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## **10 STATION ARCHITECTURE**

### **10.1 General**

- 10.1.1 The proposed Cross Island Line (CR16) Maju station is located along Clementi Road. The site is in close proximity to Clementi Forest (identified biodiversity site), Singapore Institute of Management (SIM), Singapore University of Social Sciences (SUSS), Ngee Ann Polytechnic, the Rail Corridor (Old Jurong Line) and future commercial/ residential development.
- 10.1.2 The Authority's Consultant has prepared a reference design for the station as shown in the tender drawings. The Contractor shall take ownership of the design, make all necessary changes / modifications to comply with all statutory, Authority and other relevant authorities/agencies' requirements, and develop the station design to the Engineer's acceptance.
- 10.1.3 No official submissions have been made to the relevant authorities. The Contractor shall make submissions to all authorities and obtain all necessary approvals for the construction of the Works.

### **10.2 Station Description**

- 10.2.1 The following description provides an overview of the station and shall be read in conjunction with the tender drawings. The Contractor shall also note **Appendix BH and Clause 7** of the Particular Specification and ensure that his proposed design meets all requirements stated therein.
- 10.2.2 General
- (a) The station is a three (3) basement levels Civil Defence (CD) station.
  - (b) The new CR16 station consists of three (3) entrances named "Entrance 1", "Entrance 2" and "Entrance 3".
- 10.2.3 Entrances and Other At-Grade structures
- 10.2.3.1 General

- (a) The entrances and at-grade structures where possible shall be designed to complement and blend in more seamlessly with the natural surroundings while improving pedestrian flows around entrances. The entrances are positioned such that they are easily recognisable and accessible in relation to the roads and the flow of pedestrian and passenger traffic to and from the existing surrounding developments. The entrances shall not create line-of-sight and safety issues for commuters as well as users along the cycling path/footpath/covered linkways.
- (b) The placement of entrances and at-grade structures shall be designed such that the commuters exiting the station as well as users along the cycling path/footpath/covered linkway are clearly visible to one another. As far as possible, steps do not face the cycling path/footpath/covered linkway directly. Where necessary, there shall also be sufficient buffer/ landing space provided to protect commuters exiting the station from on-coming bicycle traffic along the cycling path/footpath/covered linkway. For entrances located in close proximity to road junctions / pedestrian crossings, the entrance footprint shall be compacted and clearances from the road kerb / junction maximised, to ensure the safety for the commuters entering and exiting the entrance.
- (c) The ancillary at-grade structures such as ventilation shafts and cooling tower are grouped together and integrated with the entrances where possible and shall be designed to be as compact as possible without compromising safety, security, performance and environmental requirements.
- (d) The design of the entrances and at-grade structures shall be sensitive to the surroundings as it is located within and/or around the vicinity of identified biodiversity sites.
- (e) As these are dominant structures in environmentally sensitive areas, the Contractor shall ensure that they are designed to blend in with the surroundings. Adequate access for maintenance shall be provided. All E&M plant equipment shall be screened from public view. The Contractor shall develop the design of enclosures to ensure required ventilation is provided whilst maintaining visual and acoustic screening. The screening shall be an integrated design element of the overall facade.
- (f) All entrances shall be fitted-out with security grilles/shutters to be locked shut after operating hours. Entrances 1 and 2 will be opened to provide 24-hour underground pedestrian connection across Clementi Road.

- (g) The Contractor shall work with the relevant authorities/agencies for all entrances and ancillary at-grade structures such as fire escape staircases, ventilation shafts, cooling towers to mitigate the impact to existing and future surrounding developments in the vicinity. This shall include but not limited to the following:
  - (i) Compacting the entrances and at-grade structures;
  - (ii) Position all station entrances and at-grade structures to minimise land-take with sufficient setback to provide a maximum of 2m apron all round;
  - (iii) Consolidate all the ancillary at-grade structures to be stacked above the entrance structures to reduce land-take;
  - (iv) Comply with URA and other relevant authorities/agencies' requirements for the location of the ventilation shafts, cooling towers and exit staircases, as well as the arrangement of ventilation openings to face adjacent roads to minimise impact on future adjacent residential developments;
  - (v) Work with the relevant authorities/agencies to configure the entrances, at-grade structures, covered pedestrian connections and associated structures/facilities (including any bicycle parking, escape staircases and all ventilation shafts);
  - (vi) Adopting soft-scape and greenery into the design of the entrances and the at-grade structures;
  - (vii) Entrances with bicycle parking shall be provided with greenery and shading elements to soften the hardscape.
- (h) The Contractor shall work with the Authority and all relevant authorities/agencies to provide for the installation of Solar Photovoltaic (PV) panels on the roof of the entrances and at-grade structures.
- (i) All at-grade structures shall not cause noise, smell, fumes, vapour and heat nuisance to the surrounding developments, with abatement measures to be provided to mitigate the impact of noise, smell, fumes, vapour and heat from mechanical and electrical equipment.
- (j) For entrances and at-grade structures with future development integration:

- (i) the Contractor shall work with all relevant agencies/authorities, stakeholders and the Authority to carry out integration simulation studies, as well as to confirm and provide the necessary provisions for integration with the future development to confirm the entrance design and ensure that there is no adverse impact between the future development and the station operations and functions.
- (ii) the Contractor shall design the entrance and at-grade structure façades and finishes, such that it has the flexibility to be replaced by the future developer to integrate with the façade of the future development.

10.2.3.2 Entrance 1

- (a) Entrance 1 is located at the fringe of Clementi Forest and is expected to interface/ integrate with a future development.
- (b) Entrance 1 is designed to integrate and connect seamlessly with a bus shelter, pick-up/drop-Off (PUDO) and taxi stand via covered linkways. An integrated covered walkway shall be provided for connection to the adjacent future development.
- (c) The architectural treatment and design for Entrance 1 shall include a green roof as well as a landscaped space around the entrance to blend in more seamlessly with the natural surroundings.
- (d) Entrance 1 shall be integrated with the proposed bicycle park along with greenery and shading elements to soften the hardscape. The Contractor shall consult the relevant authorities/agencies and the Authority to finalise the design and provision.

10.2.3.3 Entrance 2

- (a) Entrance 2 is located adjacent to SIM's main entrance.
- (b) A new PUDO shall be provided along Clementi Road as shown in the tender drawings. The PUDO shall be designed to provide direct and sheltered barrier-free access to SIM/ SUSS.
- (c) Entrance 2 shall be designed to connect seamlessly to the existing bus shelter and the new PUDO via covered linkways. It shall also allow for direct and sheltered barrier-free access to SIM Blk A at the driveway/ fire engine access level.

10.2.3.4 Entrance 3

- (a) Entrance 3 is located in front of Maju Camp, near the junction of Clementi Road and Brookvale Drive.
- (b) Entrance 3 is designed to integrate with covered linkways extending to Brookvale Drive and Maju Drive. The covered linkways shall also connect to the covered linkway provided by Maju Camp. The Contractor shall work with the Authority and relevant agencies to confirm the location/ interface of the covered linkway connection.
- (c) Entrance 3 shall be integrated with the proposed bicycle park along with greenery and shading elements to soften the hardscape. The Contractor shall consult the relevant authorities/agencies and the Authority to finalise the design and provision.

10.2.3.5 At-Grade Structures

- (a) A set of cooling tower, ventilation shafts and exit staircases are located along the fringe of Clementi Forest.
- (b) The at-grade structures shall be designed to provide an integrated covered walkway for connection to the adjacent future development.

10.2.4 Main Station Box

10.2.4.1 The station box is mainly located under Clementi Road and partially within a future development site. A future development is expected to be constructed above the station within the development plot. The Contractor shall take this into consideration and make the necessary provision in his station underground roof design to meet the Authority's requirements. He shall also liaise with URA and all other relevant authorities/agencies to finalise the design to comply with the requirements stated in **Appendix BH** and **Clause 7** of the Particular Specifications.

10.2.4.2 The columns and struts in the public area are exposed and are to be designed with fair-faced concrete finish. A recessed profile shall be provided on the structure surface to allow for surface mounting of services and ceiling mounted components/fixtures. The Contractor shall construct the concrete elements according to the intended features in **Appendix BL** of the Particular Specifications.

- 10.2.4.3 All materials and workmanship for the finishes of the exposed structural elements shall be in strict accordance with BS8110: Part 1: 1997, Section 6 or the latest Eurocode equivalent and LTA Civil and Architectural M&W Specifications. The standards on the type and quality of finishes for these concrete elements shall be “Type C” in “Special Class” finish in accordance to 6.2.7.2 and 6.2.7.2 of BS8110: Part 1: 1997 or the latest Eurocode equivalent to the Engineer’s acceptance.
- 10.2.4.4 KOP
- 10.2.4.5 B1 Subway Level
- (a) B1 Subway Level shall provide an underground link between Entrances and to the B2 non-ticketed concourse area. The subway link between Entrances 1 and 2 shall be designed to provide 24-hour underground pedestrian connection across Clementi Road. Security shutters shall be provided to define the boundary and enable the non-accessible areas to be locked shut after operating hours.
  - (b) Knock out panels (KOP) minimum 6m clear width by 5m clear height are provided at B1 level to allow for future underground connections to the surrounding future developments as shown in the tender drawing. The requirements of the KOPs shall be coordinated with the agencies and stakeholders. Notwithstanding the KOPs shown in the tender drawings and/or listed in the Particular Specification are the minimum requirements, the Contractor shall work with the Authority, relevant agencies / stakeholders to confirm the requirements for the KOPs.
  - (c) CR16 station is a Civil Defence (CD) station. CD doors and PT doors shall be provided in compliance with all prevailing CD requirements.
- 10.2.4.6 B2 Concourse Level
- (a) The voids around the escalators and staircases are provided to create visual connections between the concourse and platform levels.
  - (b) The Contractor shall coordinate the station interior design with the CR2007 to incorporate and make provisions for installation of air circulation fans/cooling system to achieve the internal thermal comfort requirements.



- (c) The B2 Concourse level shall provide an un-ticketed corridor to connect both ends of the station.
- (d) Knock-out panels (KOP) with minimum 6m clear width by 5m clear height shall be provided for a future underground ticketed interchange connection.
- (e) The corridor for the future underground ticketed interchange connection shall be incorporated in the station design. For the opening year, the said corridor can be cordoned off, with the necessary provisions for inspections and maintenance access.

10.2.4.7 B3 Platform Level

- (a) The platform shall be designed to cater for a 8-car train system for the ultimate year and 6-car train operation for the opening year.
- (b) For the opening year 6-car train operations, demountable partitions shall be provided to cordon off the unused spaces in platform area without affecting the pedestrian circulation and emergency evacuation requirements.
- (c) The platform shall be column free along the platform edge as well as the passenger circulation areas.
- (d) Over-Track Exhaust Duct (OTED), Saccardo Nozzle at the station trackway and Under Platform Air Supply (UPAS) duct at underplatform level shall be provided for Tunnel Ventilation System. The Contractor shall co-ordinate the details of the provisions with Authority's In-house designer for Tunnel Ventilation System.
- (e) The Contractor shall ensure that the structural gauge requirements including vehicle throw and construction tolerance are incorporated at the station platform level. The drawing requirements will be provided to the Contractor after award.

**10.3 BCA Green Mark (GM)**

- 10.3.1 The Contractor shall comply with the requirements of the BCA Green Mark for Transit Stations and specify appropriate means to achieve Green Mark Platinum rating for all Stations.

**10.4 BCA Universal Design**

- 10.4.1 The Contractor shall comply with the requirements stated in Clause 9 of Particular Specifications.

**10.5 BCA Accessibility Code**

- 10.5.1 The Contractor shall design and construct the station, including areas surrounding the station within the contract boundaries to fully comply with the prevailing BCA Accessibility Code.
- 10.5.2 All costs associated with complying with the Accessibility Code including any inspection or approval costs shall be deemed included in the Contract Price.

**10.6 Ventilation Shafts, Cooling Towers, Make-Up Water Tanks, Condensing Units, Exhaust Fans and Exposed Plant Areas**

- 10.6.1 The ventilation shafts, cooling towers, make-up water tanks, condensing units, exhaust fans and other exposed plant areas shall meet the requirements of the Contractor's specialist sub-contractor's design for efficient operation. The design of the equipment, enclosures, louvers etc. shall provide adequate screening and complement the station design intent. Access for maintenance shall be provided. The Contractor shall develop the design of enclosures to ensure required ventilation is provided whilst maintaining visual and acoustic screening.
- 10.6.2 The design shall comply with all relevant authorities' requirements for noise, setbacks, screening, natural ventilation, health and control of legionella bacteria. The Contractor's QP shall make noise report submissions to obtain approval from the relevant authorities where required.

**10.7 Submissions to Relevant Authorities**

- 10.7.1 The Contractor shall liaise with URA and other relevant statutory authorities to obtain Provisional Permission, Written Permission and Building Plan approvals for all works, as well as all other approvals required for TFP/FSC and TOP/CSC. Any amendment submissions deemed necessary during the course of the project and all costs associated therewith are deemed to be included in the Contract Price.

- 10.7.2 Station design including entrances, commuter facilities, ventilations shafts, lifts & firemen staircases, underground egress routes and cooling towers shall be integrated with the existing developments above and adjacent to the station. The design of such surface structures shall compliment the surrounding urban context, integrate with the surrounding landscaping and the land profile and meet with the requirements of the relevant authority agencies and stakeholders.
- 10.7.3 Where there is any conflict in the requirements of relevant standards, the Contractor is to highlight to the Engineer for clarification before submitting any design or proceeding for construction at site. The Contractor shall provide all assistance, information and make submissions as required to the Engineer to assist in resolution of the conflict. The Contractor shall implement the resolution of the conflict, subject to the acceptance of the Engineer, at no cost or time implications to the Authority.
- 10.7.4 The Contractor shall comply with the landscaping requirements from NParks, which shall include the following:
- (a) Planting strip - Ground planting around station entrances and all at-grade structures; and
  - (b) Vertical trellis - Vertical trellis shall be provided at each column bay of commuter facilities infrastructure, on all covered linkway between entrances and commuter infrastructure and first transport node (i.e. bus bay, taxi bay, PUDO etc).
  - (c) Green Roof – Provision of green roofs to station entrances and at-grade structures
- 10.7.5 The Contractor shall liaise with other agencies/statutory authorities to clearly demarcate the landscaping and/or station boundaries. These include the future maintenance boundaries with adjacent properties. The Contractor shall obtain necessary approvals or letter of no objection from these agencies/statutory authorities on the landscaping and its future maintenance.
- 10.7.6 The Contractor shall liaise with relevant authority agencies and the Authority to design and construct covered linkways from station entrances to all existing/new bus stops, and taxi stands and PUDO Points, etc.

