5.1 **Visual Mock-ups**

Following are minimum compliance requirements.

### 5.1.1 Aim of Mock-up

Visual mock-up will be prepared for the following intention

- Approval for dimensions
- Approval for glass colour, frit patterns
- Approval for glass visual/optical quality acceptance
- Approval for paint finish
- Approval for external and internal appearance
- Approval for window accessories

Aluminium profiles for visual mock-up shall be fabricated instead of extruded profiles; however the visible dimensions of profiles should be as per approved shop drawings.

Glass for the visual mock-up should be actual glass processed and to be completed in all aspects. If HS or Toughened or Laminated specified then the glass for visual mock-up should follow the same.

Contractor to replace unsatisfactory work as required obtaining approval of consultant. Note that the approved VMU will become standard of workmanship for the project. The approval of the VMU does not relieve the contractor at its obligation to perform the work in accordance with contract documents

### 5.1.2 Critical elements for Visual Mock-up

Following façade elements not limited are identified as critical for mock-up, façade contractor to erect at the site.

<table>
<thead>
<tr>
<th>Façade types</th>
<th>Minimum requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical level facade</td>
<td>3 panels wide, 2 floors height. Actual glass to be used with architect approved frit pattern</td>
</tr>
<tr>
<td>Glass selection</td>
<td>Frit pattern as per architectural design intent, No. of panels minimum 4 panels</td>
</tr>
<tr>
<td>Fire Rated Glazing</td>
<td>2 modules of fire rated glazing assembly, finish as per actuals</td>
</tr>
<tr>
<td>Steel screen/ jali</td>
<td>3 modules wide.</td>
</tr>
</tbody>
</table>

### 5.1.3 Minimum Requirements

The Mock-up shall be completed with the assistance of the other contractor and the associated sub-contractors and incorporate the following features:

- The outline of elements as noted on the elevation drawings. Follow actual size of façade element and modulation.
- Use actual colour, size and type of approved glass, Include full sized glass samples produced from the production line intended for the typical glass supply.
- Include an interior floor, ceiling, side walls and a rear enclosure to mimic actual interior space.
Include proposed or typical internal blinds.
Follow the dimensions of approved system drawings with fabricated sections or use actual extrusions if it is available at that time of mock-up
Constructed solely for the purpose of demonstrating the general external and internal appearance.
Aluminium frames shall have paint finish of approved colour
Use selected and approved hardware on mock-up
Mock-up shall be prepared at suitable location on site with good natural lighting and accessible internally and externally
Enclose sides of mock-up if required to control the daylight.
Include full sized glass samples produced from the production line intended for the typical glass supply.
6 Materials and Components

6.1 General

Façade material to comply with requirements as specified in the Appendix B of this specification. This section describes minimum requirements for the materials to be used in the works covered by the specification and shown on the architectural drawings as well as the overall configuration of the curtain wall system. The Contractor shall prepare a schedule of materials to be used on the project. If alternatives are proposed, submit proposed alternatives and include samples, technical information, reasons for proposed substitution and cost. If necessary, provide an English translation. State if provision of proposed alternatives will necessitate alteration to other parts of the works and advice of consequent costs. Allow 10 working days for review and acceptance.

6.2 Procurement

Major suppliers such as glass processor, alum extruders, coating applicator and window operable accessories any sub-contractors as proposed by of façade contractors will be reviewed at the time of tender. During post tender stage, if the proposed supplier is found to be incapable or not satisfactory then the client team have right to instruct the façade contractor to terminate the particular supplier or sub-contractors.

6.3 Volatility and Compatibility

All materials and components are to be free from volatile components that may migrate with time, or evaporate and re-condense onto other components. Select, design and install materials to prevent bimetallic corrosion. Ensure all materials for the curtain wall and glazed roof are compatible with the other materials around them within their range of influence throughout the service life.

6.4 Glass

Glass performance requirements as per glass schedule issued.

6.4.1 General Requirements

All base supply glass to be float glass comply with following

- Comply with the requirements of ASTM C1036.
- Cut to accurate sizes in the factory
- Clean cut, without significant edge faults that produce risk of breakage (including feathered edges, shells or other imperfections) and free from bubbles, inclusions, cracks, rippling, dimples, sleeks or other defects.
- Assessed for optical and visual faults as described in BS EN 572-2. Spot faults to be no worse than category C. There will be no linear / extended faults. Optical faults to be within the limits set in BS EN 572-2.
- No local defects producing irregular reflections.
- Glazing more than 3m above the ground with unsupported edges to be laminated.
- Glazing that is inclined by more than 15° from vertical or horizontal to be laminated.
• Do not use Toughened (Tempered) glass in situations where breakage could result in glass falling more than 4 metres to an occupied area, unless specifically approved.

6.4.2 Visual Requirements
To comply with architectural design intent in terms of tone of glass.

6.4.3 Thickness
The thickness and dimensions of glass shown on the drawings are minimum thicknesses, not prescribed thicknesses or dimensions. Contractor should calculate the glass thicknesses, using the recommendations in the relevant standards or validated proprietary design methods to meet the structural, environmental, and acoustic and safety requirements.

6.4.4 Visual Quality
- To comply with architectural design intent of glass tone.
- Visual quality should comply with glass installed condition, i.e. glazed / installed at its final location on the building. Viewing condition apply to final installed condition.
- Visual distortions of views and reflections to be minimised.
- Visual quality of views and reflections to be established using visual mock-ups.
- Glass used for visual mock-ups to follow actual composition where possible.
- Colour consistency to be maintained throughout the supply for the project. Colour variation that exceeds allowable limits as per international standards shall not be acceptable.

6.4.5 Safety and Thermal Stresses
Ensure that no glass or glazing combination develops stresses that may lead to damage of glass, glass breakage, glazing materials, components and/or framing systems.
Conduct a thermal stress analysis to verify that all glazing that is not heat strengthened or toughened is thermally safe and will not be susceptible to heat cracking.

Take into account shading stresses that might occur from adjacent components and buildings including shading devices. Where analysis indicates thermal cracking may occur, use heat strengthened or toughened glass (subject to restrictions in Detailed Design Principles section).

6.4.6 Heat Strengthened Glass
Heat strengthened glass to be:
- Comply with the requirements of ASTM 1048 (2004) for Kind HS glass.
- Tempered on a roller hearth furnace eliminating tong marks
- Conform to the following requirements in the horizontal heat treatment process:
  - Maximum overall bow or warp: 0.1% of length
  - Roller wave: < 0.15 mm per 300 mm length
  - All thicknesses 0.15 mm depth maximum between peaks and troughs
  - Edge dip: 0.25 mm maximum
• Identification marks indicating its nature and processor to be located in the bottom left when viewed from inside.
• Locate roller marks on heat treated glass parallel to the sill (horizontal)
• Demonstrate by the prime manufacturer’s testing that the residual surface compressive stress in the glass is between 24 N/mm² and 52 N/mm² when measured by GASP in accordance with ASTM F218-95 (2000). Demonstrate the uniformity of RSCS over the area of the panel by either GASP or other tests as approved by the consultant.

6.4.7 Fully Toughened Glass

Toughened glass to be / have:
• Conform to ASTM 1048-(2004) Kind FT.
• Tempered on a roller hearth furnace eliminating tong marks.
• Conform to the following requirements in the horizontal toughening process:
  • Maximum bow: 0.1%
  • Roller wave: All thicknesses 0.15mm depth maximum between peaks and troughs
  • Edge dip: 0.25mm maximum
• Location of Identification marks indicating its nature and processor to be agreed with the consultant.
• Locating of roller marks on heat treated glass parallel to the sill (horizontal)
• Demonstrate by the prime manufacturer’s testing that surface compressive stress in the glass is greater than or equal to 69 N/mm² when measured by GASP in accordance with ASTM F218-95 (2000).
• Heat soak test all toughened glass as per EN 14179 to reduce the likelihood of breakage to 1 in 400 tonnes, consultant should witness 1st batch of heat soaking and provide copies of log records for following batches.

6.4.8 Heat Treatment

Prior to heat treatment glass must comply with the requirements for ‘all glass’.
Prior to heat treatment
• Grind flat edges to a small arris.
• Dubb Corners.
• Grind out small shells and/or chips.
• Maximum chip/shell diameter 2 mm.
• Not more than four randomly placed edge located chip/shells in any single pane of glass.

6.4.9 Laminated glass

Laminated glass to have / be:
• Comply with ASTM C1172.
• PVB interlayer complying with BS 6206 Class B (45 KG Impacter with drop height of 457 mm).
• Edge steps less than 0.5mm in toughened or heat-treated glass. Annealed glass laminate shall have no step.
• Bear identification marks indicating its nature and processor.
• Panes to have autoclaved edges. Protect the interlayer material from the effects of moisture absorption in service including clouding, shrinking back, degassing and de-lamination.
• Ensure that the interlayer is compatible with glazing sealants. Undertake a compatibility test plus accelerated weathering to ensure that leeching does not occur into the interlayer.
• Use PVB brands DuPont and Saflex, in case colour PVB use single source to maintain the visual consistency through the project.