- 10.7.7 The Contractor shall liaise with the Authority and all relevant authorities, including the preparation of drawings and documents necessary for submission to the Master Plan Committee (MPC) (including furnishing details of proposed commuter facilities and road scheme), to regularize the railway boundary, road reserve and affected areas, if there are changes to the approved boundary, and to submit these revised road plans for approval.
- 10.7.8 Should the Contractor consider that any waiver submission or authority consultation is required or beneficial for the Works, these shall be justified and presented to the Engineer for acceptance prior to any discussions with the relevant statutory authorities. All costs associated with waiver submissions deemed necessary during the course of the project are deemed to be included in the Contract Price.
- 10.7.9 The Contractor's submissions shall also comply with the latest version of the codes, standards and guidelines stipulated by the regulatory authorities or having jurisdiction where applicable.
- 10.7.10 The Authority reserves the right to issue further design guidelines to the Contractor as they become available and such information shall be incorporated without cost to the Authority. Where revisions to guidance and requirements are published after such dates, the Authority reserves the right to require the Contractor to follow any additional requirements in the newer guidance and requirements, where there is no conflict with compliance.
- 10.7.11 The Contractor shall plan his Building Plan submissions to ensure that the Works and TOP are not delayed by approval of other elements. In particular, the Contractor shall consider separate Building Plan numbers and submissions for ground level commuter facilities and the station entrance structures/link bridges so that the permanent bus/taxi shelters and linkways may obtain Temporary Occupation Permit (TOP) independently from the station and to facilitate opening to the public once ground level reinstatement is completed. The Contractor shall submit his Building Plan submissions strategy to the Engineer for acceptance.
- 10.7.12 The Contractor shall consider separate Building Plan numbers and submissions for interchange stations as and where appropriate with considerations for compliance with the latest prevailing statutory codes and regulations.

- 10.7.13 Where deemed necessary by the Contractor and accepted by the Engineer, phased TFP/ TOP are to be implemented. Consultation with BCA and SCDF shall be carried out to ensure phased TFP and phased TOP are agreeable by the approving authorities notwithstanding the acceptance of the Engineer. All time and costs to carry out all necessary submissions and inspections to facilitate the phased TFP/TOPs shall be deemed to be included in the Contract Price.

## **10.8 Legal boundaries**

- 10.8.1 In designing the station, all parts of any rooms shall be designed within the legal boundaries of the station land, with consideration to nearby structures. For surface structures whereby the Authority will create rights on private land, rooms/facilities which are non-essential to railway operation shall not be designed on private land. Examples of rooms/facilities which are not essential to railway operation are toilets, ticket office, store room, CD provisions, A/C system for public spaces, etc. Such rooms/facilities shall be designed within the legal boundary of the station.

## **10.9 Architectural Design Objectives**

- 10.9.1 The Architectural Design Concept is included in **Appendix ZZ** of the Particular Specification which indicates the station design theme. The Contractor shall develop the Architectural Design Concept in detail or propose alternative options to achieve the design theme.
- 10.9.2 The proposed station design should include design features as an integrated part of the station design to give it a unique identity. The Contractor shall designate within the station design a dedicated and prominent space, or spaces, for station art works, which may also serve as a station design feature.
- 10.9.3 The station design shall be clear, user-friendly, convenient and safe. The Contractor shall provide a high quality design which holistically integrates structural, E&M, operations, maintenance, safety and security requirements.
- 10.9.4 The Contractor shall ensure the design of the station is optimised and to avoid creating unusable and leftover spaces.
- 10.9.5 Efficient and Flexible Planning shall be obtained via the following:
- (a) Minimum station footprint;
  - (b) Economy of construction;

- (c) Ease of maintenance; and
  - (d) Minimise impact of structures into public spaces and neighbouring buildings and development sites.
- 10.9.6 The station design shall allow for flexibility. Where entrances or other at-grade structures are within future development lots or where there are constraints on site, the entrance shall be designed to allow it to be reconfigured without affecting the overall station planning.
- 10.9.7 Where integration with future development is expected, the design of the station, entrances and/or at-grade structures shall be designed to allow for full or partial integration. The Contractor shall work with the Authority to consult all relevant agencies/stakeholders to confirm the integration requirements.
- 10.9.8 The design shall be closely coordinated with that of the respective surrounding developments. Station design including entrances, ventilations shafts, exits and/or firemen's staircases and cooling towers etc., are to be compact and integrated where possible.
- 10.9.9 The Contractor shall coordinate with the Authority's E&M consultant CR2007 and SWCs and relevant authorities for the effective distribution and placement of cooling towers where applicable taking into account their impact on the urban environment and possible relocation into future developments.
- 10.9.10 The bulk and massing of the at-grade structures are to be minimized and wherever possible, all vent shaft transfers must be accommodated below ground.
- 10.9.11 All at-grade E&M plant equipment and ventilation shafts shall be screened from view. The screening shall be an integrated design element of the overall at-grade structure and wherever possible, all ventilation openings shall avoid facing the developments.
- 10.9.12 The Contractor shall work with all Interfacing Contractors/Parties to conduct and ensure that the Computational Fluid Dynamic (CFD) analysis takes into account the aesthetics and performance of the proposed screenings.

- 10.9.13 The Contractor shall take into consideration the local climate, which includes adequate protection from the full range of weather conditions, and need for cross natural ventilation. Air circulation fans, if required, will be provided by SWCs. The Contractor shall coordinate and incorporate the air circulation fans within station and entrance designs to improve the thermal comfort level.
- 10.9.14 The Contractor shall design stations that are green, sustainable and maintainable. The Contractor is required to study the incorporation of landscaping, roof planting and vertical planting for the station and the commuter facilities designs. Covered linkways shall be provided with vertical trellis between the station entrance and the next transportation node. Where greenery is provided, it shall meet security, ventilation as well as maintenance accessibility requirements.
- 10.9.15 The design shall take into consideration security, safety, durability, ease of delivery, maintenance, storage and asset replacement of, architecture, E&M services and systems. The Contractor shall provide all necessary access, fixed platforms and ladders, equipment, etc. to facilitate the delivery, maintenance and asset replacement of all plants, equipment and architectural materials achievable by commonly available means; proposals to be submitted to the Engineer following the hierarchy of the provision of permanent safe-to-use access and protection measures, before considering more specialised systems involving any operator training.

**10.10 Line Wide Identity**

- 10.10.1 The station is designed in response to specific site context and the architectural forms and expressions could vary across the CRL contracts. In consideration of the line-wide identity, common features and components will be applied for standardisation across the CRL contracts.
- 10.10.2 The Contractor shall develop and incorporate the line-wide features for CRL into the station designs. Where directed by the Engineer, the Contractor shall amend and adapt these line-wide features, and it is the Contractor's responsibility to develop these designs in detail. Any amendment of the line-wide standard details (such as in order to suit station-specific conditions) shall be submitted for the acceptance of the Engineer. The BIM components of the standard details shall be amended following any design development.
- 10.10.3 The Contractor shall coordinate with the relevant departments of the Authority for line-wide components that involve multiple disciplines.
- 10.10.4 The Contractors shall attend and make presentations at design reviews, workshops and any other forums as requested by the Authority to coordinate and develop the line-wide features.



10.10.5 The list of standard components for line-wide standardisation for stations includes but is not limited to:

S/N	Line-wide Feature	Description of Feature
1	Natural ventilation for entrances façade openings	Façades of station entrances shall be designed to maximise daylighting and natural ventilation. Where an entrance façade is designed to allow natural ventilation, there shall be ventilation openings at the top, middle and bottom portion of the façade in relation to human height. This shall be done whilst providing weather protection, including protection from wind-driven rain and to address to the Authority's PTS's requirements. Glass façade panels shall be of type to minimise heat gain and glare.
2	Protection from weather	All at-grade structures shall be designed to provide protection from the weather. Rain screen, drop and down-hang panels shall be installed to entrance facades, ramps and covered linkways to provide protection from wind-driven rain.
3	Wall cladding panels modules and wall-mounted fixtures	The Contractor shall develop the standardisation of modules and datum of the wall cladding panels, which shall be coordinated with ceiling height, door openings, maintenance access panels, wall-recessed and wall-mounted signages, equipment and fittings, skirting finishes.

S/N	Line-wide Feature	Description of Feature
4	Bulkhead above Platform Screen Doors (PSDs)	The Contractor shall develop the details of the bulkhead above the platform screen doors. The lighting above the PSDs shall be continuous to highlight the entire non-lit PSD signage, without casting any dark spots or shadows on the signage. The mounting of signages, services, lighting, fittings and fixtures on the bulkhead above the PSD shall adopt line-wide consistency.
5	FER/ Ticketing Machines	The Contractor shall develop the backdrop of FER/ ticketing machines which shall be coordinated with signage, modules and datum of the wall cladding panels.
6	Lifts serving platform and concourse	The lifts including the lift shafts and its structural support design, lift car interior, all visible control panels, lanterns and maintenance access panels, and ceiling profile around the lifts shall adopt a line-wide consistency. There shall be no exposed structures or services in between the levels that would be visible from within the glass lift. The Contractor shall work with the SWC for developing of this line-wide feature.
7	Public Toilets and Amenities	The Contractor shall develop the standard principles of layout configuration; provisions, mounting and fixing details of the fittings and sanitary ware and finishes. This applies to all public toilets and amenities as required by BCA's latest prevailing Code on Accessibility.

<b>S/N</b>	<b>Line-wide Feature</b>	<b>Description of Feature</b>
8	Handrails and Balustrades	The Contractor shall develop the standard design of all handrails and balustrades for public areas and for enclosed fire escape staircases.
9	Public Seating	The Contractor shall develop the standard design of the public seating. The Contractor shall develop the principles of placement of the seating in relation to the platform layout. The seating design shall allow for modular installation and shall enable flexibility for future re-location with minimal implications to the finishes
10	Barriers around bicycle parking area	The Contractor shall develop the standard design of the barrier enclosing bicycle parking areas.
11	Barriers at maintenance service ledges around escalator/stairwells at station exits	The Contractor shall develop the standard design of barriers around maintenance service ledges, including the service gates to restrict public access to the service ledges.

S/N	Line-wide Feature	Description of Feature
12	Service Boom	The Contractor shall develop the standard service boom details which shall be coordinated with the Authority's appointed lighting consultant and respective SWCs for mounting of lighting, services and fixtures. The Contractor shall develop principles for placement of the service boom in relation to the fare-gates and station layout.
13	Flooring pattern at platform screen doors (PSD) and Tactile band from lift to PSDs	The Contractor shall develop the standard flooring pattern at the PSDs which shall be coordinated with the rolling stock alignment. The Contractor shall develop the general principles for placement of tactile bands from the lifts to the PSDs.
14	Passenger Service Centre (PSC) and Station Master Room (SMR)	The Contractor shall refer to the typology concepts as shown in <b>Appendix BF</b> of the Particular Specification and develop the appropriate typology for his proposed station design. He shall work with the SWC to develop standard details of the PSC/SMR which shall be standardised line-wide.

<b>S/N</b>	<b>Line-wide Feature</b>	<b>Description of Feature</b>
15	Fire safety equipment on platform	All fire safety equipment (such as fire extinguishers, hosereels, exit signs, fire phones) shall be integrated seamlessly with the station's finishes, including integration within wall cladding panels, within lifts shafts, side walls of escalators and staircases, etc. Where the equipment cannot be integrated with adjacent finishes, the Contractor shall develop details for mounting, housing, casing and interfacing of the equipment, which could be stand-alone or floor-mounted or integrated with public seating, to the acceptance of the Authority. Mounting of these equipment shall not impede with commuter flow and shall not be in conflict with other services.
16	Floor-mounted posts for signage and housing of E&M services	The Contractor shall develop the standard floor-mounted posts where required at landings of escalators and/or staircases to mount signages and house E&M services. The Contractor shall coordinate with the SWCs for the mounting of these fixtures, including any maintenance access panels which shall be integrated within the floor-mounted posts.
17	Alignment of staircases and escalators	The Contractor shall look into aligning of staircases and escalators at the top landings so as to avoid any gaps to protection from falling. In the event such gaps are unavoidable, the Contractor shall develop the detailing to close up such gaps, to the acceptance of the Authority.

**10.11 Design Considerations**

- 10.11.1 The architectural design considerations provided shall be followed by the Contractor in developing the design.
- 10.11.2 Station Design Integration with External Surroundings
- 10.11.2.1 The Contractor shall appoint suitably trained and experienced transit station designers, urban designers and landscape architectural professionals to successfully integrate the Station with the surrounding area. Refer to **Clause 4** of the Particular Specification on “Contractor’s Team Qualifications”. Due consideration shall be given to the following issues:
- (a) Need for safe and suitable access for maintenance; and
  - (b) Relative height/massing/form with respect to the existing facilities and surrounding environment.
- 10.11.3 Replacement/Reinstatement of Affected Facilities
- 10.11.3.1 The Contractor shall reinstate the facilities that are affected by the Works. Where the affected facilities cannot be reinstated in the original location, the Contractor shall liaise with relevant stakeholders, authorities and agencies and obtain approvals to provide equivalent or better replacement facilities at alternative sites at his costs.
- 10.11.3.2 The Contractor shall coordinate with relevant authorities, agencies and parties to design and reinstate affected facilities due to the station construction works. The reinstatement works shall include provision of barrier free accessibility between the station exit and adjacent development. The Contractor shall liaise with all authority, agencies and relevant parties on their requirements for all the reinstatement works.
- 10.11.3.3 The Contractor shall comply with the requirements of **Clauses 7 and 12** and any other relevant provisions of the Particular Specification.

- 10.11.4 Green Roof Provision and Civil / Structure Provisions for Solar Photovoltaic (PV) System
  - 10.11.4.1 The Contractor shall design and provide the required civil provision for the solar photovoltaic (PV) system at the roofs of station entrances (unless specified otherwise) and at-grade structures including RC and metal roofs. The Consultant shall coordinate with the Authority's M&E Consultant and SWC on the PV system requirements. The Contractor shall ensure that the station's design arising from the PV system complies with the latest prevailing fire code requirements.
  - 10.11.4.2 The Contractor shall make all necessary building works, civil and structural provision for installation of solar PV system such as inverter panels, closets, cable risers, wall opening, structural loading of roofs, maintenance access to roof, fall arrest system etc. to meet the Authority's as well as technical and statutory requirements. Please refer to **Appendix AM** of the Particular Specification.
  - 10.11.4.3 The Contractor shall study the incorporation of green roofs together with solar photovoltaic (PV) panels for the station entrances and at-grade structures. The Contractor shall coordinate and liaise with all relevant agencies and Authorities for the percentage of roof space to be used for green space and PV panels. The Contractor shall maximise the space for PV panels and allow for all civil and fire safety provisions at those locations.
  - 10.11.4.4 The Contractor shall carry out sun-path analysis for the incorporation of solar photovoltaic (PV) panels.
- 10.11.5 Passenger and Commuter Flow
  - 10.11.5.1 The Contractor shall engage his own relevant qualified consultant with minimum 5 years of relevant experience in pedestrian movement analysis for transit projects, acceptable to the Engineer to carry out the required pedestrian modelling simulation for each station using locally calibrated and recognised software as approved by the Authority.
  - 10.11.5.2 The scope shall include all public areas of the station and any links to neighbouring developments and this station. For interchange stations, it shall include the existing station and all new transfer routes.