6.4.10 **Fritted glass**

Frit coated glass to be/have

• Comply with requirements of ASTM C 1376-97.
• Ceramic ink applied to areas of heat-treated glass using the silk screen process.
• Fuse the ceramic ink to the surface of the glass during the heat treatment process.
• Ceramic ink to be permanent, durable and resistant through the design life of the curtain wall.
• The type, colour and solar properties of the ceramic ink to be submitted for review prior to commencement of production.
• Resistance to attack from mechanical damage or abrasion, during normal use and maintenance.
• Resistance to weathering, fading or discolouration due to attack from climatic conditions, UV or atmospheric pollutants.
• The screen printed face of the glass facing the inside of the building in the final construction.
• Refer to the project drawings as directed by the Construction Manager for pattern and submit samples to the Construction Manager prior to manufacture.

6.4.11 **Glass Warranties**

• Glass supplier should produce written warranty on performance and manufacturing defects for the period of min. 10 years from the date of supply for this project.
• Warranty should cover all manufacturing and processing defects including performance and visual criteria under glass installed conditions.
• Glass supplier should provide Back to Back or Joint Warranty to the owner, warranty should be given through the façade contractor.
• Draft warranty copy should be given prior to finalisation and final warranty should be issued upon completion of glass supply.
6.5 Aluminium

6.5.1 Extrusions

- Aluminium shall have the chemical composition and temper appropriate for its function, exposure and applied finish.
- Use Grade 6061 T5 of BS EN 12020 for exposed anodised aluminium extrusions
- Use Grades 6061, 6063 or 6106 of temper class T5 or T6 of BS EN 12020 for other locations
- The extrusions shall have the webs, walls, and flanges of sufficient thickness and eliminate permanent distortion of elements in the finished Works.
- Structural design of aluminium extrusions to comply with requirements of BS 8118 or AS 1664.
- Comply with BS EN 486, BS EN 573-3, BS EN 755 and BS 1161.
- Minimum wall thickness in structural parts to be 2mm.
- Minimum wall thickness for covers, trims and other visible elements to be 1.2mm
- Platforms, webs, flanges, races and screw flutes of sufficient size to satisfy all structural requirements and eliminate distortion to the finished surfaces.
- Contractor should take due care to have sufficient wall thickness for extrusion in order to extruder the profiles with acceptable tolerances. Thickness should be adequate to avoid warping and twisting of profiles. Contractor cannot claim extra cost if the thickness needs to be increased at design development stage.

6.5.2 Extruder

- Extruder will be subject to quality review by consultants, extruder to be capable of extruding profiles with acceptable tolerances and international quality.
- All mating sections should only be extruded with single extruder to avoid profiles mismatch
- Full production of extrusions should only start after successful completion of trial runs with approved samples of extrusions.
- Extruder shall have spare die for critical section to avoid any production loss and delay in the event of die break down.
- Following submissions need to be made at the time of extruding
  - Mill certificate and test results for billets
  - Results of the spectrometer analysis on billets
  - On completed extrusions after heat treatment
  - Results of Ultimate Tensile Strength (UTS) on aged samples
  - Results of hardness test on each lot
  - QA checking recorded form or table to show the extrusions were checked dimensions, tolerances, straightness at the agreed frequency

6.5.3 Sheet, strip and plate

- Alloys to comply with BS EN 485-3
- Not less than 1mm thick GI for hidden flashings.
- Not less than 3mm thick for components exposed to view or to impact.
- Chemical composition and temper to be suitable for application and anticipated exposure and loading.
6.6 Weather Seals and Air Seals

Select and install in accordance with BS 6213. Sealants shall be compatible, non-staining and fit for their intended purpose. Design sealant geometry (and cross section) to accommodate the anticipated substrate movement. Use in accordance with the manufacturer’s directions, particularly relating to the use of primers.

Sealants to be / have:

- Design of the seals and selection of glazing materials (eg. Backing rod, glazing tapes) submitted to the sealant supplier for approval
- Low modulus – E less than 0.4MPa (@ 100% elongation)
- +/- 50% elongation capacity
- Glazing materials as recommended by sealant manufacturer. Selection to be based on proposed glazing and curing procedures.
- Backing rod to be 25% wider than joint width
- Primers and joint preparation materials - as recommended by the sealant manufacturer.
- Colour selection of any visibly exposed sealants as advised by the SO.
- Acrylic sealants are not acceptable for frame seals or smoke flashings.
- Acid curing sealants are not acceptable.

6.7 Sealants - Structural Glazing

Structural silicone shall be to approval as manufactured by Dow Corning & GE. Primers shall be the same brand manufacture as the sealants used and shall be compatible with the substrate and all adjacent materials.

Determine structural silicone bite requirement from design wind pressure and panel size, using the sealant manufacturer's recommended procedure. Joint design must be in accordance with the sealant manufacturer's recommendation for glue-line and bite to glue-line ratio.

Provide documentation of the sealant manufacturer's requirements for the particular substrates of the project regarding joint size, limitations, backer fin, mixing, cleaning, surface preparations, priming and application, temperature and humidity of glazing conditions and any other criteria which may affect sealant performance. All weather sealants of specified make should not bleed, stain adjacent façade during installation or in service.

The colours of all visible sealants are to be approved by the Architect.

6.8 Frame and Small Joint Sealant

Sealants used between aluminium frame elements to be / have:

- Compatible with aluminium surfaces and finishes.
- Able to accommodate predicted frame movements and distortions.
- Colour selection of any visibly exposed sealants as advised by the SO.
6.9 Brackets

All fixing brackets shall be galvanized steel or aluminium grade 6061 T6. Refer to attached table in the appendix.

Brackets to be / have:
- Resist all loads, movements and dimensional changes that may occur in the building due to thermal changes, deflections, settlement and creep.
- Allow for construction tolerance in the all components and structure.
- Adjustable by small increments in and out, up and down and side
- Use lock nuts to prevent loosening due to movements and/or vibrations.
- No site welding is permitted on steel or aluminium brackets.

State the torque values for tightening all bolts and the maximum allowable shim dimension in the shop drawings. (Not to be greater than 10mm)

6.10 Fasteners

The selection and usage of fixings is to be strictly in accordance with the manufacturer’s recommendations. Where the visual appearance is of prime concern exposed fixings are not allowed and the fixing details are to be approved by SO. Refer to attached table for fastener material to be used.

Stainless steel fasteners may have hardened tips of other composition for self-drill and self-tap screws only.

Washers shall be minimum aluminium grade 6061 T5 or T6 or stainless steel grade 304.

Bolts to mullion shall be minimum of stainless steel grade A2-70.

6.11 Insulation

Thermal or sound deadening insulation to be
- Inert, durable, rot and vermin proof, CFC and HCFC free.
- Not capable of supporting mould fungal or bacteria growth.
- Capable of maintaining the specified performance throughout the service life of the curtain wall.
- An approved mineral wool
- At 50mm minimum thickness for all spandrels insulation
- Maximum U-value for insulation to be 0.11 W/m².°C.
- Reinforced aluminium foil backing factory applied to the insulation
- With a minimum density of 60kg/m³
- With melt point in excess of 1000°F.
- Be supported within the prefabricated panel by a continuous aluminium angle or equivalent.

All fixing pins and accessories needed for fixing insulation to be manufactured from materials which will provide a life equal to that of the metal finishes and result in the insulation maintaining its position, not to sag or delaminate for the duration of its design life.
6.12 Gaskets and Spacer

Gaskets to be extruded EPDM complying with the provisions of BS 4255-1 or cellular profiled rubber to ASTM-C509. Inner gaskets of drained and ventilated or pressure equalised curtain walling systems must be formed in a complete frame with sealed joints. Vulcanised rubber gaskets to have factory moulded corner joints.

All gaskets/ weather seals/ spacers are to have continuous mechanical attachment to framing members. Adhesive attachment is not acceptable.

All gaskets must be resistant to oxidation, ozone and UV degradation.

Gaskets in contact with silicone sealants are to be heat cured silicone rubber, chemically compatible with the silicone sealant and suitable for the specific purpose intended.

Sponge gaskets/ weather seals/ spacers are to be extruded black neoprene or silicone rubber and conform to ASTM C509 (for neoprene).

6.13 Setting Blocks for Glazing

Setting blocks to be / have
- Comply with BS2571
- Polychloroprene, EPDM or dense heat cured silicone rubber.
- Shore A Hardness of 80-90 Durometer.
- No compounds that could leach out over time and cause staining, or deterioration of adjacent materials. Demonstrate this by compatibility testing.

6.13.1 Location blocks

Location blocks or side blocks to be/have:
- Comply with BS2571
- Polychloroprene, EPDM of dense heat cured silicone rubber.
- Shore A Hardness of 60-70 Durometer.
- No compounds that could leach out over time and cause staining, or deterioration of adjacent materials.

6.14 Flashings and Smoke Barriers

Flashings and smoke barriers visible externally or internally shall be minimum of aluminium sheet, grade 3003 or 5005 with finish to match the curtain wall.

Flashings and smoke barriers not visible externally shall be minimum aluminium sheet grade 3003 or 5005.

6.15 Separating/Isolating Materials

Separating material is to be compatible with any material with which it comes into contact and isolating material should be non-conducting, non-compressible and non-water absorbing.
6.16 Backing sheet

The backing sheet behind the weather proof louvers made from mild steel galvanised and paint finish to match the colour of the louvers. The sides of backing sheet shall be fixed to mullion.

6.17 Hardware

Provide to operable elements, such as doors or opening sashes, hardware purpose-made for the element or recommended for the purpose by the window or door manufacturer and reviewed by the Engineer. The aluminium framing systems are to be designed to be accommodating the requirements of the proposed hardware.

Unless noted otherwise, hardware shall be 316 grade stainless steel with No.8 polished finish where exposed. All mechanisms and operable devices to be rated for external use with minimal maintenance. All hardware of operable should be tested for 50,000 cycles.

Provide a full hardware schedule confirmation for all windows and doors as per the Architects schedule. Only approved brands as stated in the Appendix will be acceptable.

6.18 Aluminium Finish –Powder Coating

All visible surfaces of aluminium extrusions, pressings and the like shall be shop finished prior to assembly. Colour and gloss level to be nominated by the Architect. Coating systems shall be selected for durability, colour fastness and resistance to damage.

All finish coated aluminium sheeting and frames shall be protected during manufacture and erection. Provide details of protection to consultant for review and acceptance. Façade contractor shall finalise coating applicator only after review of consultants, if the proposed coating applicator is not satisfactory then alternate applicator should be sourced by the façade contractor. Façade contractor is responsible to get the colour approval on time and finalise the coating applicator.

Following are minimum requirements

- Comply with the minimum requirements of AAMA 2604
- Use a single supplier and applicator throughout production to ensure consistency of appearance.
- Coat all significant surfaces with the following minimum (unless noted otherwise):
  - DFT Nominal thickness of 70 micron, (Min. 60 micron at any coated surface & not exceeding 120 micron)
- If a two coat system is used, the top coat is to have a minimum thickness of 25 microns.
- The coatings are to be free of flow lines, streaks, blisters, pin holes, tears, damage and other surface defects. Visual inspection for scratches, dents and blemishes to be from 1m under normal diffused daylight.
- Apply the coating using an applicator approved by the polyester powder manufacturer and agreed by the SO. Use international powder (paints) suppliers such as Akzo Noble, Jotun

6.19 Façade Structural Steel

All Structural steel works brackets and accessories by the facade contractor should comply with Structural Steel work specification from the Structural Consultants. The contractor should also satisfy the following additional norms.

- All structural steel shall be hot rolled steel complying with the requirements of BS EN 10025 or equivalent Indian Standard unless noted otherwise.
• Unless noted otherwise, structural steel shall be hot dip galvanised in accordance with BS EN 1461 or equivalent Indian Standard

• Should cold formed sections be required, they shall conform to BS EN 10142, BS EN 10143, BS EN 10147 or equivalent Indian Standard and shall be roll-formed from zinc coated high strength steel strip, zinc-hi-ten minimum yield stress 450 Mpa, Minimum coating mass of 300g/m3 unless otherwise noted.

• All steel works shall be fabricated to a tolerance as specified in BS 5950 Part2 or equivalent Indian Standard and on corresponding drawings.

• The contractor will be responsible for the placement of holding down bolts for anchorages to concrete structure.

• A complete set of welding procedures shall be submitted for comment and endorsement will include the following
  i. Welding consumables used
  ii. Welding tools used and method of welding
  iii. Angle of weld
  iv. Number of welding pass

• The contractor shall submit a full set of quality control procedures for each of the fabrication process on site and in the workshop

• The contractor shall submit samples of welding for architecturally exposed steel works.

• The contractor shall employ an independent registered material testing laboratory for testing the fabricated steel works to full compliance with specification. Finishes to Structural Steel

6.20 Certification of Materials

Prior to commencement of fabrication, obtain certification from the manufacturer of each material that the material is of the correct grade, strength, size, finish etc, and that all applied coatings, finishes and the like have been applied to the relevant standards specified herein. Provide copies of all such certification to the Engineer for inspection.

Such materials requiring certification include but are not limited to:

a. Glass
b. Aluminium (coated and uncoated, sheet, pressings and extrusions)
c. Aluminium surface finishes
d. Steel and stainless steel Sections
e. Bolts, Screws, Fixings.
f. Sealants and Gaskets

Certification from structural silicone and other sealant manufacturers shall indicate that the sealant manufacturer has reviewed all sealant details and tested all contact surfaces, and finds same suitable for use with proposed sealant and the purpose intended.

Further, the sealant manufacturer(s) shall certify that the sealants used are compatible with and will not stain the surfaces with which they are in contact and no leakage or contamination from run-off water will occur.
7 Fabrication

7.1 General

Facade and associated elements shall be fabricated in strict accordance with approved Shop Drawings. The Nominated Sub-Contractor shall comply as a minimum with all the relevant regulations and with the current edition of the relevant Standards and Codes. Where conflicts arise between this specification and the Code or Standard listed below the more stringent requirement shall apply.

7.2 Inspection

Operate an inspection system, using a competent independent Inspection Authority, to verify that all materials, workmanship and completed work conform to the performance criteria and minimum requirements. This should include a system for identifying the inspection status at all stages of manufacture and testing. Give sufficient notice to the Project Manager that inspection may be made at the following stages:

a. Materials Testing
b. Commencement of delivery of fabricated assemblies to the site.
c. Prepared site storage areas for cladding system assemblies before the assemblies are delivered.
d. Required prototypes constructed and ready for inspection and testing.
e. Fabricated cladding system assemblies at the factory ready for delivery to the site.

Facilities shall be afforded the Project Manager to carry out inspections of facade and glazing roof systems to establish conformity with the general design and finishes. The Nominated Sub-Contractor is to provide transportation, and any associated accommodation and meal expenses.

7.3 Fabrication Tolerances

7.3.1 Aluminium frame

The maximum allowable tolerances for all Curtain Wall frameworks shall be:

a.  ± 1.5 mm on length on mullions.
b.  ± 1.0 mm on length on transoms.
c.  ± 1.5 mm on straightness of mullions.
d.  ± 1.0 mm on straightness of transoms
e.  ± 2° accuracy at angles between mullions and transoms
f.  ± 1mm on sides and ± 2 mm across diagonals on the spandrel and vision panel opening position.

7.3.2 Glazing

Achieve the following maximum allowable tolerances for individual panes of glass:

a.  ±2.0 mm on height and width
b.  ±1.0 mm on straightness of edges

Tolerances on insulating glazed units allowed by BS 5713.
7.4 Structural Silicone Glazing Units

7.4.1 Procedures

Obtain and review procedures from the specialist supplier/manufacturer for fabricating structural silicone glazing units:

- 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 and application.
- Glazing procedures including frame assembly, cleaning, priming (if necessary), gunning, tooling, frame handling after glazing and curing.
- Silicone batch logging procedures to record all batches used including batch manufacture, date and arrival date of each batch at the fabrication works.
- Details of sealant testing to be carried out to ensure continued high quality of silicone being used on a batch or shift basis whichever is the least.
- Details of tensiometer and any other testing equipment as required.
- Details of substrate testing carried out on a daily basis to ensure continued high quality of and consistency of silicone adhesion to the substrate.
- Frame logging at time of assembly, which shall include identifying every panel by a unique number. 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 of each day.
- Details of de-glazing to ensure quality of the silicone joints. 3 no. frames for each type of structurally bonded glazing to be chosen at random by the SO and de-glazed. The quality of the de-glazed units to be assessed against the requirements for cohesion, adhesion, tear resistance and compatibility as defined by the sealant manufacturer.
- 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 SO shall call for further de-glazing of the frames glazed on the same day and using the same silicone batch as the rejected frame.

7.4.2 Sealant Works

- Carry out works in accordance with the agreed procedures above
- Complete structural sealant works in a continuous operation for any single element
- Handling of panels to be consistent with setting periods of sealant

7.4.3 Production Records

Obtain review and approve factory production control records specific to the fabrication of the project structural glazing units, from the specialist supplier demonstrating that all procedures above have been satisfactorily followed.
7.5 Glazing QAQC Testing

Documentation, preparation, installation and testing of structural silicone seals shall include, but not be limited to:

- Silicone batch logging procedures to record all batches used including silicone batch manufacture date and arrival date of each batch at the Contractor's premises.