- 10.11.5.3 For the opening year 6-car train operations, pedestrian modelling study shall be conducted to determine the impact to the pedestrian flow of the 6-car train stopping position. The Contractor shall provide design options to optimise escalators and stairs arrangement for opening year requirement as well as to minimise works and impact to station operations/finishes when converting the station to cater for the ultimate year 8-car train operation.
- 10.11.5.4 The simulation shall comply with the Authority's Design Criteria requirements as advised for all elements impacting on pedestrian movement such as fare gates, lifts, escalators and trains. Simulation and reports shall be presented and submitted to verify that station spaces are adequately provided to meet the technical requirements stipulated in the Authority's Design Criteria and all other technical requirements as advised by the Authority.
- 10.11.5.5 The simulation shall test the design as developed by the Contractor, for compliance with the Authority's Design Criteria and all other the technical requirements as advised by the Authority for all elements impacting pedestrian movement such as fare gates, escalators, physical obstructions and trains.
- 10.11.5.6 Planning figures for both opening year 2032 and the ultimate year 2055 shall be used as the baseline design assumptions.
- 10.11.5.7 The Contractor shall propose and determine, through the modelling simulation analysis, any facilities that can be implemented in stages in anticipation for both opening year 2032 and the ultimate year 2055 planning figures.
- 10.11.5.8 The Contractor shall submit a full report to the Engineer for acceptance.
- 10.11.5.9 The report shall include of the following:
- (a) Summary of the pedestrian modelling results for both normal operations and stress tests;
  - (b) Analysis of the pedestrian movement and crowd behaviour;
  - (c) Identify areas of congestion, any under and over provisions;
  - (d) Identify crowd controls and security screening measures;
  - (e) Elements impacting pedestrian movement such as fare dates, escalators, physical obstructions and trains;



- (f) Demand distribution analysis at the various proposed entrances, and
  - (g) Propose design changes where necessary to optimise the design while retaining the necessary allowance for future expansion.
- 10.11.5.10 The Contractor shall substantiate the proposed design strategies with rigorous analysis of the anticipated pedestrian/ commuter movement and crowd behaviour. Where outcomes/ metrics of the simulation differ from critical dimensions identified in the Authority's Design Criteria, the most onerous condition shall be adopted. The Contractor shall utilise the outputs/results/metrics of the pedestrian modelling simulation to determine that the station design adequately addresses/responds to the technical requirements.
- 10.11.5.11 If the required simulation results are not met, the Contractor shall make recommendations to re-design the layout as appropriate to meet the requirements. The Contractor shall carry out revised pedestrian modelling simulations to the re-designed layout to the approval of the Authority. Further design work and pedestrian analysis testing is deemed to be included in the Contract Price.
- 10.11.5.12 Where the scope overlaps with existing infrastructure, the report shall also propose additions and alterations required to existing infrastructure. During the course of developing the design, the pedestrian modelling simulations and any proposed design changes shall be presented to the Authority. The full report shall be submitted together with the pre-final submission.
- 10.11.5.13 During the course of developing the design, the pedestrian modelling simulations and any proposed design changes shall be presented to the Authority. The full report shall be submitted together with the pre-final submission. Where outcomes/ metrics of the simulation differ from critical dimensions identified in the Authority's Design Criteria, the most onerous condition shall be adopted. Further design work, co-ordination and pedestrian analysis testing is deemed to be included in the Contract Price.
- 10.11.5.14 The Contractor shall provide updates and verification to the dynamic pedestrian modelling simulations of commuter flow at all submission stages (preliminary, pre-final and final stages) and as directed by the Engineer.

**10.12 Materials Selection/Specifications**

- 10.12.1 Choice of materials for Public Areas shall be appropriate and fit for purpose. Materials selection and finishes shall be presented to the Engineer for acceptance.
- 10.12.2 Notwithstanding the above, materials selected shall be of high durability, low maintenance, easy to clean and replace. Proposed architectural finishes should not be a safety hazard to the general public. It should not require cyclical painting or re-coating. Access for replacement and ongoing maintenance shall be achievable by commonly available means. Customised cleaning equipment shall be avoided.
- 10.12.3 All maintenance and equipment access hatches and covers, including access doors to all ducts, risers and double slabs in the public areas shall be designed and finished to integrate and match with the station architectural finishes. Access panels shall be minimised in public areas through combining of access points where feasible; where necessary full panels to be made operable with minimal difference in panel size and joints with architectural wall finish sizes and joints to facilitate use as a panel door. Access hatches shall be coordinated fully to match with floor finish sizes and joints. The Contractor shall coordinate with the M&E Consultant to design the maintenance access to be located away from the track.
- 10.12.4 There shall be no aluminium cladding, glass reinforced concrete and gypsum panels in all touch zones. Vitreous enamel, granite or equivalent durable materials are acceptable.
- 10.12.5 There shall be no Quartz stone used for flooring.
- 10.12.6 The Contractor is responsible for the design, calculation verification of all glass thicknesses based on loading requirements, including for use as barriers/ guarding as necessitated by his design. Where glass is listed as the same material code, it shall be of a consistent thickness to suit the most onerous loading condition, except where the change in thickness will not be visually apparent and subject to the acceptance of the Engineer.
- 10.12.7 The Contractor shall undertake, manage and record the dry-lay of all public area floor finishes. Prior to requesting inspection, the dry-lay area shall be properly cleaned and adequately lit for inspection. After approval from the Engineer, each floor tile to be uniquely identified and carefully stored in advance of installation as per the agreed dry-lay. Prior to final installation, the Contractor shall verify with SWC's that all under-floor installation works affected have been completed and tested.

- 10.12.8 All maintenance and equipment access hatches and covers, including access doors to all ducts and risers and double slabs in the public areas shall be designed and finished to integrate and match with the station architectural finishes. Access panels shall be minimised in public areas through combining access points where feasible; where necessary full panels to be made operable with minimal difference in panel size and joints with architectural wall finish sizes and joints to facilitate use as a panel door. Access hatches shall be coordinated fully to match with floor finish sizes and joints.
- 10.12.9 Aluminium Composite Panels are not allowed in any area of the station.
- 10.13 Materials and Workmanship Specification for Architectural Works [M&W Specification (Architectural)]**
  - 10.13.1 Reference shall be made to the Materials & Workmanship (M&W) Specification for the requirements of architectural finishes and components of the Contract.
  - 10.13.2 The Contractor shall expand the M&W Specification (Architectural) to create a complete set of specifications to fully cover the architectural works required for the Contractor's proposed design to the acceptance of the Engineer. Where amendments to the specifications are deemed necessary, the Contractor shall highlight to the Engineer, provide and incorporate the amendments to the specifications, subject to acceptance.
  - 10.13.3 The Contractor shall prepare his Architectural drawings in conjunction with the M&W Specification (Architectural) to be submitted to the Engineer for review and acceptance as a mutually coordinated package for the architectural works.
- 10.14 Lighting Design**
  - 10.14.1 The Authority has engaged lighting consultant under Contract CR2007 (CR2007) to carry out lighting design for the stations. The Authority will engage separate SWC for the procurement and installation of lighting. The Contractor and his Architect shall lead the coordination with CR2007/SWC to develop the lighting design for the stations, commuter facilities, landscape area, bicycle parking areas and all above ground structures. The detailed scope of works is enumerated below:

- (a) The overall lighting design shall tie in with the overall architectural design intention. The Contractor's Architect and CR2007/SWC shall jointly conduct regular design workshops to review the lighting design and jointly present the overall lighting scheme at forums such as ADRP, Design Presentations, Reviews, Workshops and other forums, as requested by the Authority.
- (b) The Contractor shall coordinate with CR2007/SWC and make provisions for the installation of LED lighting integrated with handrails/balustrade.
- (c) The lighting design shall adhere with the overall station design requirements, including but not limited to maintenance, aesthetic integration, security requirements, etc.
- (d) The Contractor and his Architect shall lead the coordination with CR2007/SWC to ensure that the luminaries and interfacing of the lighting fixtures with the finishes is seamless with the station design. All associated equipment, e.g. drivers, and their access points, are to be accessible and fully integrated with the overall design.
- (e) The Contractor and his Architect shall work with CR2007/SWC to coordinate on the position and location for all light fittings and peripherals that are installed in the public, non-public areas and outside plant and equipment rooms. Interfacing details of the luminaires to the mounting surfaces shall be submitted to the Engineer for acceptance. Light fittings in the public areas shall be integrated with cladding design and where unable to be mounted at joints or in recess ceiling bands, to be centred or otherwise evenly spaced on panels.
- (f) The lighting strategy shall consider sustainability and energy efficiency to meet with Green Mark Platinum standard certification. Purely decorative lighting shall be avoided.
- (g) The Contractor and his Architect and CR2007/SWC shall jointly coordinate with the lighting design and maintenance strategy with LTA RAOM and the Operators. The lighting design shall ensure and demonstrate the ease of access for replacement and maintenance of the lighting fixtures.

- (h) CR2007/SWC shall calculate luminance levels for the proposed station lighting design. The results of the calculation and proposals are to be submitted to the Engineer for acceptance. The luminance levels shall comply with the Authority's Design Criteria.
- (i) The Contractor and his Architect shall make amendments to his documents and drawings to accommodate any Authority approved changes that arise from such co-ordination.
- (j) Upon installation, the CR2007/SWC shall undertake readings and required simulations to measure and validate the required lighting levels and desired lighting effects and compliance with the Authority's requirements. Where the required levels and intended lighting effects are not met, the Contractor and his Architect shall coordinate and work with CR2007/SWC to propose and carry out remedial measures to modify the lighting scheme until the required measurements and effects are met.

10.14.2 The lighting design developed shall also consider functionality efficiency and easy access for maintenance.

10.14.3 Light fittings shall be reachable and located at maximum height of 4.5m from finished floor level.

10.14.4 Light fittings directly above escalators and staircases are not allowed.

10.14.5 Minimum 800mm wide ledges shall be provided around escalators and staircases wells at exit level to provide access for maintenance. Balustrades shall be provided around the maintenance service ledges for protection from falling, with securable swing gates to restrict public access.

10.14.6 Light fittings shall be wall-mounted on the sides of staircases and escalators. This will ensure easy access to the light fittings for maintenance.

## **10.15 Acoustic Design**

10.15.1 The Contractor shall ensure that the architectural design of the station incorporates all the necessary acoustic requirements in accordance with the Authority's Design Criteria.

- 10.15.2 The Contractor shall appoint a qualified and experienced Acoustic Consultant with recognised degree in relevant field and at least minimum 5 years of relevant experience in the design of projects of similar scale, complexity and nature of works, acceptable to the Engineer to carry out an acoustic study of each station inclusive modelling of the station acoustic environment in 3D. The Contractor shall submit the acoustic consultant's track records, details of the accredited modelling software and experience for the Engineer's acceptance.
- 10.15.3 The acoustic proposal/strategy shall be presented for reviews at Design Reviews, Workshops, or any forums as requested by the Authority.
- 10.15.4 The Contractor shall ensure all sound insulation (STC) values, coefficients of absorption, vibration separation, or any other acoustic properties required of the structures, finishes and fittings within the station as outlined in the Acoustic Consultant's report are implemented and complied with the design, and included as properties of the structures, fittings and doors.
- 10.15.5 The Contractor shall ensure any changes to the design are picked up and applied in an update to the acoustic report by the acoustic consultant to ensure the acoustic performance required is still being maintained.
- 10.15.6 If at any time the implementation of features which directly impact the acoustic performance are required to be modified, the Contractor shall engage the Acoustic Consultant to re-evaluate and identify the alternative mitigating measures that need to be undertaken, subject to the Engineer's acceptance.
- 10.15.7 The Acoustic Consultant's scope of works shall include the following:
- (a) Develop and implement an acoustic design strategy;
  - (b) Advise on the selection of architectural finishes to achieve the required performance criteria and coordinate with the Contractor to ensure that the acoustic design is integrated with the station architectural design and finishes;

- (c) Propose the Public Address (PA) system in the station, and assist on matters relating to the acoustic design of the station. He shall advise on the location, layout and orientation of PA speakers and review the qualities, types, specifications and finishes of PA system proposed by Communications System SWC with considerations on the ease of accessibility for maintenance of the PA system to be performed;
- (d) Consult and coordinate with the Communications System SWC on his speaker layout designs, for which the Communications System SWC shall verify and satisfy himself that the speaker layouts proposed by Acoustic Consultant meet Speech Transmission Index for Public Address Systems (STIPA) requirements. The coordination between the Acoustic Consultant and the Communications System SWC shall be an iterative. All necessary iterations between the Acoustic Consultant and the Communications System SWC to ensure that the PA speaker layout meet STIPA requirement shall be deemed included in the Contract Price;
- (e) Calculate the Speech Transmission Index (STI) and the Reverberation Times (RT) for station public area and Passenger Service Centre. The STI shall be submitted for verification by Communications System SWC;
- (f) Submit the proposal for the PA system in a timely manner to enable the Communications System SWC to proceed with STIPA verification. The Acoustic Consultant shall ensure that the reverberation times (RT60) at 1 kHz shall not exceed 1.8 seconds in any public area. In areas where the ceiling height is lower than 5m, the target reverberation time (RT60) at 1 kHz shall be less than 1.6 seconds. The speaker layout shall provide a minimum STIPA level of 0.5 in at least 75% of each public area (zone) of coverage. For the remaining 25% of each area, the STIPA level shall not fall below 0.45 and shall not be concentrated in one location but shall be distributed throughout the area of coverage. The Acoustic Consultant and the Communications System SWC shall produce a joint agreement to confirm this;