- Frame logging at time of assembly will include identifying every panel by a unique number. Glazing records will then provide information on each panel (by its number) including silicone type and batch, date of silicone installation, glazier's name, temperature and humidity measured inside the factory at a nominated time each day.

- Deglazing to ensure quality of the silicone seals will be done periodically. Frames will be chosen at random as follows:
  1. 1 out of the first 10 frames (frames 1 to 10)
  2. 1 out of the next 40 frames (frames 11 to 50)
  3. 1 out of the next 50 frames (frames 51 to 100)
  4. 1 out of each 100 frames for the remainder of the project.

- Establishment of an acceptance criteria for the periodic de-glazing.

- Establishment of a procedure in case a frame is rejected. This shall include de-glazing of frames glazed on the same day with the same silicone batch as the reject frame. The procedure shall provide for the identification of all frames of unacceptable quality and their re-glaze or rejection.

7.5.1 Glass- QA/QC

Following are the minimum checks that the glass processor should follow as part of their QA/QC system. The testing frequency and schedule to be followed accordingly.

- **Glass Pre - process**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Checking Method</th>
<th>Frequency of Checking</th>
<th>Pass Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>Micrometer</td>
<td>Once per shift</td>
<td>To be within the tolerance</td>
</tr>
<tr>
<td>Size</td>
<td>Measuring tape</td>
<td>100%</td>
<td>To be within the tolerance</td>
</tr>
<tr>
<td>Visual defects</td>
<td>visual</td>
<td>100%</td>
<td>No visual defects</td>
</tr>
</tbody>
</table>

- **Heat treatment process**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Checking Method</th>
<th>Frequency of Checking</th>
<th>Glass Sample Size (mm)</th>
<th>Pass Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual Surface compressive Stress</td>
<td>Use GASP (Grazing Angle Surface Polarimeter)</td>
<td>Every Heating Batch</td>
<td>300x300</td>
<td>24-52 MPa (for HS glass)</td>
</tr>
</tbody>
</table>
7.6 Façade Structural Steel

7.6.1 General

Fabricate finish in accordance with Part 2 of BS 5950. For exposed steelwork, visual appearance is of the highest importance. All exposed steel surfaces are to be finished smooth and true with a surface roughness such that it will not be visible after application of the corrosion protection and finish coats. All imperfections that might be visible are to be ground out if this can be achieved invisibly, or repaired by welding and grinding in accordance with BS 5135. All corners are to be smoothly rounded with a radius of curvature 1mm. All visible welds are to be continuous fillet welds. All welds are to be ground flush and smooth, as required by the Engineer. All grinding shall maintain a consistent even surface finish so as to remove all signs of corrective work.

Raw or mill finished steel works (framing / brackets) shall not be installed without basic corrosion protection i.e. Zinc rich primer or Hot dip galvanised.

7.6.2 Welding

Manual welding and Semi-automatic welding shall be in accordance with BS 5135 evenly match butt edges and faces to be welded, brazed or soldered. Where joints made by these methods are visible, finish them by grinding buffing, or like methods appropriate to the class of work and before any further treatment such as painting or galvanising is carried out. All exposed continuous welds in structural members must be completely watertight.

Welders shall have passed the relevant tests specified in BS 4870 or equal international standard. Welding supervisors shall have passed the tests specified in BS 4870 (or under equivalent international standard) and possess the certificate specified therein.

All welding consumables and methods are strictly in accordance with the codes or any special requirements of the plate manufacturers. All work to be carried out by operators experienced in this type of work.

7.6.3 Hot Dip Galvanising

Clean steel after chemical de-scaling in accordance with BS 7079, so that all rust, mill scale, oil, grease and other foreign matter is removed leaving a clean surface of metal. Reinstate all transport and erection abrasions, site welds, etc., by thoroughly wire brushing all affected areas to achieve a clean sound substrate and patch coating with an inorganic zinc silicate film thickness of 100 microns.

7.6.4 Paint Finish to Structural Steelwork

Structural steel shall be paint finished in the factory or paint shop after galvanising as follows (site painting will only be permitted for touching up of the paint film) refer to appendix for finish to structural steel works.

- Prior to painting, degrease all galvanised surfaces in accordance with BS 7079. Paint treatment shall then be applied.
- Oil and grease shall be removed with a suitable de-greasing solvent, care shall be taken when using solvents that a film of oily residue does not remain after the solvent has evaporated. Slow evaporating solvents (Paraffin, etc.) shall not be used, only clean rags and brushes shall be used.
- All colours to be nominated by the SO.
• All painting shall be applied in accordance with this specification and in accordance with BS-EN-ISO-12944 Parts 1-8
• All areas to be painted onsite shall be adequately protected against the weather to the satisfaction of the Engineer.
• All coating materials shall be applied in a neat workmanlike manner by skilled personnel working under supervisors with experience in the application of the particular systems and in accordance with the manufacturer’s shop application instructions and as specified in this Clause. Unless specified otherwise all paint shall be spray applied.
• Paint shall be carried out in a covered area remote from any abrasive blast cleaning operations.
• All sharp edges and corners to the steelwork shall be rounded prior to painting to an approximate radius of 5mm. All weld spatter, flux residues, oil and grease, abrasive dust and other paint contaminants shall be removed. All moisture shall be removed and surfaces shall be dry before coating.
• The Sub Contractor shall provide certificates of coating adhesion and of uniformity of coating in accordance with BS-EN-1461 for galvanised coatings, and BS-EN-ISO-12944 for paint coatings. Other Manufactured Components
• Submit manufacturers intended method and details of manufacture of other components for approval of the Engineer.

7.7 Aluminium Finishes

7.7.1 General
Aluminium finishing shall comply with the minimum requirements as specified on this specification. The coating shall be carried out by an applicator nominated by the Contractor, approved by the polyester powder manufacturer and agreed by the Architect & Curtain Wall Consultant. One single paint applicator and source shall be used for the duration of the Works.

7.7.2 Colour
The coating finish colour and gloss level shall be as specified by the Architect or as noted the Architect’s Drawings.

7.7.3 Service Life
The minimum service life as defined in BS7543 shall not be less than 25 years. Paint applicator should provide a minimum warranty period of 10 years covering paint finishing including application and workmanship of finished surfaces.

7.7.4 Agreement Certificate
Coating shall be carried out in full compliance with the appropriate Agreement Certificate. A copy, headed with the name of the project and countersigned by a director of the coating company shall be submitted to the Architect & Curtain wall Consultant before any production commences.
7.7.5 **Mandatory QAQC Tests**

Following tests to be carried out by an external approved third party test agency for each colour.

<table>
<thead>
<tr>
<th>Test</th>
<th>Standards</th>
<th>Frequency of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFT-Dry Film Thickness</td>
<td>ASTM D6633</td>
<td>All tests specified herein to be carried out for every 100 Tons of aluminium profiles for each colour.</td>
</tr>
<tr>
<td>Pencil hardness</td>
<td>ASTM D6633</td>
<td></td>
</tr>
<tr>
<td>Scratch resistance</td>
<td>ASTM D2793</td>
<td></td>
</tr>
<tr>
<td>Abrasion resistance</td>
<td>ASTM D4060</td>
<td></td>
</tr>
<tr>
<td>Impact Resistance</td>
<td>ASTM D2794</td>
<td></td>
</tr>
<tr>
<td>salt spray</td>
<td>ASTM B117</td>
<td></td>
</tr>
<tr>
<td>Adhesion</td>
<td>ASTM D2197, D3359</td>
<td></td>
</tr>
<tr>
<td>Gloss level</td>
<td>ASTM D523</td>
<td></td>
</tr>
<tr>
<td>Colour</td>
<td>ASTM D2244</td>
<td></td>
</tr>
</tbody>
</table>

Above tests to be completed at the time of first batch of coatings, 5 samples of actual profiles of the project to be tested for each of these tests. Test results to be submitted for client review and acceptance, subsequent batches of tests to be carried out at specified frequency as above.

Should any one or more of the tests not meet the pass criteria specified, the production batch shall be stripped of the coating and re-subjected to the coating process from the beginning. No overcoating shall be permitted. The sample panels shall be coated during coating operations for main work. Following the process tests, the samples shall be labelled, indexed against their respective test and kept for a period not less than 6 months following practical completion of the works. Test records comprising all pre-treatment processes records and appropriate test panels and test reports are to be made available for inspections.

7.7.6 **Fabrication requirements**

Fabrications shall be from pre-finished or finished machine lengths at the recommendation of the powder coating applicator. The contractor shall state in his Tender, which he has used. No visible or exposed areas of un-coated metal or unsealed crevices open to the exterior shall be accepted. Any area where coating is carried out after machining, satisfactory jigging points shall be arranged between the contractor and the powder coating applicator. Where necessary, drain holes shall be provided. Two sample joints shall be submitted to the Architect for approval, 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 contractor shall ensure uniformity of colour, texture and gloss, on the completed elevations, between adjacent panels and/or components within the approved 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.

7.7.7 **Workmanship**

Fabrications shall be from pre-finished or finished machine lengths at the recommendation of the Coating Applicator. No visible or exposed areas of uncoated metal or unsealed crevices open to the exterior shall be accepted. Any area where coating is carried out after machining, satisfactory jigging points shall be arranged between the Contractor and the Coating Applicator.
necessary, drain holes shall be provided. All welds, burrs and other edge machining shall be ground smooth to the requirements of the Coating Applicator prior to coating.

The Contractor shall obtain from the Coating Applicator a detailed method statement for the coating process and submit it to the Architect & Curtain Wall Consultant for approval. Prior to submission, the Contractor shall ensure that the Paint Manufacturer has endorsed the method statement. This shall include but not be limited to the following:

(a) Receipt, labelling and storage of components prior to coating.
(b) Pre-treatment (degreasing, rinsing, de-mineralizing).
(c) Drying.
(d) Coating application(s).
(e) Curing.
(f) Labelling.
(g) Protection.
(h) Storage and vehicle loading.
(j) Recommendations for handling and transportation.

7.7.8 Temporary Protection

All coated surfaces vulnerable to damage during handling and installation or by subsequent site operations shall be fully protected for the duration of the works.

Protective coverings 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 contractor shall, in conjunction with the Architect agree a programme for monthly inspections and make good/replace the coverings as may be required.

7.7.9 Remedial Works

Site rectification of damage shall be subject to the approval of the Architect and shall only be permitted subject to the submission and approval 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 shall be at the discretion of the Architect. The Architect as control samples shall keep accepted trial samples. Repair record sheets shall be logged by the contractor and submitted to the Architect on completion of the works together with the coating Warranty documents.

7.7.10 Maintenance

The 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:

- Frequency of washing
• Solutions/detergents to be used and recommended dilution levels
• Type of cleaning materials Recommendations (if any) for deep cleaning processes (including solutions/compounds etc.) and their frequency.

7.8 Assembly

7.8.1 General
Assembled components shall comply with the approved shop drawings and, as a minimum, with the following requirements.

7.8.2 Checking of Manufactured Components
As part of the Quality Assurance system, the Contractor shall, upon receiving manufactured components into the factory, and prior to incorporating these into the Contract Works, check for compliance of the manufactured components with the requirements of the Specification and Shop Drawings. Such checks shall include but shall not be limited to:

a) Painted aluminium extrusions
   • Correct extrusion type/size
   • Correct grade of aluminium
   • Correlation with die drawings
   • Colour and type of finish
   • Review of manufacturer’s testing of paint film
   • Dimensional tolerances
   • Free from damage and defect

b) Painted aluminium sheet
   • Dimensional tolerances
   • Correct grade of material
   • Colour and type of finish
   • Review of manufacturer’s testing of paint film
   • Free from damage and defect

c) Structural and Stainless Steel elements
   • Dimensional correctness and tolerances
   • Correct grade of material
   • Colour and type of finish
   • Review testing of galvanising and paint film
   • Free from damage and defect

d) Glass
   • Dimensional tolerances
   • Free from damage and defects, including:
     • bubbles
     • spalls
     • waves
     • spots
     • scratches
     • distortion /deformation
     • discoloration
     • chipping
• colour inconsistencies
d) Correct colour and finish
Additionally, all other materials delivered to the factory shall have a QA check and sign off.

7.8.3 Frame Assembly
• As far as is possible, fabricate all frames under controlled factory conditions.
• Provide stable, clean surfaces and supports for the assembly
• Ensure the ends of all components are correctly prepared prior to assembly.
• Ensure all fasteners and fixing are installed with appropriate force and that no fixings are loose or overstressed.
• All sealant works to be tooled and neatly finished
• Ensure no ventilation or drainage holes are blocked.
• All junctions shall be adequately reinforced and accurately cut, fitted and sealed to leave only sealed hairline joints, in such a manner that drainage within sections is not impaired.
• Where dissimilar metals are in contact with the frames and there is a risk of galvanic corrosion, adequate means of separation shall be provided.
• Similar fabrication techniques and detailing shall be used in all assemblies to ensure consistent appearance of all completed work.

7.8.4 Setting Blocks and Spacers
Setting blocks shall be of length calculated to properly support the glass. Provide a minimum of 2 blocks per glazed unit located at quarter points or as required for the installation. Blocks shall not be closer than 150mm from a glazed unit corner and shall have a minimum length of 100mm.

7.8.5 Structural Silicone
Structural silicone shall be installed in clean factory conditions. Site application of structural silicone shall be restricted to replacement panels only.

7.9 Transportation and Handling

7.9.1 General
• Method statements are required for all stages from the production of the panels through to installation on site.
• Methods to minimise handling, repacking and lifting of panels. Panels to be stored directly after fabrication allowing for the setting and curing of sealants.
• Crates and packing to provide resistance to damage, the ingress of moisture and infestation
• All elements to be stored and protected against degradation due to weathering, distortion and damage by other construction activities.
7.9.2 Temporary Protection

Fully protect all coated surfaces vulnerable to damage during handling and installation or by subsequent site operations.

For protective tapes in direct contact with the coating, use a low tack, self-adhesive type in white or any colour lighter than the coating to be covered. Apply and remove in accordance with the recommendations of the powder manufacturer guidelines.

Do not keep protective tapes in contact with coated surfaces for longer than 6 months. If protection is needed for longer period than use appropriate protection material that will not cause stains to finished surface. Façade contractor will be fully responsible to project internal and external face of installed façade works until handover to client. Partial handover shall only be acceptable as instructed by client.

7.10 Quality Assurance

The Contractor shall be responsible for all quality control procedures necessary to ensure that all finished elements conform with the requirements of this specification. The quality system requirements shall be in accordance with ISO 9001 -2000. The Contractor shall prepare a Quality Plan and Quality Manual for the fabrication of the facade components. Document all quality control systems, work procedures, checklists, and an inspection and test plan, for the manufacture of all elements in accordance with this specification.

Internal quality audits shall be scheduled and shall include the quality system, inspection and testing, handling, storage, packaging and the control of quality records.

The Quality Manual and site Quality Plan shall be submitted to the Project Manager for approval before commencement of work. Submit in accordance with Schedule.

7.11 Fabrication Inspections

Following are critical factory inspection to be completed by façade consultants, contractor shall be responsible to schedule and organise these visits at appropriate time.

<table>
<thead>
<tr>
<th>Elements</th>
<th>Purpose of inspection</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curtain wall – Aluminium framing fabrication</td>
<td>Check for overall compliance, tolerances</td>
<td>To be scheduled for the initial fabrication</td>
</tr>
<tr>
<td>and assembly</td>
<td>and finishes</td>
<td>for typical façade system.</td>
</tr>
<tr>
<td>Façade Steel works</td>
<td>Check for fabrication workmanship, overall</td>
<td>To be scheduled at the initial stage</td>
</tr>
<tr>
<td></td>
<td>compliance, tolerances and finishes</td>
<td></td>
</tr>
<tr>
<td>Façade steel Finishes</td>
<td>Aluminium and steel finishing, QAQC</td>
<td>First batch of finished components</td>
</tr>
<tr>
<td></td>
<td>verifications</td>
<td></td>
</tr>
<tr>
<td>Stainless steel - fabrication</td>
<td>Check for fabrication, welding workmanship</td>
<td>To be scheduled at the initial stage</td>
</tr>
<tr>
<td></td>
<td>overall compliance, tolerances and finishes</td>
<td></td>
</tr>
<tr>
<td>Stainless steel finishes</td>
<td>Polishing and finishing approvals</td>
<td>First batch</td>
</tr>
</tbody>
</table>
8 Installation

8.1 General

- Installation shall be carried out in accordance with approved Shop Drawings by personnel experienced in the handling and site installation of all facade system and associated elements.
- Installation will not commence until shop drawings and method statement for installation approved by consultants and client.
- Client have right to instruct façade contractor to modify and change the sequence of site installation that will suit the construction progress. Thus façade contractor shall not claim any extra time or cost to follow the client instructions.
- Following review of samples, prototypes and demonstrations all subsequent materials and workmanship are to be the same or better standard.
- Use jigs laser lines, and computer-controlled methods wherever appropriate to achieve accuracy.
- Use the correct tools for each task and equipment that is well maintained. Do not use blunt and worn tools.
- Do not carry out grinding, cutting, shaping and finishing of materials using tools, techniques and ancillary materials that will contaminate curtain wall components with particles or substances, which could disfigure, stain or corrode them.
- Do not carry out any rectification or modification for the façade elements to be installed, if any modification required then the façade elements should only be corrected or re-worked at factory.
- Use experienced operatives skilled in using the techniques involved.
- Control the installation weather conditions by shading and shelter as appropriate to ensure performance requirements are met. It is the duty of façade contractor to provide adequate working environment to the installation team.
- If the façade contractor fails to provide adequate working condition to his installation team then client will provide the same and back charge the cost from the façade contractor.
- Façade contractor should allow adequate time delay and work disruption in the installation programme that may arise due to natural weather conditions.