- (g) The Acoustic Consultant shall assure that the Reverberation Times (RT) values as specified in Authority's Design Criteria are met for station public areas. The Acoustic Consultant shall calculate the RT for the stations and make recommendations if the RT does not meet the LTA's requirements. Should there be any non-compliance, the Acoustic Consultant and Contractor are to make proposals to the Engineer for integration of additional acoustic insulation as the first method of resolving RT matters; changes to the design or finishing materials shall only be considered as a last resort;
- (h) Liaise, interface and coordinate with the relevant SWCs to ensure that the PA system is successfully integrated with the station design, and that all performance criteria requirements are met;
- (i) Coordinate architectural, Civil, Systems and M&E design requirements to achieve an integrated and optimised acoustic design. Ensure the acoustic design is integrated spatially and aesthetically with the station design to enable announcements over the station PA systems to be heard distinctly. To make amendments to documents to accommodate any Authority approved changes that arise from such coordination;
- (j) Coordinate with the SWCs to review the E&M plant rooms and above ground structures of the station including vent shafts and cooling towers, and identify potential noise sources and recommend mitigation measures (which may include providing acoustic louvers at the cooling tower enclosure and/or acoustic lining within the ventilation shafts and/or E&M plant rooms, etc.) if the noise criteria are exceeded. A noise report is to be submitted to demonstrate that the noise generated from these station structures are within the NEA's requirement. The effect of potential external noise sources on the station and its exits shall be taken into account. The design shall avoid exterior noise affecting the PA system;
- (k) Involve in the testing and mock-ups and advise the Authority of compliance/non-compliance, as well as remedial action if necessary to ensure compliance with design criteria;



- (l) Submit acoustics design report comprising drawings, specifications, test results, calculations, mapping and computer simulations necessary to demonstrate the proposed acoustic design. The report shall also consist of analysis of acoustic qualities for all proposed design and finishes, and to recommend any acoustic treatment, mitigation measure and selection of architectural finishes to achieve/improve the acoustics environment in order to meet the Design Criteria and technical requirements. The acoustic report shall be submitted to demonstrate that the noise generated from the E&M plant rooms and the aboveground structures to the adjacent spaces/rooms or surrounding developments are within Authority's Design Criteria and NEA's requirements;
- (m) Provide the above-mentioned test reports, drawings, calculations, specifications and computer simulations for the preparation of the Tender Documents of the Provisional Sum for Architectural Works;
- (n) Coordinate with the Communication System SWC during its preliminary, pre-final, and final design and updated final stages to review the PA system speaker location and layout design as proposed by the Consultant based on the quantity of speakers and specification of the PA system to be provided by the Communication System SWC. The proposed speaker layout by the Consultant shall achieve the acoustic and intelligibility performance as specified in the specification;
- (o) Work with the Communications System SWC to incorporate any necessary modifications to obtain a design agreeable to all and accepted by the Engineer;
- (p) If the required RT and STIPA values are not met, the Acoustic Consultant shall make recommendations to re-design the PA speaker layout and to improve the RT values as appropriate to meet the requirements; and

- (q) To ensure that the noise in public areas and office areas within the station are kept within the noise limits as required in the Authority's Design Criteria as well as what is determined for the operation of the PA system and as mapped out under the simulation software. Rooms with equipment that would generate noise beyond the anticipated ambient noise level should avoid opening into public areas. Office areas should be designed to avoid having a shared corridor with rooms housing equipment that generates noise beyond the anticipated ambient noise level. Acoustic insulation properties (i.e. STC values) shall be identified where necessary for containment of noise when directly impacting the limits set for public and office areas.

## **10.16 Environmental Building Analysis, Weather Protection and Thermal Comfort**

- 10.16.1 The design shall incorporate adequate ventilation openings and fans to provide cross natural ventilation and thermal comfort to the station entrances. The design shall ensure protection from the wind-driven rain. Protection from wind-driven rain shall also be provided at the interface between station entrances and link canopies, as well as between and at PUDO/ Taxi stand/ Bus stop roofs and link canopies. Air circulation fans, if required, will be provided by SWCs to improve the thermal comfort level.
- 10.16.2 The Contractor shall make use of Computation Fluid Dynamics (CFD) or other simulation methods through the use of recognised proprietary environmental building analysis software/s as agreed by the Engineer, undertake a comprehensive environmental building analysis for each station based on the given reference design. Simulation and modelling reports shall be submitted for the station to verify that interior spaces are adequately protected from wind-driven rain whilst achieving adequate cross natural ventilation, thermal comfort with or without air circulation fans and smoke ventilation. The Authority will provide the reference metrics and acceptable performance for each station/zone.
- 10.16.3 The outputs of the simulations shall be used to determine any issues with glare, solar radiation mitigation, daylighting, energy modelling, weather protection, shadow projections, rain penetration, prevention against wind driven rain, orientation, adequate natural & mechanical ventilation, landscaping/ greening layouts, etc. and to inform the Engineer-should any concerns be raised.

- 10.16.4 The environmental building analysis shall include but not limited to bioclimatic analysis, sun-path analysis, wind analysis, solar radiation and insolation analysis, daylight and glare analysis, energy modelling, weather protection, shadow projections, rain penetration, building orientation, natural and mechanical ventilation strategies, landscaping/ greening layouts, etc.
- 10.16.5 The Contractor shall utilise the outputs/ results/ metrics of the environment building analysis for the architectural design to determine that the station design adequately addresses/ respond to site specific local climatic conditions and demands.
- 10.16.6 Should the outputs/ metrics not be met, the Contractor shall present his findings to the Engineer including any recommendations for guidance from the Engineer. Should the Authority require additional mitigation design work, revised analysis, reports and presentation, they shall be undertaken by the Contractor and presented to the Engineer for the acceptance at no additional cost.
- 10.16.7 For interchange stations, the environmental building analysis shall include both the new station exits and the existing station.

**10.17 At-grade Structures**

- 10.17.1 The proposed ventilation shaft structures are for reference. The Contractor shall design the ventilation shaft structure with the following considerations:
- (a) No increase in the station footprint and minimise the impact to the station layout.
  - (b) The Contractor shall ensure that the spacing / sizes when designing the ventilation shaft structures and station entrances are minimised. Taking full consideration of any wind effects or external influences on airflow/smoke circulation, there shall be no re-circulation of air/ smoke between the ventilation shaft openings and between the ventilation shaft openings and station entrances during any fire emergency.

- (c) The Contractor shall perform and submit Computational Fluid Dynamic Analysis (CFD) simulations endorsed by a registered fire safety engineer to demonstrate that the proposed design will not result in air/smoke recirculation between the ventilation shaft openings and re-circulation of air/smoke into the station entrances. The Contractor shall interface with M&E Consultant C2007 and the Authority to discuss and agree on the CFD input parameters and passing criteria. The results shall be incorporated in the Fire and Life Safety report. The routing of the vent shafts when seen from above ground should be as small as possible, with as much of the routing being beneath ground and concealed from view as is achievable, to the Engineer's acceptance.
  - (d) Maximum pressure drop of the ventilation shafts including louvres shall be less than 150 Pa for VE/VS and 300 Pa for TV and the Contractor shall ensure the aspect ratio throughout the ventilation shafts is close to unity and limit the number of bends in the ventilation shaft so as not to exceed 2-3 bends. Each bend shall not be of acute angles or less than 90 degrees. The Contractor shall submit the pressure drop calculations for the ventilation shafts (VE/VS/TV) to the Engineer for acceptance.
  - (e) For top-discharge vent shafts, the Contractor shall ensure requirements for drainage and CD Shelter are met with within the design.
  - (f) The Contractor shall study the ventilation structure design and configuration, and provide alternative proposals to meet requirements stated in **Appendix BH** of the Particular Specification and obtain all necessary statutory/agency approvals.
- 10.17.2 The Contractor shall liaise with all relevant authorities on the location, massing and architectural treatment of ventilation shafts, cooling towers, make-up water tanks, thermal energy storage tanks, condenser units and exposed plant areas.
- 10.17.3 In determining the sizes, locations and orientation of the ventilation shafts, cooling towers, make-up water tanks, thermal energy storage tanks, condenser units, battery rooms and exposed plant areas, the Contractor shall work and liaise closely, and comply with the requirements from the Authority's Design Criteria, the M&E consultant C2007 and the Authority's In-house designers for Tunnel Ventilation System.

- 10.17.4      The Contractor shall ensure that the adequate separation distances are provided between source of exhaust and supply air to prevent re-circulation of the ventilation system.
  
- 10.17.5      The Contractor shall also comply with recommendations and mitigation measures outlined in the EIA report to minimize any adverse environmental and noise impact of the ventilation shafts and services structures on the surrounding.
  
- 10.17.6      As these are dominant architectural features in the urban environment, the Contractor shall ensure that they shall be designed to integrate with the station architecture and complement their surroundings. Adequate vertical access for maintenance shall be provided. All E&M plant equipment shall be screened from view. The screening shall be an integrated design element of the overall surface structure.
  
- 10.17.7      The design shall ensure that exhaust air complies with relevant authority's requirements. The Contractor shall ensure that the exhaust air does not cause inconvenience to pedestrians or the general public. It should not present a negative environmental impact to its surrounding especially when adjacent to public spaces or buildings. Measures to prevent exhaust air/smoke/heat (generated by the cooling towers, air vents and the like) from affecting the use of existing facilities shall be proposed.
  
- 10.17.8      Clearly defined spaces shall be provided for the cooling tower, thermal energy storage tanks and make-up water tank enclosure and all services routed between it and the station with provision for access to these spaces for maintenance. The cooling tower shall be located at least five (5) metres away (measured from the base of the cooling tower which shall be subjected to NEA requirement also) from air circulating and ventilating inlets, open windows and occupied areas, pedestrian thoroughfares, trafficable areas, areas of public access, exhaust discharges from kitchens, air handling system or other areas where nutrients conveyed from these systems could assist in the growth of legionella.
  
- 10.17.9      Access for maintenance shall be provided for all vent floor openings via catladder and/or platforms. Safety railing shall also be provided around the opening voids. For equipment delivery void, hoisting beams shall be provided where required.
  
- 10.17.10      The location of the VE and TV shaft openings with respect to the fire fighting breeching inlets shall be arranged such that the smoke discharge from the VE and TV shafts will not pose a hazard for access to the breeching inlets.

- 10.17.11 Thermal energy storage tanks (TES) (including insulation) shall be provided by ECS System-wide Contractor. The Contractor shall liaise with the ECS System-wide Contractor on the locations of pipe penetrations, nozzle installations and fittings for the thermal energy storage tanks. The Contractor shall ensure that all structural requirements for the TES tank, including but not limited to structural loads, support systems, foundations and connections to the main slab are taken into consideration and allowed for in his design.

**10.18 Station Area Database and Monitoring of Room Sizes**

- 10.18.1 The Contractor shall provide marked up plans and calculations of station area which shall also be used to track the design development of the station at all stages of the design in accordance to the following:
- (a) A set of tabulation showing calculations of station area following the method and format as described in the Measurement Guidelines for Station Area Database with a set of plans showing the demarcation of areas; and
  - (b) A set of tabulation showing calculations of station area following URA's definition of Gross Floor Area (GFA) with a set of plans showing the demarcation of areas.
- 10.18.2 The Contractor shall also provide a tabulation of the room sizes of all rooms to track deviation from the Authority's Design Criteria or other documents issued by the Authority and changes occurring during all design stages of the stations and provide justifications for all variances.

**10.19 Fire and Life Safety Report**

- 10.19.1 The Contractor shall demonstrate an appropriate strategy for fire and life safety for the station that shall be fully compliant with requirements of the current prevailing Code of Practice for Fire Precautions in Rapid Transit Systems (CPFPRTS) and the Fire Code, and all requirements imposed by all relevant authorities. The Contractor shall appoint a fire and life safety consultant acceptable to the Engineer with minimum 10 years of relevant experience in fire and life safety studies for rail transit projects and conversant with the CPFPRTS.
- 10.19.2 The Contractor's QPs shall consult where deemed necessary as well as make all necessary submissions to SCDF, including any consultations and waivers. If, in the Contractor's opinion the design requires amendment for any Fire and Life Safety compliance matters, the Contractor shall seek the acceptance of the Engineer before proceeding with waiver submission. In the event the waiver is not granted, the Contractor shall ensure the station design is resolved for compliance.
- 10.19.3 The Contractor shall work with his QP for architectural work, QP for E&M works and coordinate with the E&M System-wide interfacing parties in the preparation of the fire and life safety report. The Contractor shall submit the Fire and Life Safety Report to the Engineer for acceptance.
- 10.19.4 The Contractor shall ensure that his Coordination Team carry out coordination with appointed SWCs and prepare CCSM, Reflected Ceiling Plan, Structural Electrical Mechanical and Combined Services Drawings taking into account type of architectural works. There shall be proper record of installation and recording of all fire stopping, seals and dampers required for fire compartmentation.
- 10.19.5 Where requested by the Authority, the Contractor shall study the possibility of delinking the TOP for one or more entrances from the main station Temporary Occupation Permit (TOP) in their fire escape strategy.
- 10.19.6 The Contractor shall demonstrate the strategy for fire and life safety for the station with appropriate drawings and illustrations, encompassing both public and ancillary areas.
- 10.19.7 The emergency evacuation provisions shall be designed to cater for a 8-car train system for the ultimate year and 6-car train operation for the opening year. The Contractor shall demonstrate the strategy for fire and life safety for the station with appropriate drawings, calculations and illustrations.

- 10.19.8 Exiting analysis shall be carried out to demonstrate full compliance to latest CPFPTS requirements. Softcopy of analysis (e.g., spreadsheet in Microsoft Excel or other version accepted by the Authority) to be submitted. A print-out together with soft copy version of the spreadsheet showing the formulae shall also be submitted with the cell reference clearly labelled the top and left hand margins of each page.
- 10.19.9 Where the station is an interchange, the fire and life safety study shall holistically include the entire development. The Contractor shall design the necessary changes and provisions to the existing station to ensure compliance with the latest statutory codes and requirements.
- 10.20 Station Security**
- 10.20.1 The Contractor shall ensure that all security requirements imposed by the Authority are incorporated in the design, with suitable protection and mitigation measures.
- 10.20.2 The Contractor shall prepare a Security Design Plan for each station in consultation with the Engineer, for the Authority's acceptance. Any variations from the Contractor shall be endorsed by a Qualified Person (QP)/ Security & Blast Consultant and submitted for acceptance by the Authority with costs arising from the submission to be borne by the Contractor.
- 10.20.3 The Contractor shall ensure that the architectural design of the Station incorporates all the necessary security requirements in accordance with the Authority's Design Criteria, **Appendix AE** of the Particular Specification – Key Security Requirements for MRT Stations, Security Protection Plan (SPP)/ Final Security Protection Plan (FSPP) and other relevant security requirements imposed by the Authority. The Contractor is required to submit architectural drawings, security checklist and any other relevant documentations deems necessary by the Authority to ensure compliance to the security requirements.
- 10.20.4 The Contractor shall coordinate with the Communications System Contractor on the position and location for the Video Surveillance System (VSS) and peripherals that are to be installed in the Station, entrances and surrounding areas. The location of the cameras, housing, finishes and mounting interface details shall be submitted for approval by the Engineer and the Authority prior to installation. There shall be full compliance to the latest MHA VSS Standard for Mass Rapid Transit (MRT) Stations.