8.2 Erection Tolerances

Erect the facade system to the more onerous of the following permitted deviations, tolerances are not cumulative

<table>
<thead>
<tr>
<th>Line:</th>
<th>± 2 mm in any structural bay width.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level:</td>
<td>± 2 mm in any one structural bay.</td>
</tr>
<tr>
<td>Plumb:</td>
<td>± 2 mm in any one storey height.</td>
</tr>
<tr>
<td>Plane:</td>
<td>± 2 mm in any one storey height or structural bay width.</td>
</tr>
<tr>
<td>Intersection:</td>
<td>± 2 mm in alignment in any direction between any two adjoining panels, at a 4-way intersection of panels.</td>
</tr>
</tbody>
</table>

- Construct joints between components 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 10%. Any variation to be evenly distributed with no sudden changes.

• The offset end elevation between nominally in-line edges across a transverse joint to be not more than 10% 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 10% of the width of the joint or 1.5 mm whichever is lesser.

• Tolerances are not cumulative.

8.3 Site Glazing Work

• Site applied structural silicon glazing works are not acceptable, structural sealants are to be factory applied.

• Site deglazing panels / replacement panels are acceptable to site applied silicone structural subject to consultants approval for glazing procedure.

• Install glazed units in accordance with their manufacturer’s instructions and procedures.

• Comply with the recommended guidelines set out in BS 6262

• Remove any protective tapes from the edges

• All roller wave to be horizontal

• Install glazing units with at least 5mm clearance at the sides and top from the framing, and 6mm at the bottom with allowance for water to drain freely.

• Install gaskets without incorrect distortion such as stretching or compression of length, or folding back of wiper seals.

• Do not undertake any site applied structural silicone glazing.

8.3.1 Site Sealant Work

• Apply and cure sealants in accordance with their manufacturer’s directions on minimum and maximum temperature and RH conditions.

• Achieve the depth to width geometry.

• Prevent three-sided adhesion.

• Protect adjacent surfaces with masking tape while applying sealant

• Use appropriate backer rods, tapes, surface preparation and primers as manufacturer’s directions. Tool off sealants neatly

8.4 Installation of Fire and smoke stop

Install fire and smoke stopping at all voids and penetrations between compartments at designated locations to achieve the specified fire and smoke stopping performance. Support smoke stopping with galvanised steel sheets. Provide smoke seal where necessary to maintain fire integrity.
8.5 Setting Out

The Contractor shall co-ordinate with the builder or civil contractor to ensure the correct positioning of all concrete inserts for attachment of the facade and support structure to the concrete structure. The responsibility for casting in the inserts to the agreed positions is with the facade contractor; however civil contractor will help to fix the inserts as marked by facade contractor. Final locations and accuracy of inserts should be the responsibility of facade contractor.

9 Testing and Verification

9.1 Testing of Steel Finishes

The Contractor shall ensure following tests are carried out in addition to standard QAQC methods of paint applicator. Contractor should submit report from the paint supplier for following specified tests, all these tests are be carried out on actual painted steel not on samples.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Process</th>
<th>Compliance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface preparation</td>
<td>Abrasive / Blast Cleaning:</td>
<td>BS EN ISO 8504-2:2001 - Part2. Comply with • Sa2½ -surface conditions. Viewed without magnification, the surface shall be free from visible oil, grease, dirt, and poorly adhering mill scale and rust. Surface roughness range within 30-50 microns when measured with “Surface Profile Gauge”</td>
<td>Paint application shall proceed upon consultant’s verification on surface.</td>
</tr>
<tr>
<td>Paint application</td>
<td>Film Thickness</td>
<td>Dry film thickness readings are to be taken by the Contractor using Elcometer Readings to be submitted at the frequency of every 20 Tons of steel works.</td>
<td>Instruments should be calibrated in accordance with international standards</td>
</tr>
<tr>
<td>(apply to all primer,</td>
<td>Adhesion (cross cut test)</td>
<td>AS 1580. 408.4 or BS EN 2409, Most stringent criteria of standards to be considered- Readings to be submitted at the frequency of every 20 Tons of steel works.</td>
<td></td>
</tr>
<tr>
<td>intermediate and final</td>
<td>Resistance to Impact</td>
<td>International standards - Readings to be submitted at the frequency of every 40 Tons of steel works.</td>
<td></td>
</tr>
<tr>
<td>coats)</td>
<td>Final finish</td>
<td>Test for colour fastness and consistency (Grey scale) International standards- Readings to be submitted at the frequency of every 40 Tons of steel works.</td>
<td></td>
</tr>
</tbody>
</table>
9.2 Testing of Sealants

9.2.1 Compatibility
As previously specified, test certificates for each sealant used shall be provided by the Contractor which confirm compatibility of the sealant with all surrounding materials including finishes (PVF2, paint etc.), glass coatings, glazing gaskets, setting blocks, spacers, backing fin, steel, aluminium, etc.
Compatibility means that the sealant will not cause staining of the adjacent material at any time during the service life of the facade, nor will the adjacent material affect the performance of the sealant.

9.2.2 Weather seals and Air seals
Wet sealants shall be tested prior to installation on site. At least 3 tests of each type of detail, at 3 separate locations, shall be checked using the "Hand Pull" method to ASTM C794.
Provide a certificate from the sealant manufacturer stating that they were present during application of sealant and testing, and confirming that the methods used were appropriate.
Dry weather seals (gaskets) and air seals shall be tested in the actual position and on the actual substrates for the relevant seal.
No sealing shall be carried out until the sealants and gaskets have been reviewed by the Engineer.

9.2.3 Structural Silicone Seals
Documentation, preparation, installation and testing of structural silicone seals shall include, but not be limited to:
Silicone batch logging procedures to record all batches used including silicone batch manufacture date and arrival date of each batch at the Contractor's premises.
Frame logging at time of assembly will include identifying every panel by a unique number.
Glazing records will then provide information on each panel (by its number) including silicone type and batch, date of silicone installation, glazier's name, temperature and humidity measured inside the factory at a nominated time each day.
- Deglazing to ensure quality of the silicone seals will be done periodically. Frames will be chosen at random as follows:
  - 1 out of the first 10 frames (frames 1 to 10)
  - 1 out of the next 40 frames (frames 11 to 50)
  - 1 out of the next 50 frames (frames 51 to 100)
  - 1 out of each 100 frames for the remainder of the project.
- Establishment of an acceptance criteria for the periodic de-glazing.
- Establishment of a procedure in case a frame is rejected. This shall include de-glazing of frames glazed on the same day with the same silicone batch as the reject frame. The procedure shall provide for the identification of all frames of unacceptable quality and their re-glaze or rejection.
9.3 On Site Water Testing of the Facade

- To prove the installation of the facade, on-site water testing shall be carried out to test standard AAMA 501.2 at contractor expense.
- The Contractor shall provide all necessary labour, access and equipment necessary to carry out the tests.
- The areas to be tested will be selected by the Consultant and will include all typical facade types.
- The contractor shall carry out initial water testing not less than 10 locations, these locations randomly specified by the consultant.
- Tests should be carried out using appropriate nozzle and pressure as prescribed in AAMA 501.2 test standard. Test should be witnessed by consultant and client representative, the schedule of tests will be according to the working progress.
- If during or following the test, there is evidence of water penetration to the inside surface of the glass, back-pan or other surfaces, the weather proofing of the element shall be considered unsatisfactory. The Contractor shall carry out rectification. Further tests shall then be carried out at the expense of the Contractor until a satisfactory result is achieved.

Following is minimum criteria for site water testing on façade to verify water leakage at façade.
- Typical facades to be tested for field water test upon completion of 1000 sqm façade area, thereafter frequency of water tests shall be as per consultant’s instruction.
- Testing should be carried out with interfaces, end terminations completed
- Testing method to as per AAMA standard with Monarch Nozzle with pressure gauges

9.4 Weld Tests

Following are minimum requirements of welding QA/QC records, contractor to carry out any additional tests to comply with structural consultant or statutory requirements.

9.4.1 Magnetic Particle Testing (MT) and Penetrant Testing (PT)

Where magnetic particle testing (MT) is required in accordance with Clause 7.14.3 (Scope of Inspection), the procedure and technique are to be in accordance with ASTM E709.

The choice of using MT or PT depends on a number of factors such as surface conditions of materials or weld joints to be tested, site conditions such as accessibility, power supply, etc. type and sensitivity of discontinuities to be detected, type of materials to be tested.

9.4.2 Ultrasonic Examination (UT)

Where ultrasonic testing is required in accordance with Clause 7.14.3 (Scope of Inspection), the procedure and technique are to be made in accordance with ANSI/AWS D1.1 Section 6 Part F.

If ultrasonic testing is impractical, for example when the plate thickness is less than 8mm, use radiographic testing in accordance with the procedure and technique given in ANSI/AWS D1.1 Section 6 Part E.

The procedures and standards set forth in ANSI/AWS D1.1 Section 6 part Fare to govern the ultrasonic testing of groove welds and heat-affected zones between the thicknesses of 8mm and 200mm inclusive.

In addition to weld examination through-thickness ultrasonic testing of the parent material may also be necessary for weld geometries susceptible to laminar tearing.
9.4.3 **Acceptance Criteria and Corrective Actions**

Acceptance criteria are to be in accordance with ANSI/AWS D1.1 Section 6 Part C. Propose corrective actions to the SO for acceptance if the welds do not conform to the acceptance criteria.

9.4.4 **Weld Test Records**

Record the results of all visual inspections and non-destructive testing and make all records available for inspection.

are minimum requirements of welding QA/QC records, contractor to carry out any additional tests to comply with structural consultant or statutory requirements.

9.5 **Welding Testing method and verification**

The contractor shall conduct the tests in accordance with the following table. Following table explains the welding testing methods and their frequency.

<table>
<thead>
<tr>
<th>Type of test</th>
<th>Methods of testing</th>
<th>Welding tests Frequency of testing</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual</td>
<td>Examination</td>
<td>100% of the welded Joints.</td>
<td><strong>Carry out visual inspection over the full lengths of all welds prior to any Non-Destructive testing (NDT)</strong></td>
</tr>
<tr>
<td>Die penetration test- (DP-Test)</td>
<td>Minimum 75 % of weld shall be checked for DP test</td>
<td><strong>Defective welding revealed by testing shall be corrected to the satisfaction of the QA/QC in charge at the cost of the contractor</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Magnetic particle test(MT) and Penetrant testing(PT) | Minimum 20% of critical type welds shall be checked for MT & PT | **The critical welding type shall be decided by QA/QC in charge/Engineer.**  
**The defective welding shall be corrected and retested for the same tests to the satisfaction of the Engineer.**  
**If Magnetic Particle testing is impractical, use penetrant testing in accordance with the procedure and technique given in ASTM E165.** |
| Ultrasonic Examination (UT) | Minimum 5-10% of critical type welds shall be checked UT | **This test shall be as advised by consultants.**  
**The Procedure and technique are to be in accordance with ASTM E94 and ASTM E747** |
| Site welded structural supports and brackets – 100 % UT tested | **All site welded structural brackets and connections** |
9.6 Tests on Fixings

9.6.1 General

The Contractor shall carry out the following inspections as the Works proceed to check that:

a. The fixings as detailed on the Contractor’s installation drawings have been installed.

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

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

In order to demonstrate that his proposed fixings are adequate, the Contractor shall provide all the necessary test data, calculations and technical literature. Where this information is not available, he shall arrange as part of his Works, for an Independent Testing Authority to carry out the tests noted below out. The tests shall be carried out generally in accordance with BS 5080 Parts 1 and 2. After testing, all test specimens shall be retained by the Independent Testing Authority for inspection by the Contractor and the Project Manger.

As the Works are installed, the Contractor shall carry out 10 No. of tests to each type of mechanical, Chemical Anchors and embedded bolts forming part of the Works at each floor level.

9.6.2 Anchors and Cast in Inserts

Provide manufacturers’ statement or calculations certifying that the cast in inserts/drilled fixing anchors supporting the bracket fixings for the Facade elements will resist the types of loading required and will satisfy the following criteria. Testing of anchors during progress of the works will be required to satisfy the following.

- Mechanically test a minimum of 2% of fixings for pullout load on-site to a proof load of 1.5 design capacity.
- No permanent deformation or failure of the insert at 1.5 times design working load.
- The pullout test will be non-destructive tests; tests should be carried out on actual fixed anchors that will be used to attach bracket. (not on trial anchors)
- Consultant will select anchors randomly for testing.

9.7 Structural Certification

Provide certification by the Contractor’s Professional Structural Engineer, that the completed works meet the requirements of the Contractor’s design.

9.8 Quality Assurance

The Contractor shall be responsible for all quality control procedures necessary to ensure that all finished elements and their installation conform to the requirements of this specification. The quality system requirements shall be in accordance with ISO 9001-2000. The Contractor shall prepare a Quality Plan and Quality Manual for the installation of the facade components. Document all quality control systems, work procedures, checklists, and an inspection and test plan, for the installation of all elements in accordance with this specification. Internal quality audits shall be scheduled and shall include the quality system, inspection and testing, handling, installation and the control of quality records. The Quality Manual and site Quality Plan shall be submitted to the project in charge for approval before commencement of work. The Contractor’s Professional Structural Engineer shall carry out
external quality audits of the design process carried out by the Contractor. All such reviews shall be submitted to the Main Contractor & Façade Consultant for review and record purposes.

9.9 Site Inspections

Following are critical site inspection to be completed by façade consultants, contractor shall be responsible to schedule and organise these visits at appropriate time.

<table>
<thead>
<tr>
<th>Elements</th>
<th>Inspection schedule</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical façade systems</td>
<td>Initial installation completed 1-grid 2 floors</td>
<td>Apply to all façade types</td>
</tr>
<tr>
<td></td>
<td>Typical corner details.</td>
<td></td>
</tr>
<tr>
<td>Façade fins / features / shades</td>
<td>Initial installation completed for minimum 5 panels wide and 2 floors heights</td>
<td>Apply to all typical features.</td>
</tr>
<tr>
<td>Steel works – corrosion protection</td>
<td>Typical framing and brackets- initial works</td>
<td>Mill finished / raw steel works shall not be installed in place without basic corrosion protection</td>
</tr>
<tr>
<td>Steel works- paint finishes</td>
<td>Typical frame works – Initial works</td>
<td>To be inspected to application methods and finish finishing.</td>
</tr>
<tr>
<td>Steel works - Installation</td>
<td>Initial installation of typical critical members</td>
<td>Apply to all critical structural elements.</td>
</tr>
</tbody>
</table>
Appendix

A1- Material Table- Minimum Requirements
## A1 Materials Table - Minimum Requirements

Following are minimum requirements for materials, this table will take precedence in case of any contradiction within any clauses of this specification. Contractor to submit technical data and material samples for approval.