- 10.20.5 The Contractor shall ensure that Closed-Circuit Television (CCTV) camera locations form part of a rational/ effective and cohesive integrated design strategy. Camera positions in the public areas shall be integrated with cladding design and where unable to be mounted at joints or in recess ceiling bands, to be centred or otherwise evenly spaced on panels. Where VSS design requires clustering of cameras, the Contractor is to review options and provide for shared mounting brackets including bespoke at his cost designed supports to minimise poles (at his cost); all for review and acceptance by the Engineer. This also applies to camera coverage outside of the station; not limited to entrances, new camera poles (at his cost) and installation at linkways. The Contractor, their Landscape Designer and the Communications System Contractor are to liaise with NParks and the Engineer to coordinate external works, planting and VSS coverage. All costs for the provision of CCTV cameras, camera poles, etc. for security and surveillance coverage of the station, entrances and its surrounding shall deem to be included in the Contract Price.
- 10.20.6 Each member of the Contractor's team working on the project, depending on his/her level of access to sensitive information in relation to the project, shall be required to undergo the necessary security clearances by the Authority and/or other relevant agencies before being allowed to commence work on the project. The Authority and/or other relevant agencies reserves the right to deny the security clearance without explanation.
- 10.20.7 The Contractor is expected to attend relevant meetings and/or present its findings as required by the Authority, furnish documentation and information pertaining to the security assessments and solutions proposed. This shall include meetings with and information requests by the Authority and/or other relevant agencies.
- 10.20.8 Should the Engineer not accept any of the submissions prepared by the Contractor, the Contractor shall make the necessary revisions, undertake further analyses or provide additional information as required. These additions and/or amendments shall then be consolidated and incorporated into a fresh submission that shall be prepared and re-submitted for acceptance.

- 10.20.9 The Contractor shall be subject to the Official Secrets Act. The Contractor shall not disclose or release to any person, entity or otherwise deal with the same in any manner whatsoever without the written consent of the Authority, as all information relating to this project shall vest in and be the absolute property of the Authority. The Contractor shall safeguard any information collected and return and/or delete all information collected/processed at the end of the contract in accordance with the Authority's instructions.
- 10.20.10 Any security measures that have potential impact to commuter flow (such as Transit Security Booth, security screening, etc.) shall be included in the Contractor's pedestrian modelling analysis. The Contractor shall make reference to the Passenger and Commuter Flow as stated in **Clause 10.8.5** of the Particular Specification. The Contractor shall take into consideration security requirements as imposed by the Authority in the design. The Contractor shall address the requirements and propose various protection and mitigation measures for the Authority's acceptance. A list of these security requirements is listed in **Appendix AE** of the Particular Specification. The Contractor shall prepare the Security Design Plan in consultation with the Authority, taking into account the security requirements. Any variations from the Contractor shall be endorsed by a Qualified Persons (QP)/ Security & Blast (S&B) Consultant Contractor and submitted for acceptance by the Authority with costs arising from the submission borne by the Contractor.
- 10.21 Ancillary Facilities**
- 10.21.1 The Contractor shall coordinate and provide all facilities required for the installation by others for Automated Teller Machines (ATMs), shops, vending machines, SAM, public phone booths, commercial signage, etc. within the boundary of the station. The Contractor shall incorporate into the design structural lintels for the future installation of security shutters at shop fronts. The Engineer shall advise prior to handover any required temporary hoarding or other installation at shop areas. The Contractor's QP shall ensure that authority compliance can be achieved based on the Engineer's handover requirements.
- 10.21.2 The Contractor's design for letter boxes at the station and shall make allowance for the future integration of the all retail unit letter boxes. Unless otherwise directed by the Engineer the Contractor shall obtain postal addresses from IRAS for the station and shops, and to obtain SingPost approval for the station letterbox assembly including letter boxes for station, shops and returned mail.

- 10.21.3 The Contractor shall submit a Development Interface Report (DIR) to the Engineer. It shall include both written and drawing information on the shop unit provisions installed, outline the design and arrangements that have catered for the future fitting out, all constraints with respect to architectural, civil & structural, electrical & mechanical and other services requirements which must be observed by the future designer/contractor and any restrictions on the usage and modifications imposed.

**10.22 Anti-Avian Measures**

- 10.22.1 The Contractor shall design and provide integrated measures so as to prevent bird roosting within and along the edges of the station.
- 10.22.2 The design of the roost inhibitors shall be integrated with the station design and shall require the Engineer's acceptance prior to implementation. Preferred options shall be sloping surfaces against bird spike, for example.

**10.23 Public Seating**

- 10.23.1 The Contractor shall design, develop, fabricate, supply, deliver and install the platform seats that meets the following criteria, but not limited to:
- (a) Compliant with prevailing codes, standards and guidelines on accessibility provisions and relevant regulatory requirements;
  - (b) Quantity and location of the seats to be provided shall be in accordance with the Authority's Design Criteria requirements;
  - (c) Considerations of ergonomics, usability, visibility, constructability;
  - (d) Safe, accessible and comfortable to users of all ages and needs;
  - (e) Visually distinct and attractive for enhanced user experience;
  - (f) Fixing method to allow flexibility to add, relocate or remove the platform seat with minimal damage to the floor finishes or stability of the seat;
  - (g) Optimise visibility of platform seat to avoid obstructing commuter movement;
  - (h) Adequate use of material or materials for the structure and seat so that it does not add to bulkiness, and minimise material wastage where seats are placed back to back or against a wall;

- (i) Easy for cleaning, maintenance and replacement;
- (j) In modular design that can be configured and assembled in various ways to achieve the required number of platform seats; and
- (k) Elimination of any area that can conceal packages;
- (l) Avoid having seats in close proximity to CCTV to prevent it from being used as a tool to reach the CCTV.

10.23.2 The design of the platform seats shall be presented at Design Reviews and subject to the acceptance of the Authority. The Contractor shall design, develop and provide documentation on all necessary technical information, shop drawings, material samples and mock-ups for the Engineer's acceptance prior to fabrication and installation.

**10.24 Architecture Workshop, Design Review and Architectural Design Review Panel (ADRP)**

10.24.1 The Contractor shall make design presentations, for each of the major deliverables to clearly present the design and construction methods proposed. Design presentations shall be made various forums to the Engineer, Authority's representative through Steering Committee, Architecture Workshop, Design Review and Architectural Design Review Panel appointed by the Authority, as and when requested by the Authority. Presentations shall be made to all relevant authorities/agencies such as URA, BCA, JTC etc. if so required.

10.24.2 Architecture Workshop

10.24.2.1 The Contractor shall make presentations at regular Architecture Workshops with the Authority during design stages and prior to submission milestones to present, coordinate and develop the station design to the satisfaction of the Authority. Issues that are interdisciplinary shall involve all relevant parties from the Contractor as well as relevant departments from the Authority and Engineer.

10.24.3 Design Review Sessions

10.24.3.1 The Contractor shall make presentations at design review sessions on a regular basis to the Authority during design stages and prior to submission milestones to clearly present the architectural design, detail, interfacing and construction methods adopted, as and when requested by the Authority. Comments from these reviews must be addressed and incorporated into the station design.

- 10.24.4 Architecture Design Review Panel (ADRP)
- 10.24.4.1 The Architectural Design Review Panel (ADRP) shall be appointed by the Authority. The presentations to ADRP shall precede the main design stages as stipulated in the Contract. The Contractor shall make due allowance for this primary design approval activity. The presentations shall be as follows:
- (a) ADRP A: Preliminary Design Stage (2 weeks before Preliminary Design Submission);
  - (b) ADRP B: Pre-final Design Stage (4 weeks before Pre-final Design Submission); and
  - (c) ADRP C: Final Design Stage (4 weeks before Final Design Submission).
- 10.24.4.2 The Contractor shall make additional presentations to the ADRP requested on an ad-hoc basis as required.
- 10.24.4.3 The Contractor shall submit the presentation material two (2) weeks in advance of the presentation for the Authority's review and shall ensure the presentation materials is amended accordingly and be circulated to the ADRP members one week in advance of the presentation for their reference.
- 10.24.4.4 Additional wrap-up reviews incorporating ADRP comments shall be arranged three (3) weeks after each ADRP to close out any outstanding issues following each ADRP session. The deliverables for the wrap up reviews shall be defined based on the outcome of each ADRP session and subject to the acceptance of the Engineer. This shall be given due consideration in the Contractor's programme before being recognised in the design.
- 10.24.4.5 Design Review with the Authority shall be conducted before each ADRP session.
- 10.24.4.6 The Contractor shall take minutes and keep records, of Design Workshop, Design Review and ADRP meetings and shall close off all comments given. The minutes shall be submitted to the Engineer for comments within a week of the presentations, design workshops, design reviews prior to final submission to the Engineer for record. The Contractor shall make presentations of the design to the ADRP as specified as well as any additional presentations requested on an ad-hoc basis.

- 10.24.4.7 The topics for ADRP presentations as listed shall serve as a guideline and minimum requirements. The Contractor shall discuss with the Engineer to formulate and prepare the topics for presentation of each station based on the design development, to the acceptance of the Engineer.
- 10.24.4.8 ADRP A
- (a) Station-specific site analysis with photographs, including urban context, land use, topography, orientation, water-bodies, parks, etc.
  - (b) Analysis of urban integration with the surrounding.
  - (c) Major design-driving considerations.
  - (d) Catchment analysis using evaluation matrix and PedShed analysis in format accepted by the Authority.
  - (e) Presentation of Contractor design proposal.
  - (f) Planning principles: analysis of spatial sequence, integration and quality, passenger movement and flow, way-finding, circulation, spatial planning and sequencing, strategies for future proofing, etc.
  - (g) Accessibility and intermodal connectivity between station and the surrounding.
  - (h) Interfaces with adjacent development.
  - (i) Passenger and commuter flow analysis, findings and recommendations.
  - (j) Design of all at-grade structures, landscape and urban design.
  - (k) Computer generated perspectives of preliminary designs for station interior and exterior forms, including all ancillary at-grade structures, showing interface with surrounding developments and structures that are rendered to achieve an appropriate level of realism, including material, colour & texture, lighting, components, etc.

- (l) 3D computer-generated animated walk-through video rendered to achieve an appropriate level of realism (including material, colour & texture, lighting, components, systems installation, etc.) with virtual environmental activities (including for example surrounding context, pedestrians to provide human scale, MRT trains arriving/ departing, platform screen doors and train doors opening, fare operation, flashing lights, etc.).
- (m) Interim progress video/prints and other such information relating to the services which LTA may request from time to time.

10.24.4.9 ADRP B

- (a) Summary of ADRP A comments and design updates to address ADRP A comments.
- (b) External envelope design update of all at-grade structures showing:
  - (i) Considerations for urban responses
  - (ii) Considerations for connectivity
  - (iii) Environmental and climatic response
  - (iv) Maintenance and security
  - (v) Interface and connection to commuter facilities
  - (vi) Photographs of existing site and surrounding developments
- (c) Addressing of construction, maintenance and aesthetic design concepts.
- (d) Computer generated perspectives of updated designs for station interior and exterior, including all ancillary at-grade structures, showing interface with surrounding developments and structures that are rendered to achieve an appropriate level of realism, including material, colour & texture, lighting, components, etc.

- (e) 3D computer-generated animated walk-through video rendered to achieve an appropriate level of realism (including material, colour & texture, lighting, components, systems installation, etc.) with virtual environmental activities (including surrounding context, pedestrians to provide human scale, MRT trains arriving/ departing, platform screen doors and train doors opening, fare operation, flashing lights, etc.).
- (f) Interim progress video/prints and other such information relating to the services which LTA may request from time to time.

10.24.4.10 ADRP C

- (a) The objective of ADRP C is to close out all outstanding ADRP comments.
- (b) Summary of ADPR B comments, design updates and resolution of issues raised in ADRP B.
- (c) Resolution of any other issues subject to the design development of the station as requested by the Authority.
- (d) Summary of consultation/s with agencies, stakeholders and impact on station design.

10.24.5 Presentation Materials for ADRP

10.24.5.1 Presentation materials to include soft copy of slides and 6 coloured hardcopies.

10.24.5.2 Materials of the presentations shall include but not limited to:

- (a) Site analysis diagrams and photographs.
- (b) Evaluation matrix and PedShed analysis for catchment analysis.
- (c) Photo-montage of stations in actual site context.
- (d) Site plans showing layout of station at-grade structures, subterranean footprint, surrounding developments and structures, and commuter facilities.
- (e) Full set of rendered station plans and sections showing all public and ancillary BOH areas in accordance to LTA standards.



- (f) Computer-generated perspectives of the station interior and exterior, including all ancillary at-grade structures, showing interface with surrounding developments and structures that are rendered to achieve an appropriate level of realism.
- (g) Appropriately scaled working models will be required to support the drawings to describe and convey the design intentions more effectively.

10.24.5.3 The final presentation videos shall be with real and virtual environmental activities i.e. with the surrounding context, pedestrians to provide human scale, MRT trains arriving/ departing, platform screen doors and train doors opening, fare operation, flashing lights, etc.). The speed and path of the walk-through video shall be realistic and at a pace agreeable to the Authority. The duration of the video shall be sufficient to demonstrate/ convey a thorough understanding of most of the public spaces, access/ transfer/ movement paths, etc. for each station. Various forms of multi-modal transfers are to be demonstrated. In interchange stations, the interchange movement/ path is to be demonstrated. The video shall be sufficient to cover all information listed above and at least 240 seconds long. The final master copy of the video shall be in Digital Beta format with one copy on DVD submitted.

10.24.5.4 All Presentation materials in editable, PowerPoint format shall be provided to the Authority in advance of the presentation. Presentation materials in high resolution Pdf format (not less than 300dpi) shall be provided when requested.

10.24.5.5 Interim progress video/ prints and other such information relating to the services may be requested by the Authority from time to time, and they are to be duly provided by the Contractor and are deemed included in the Contract Price.

10.24.5.6 Unless otherwise stated, all material prepared and used by the Contractor for ADRP presentation under this Contract shall become the property of the Authority. The Authority shall retain complete ownership rights to the completed video and all the raw footage. The final video as well as the raw footage shall be the property of Authority and the Contractor shall have no rights to use or display such footage without the written permission of the Authority.