<table>
<thead>
<tr>
<th>Components</th>
<th>Material &amp; Grade</th>
<th>Comments and basic requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Glass</strong></td>
<td></td>
<td>All toughend glass to be 100% heat soaked.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Base float or tinted glass (uncoated) to be any one of the following glass manufacturerers. NiS inclusion on base float glass should be under acceptable international guidance. Glass supplier to provide certificate / evidence.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Saint Gobain, PPG, SYP &amp; CSG</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glass type and thickness should satisfy respective standards and special conditions as mentioned in the tender.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All toughend glass to be 100% heat soaked.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Base float or tinted glass (uncoated) to be any one of the following glass manufacturerers. NiS inclusion on base float glass should be under acceptable international guidance. Glass supplier to provide certificate / evidence.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Saint Gobain, PPG, SYP &amp; CSG</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glass type and thickness should satisfy respective standards and special conditions as mentioned in the tender.</td>
</tr>
<tr>
<td><strong>Laminated glass</strong></td>
<td>PVB laminated</td>
<td>Use PVB from Saflex or DuPont for laminated glass.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resin laminated shall not be acceptable.</td>
</tr>
<tr>
<td><strong>Aluminium Extrusions</strong></td>
<td>Aluminium grade 6063T5 or T6 for framing generally. Min. wall thickness 2.0 mm (struct.), 1.5mm (non-struct ie., adopters)</td>
<td>Following acceptable alum extruders • Bhoruka, Hindalco, Jindal, Royal Touch, Sapa All other extruders are subject to facade consultant review. Wall thickness should comply with minimum requirements for flatness and dimension tolerances requirements.</td>
</tr>
<tr>
<td><strong>General sub-frames / façade support frames</strong></td>
<td>Galvanised Mild Steel with Min. Yiled stres of 240 MPa.</td>
<td>Structural steel specifications apply Concealed elements. Finish for exposed steelwork to be determined.</td>
</tr>
<tr>
<td><strong>Support frames / runners (for Cladding only)</strong></td>
<td>Aluminium extrusion 6063-T5/T6 or hot dip galvanised mild steel</td>
<td>• Min. 3.0mm thk for aluminium • Min. 4.0 mm thk for mild steel • Hollow sections to be sealed at terminations</td>
</tr>
<tr>
<td>Components</td>
<td>Material &amp; Grade</td>
<td>Comments and basic requirements</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Finish to Aluminium frames</strong></td>
<td>External visible surfaces (colour to be approved by architect)</td>
<td>High performance Powder coated comply with AAMA 2604 (Min. DFT 70 microns) with min. 20 years warranty. Recommended paint suppliers: Akzo Noble / Jotun QAQC tests on samples to be completed as per facade specifications. Applicator is subject to facade consultant’s review.</td>
</tr>
<tr>
<td></td>
<td>External or Internal -non visible: (cladding sub-frame &amp; brackets)</td>
<td>Choromotised, use of mill finished Aluminium in any form not acceptable.</td>
</tr>
<tr>
<td><strong>Steel frame finish</strong></td>
<td>-Surface Preparation: blast cleaning / wire brushing</td>
<td>All coatings should be factory applied with site touch-up if necessary. Appropriate cleaning or treatment should be done for galvanised surfaces prior to any further coatings to get smooth finished surface. Approved paint make for all steel finishes Jotun &amp; Akzonoble</td>
</tr>
<tr>
<td><strong>-all visible</strong></td>
<td>- Primer - Zinc Rich Epoxy 75 mic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Intermediate: Epoxy MIO 125mic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Finish: Polyurethane 50mic (for visible locations only)</td>
<td></td>
</tr>
<tr>
<td><strong>Fixing Brackets - External</strong></td>
<td>-External weather:-SS grade 316</td>
<td>Min. 4mm thick for all cladding brackets (steel/SS/aluminium) and min. 8mm thick for main structural brackets such as hand railing, main structural frames. Brackets should use rolled / welded, bend brackets are not acceptable</td>
</tr>
<tr>
<td><strong>Fixing Brackets - Internal</strong></td>
<td>-Interior or Inside of air seal:- Hot-dip galvanised steel for non visible and Galvanised + painted steel for visible.</td>
<td></td>
</tr>
<tr>
<td><strong>Anchor bolts</strong></td>
<td>External weather:- Stainless steel for visible or non-visible areas (same applicable for all cladding systems) Internal or inside air seal:- Galvanised for non visible and SS for visible</td>
<td>Acceptable brands are Fischer or Hilti Use of Chemical anchors and undercut anchors require prior approval from consultant Fixings on brickworks are not accepted Min size M10 -2nos /bracket</td>
</tr>
<tr>
<td><strong>Screws &amp; Bolts</strong></td>
<td>Stainless steel grade 316 (for both visible and non-visible)</td>
<td>Bolts: Min. size M10 for all strcutural connections with min. 2 nos. / fixing Use of teks screws or self drilling screws for structural brackets requires consultant’s approval</td>
</tr>
<tr>
<td><strong>Cast In Channels</strong></td>
<td>Make: Halfen or Jordhal</td>
<td>Min 250mm lg. HDG</td>
</tr>
<tr>
<td><strong>Pop Rivets</strong></td>
<td>Stainless steel with stainless steel mandrel. Stainless steel grade 316</td>
<td>Aluminium rivets with SS mandrels required consultants review.</td>
</tr>
<tr>
<td>Components</td>
<td>Material &amp; Grade</td>
<td>Comments and basic requirements</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Aluminium Composite panels | -Fire Rated (FR) grade  
-External and internal skin with min. 0.5mm thick alum (overall 4mm thick panel) | Acceptable make Alpolic FR and Reynobond FR  
-Provide stiffeners wherever necessary to achieve flatness and strength |
| Flashings                | 1.0 mm GI                                                                       | Thickness verified for wind loads, stiffeners to be provided for >300 mm wide                      |
| Gaskets                  | EPDM or Neoprene 60 durometer                                                   | Test certificates to be submitted                                                                   |
| Setting blocks           | Neoprene 90 durometer                                                           | Test certificates to be submitted                                                                   |
| Sealants                 | Silicone                                                                        | Acceptable suppliers: Dow Corning, GE and Sika. All structural sealants require prior approval.  
- Compatibility and adhesion test should be carried out with actual profile and paint finished by actual applicator  
- Certificate from Sealant supplier to be submitted for glazing approval. |
| Backing Rods             | Open cell                                                                       | Closed cell not accepted.                                                                          |
| Glazing Tapes            | Breathable spacer tape                                                          | Double sided tape from Norton or 3M                                                                  |
| Insulation               | Glass fibre or mineral wool insulation -min. weight 60 kg/m³                   | 50 mm min. thick                                                                                    |
| Fire Proof               | Glass fibre insulation -min weight 70 kg/m³                                      | Min thick 50 mm to be achieved after compression, fixing clips to be provided whenever necessary    |
| Stainless steel Elements | Grade 316 –matt finished                                                        | SS elements to be isolated from aluminium and mild steel frames                                     |
| Operable Hardware (Doors/ Windows) | SS Make : Securistyle, Giesse, Alu Alfa, Sobinco, Cotswold. | Make to be approved by architect and consultants  
Test certificates to be submitted |
| Frameless glass fittings | Glass point fixes uses Articulated bolts                                         | Acceptable make Dorma, Kinlong, Sadev.                                                             |
A2- Post Tender –Critical Submissions

Prior to procurement of façade materials following are façade contractor’s critical submissions which shall be reviewed and approved by façade consultants, Client / Architect

<table>
<thead>
<tr>
<th>Materials</th>
<th>Details for submission</th>
<th>Document Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Aluminium extrusions</td>
<td>Submit supplier information and details, (manufactures details)</td>
<td>• Information</td>
</tr>
<tr>
<td>• Aluminium sheet</td>
<td>Mill certificate of extrusions for strength, size and, finish &amp; grades and structural properties of Billets for each lot.</td>
<td>• Certificate</td>
</tr>
<tr>
<td></td>
<td>Hardness test for each lot.</td>
<td>• Samples</td>
</tr>
<tr>
<td></td>
<td>Submit samples-200 length(male &amp; female ) for fitment checks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Third party test for chemical and physical properties.</td>
<td></td>
</tr>
<tr>
<td>• Finish to Aluminum extrusions</td>
<td>Applicator name and information’s</td>
<td>• Information</td>
</tr>
<tr>
<td></td>
<td>QA/QC tests as per specification to be conducted</td>
<td>• Method statement</td>
</tr>
<tr>
<td></td>
<td>Third party tests for Finishes/Coating have to be done in presence of BES &amp; client representative</td>
<td>• Test certificates</td>
</tr>
<tr>
<td>• Glass</td>
<td>Supplier, Processor Details</td>
<td>• Information</td>
</tr>
<tr>
<td></td>
<td>Sample- Final Approval will be done upon review of big size sample for visual aspects.</td>
<td>• Certificates</td>
</tr>
<tr>
<td></td>
<td>Processor should comply tender specification</td>
<td>• Samples</td>
</tr>
<tr>
<td>• Steel finish</td>
<td>Paint application method statement</td>
<td>• Documents</td>
</tr>
<tr>
<td></td>
<td>Painted steel samples – 3 specimens 500 mm long finished with specified finishes</td>
<td>• Samples</td>
</tr>
<tr>
<td>• Sealants</td>
<td>Supplier</td>
<td>• Information</td>
</tr>
<tr>
<td></td>
<td>Types of sealants</td>
<td>• Material Certs</td>
</tr>
<tr>
<td>• Glazing materials</td>
<td>Material type and supplier</td>
<td>• Information</td>
</tr>
<tr>
<td></td>
<td>Shore hardness</td>
<td>• Certificates</td>
</tr>
<tr>
<td></td>
<td>Physical and chemical properties.</td>
<td>• Method statement</td>
</tr>
<tr>
<td>• Glass fittings / hardware</td>
<td>Spiders and similar materials have been third party lab tested for following</td>
<td>• Information</td>
</tr>
<tr>
<td></td>
<td>-Mechanical properties</td>
<td>• Material test</td>
</tr>
<tr>
<td></td>
<td>-Chemical properties</td>
<td>• Certificates</td>
</tr>
<tr>
<td>• Operables</td>
<td>Make</td>
<td>• Test certificates</td>
</tr>
<tr>
<td></td>
<td>Supplier information</td>
<td>• samples</td>
</tr>
<tr>
<td>• Fire rated glazing</td>
<td>Hardware , fixtures used in fire rated doors</td>
<td>• Test certificates</td>
</tr>
<tr>
<td></td>
<td>Steel profile used on glazing – 300mm lg</td>
<td>• samples</td>
</tr>
<tr>
<td></td>
<td>Glass samples</td>
<td></td>
</tr>
</tbody>
</table>