## **10.25 Provisional Sum for Architectural Works (APS)**

10.25.1 The Provisional Sum for Architectural Works (APS) is applicable only to station.

- 10.25.2 The Contractor shall complete the design and detailing of all aspects of the Works included in the Architectural Provisional Sum and obtain acceptance from the Engineer prior to calling of APS tender. Thereafter, the supply/fabrication and installation/construction of the same shall be carried out by a separate APS sub-contract, the tender of which shall be prepared and called by the Contractor, in accordance with the Authority's Requirements.
- 10.25.3 The APS sub-contractor shall be appointed not less than twelve (12) months before the station BSC date in **Appendix B** of the Particular Specification.
- 10.25.4 The Contractor is required to enter into Sub-Contract(s) with the successful tenderer(s) for the various packages. The liquidated damages for this Sub-Contract(s) shall be as follows;
- (a) Architectural Works for station S\$6,000.00 per calendar day
  - (b) The total liquidated damages shall not exceed the Sub-Contract Price.
- 10.25.5 The Contractor shall make due allowances for the abovementioned including all other risks, obligations and liabilities in his Contract Price.
- 10.25.6 The Contractor shall design and detail all aspects of the Architectural Provisional Sum Works. Thereafter, the supply/fabrication and installation/construction, of the same, shall be via an APS sub-contract to be prepared and called by the Contractor in accordance with the Authority's Requirements.
- 10.25.7 The Contractor shall liaise, coordinate and provide all necessary provisions for interfacing with the APS sub-contractor on all aspects of all APS works. Where scope of works is not covered by the APS sub-contractor, the Contractor shall design for visible detailing and supply materials to match adjacent finish supplied by APS sub-contractor.
- 10.25.8 The Provisional Sum for Architectural Works is exclusively limited to the following items and any items not explicitly listed are deemed included in the Contract Price:
- (a) EXTERNAL WORKS (EXCLUDING ITEMS RELATING TO ROAD WORKS AND REINSTATEMENT)
    - A1 Apron finishes, around station.
    - A2 Railings around station.

- A3 Stair finishes.
- A4 Gratings and drain covers around exits and above ground structures.
- A5 Permanent fencing.

(b) FINISHES TO ABOVE GROUND STRUCTURES

- B1 Glass screen, enclosures, balustrade and doors.
- B2 Curtain wall system with windows, fixed glazing, associated weather seals/ gaskets and excluding wall structural system.
- B3 Skylights, roofing materials inclusive their proprietary fixings to structures of exits (all structures and purlins including any proprietary roof supporting system as proposed by the Contractor shall be excluded from the Provisional Sum).
- B4 Floor finishes including tactile tiles.
- B5 Ceiling finishes.
- B6 Wall/column finishes including associated cladding, windows, fixed glazing and associated weather seals/gaskets.
- B7 Commuter facilities (first bus shelters, taxi and passenger pick-up point shelters) as well as covered linkway connections from the station entrances to the aforementioned and associated covered linkways to adjacent developments including structures (except base slab and foundations), paving, cladding, roofing, seats, noticeboards, painting and signage.

Where the structure of the commuter facility is incorporated to the MRT structure and/or foundation, the construction of the commuter facility structure (in addition to the base slab and foundations) shall fall under the scope of the Contractor and not under the APS contractor.

B8 Windows and associated aluminium and glazing works including associated frame, purpose-built structural supports (if any), fixings and the like.

B9 Weatherproof air intake and exhaust duct grills at façade.

(c) INTERIOR ENCLOSURES

C1 Operable cladding and/or partitions (including demountable panels as maintenance access hatches that is part of or to match the operable cladding/partition system) provision to wet area sealed space, cavity wall and for CD usage, including ironmongery.

C2 Non fire-rated glass partitions and non-fire-rated glass doors.

C3 Wall/column finishes including their proprietary fixing e.g. hooks, brackets, pins (excluding wall structural system or any support system for the finishes). Including cladding of doors and access hatches in public spaces that is part of or to match wall/column finishes system.

C4 Acoustic treatment to walls.

C5 Wall rendering and plastering (except where necessary to meet fire resistance requirements).

C6 Glazing and cladding work to lift shafts (structural works, sub-frames, clamps are by the Contractor).

C7 Non fire-rated fixed and movable partitions.

(d) FLOORS

D1 Floor finishes including associated finishes to movement control joints and skirtings.

D2 Screeding for floor finishes.

D3 Floor gratings and covers.

D4 Floor trap covers.

D5 Floor removable panels.

- D6 Finishes around escalator intermediate supports.
- D7 Raised floor system.
- D8 Lift car floor finishes (supply only).
- D9 Interior gratings and drain covers.

(e) CEILINGS

- E1 Acoustic tiles / panels.
- E2 Skim Coat / Gridded Plaster board.
- E3 Gypsum board.
- E4 Metal ceiling systems.
- E5 Acoustic insulation to ceiling panel (thermal insulation is not part of the Provisional Sum).
- E6 Ceiling system inclusive of fixings including supports/suspension and tests (excluding lifting hooks, lifting eyes, lifting beams, lifting blocks and load tests and certification).
- E7 Ceiling access hatches and exposed catwalks or the like.
- E8 Hinged access panels (with hook and chain).

(f) FABRICATIONS

- F1 Stainless/mild steel railings and gates.
- F2 Glass railings, balustrades and screens including braille rail (except recessed LED light under SWC).
- F3 Cabinets.
- F4 Shelving.

- F5 Roller shutters and manual operation system, closet, collapsible gates, emergency gates and grilles, excluding fire shutters.
- F6 Hardware and lock sets for the items above.
- F7 Letter boxes with labels or word imprints.
- F8 Fixed furniture and seating.

(g) SPECIAL CONSTRUCTION AND OTHERS

- G1 Removable railings along platform edge.
- G2 Louvers and dummy air-conditioning grilles.
- G3 Sanitary fixtures and wares, electrical cable to isolator/fuse units and associated accessories.
- G4 Non-Statutory signage (listed in **Appendix G** of the Particular Specifications, TSM Volume 1, Part B, Items 5-9)
- G5 Bicycle parking racks and barricade enclosure.
- G6 Exit floor mat.
- G7 Painting to wall and ceiling.
- G8 Housings and cabinets (including ironmongery) for E&M equipment within the public area.

10.25.9 Exclusions from the Architectural Provision Sum:

10.25.9.1 The following list is not exhaustive and only includes those items where additional clarity is deemed necessary to define the scope of the items excluded from the Provisional Sum for Architectural Works. The following list of items are not included in the APS and are deemed included in the Contract Price:

- X1 External waterproofing of structures.
- X2 Waterproofing of internal slabs.

- X3 Protective screeding and other protection measures to waterproofing.
- X4 Fire-rated partitions and shutters.
- X5 Demountable panels in stations and plant rooms.
- X6 Permanent fire-rated doors and non-fire-rated doors (other than non-fire rated glass doors), and frames including ironmongery, temporary cylinders, hinges, hasp, end staples to gates, airtight sealing gasket, mechanical seals around doors, painting and all necessary hardware.
- X7 Temporary doors mounted on permanent door frames complete with temporary ironmongery complete with lock-sets and cylinders.
- X8 Handrails, ladders, covers and the like in tunnels, tunnel sumps, cross-passages and emergency escape shafts.
- X9 Breeching inlet boxes complete with words imprinted on the door and fire extinguisher cabinets.
- X10 Water services.
- X11 Reinstatement.
- X12 Sewerage systems, sanitary works and drainage systems including seepage drainage systems (except sanitary porcelain ware, traps to basins and sinks and covers to floor traps) and rainwater drainage systems.
- X13 Drains forming part of the drainage system at ground level.
- X14 Lifting hooks, lifting beams and lifting eyes for SWC equipment delivery and installation including safe working load tests and certification.
- X15 Insulating membrane along platform edge and PSD end returns.
- X16 Platform screen door (PSD) top support structure from concourse slab soffit to top of platform screen door and end returns including fire-stopping board/insulation and support framings.
- X17 Platform edge facing/rubbing strip.

- X18 Temporary ironmongery to permanent doors.
- X19 Painted markings and identifier labels on pipes, fittings and equipment supplied by the Contractor.
- X20 Brick walls, concrete block walls and all non-structural reinforced concrete walls.
- X21 Structural framework (including bulkhead) to support wall/ceiling to create a cavity for external walls and internal walls.
- X22 Sealing, repairing and otherwise making good all works not included in the Provisional Sum for Architectural Works.
- X23 Bus bays and taxi/passenger pick-up bays road surfacing, road markings and kerbs.
- X24 Rendering, plastering or other coatings to meet fire resistance requirements.
- X25 Primary Structural support necessary for fixing of the Passenger Information display (PID) support system.
- X26 Staircases and steps (structures and base slabs).
- X27 Structural system for curtain walls and skylights.
- X28 Chequered cover plate for cable trenches in plant rooms.
- X29 Floor Access Cover with lifting rod.
- X30 Access platform at airshafts.
- X31 Caged ladders.
- X32 Cat ladders, step rungs, safety platforms, handholds and catwalks.
- X33 Grating covers for all pump sumps, lift sumps, airshafts at ground level and trackside drains and roadside drain.
- X34 Fire rated and non-fire rated floor and wall access hatches and frames.
- X35 Walking and Cycling bridge with planter box, electrical lightings and lightning protection system (where applicable).



- X36 Fire Stops.
- X37 Trees felling and transplanting, treatment to existing trees affected by the Works such as propping, supporting, pruning of the roots etc.
- X38 Ironmongery, temporary cylinders (for locking during construction), hinges, hasp and staples to gates, airtight sealing gasket, mechanical seals around doors, painting and all necessary hardware to all clad and non-clad permanent doors, wall and floor access hatches and glass doors.
- X39 All statutory and operational signages.
- X40 Painting to all structural steelwork.
- X41 Maintenance access equipment, ceiling gantry rail and maintenance gantries over voids.
- X42 Equipotential bonding for all items.
- X43 Green roof, landscape and irrigation system.
- X44 Security Grilles/shutter.
- X45 Fair-faced concrete

## 10.26 **System-Wide Contracts Interfacing with Architectural Finishes Work**

S/N	Item Description
1	Platform Screen Doors (PSD)
2	Communications System (including Traveller Information System)
3	Facility for Commercial Info-communication Services
4	Access Management System
5	Lifts and Escalators including stainless steel claddings to escalators and lifts and interior finishes to lifts
6	Supply of Automatic Fare Collection Gates and GTMs

S/N	Item Description
7	Tunnel Ventilation and Environmental Control System
8	Electrical Services (including light fittings and all different services fittings)
9	LED Lighting in Handrails
10	Fire Protection System
11	Engineering Consultancy for CRL/CRL E&M Services
12	Passenger Service Centre and Station Master Room
13	Permanent Masterkey System

The above classification applies to subway/transfer links to the station.

## **10.27 Ironmongery**

- 10.27.1 The Contractor shall design, supply and install all ironmongery including temporary cylinders as identified in **Table 10.1** below for securing all doors during the construction period and for handover to the operator. The Contractor shall be responsible for the fitness and function of the temporary cylinders up to the installation of the master key cylinders and dummy cylinders by the SWC for permanent cylinders. The Contractor shall also be responsible to provide protection to the installed doors and all ironmongery until the completion and handover of the station.
- 10.27.2 The Contractor shall engage the ironmongery supplier together with the door supplier. The two parties shall work together as a combined unit to ensure the selection of ironmongery directly matches the performance requirements of the doors. The full set of ironmongery samples as well as working samples of the main locksets shall be submitted for approval together with the working samples for the different types of door. The door supplier shall install all their own doors while the ironmongery supplier shall install all their own ironmongery. The Certificate of Conformity (COC) and labelling of the doors together with their ironmongery shall be submitted by the door supplier after a joint verification by both parties as to the correct functioning and installation of the doors and ironmongery.

- 10.27.3 Permanent cam locks wherever necessary including for all cladding doors and hatches shall be installed by the Civil Contractor/the APS Contractor. Such locks shall be grouped by type of door and issued with a common key by group (e.g. one key for all seepage drain access cladding panels) apart from emergency access locks with break-glass such as for extinguisher and hose reel cabinets. Such cam locks shall have both individual keys per lock to be included in the break-glass and a common key for the operator.
- 10.27.4 For cladding doors and hatches secured with cam locks, a common permanent lock for all doors and hatches not for CD usage shall be installed by the Civil Contractor/ the APS Contractor. For CD usage, a common lock in accordance to CD requirements shall be installed by the APS Contractor.
- 10.27.5 The Contractor shall co-ordinate the position and location of all Access Management System (AMS) locks and peripherals with the AMS Contractor. The AMS locks shall be supplied by the AMS contractor and installed by the Contractor for all doors under the Contractor's scope as identified in **Table 10.1** below. Interfacing details of the walls and doors/ door frames and fire door approvals incorporating the AMS shall be submitted to the Engineer for acceptance.
- 10.27.6 The Contractor shall supply and install temporary cylinders for securing all doors during the construction period and for hand-over to the operator. Subsequent to hand-over the temporary cylinders can be returned to the Contractor upon installation of the system wide master key cylinders. The Contractor shall be responsible for the fitness and function of the temporary cylinders up to the installation of the master key cylinders. The Contractor shall also be responsible and shall provide protection to the installed doors until the completion and handover of the station.
- 10.27.7 The Authority engage a SWC for the System-wide supply and installation of master key cylinders for all permanent doors and hatches before hand over to the operator. The Contractor shall liaise and co-ordinate with the SWC for the SWC to install the permanent cylinders for all permanent doors and hatches. Upon installation of the master key cylinders by SWC, all temporary cylinders shall be returned to the Contractor.

10.27.8 The Contractor is required to provide ironmongery schedules in the format stipulated by the Authority. These schedules shall be submitted; as part of each design submission, together with the door shop drawings, and updated to incorporate all amendments and on-site adjustments including the confirmed depth of the doors six (6) months before targeted TOP date. This is required for the Authority to prepare the order for the supply and installation of permanent master key cylinders and dummy cylinders by the SWC for permanent cylinders.

10.27.9 Subsequent to the handover of the station(s) to the Operator, the Contractor shall liaise and co-ordinate with the SWC for permanent cylinders to facilitate the removal of temporary cylinders for all permanent doors and hatches and installation of the cylinders by the SWC for permanent cylinders.

Upon Installation of the permanent master key cylinders and dummy cylinders by the SWC for permanent cylinders, all temporary cylinders will be returned to the Contractor's representative in attendance during the changeover of cylinders.

**Table 10.1** - Door, Ironmongery, cylinder and Electrical locking (AMS/ Emergency Door Release (EDR)/Emergency Gate (EG)) scope of works:

Doors & Ironmongery (Other than Cylinder)	Scope – Door & Ironmongery Supply & Installation		
	Doors & Ironmongery (Other than Cylinder)	Temporary Cylinder	
		Supply	Installation
End Return Doors	PSD SWC	None	None
Doors for Passenger Service Centre & Station Master Room	PSC SWC	PSC SWC	PSC SWC
Shop Unit Doors			

Non-glass	Civil Contractor	Civil Contractor	Civil Contractor
Fire-rated glass	Civil Contractor	Civil Contractor	Civil Contractor
Non fire-rated glass	APS Contractor	APS Contractor	APS Contractor
Glass doors (Other than for shops)			
Fire-rated	Civil Contractor	Civil Contractor	Civil Contractor
Non fire-rated	APS Contractor	APS Contractor	APS Contractor
All other doors			
Fire-rated	Civil Contractor	Civil Contractor	Civil Contractor
Non-Fire rated	Civil Contractor	Civil Contractor	Civil Contractor

Door Type	Scope – Door & Ironmongery Supply & Installation			
	Permanent Cylinder		Electrical Locking (AMS/EDR/EG)	
	Supply	Installation	Supply	Installation
End Return Doors	None	None	Systems (AMS) SWC	PSD SWC

Doors for Passenger Service Centre & Station Master Room	Permanent Cylinder SWC	Permanent Cylinder SWC	Systems (AMS) SWC	PSC SWC
Shop Unit Doors				
Non glass	Operator	Operator	None	None
Fire-rated glass	Operator	Operator	None	None
Non-fire rated glass	Operator	Operator	None	None
Glass doors (Other than for shops)				
Fire-rated glass	Permanent Cylinder SWC	Permanent Cylinder SWC	Systems (AMS) SWC	Civil Contractor
Non-fire rated	Permanent Cylinder SWC	Permanent Cylinder SWC	Systems (AMS) SWC	APS Contractor
All other doors				
Fire-rated	Permanent Cylinder SWC	Permanent Cylinder SWC	Systems (AMS) SWC	Civil Contractor
Non-Fire rated	Permanent Cylinder SWC	Permanent Cylinder SWC	Systems (AMS) SWC	Civil Contractor

10.27.10 The Contractor shall provide and submit the proposed ironmongery schedules in the format to be stipulated by the Engineer for acceptance. These schedules and summary shall be made ready and submitted to the Engineer for review. The Contractor shall update the schedules diligently and shall provide as-built schedules upon the Substantial Completion of the whole of the Works.

**10.28 Platform Screen Doors (PSDs) including End Return Doors (ERD)**

10.28.1 The Contractor shall liaise/co-ordinate with PSD SWC on all aspects of safety precautions/requirements (eg: touch voltage and the like) that the Contractor must provide for and take into account when designing and constructing (including all insulation tests) the architectural finishes in the vicinity of the platform screen doors and ERD.

**10.29 Automatic Fare Collection (AFC) Gates and Top-Up Kiosk (TUK) Requirements.**

10.29.1 The SWC (AFC Contractor) shall supply and install the AFC equipment (such as AFC gates, Station Computers (SC), Passenger Service Machines (PSM) and ticketing kiosks). The Contractor shall liaise and co-ordinate with the AFC contractor on all aspects of the requirements for the supply and installation of the AFC equipment.

10.29.2 The Contractor shall verify at each design stage that the number of AFC gates and any emergency gates (if any) required to comply with the CPFPRTS exit requirements and advise the Engineer of any mitigation proposals.

10.29.3 The figures below are AFC gate and ticketing kiosk minimum guideline/quantity for the station. In addition, the design shall allow for future provisions. The Contractor shall review with the Authority in conjunction with the pedestrian modelling study to finalise the number of AFC gates and ticketing kiosks.

	AFC minimum requirement	
	Normal Stations	Future provision
Main Fare line	7 normal + 2 wide aisle	Extend to cover the full fare line as much as possible
Remote Fare line	4 normal + 1 wide aisle	

	TUK and ASK Minimum Quantity	
	TUK	Future provision for TUK
Main Fare line (station with two or more fare line)	2	1
Remote Fare line (station with two or more fare line)	1	1
Single Fare line	2	1

- 10.29.4 To allow installation of additional AFC gates for future expansion, the underfloor ducting shall be extended to cover the full fare line subject to physical constraints on site.
- 10.29.5 The underfloor trunking including the cable upstands/junction box of AFC equipment (ticketing kiosk and AFC gate) shall be provided by the AFC contractor. The AFC gate mounting plinth shall be provided by the Contractor. The Contractor shall liaise and co-ordinate with the AFC contractor on all aspect of the requirement to enable the AFC contractor to install the underfloor trunking/upstands/junction box.
- 10.29.6 The number of AFC gates is dependent on the aisle configuration, e.g. eight (8) aisles in a single group requires nine (9) AFC gates. If divided into two (2) groups of four (4) aisles, then a total of ten (10) AFC gates are needed.
- 10.29.7 The AFC contractor shall supply and install the AFC Emergency Stop Switch (AFC ESS), PSM and SC in the station's Passenger Service Centre (PSC). The Contractor shall liaise and co-ordinate with the AFC contractor on all aspects of the requirements for the supply and installation of the AFC ESS, PSM and SC in the PSC.



10.29.8 The AFC contractor shall supply and install the AFC Network Equipment into the station's Fare Equipment Room (FER) or Fare Equipment Closet (FEC) at a location near to the AFC equipment. The Contractor shall liaise and co-ordinate with the AFC contractor on all aspects of the requirements for the supply and installation of the AFC network equipment into FER or FEC.

10.29.9 The AFC contractor shall supply and install the AFC Distribution Box (DB) at the station's AFC DB Closet at a location near to the AFC equipment. The Contractor shall liaise and co-ordinate with the AFC contractor on all aspects of the requirements for the supply and installation of the AFC DB into AFC DB Closet.

### **10.30 Layout Provision for Public Address System**

10.30.1 The Contractor shall propose a speaker layout for the PA systems in the station to Communications System SWC in a timely manner to enable Communications System SWC to proceed with the STIPA verification. The Contractor shall ensure that the reverberation times (RT60) at 1 KHz shall not exceed 1.8 seconds in any public area. In areas where the ceiling height is lower than 5m, the target reverberation time (RT60) at 1 kHz shall be less than 1.6 seconds. The speaker layout shall provide a minimum STIPA level of 0.5 in at least 75% of each public area (zone) of coverage. For the remaining 25% of each area, the STIPA level shall not fall below 0.45 and shall not be concentrated in one location but shall be distributed throughout the area of coverage. The Contractor and the Communications System SWC shall produce a joint agreement to confirm this.

10.30.2 The Contractor shall co-ordinate on the position and location for all devices and peripherals that are installed in the public and non-public areas outside plant and equipment rooms. The Contractor and Communications System SWC shall produce a joint agreement on the co-ordinated information.

### **10.31 Passenger Service Centre (PSC) and Station Master Room (SMR)**

10.31.1 The Authority will call tender for a System Wide Contractor (SWC) for the supply and installation of the PSC and SMR.

- 10.31.2      The Contractor shall design the PSC and SMR including the structure, furniture, external façade and the internal fit-out. The design shall include the furniture details, internal steel structures, location and fixing of all equipment, external envelope, all finishes and internal layout of the PSC and SMR in compliance to the prevailing codes, standards and guidelines, with due considerations to achieve a consistency in external envelope, datum lines, finishes selection across the line. The design shall be presented to the Authority at Design Reviews, or at other forums as requested by the Authority. The Contractor shall refer to **Table 7C** of **Clause 7** of the Particular Specification for the design scope and provisions with respect to the PSC and SMR.
- 10.31.3      As the PSC and SMR are to be a line-wide component, the Contractor shall develop the design for Authority calling of the SWC tender and shall amend the design to take on line-wide elements of the design as directed by the Authority in order to facilitate the production of the line-wide tender drawings. The Contractor shall adopt all final agreed line-wide details and shall amend the setting out of all the interfacing structures, finishes and amend the internal layouts and furniture details as required prior to the calling of tender.
- 10.31.4      Upon award of the SWC tender, the Contractor shall work with the SWC for the design development, detailing and production of shop drawings of both the external envelope and internal layout to accommodate any line wide modifications required to the equipment, furniture and detailing of the PSC and SMR. The Contractor shall also work together with the SWC on finalising the interfacing and adjusting the concourse finishes as well as any re-routing of services as required.
- 10.31.5      The Contractor shall liaise and co-ordinate with the Operator and all the relevant appointed Contractors with equipment within the PSC on all aspects for the running of services, access and equipment mounting and to ensure proper termination when constructing the architectural finishes at the interface with the PSC and SMR.
- 10.31.6      The Contractor shall refer to **Clause 7** of the Particular Specification for the development and submission of CCSM drawings.

**10.32 Glass Cladding and Balustrade with Supports**

- 10.32.1 The Contractor shall be responsible for the design, supply and installation of glass cladding, glazing system, handrails, braille rail, and balustrade including the relevant authorities' submissions and approvals. The LED lighting design for handrails and balustrade shall be under Authority's appointed M&E Consultant. The supply and installation of LED lighting for handrails and balustrade shall be under SWC. The Contractor shall coordinate with Authority's appointed M&E Consultant and SWC for LED lighting for handrails and balustrade.
- 10.32.2 The Contractor shall engage a PE to complete the detailed design of framing systems for glass cladding and balustrades that comply with the LTA Civil Design Criteria (CDC) and LTA Materials & Workmanship Specification for Civil & Structural Works, and submit to the Engineer for acceptance.
- 10.32.3 The Contractor shall provide glazing systems that comply with the Authority's Design Criteria LTA Materials & Workmanship Specification for Civil & Structural Works and security design.
- 10.32.4 The Contractor shall be responsible for the completion of the detailed design, the supply and installation of all glazing and glass cladding; including verification of thicknesses as necessary for barrier use code compliance. Approvals from the relevant authorities shall be obtained for the design of the glazing and its support system.

**10.33 Cycling Path**

- 10.33.1 The Contractor shall design and construct cycling path within the contract limits for road works.
- 10.33.2 The Contractor shall refer to the tender drawings for the locations and minimum extent of the cycling path.
- 10.33.3 The Contractor shall work with relevant authorities/agencies to ensure that the cycling path and entrance infrastructure are well-integrated to provide convenient and seamless connectivity with the residential neighbourhood.
- 10.33.4 The design and construction of the cycling path shall include the structural, electrical and illuminance design works, foundation pipe laying for light fittings and fixtures, underground cables, electrical control boxes, light fittings and fixtures, all ancillary works and any necessary adjustment to the road side table.

- 10.33.5 The level of the cycling path within the Road Reserves shall be fully flushed with the side table and is to avoid all structures, i.e. covered linkways, lamp posts etc. Refer to **Appendix AN** of the Particular Specification.
- 10.33.6 The cycling path shall be constructed in accordance with the Standard Details of the Authority and the required Specifications (Materials & Workmanship Specification for Architectural Works, Section 240 – “Cementitious Toppings”). It shall be denoted by application of red “Coloured High Strength Coating System” over the concrete surface, with bicycle logos painted at regular intervals. The detailed design, material specification and construction of floor finishes, signage and lighting shall comply with the requirements of the relevant authorities. Where the information is inadequate, the Contractor shall ensure that due diligence is exercised to obtain the necessary information and to be coordinated with the relevant authorities, prior to construction.
- 10.33.7 The Contractor is to provide as-built construction drawings (in CAD format) for cycling paths to LTA’s Active Mobility Group two (2) months before the path is opened to the public. This is for the gazetting of the new cycling paths as Type 3 public paths. The Contractor is also to update and provide the built cycling path layer in a GIS-compatible format such as .shp file.
- 10.34 Service Boom**
  - 10.34.1 The Contractor shall carry out further coordination for all civil and structural design necessary, and to coordinate with SWC to incorporate mounting of fittings and equipment such as lighting, cameras, monitors, etc. The Contractor shall work with the Authority’s relevant departments to coordinate the placement of the service boom in relation to the fare-gates and station layout.
  - 10.34.2 In the development of the service boom design for installation, the Contractor shall preserve the design intent, including details such as finished dimensions, choice of materials and finishes. Any deviations shall be subject to acceptance of the Engineer.

**10.35 Commuter Facilities and Connectivity**

- 10.35.1 First and Last Mile (FLM) connectivity shall be provided to connect commuters between station entrances, commuter facilities and trip generating hubs. Design and construction of covered linkways and cycling paths shall extend from the station up to the first bus-stop, taxi stand, pick-up/drop-off point (PUDO) and/or the first junction. Notwithstanding that, the Contractor shall carry out further coordination with the Authority and other relevant authorities/agencies to determine the final extent and details of the FLM covered linkways and cycling paths (Refer to **Appendix AN** of the Particular Specification).
- 10.35.2 The Contractor shall design, coordinate and build all elements of FLM, including lighting, lightning protection and signage as required in the Works. All structural, electrical and illuminance design works, foundation pipe laying for light fittings and fixtures, underground cables, electrical control boxes, light fittings and fixtures, all ancillary works and any necessary adjustment to the road side table are deemed included in the scope of works. All coordination and changes arising from the coordination works are deemed included in the scope of the Works.
- 10.35.3 The FLM covered linkways and cycling paths are shown for reference in the Authority's Drawings. The Contractor shall make provisions for all Works to be constructed unless instructed otherwise by the Engineer. There are FLM covered linkways and cycling paths to be constructed by others beyond the Contract Limits. The Contractor shall make allowance for interfacing design with covered linkways and cycling paths (by others) beyond the Contract Limits.
- 10.35.4 The FLM covered linkways and cycling paths, shelters and their associated works, shall adhere to the guidelines, specification and details as stipulated by the Authority and **Appendix AN** of the Particular Specification. Where the guidelines and details do not apply, the Contractor shall propose a design for the works, which shall be subject to the Engineer's acceptance before construction.
- 10.35.5 Where existing works / facilities are affected by the proposed works, the Contractor shall make good all affected works to match the existing. The extent of the repair and/or reinstatement works shall be accepted by the Engineer. The final works shall be inspected, accepted and handed over to the relevant authorities and stakeholders.
- 10.35.6 The Contractor shall design the interface between the covered linkways, cycling paths, road crossings, connection to buildings and commuter facilities.

- 10.35.7 The Contractor shall coordinate with the relevant authorities to determine the final extent and details of the FLM covered linkways. The Contractor shall secure approval for their proposals, and if necessary, shall enhance the proposals as required to secure all necessary approvals from relevant authorities and departments of the Authority. All such additional provisions are deemed included in the Contract Price.
- 10.35.8 The Contractor shall obtain necessary approvals or letter of no objection from all relevant LTA departments involved. Once all comments have been cleared and approvals obtained from each department, the Contractor shall submit a set of drawings to LTA Commuter Infrastructure department together with other departments' approvals for their review. Finally, Contractor will submit Commuter Facilities drawings and departments' approvals to the Engineer for final acceptance.
- 10.35.9 Commuter facilities namely bus stops, taxi stands pick-up/drop off points (PUDO) and at grade bicycle parking, shall be provided close to the station, connected to the nearest entrances with typically 3.6m width covered link ways. High covered shelters shall be provided over the bus, taxi bays, PUDO and access roads to developments. The contractor shall propose a suitable interface between covered linkways of varying widths to allow a smooth flow of pedestrian and cyclist movement.
- 10.35.9.1 The land-take requirements for First-and-Last-Mile (FLM) programme, road realignment, station entrances and working area required for construction have been pre-consulted with Urban Redevelopment Authority (URA), and other authorities. The extent of construction and layouts has been provided to the relevant authority agencies. The Contractor shall undertake further liaison, submissions and coordination to finalise the land take requirement with all relevant authorities and stakeholders. This includes reviewing sub-standard commuter infrastructure (including footpath, cycling path and covered linkway) to achieve the required standard where possible. Proposed changes / improvements shall be achieved within the approved road reserve. Any changes would require the regularisation of the approved road reserve from the previous FPA.
- 10.35.9.2 Bicycle parking
- (a) The bicycle lots shown in the Authority's drawings are for reference only. Bicycle parking area shall be provided at every station entrance. The Contractor shall develop the design to provide a total of 550 nos. of bicycle parking lots within the Railway Area for CR16.

- (b) If the total number of bicycle lots provided within Railway Area do not meet LTA AMG's bicycle parking provision requirement, the Contractor shall design and construct the remaining lots at the additional land, that are on state land within/adjoining to the railway area/RRL, which would be secured by the Authority in order to meet the numbers of bicycle lots required, with the Contractor's assistance in preparing the MPC submission. The design and construction of the bicycle lots and the areas, whether these are on state land within/adjoining to the railway area/RRL or otherwise shall be deemed included in the Contract Price. The Contractor shall submit the proposed bicycle parking layout for approval by the relevant agencies and the acceptance of the Engineer. The Contractor shall handover the bicycle lots to the relevant maintenance party.
- (c) The Contractor shall consult and make the necessary submissions to LTA's Active Mobility Group (AMG) and Public Transport Safety (PTS) to comply with their requirements and obtain their acceptance.
- (d) The Contractor shall work with LTA AMG, the relevant authority agencies to ensure that the overall bicycle parking provision is sufficient to serve the location and the surrounding developments.
- (e) The Contractor shall conform to AMG's requirements on the U Bar types of bicycle rack to be used at each exit; all such provisions shall be deemed included in the Contract Price.
- (f) The Contractor shall furnish details and arrange for the fabrication and installation of the unique QR code sticker/plate as part of the geo-fencing requirement to LTA\_AMU\_Registry@lta.gov.sg, two (2) months before completion of bicycle parking lots in public areas.
- (g) Bicycle parking directional signage and bicycle parking maps shall be installed within station boundary to direct cyclists to bicycle parking locations. The Contractor shall refer to **Appendix AP** of the Particular Specification on the requirements of the bicycle parking directional signage and bicycle parking maps (design and dimensions subjected to changes). The Contractor shall take reference to Authority's latest design of signage and maps.

- (h) The Contractor is to submit the locality map with the existing and planned cycling path within 400-600m radius as well as new cycling paths implemented within the contract scope following the guidelines stipulated in the Transit Signage Manual 1.
- (i) The Contractor shall conform to the requirements of other departments of the Authority for all provisions associated with bicycle parking.
- (j) The Contractor shall liaise with the Authority and all relevant authorities, including the preparation of drawings necessary for submission to the Master Plan Committee (MPC), including furnishing details of the proposed commuter facilities and road scheme, to regularise the railway boundary, road reserve and affected areas, if there are changes to the approved boundary and to submit these revised road plans for approval.

#### **10.36 Commuter Facilities Signage**

- 10.36.1 Information panels for bus stops, taxi stands and drop off/pick up shelters are to be compliant with the standard details of the LTA. The Contractor shall make all necessary submissions to Commuter and Road Infrastructure to determine signage requirements to bus stop, taxi stand and PUDO's (or combinations thereof).
- 10.36.2 Shelter road height limit signs shall be provided with minimum 3 chains such that failure of one does not result in free-swinging sign.
- 10.36.3 Signage shall be coordinated and integrated with the station design.
- 10.36.4 The Contractor shall, at all appropriate/relevant stages of the design development process, present the signage proposal for review at meetings, design reviews or forums as requested by the Authority.

#### **10.37 Design Submission Requirements**

- 10.37.1 The Contractor shall comply with the M&W Specification (Architectural) requirements and any further requirements for submission of the Contractor's design development and construction documentation.



- 10.37.2 The Contractor's key design personnel, including architectural staff and other persons producing/ coordinating or reviewing for quality assurance purposes Design Acceptance Request (DAR) submissions prior to issuance to the Engineer, and the Contractor's BIM team shall arrange and meet with the Engineer at the commencement of the Project. The purpose is to discuss the process and procedures for progressing design submissions, minimum quality standards, proposed drawing list and level of detail and scale for the submissions and frequency of updating, including BIM models, to the Engineer's requirements and acceptance. The Contractor shall explain his intended drawing office procedures including his processes for CAD/BIM quality control. The Engineer may require modification of the Contractor's procedures and processes to facilitate use and exchange of CAD & BIM data with the Interfacing Contractors.
- 10.37.3 Where required, the Contractor shall submit accurate 3-dimensional models and perspective views, isometrics or axonometric of modelled interfaces, at a scale and level of detail as agreed with the Engineer.
- 10.37.4 The Contractor shall submit to the Engineer, designs, general layout, detailed drawings, specifications and other technical documents, calculations, schematics, programmes, samples, CAD/BIM data and models, etc. in a timely manner allowing for Engineer's review time and any resubmissions that may be necessary. The Contractor shall be responsible for the completeness of the information for each submission and its consistency against other submissions and approved developed designs. The Authority shall not be liable for any delays by the Contractor due to non-approval of submissions, nor shall the Engineer be obliged to reduce his DAR process period due to the Contractor or SWC having made late submissions in relation to site works progress.
- 10.37.5 The Contractor shall make separate DAR submissions for the station, unless otherwise agreed by the Engineer, including for Materials and Method Statements. The Contractor shall not assume that acceptance of a DAR for one station obviates the requirement to submit for the other.
- 10.37.6 At each milestone submission, the Contractor shall submit a table documenting the compliance and/or deviation of the station design, detailing and provisions from the M&W specification (Architectural) and the Authority's Design Criteria

- 10.37.7 Approval of any Contractor's submission or BIM model does not constitute a complete check, but indicates only that the design concept, general method of construction and detailing are satisfactory. Approval by the Engineer does not imply that the Contractor is permitted to deviate from the Contract requirements and does not relieve the Contractor of the responsibility for errors in dimensions, details, size of member, etc., of for coordinating installation and construction with actual conditions of the Works.
- 10.37.8 Any 'Approved with Comments/ No Resubmission required' or similar response to a DAR submission does not alleviate the Contractor from the need to update the drawings to address all remaining comments prior to their use in procuring/ fabricating/ constructing or installing the works described in the DAR submission.
- 10.37.9 The Contractor shall ensure that only "Approved" copies of drawings bearing the approval of the Engineer and addressing all comments made are allowed to be issued for fabrication or on site.
- 10.38 Architectural Mock-Ups**
- 10.38.1 The Contractor is required to submit mock-ups for the key components to the Engineer for acceptance before procurement and installation. The Contractor shall make full allowance for time required for review/ approvals of mock-ups and procurement in his programme such that Works can be carried out in a timely manner to meet the stipulated contractual key dates. Refinement of mock-ups might be required and Contractor shall make due allowance in his programme for resubmissions.
- 10.38.2 The Contractor shall provide for programme, milestone dates for mockups, procurement, delivery, installation of all necessary items for the timely completion of the Works and to be accepted by the Engineer.
- 10.38.3 The required mock-ups, but not limited to, in **Table 10.3** below shall be done with reference to the Contractor's detail drawings and M&W Specification. The Contractor shall make provisions for mock-ups to be provided for in at least 2 stages:
- (a) Off-site at site office or at factory; and
  - (b) On-site actual full mock up
- 10.38.4 The locations, programme, timeline for installing and reviewing the mock-ups, shall be proposed by the Contractor to the Engineer's acceptance.

- 10.38.5 The Contractor shall refer to the general list of Mock-ups in the Materials & Workmanship Specification for Architectural Works, Section 20. The list of additional Mock-ups required in the **Table 10.3** below is not exhaustive and any special features proposed by the Contractor shall be provided with Mock-ups as required by the Engineer. The Contractor shall note the mock-ups required under the APS sub-contract are also mentioned in the **Table 10.3** below and is required to provide the necessary attendance and provisions for the facilitation of APS mock-ups. Where a set of mock up is indicated in **Table 10.3** below, the Contractor shall ensure provision of at least 3m continuous extent of mock-up provision.

**Table 10.3 - Listing of Architectural Mock-Ups**

S/No	Mock-ups	Quantity/Extent
By Civil Contractor		
1	Service boom	1 no. full set of service boom prototype, showing mounting position in relation with fare-gates, incorporating cable supports, and all required fixtures and services, such as lighting, signage, speakers, cables, VSS, PIDS.
2	All Male/Female Toilets, Accessible Washroom and Family Washroom, including all finishes & sanitary provisions	1 full set of each amenity completed and comprising of vanity counter, basin and fittings, mirrors, WC cubicle partition systems, urinal grab bars, furniture, with floor, wall & ceiling finishes.
3	Baby Care Room	1 full set of completed lactation room comprising of vanity counter, all fittings and fixtures, furniture, doors, with floor, wall and ceiling finishes.
4	Changing Room	1 full set of completed changing place room comprising of all fittings and fixtures, furniture, doors, with floor, wall and ceiling finishes.
5	Ticketing Service Centre (only where applicable)	1 set of mock-up for each location at floor, wall, ceiling and external shell

S/No	Mock-ups	Quantity/Extent
By APS		
1	All key interior and exterior finishes	1 set of mock-up for each key area, incorporating floor, wall, ceiling finishes, including all visible services
2	Station entrances	1 set of mock-up incorporating floor, ceiling finishes, balustrade, glass louvres, windows, ventilation screens/ mesh
3	Façades and roofs of at-grade exits and ancillary structures	<p>The mock-up shall enable the review of both the façade and roofing holistically, showing adjoining interfaces of all components.</p> <p>(a) 1 full set of mock-up completed incorporating entire façade cladding systems and cladding supports, glass panels, perimeter planting trough, wall cladding panels, rain-screen panels, security screen, louvers (including performance and aesthetic louvers).</p> <p>(b) 1 full set of mock-up completed incorporating of roofing materials, fall restraint system, skylights (where applicable), inclusive of proprietary fixings to structures of exits. (Contractor shall install all structures including any proprietary roof supporting system.)</p>

<b>S/No</b>	<b>Mock-ups</b>	<b>Quantity/Extent</b>
4	At-grade commuter facilities (covered linkway, extended canopy integrated with station exits)	<p>1 set of mock-up showing interfacing of these adjoining components, including fall-restraint system, down-hang, rain-screen and drop panels, structural columns, integration of fittings and services such as lighting fixtures and lightning provisions.</p> <p>The mock-up of the extended canopy which is integrated with the station exit shall be installed in conjunction with the station façade to enable a holistic review with the station exit exterior facade.</p>
5	Integrated Cabinet and maintenance access panels along balustrades at platform level	1 set of mock-up incorporating maintenance access panels, cabinets to house each emergency/ fire service equipment such as fire extinguisher, emergency stop plunger, fire phone, SCDF closet, AED, etc.
6	Glass Lift Shaft serving platform and concourse	1 set of mock-up of the front wall including the return corners and side walls, including the interface with ceiling finishes around the lifts.
7	Lift shaft at station entrances	1 set of mock-up of the front wall including the return corners and side walls, external wall and roofing finishes.
8	Security Screen between Paid and Unpaid areas	1 set of mock-up for minimally 2 bays
9	Typical handrail and balustrades	1 set of mock-up for each type of handrail and balustrade, including each different interfacing details, including that with escalators, staircases and wall cladding panels.

S/No	Mock-ups	Quantity/Extent
10	Coordinated bulkhead above platform screen doors	1 set of mock-up showing the coordinated services above the platform screen doors, including lighting, signage, CCTV, speakers, diffusers, etc
11	Privacy Screen	1 set of mock-up
12	Signage including integrated service pole	1 no. per type
13	Platform Seats	1 no. per type

### **10.39 Provision of Art-in-Transit Programme**

- 10.39.1 This Clause is for the provision of Art-in-Transit Programme by the Contractor.
- 10.39.2 The Contractor shall liaise, coordinate and provide all necessary provisions for interfacing with the Authority for the details of all aspects of Art in Transit Programme Works. Thereafter, the supply, fabrication, delivery, installation and construction of the same, shall be via an Artwork sub-contract to be prepared and called by the Contractor in accordance with the Authority's Requirements.
- 10.39.3 The Contractor is required to enter into Sub-Contract(s) with the successful Artwork tenderer(s).
- 10.39.4 The artwork shall be integrated as part of the station design, within the architectural detailing and finishes. The Contractor shall:
- Designate within the station design a dedicated and prominent space, or spaces, for station artworks;
  - Coordinate, attend meetings and work with the station artists and curators appointed by the Authority, and integrate the approved artworks into the station architectural finishes as appropriate;
  - Coordinate the artwork with the architectural design and selection of materials and finishes;

- (d) Provide all necessary technical information including but not limited to adequacy of proposed materials, installation details, loading requirements and shall highlight any deficiency to be mitigated for the successful implementation of the approved artworks;
  - (e) Provide budgetary estimates for the station artworks at various milestones; i.e. Concept, Design Development and Final Artwork, to ensure artworks are within the allocated budget prior to tender calling;
  - (f) Provide tender documentation, including technical specifications for calling of Artwork sub-contract including the production, fabrication and installation of the artworks;
  - (g) Implement the production, fabrication and installation of the artwork to the acceptance of the Engineer; and
  - (h) Ensure the artwork is installed according to the approved design.
- 10.39.5 The design of artwork shall be carried out by the artist(s) appointed by the Authority. The Artwork sub-contractor shall produce the artwork in the medium to be advised by the Authority.
- 10.39.6 The Artwork sub-contractor shall produce shop drawings, material samples and mock-ups of the artwork for Artist's and the Engineer's acceptance prior to production, fabrication and installation. The samples and mock-ups shall show the texture, colour, material, quality of the final product and fixing method. The samples shall consist of three (3) nos. of 300x300mm panels, and the mock-ups shall consist of two (2) nos. of full-size panels (actual size subject to acceptance by the Engineer) or as appropriate. The production, fabrication and installation of the artwork shall be carried out by the Artwork sub-contractor.
- 10.39.7 The warranty for the artwork shall be consistent with the warranty for the architectural finishes, subject to a minimum period of ten (10) years.