Section 2
ARCHITECTURAL DESIGN REQUIREMENTS

Architectural Design Requirements

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1 OBJECTIVES

1.1 General

Land transport facilities are intended for the people of Singapore and shall be representative of their sophistication, dignity and achievements.

The Authority has determined a set of design objectives for these which designers are required to meet.

Other design objectives may be required to suit the needs of particular locations.

1.2 Architectural aims

The design shall be appropriate to the local context; simple and clear in plan, section and detail and employ materials and colours suited to the function of the facility.

Designers shall explore volume, proportion, colour, materials, lighting, and contrast to enhance the user's appreciation of the facility.

The Designer shall consider the scale and character of the surrounding urban fabric in designing above ground structures.

The Designer shall consider where-ever possible to providing unique design features within an individual facility in order to promote ease of identification particularly at station platforms along a single line.

1.3 Clarity and simplicity

Efficient use shall be made of space. Designers shall ensure that facilities are planned to reinforce the recognition of pathway, destination and function. The designer shall maximise views between levels particularly at locations leading to vertical circulation elements. Backtracking and changes of direction shall be minimised where possible with the aim of ensuring a direct line of sight in pedestrian flow and the safety of the travelling public.

Structural solutions should optimise use and visual clarity of the space. Columns, where necessary, shall be co-ordinated with the vehicle module to minimise visual and physical interuptions.

Signage shall be incorporated as an aid in wayfinding.

1.4 Buildability

The designer is encouraged to explore innovative solutions to determine the most appropriate building systems and products to be used to meet the statutory buildability requirements.

Through the use of repetitive grids, connection details and prefabricated components, the designer shall aim to achieve faster construction and improvements in quality.

1.5 Integration with commercial or other facilities

The primary purpose of transport facilities shall not be compromised through the introduction of commercial or other facilities. Where provided, these shall not result in congestion, confusion or disorientation.

Where future development will be located above transport facilities, designers shall provide the optimum structural grid for the development without compromising public safety, movement, organisational clarity, simplicity, or visibility in the facility.

1.6 Existing Infrastructure

Proposed modifications shall seek to maintain the existing character of the affected transit facility with significant design elements being identified prior to concept design through the preparation of Heritage Reports.

A Heritage Report is to be submitted for approval by the Authority. It shall contain, but not be limited to, the following:

- Identification of significant elements of the affected facility, such as iconic architecture, double height volumes, and small but locally significant details such as colour schemes
- Discussion of how the identified heritage elements may be integrated into the proposed design.
- Drawings and images to convey the above.

1.7 Future Expansion

Transport facilities shall be planned to accommodate future increases in passenger numbers and integration with future developments.

1.8 Legislation

Transport facilities shall be designed to comply with the laws and regulations of the Republic of Singapore.

2 ACCESSIBILITY

2.1 Pedestrian Access

Designers shall ensure that transport facilities :

- Are in accordance with the Building Control Regulations
- Are accessible to people with disabilities in accordance with the current edition of the Code on Accessibility in the Built Environment.
- Are modally integrated.
- Have a clear sequence of spaces each indicative of their function.
- Are designed in accordance with the principles outlined in the Guidelines for Enhanced Building Security by MHA

Designers shall ensure that stations are accessible according to the Guide to the layout of the tactile Guidance System in MRT and LRT Stations.

Each transport facility building shall have at least one designated barrier free route leading into the building and linking to all possible passenger destinations within the building in compliance with the Code on Accessibility in the Built Environment.

All disabled access routes into the transport facilities shall, where possible, be via the main entrance.

Application of multiple barrier free routes shall be considered for transport facilities with multiple major passenger flow routes.

Doors astride the tactile route shall be automatic or permanently fixed open. Automatic doors shall be sliding in preference to swing doors.

All doors accessed by the public shall require a maximum force of 22N to open or close.

Any straight portion of an underground paid link between two MRT Stations which is 75m or greater in length shall include 2 travelators covering at least two thirds the distance unless otherwise agreed with the Authority.

2.2 Congestion

2.2.1 General

Congestion modeling shall be carried out for all transport facilities with public areas as part of the preliminary design. Simulations shall be carried out for all critical areas as and when-ever required.

All congestion modeling, simulations and calculations shall be based on projected passenger figures, any ultimate pedestrian numbers as provided by the Authority or site survey data weighted to suit future site loadings to the approval of the Authority. Reassessments shall be undertaken given any significant changes to a design or projected passenger numbers.

Simulations and modeling shall be carried out for both the peak evening and morning hours or any other critical period as advised by the Authority. Within the peak hours being simulated a peak within the peak shall be include by introducing a 1.3 weighting to the central 20 minutes of the simulated hour.

Designers shall assess predicted passenger movement, capacities and waiting times at circulation elements during peak operations.

Designers shall ensure and demonstrate clear widths leading to all transport facilities allow uncongested access during peak operations.

Station designers shall demonstrate that platforms can be cleared prior to the arrival of the next train during normal peak operations.

The practical capacity per escalator, staircase and fare gate shall be based on the following:

- Escalators : 7200 passenger per hour (based on standard 1m wide, 0.75m/s transit escalator)
- Staircases : 3600 passengers per metre clear width per hour
- Fare gates : 2400 passengers per hour

The designer shall include a 10% deduction in the practical capacity as a factor of safety.

The quantity of both escalators and fare gates shall be defined by the designer to meet the projected patronage figures. Future expansion of escalators and fare gates shall be included in the design to cater for future projected changes in demand. Facilities for the delivery, installation of such elements shall be allowed for and highlighted in the design.

2.2.2 Simulation

A congestion simulation and pedestrian flow analysis, using pedestrian simulation software, shall be provided as part of the congestion modelling within and leading to any MRT station interchange, bus interchange or at critical areas where potential crowding is identified in the modelling or as required by the Authority

The scope, assumptions and calibration of the simulation shall be proposed in consultation with the Authority. The simulation shall be customised to reflect the influence of surrounding developments,

future linkages, availability of holding area, escalator speeds, local preferences to use lifts/ staircases, local walking speeds, etc.

The influence of walls, balustrades or other obstructions shall be considered in the simulation by the inclusion of a 0.3 metre zone beyond the obstruction were there is no pedestrian movement.

The influence of shops alongside access routes shall be considered in the simulation by the inclusion of a 1 metre zone beyond the shop front were there is no pedestrian movement.

The influence of waiting and queuing areas such as for ticket machines or other vending machines shall be allowed for to the approval of the Authority.

The simulation shall include any interfacing station or bus interchanges (both existing and under construction) and make allowance for all trains and pedestrian movements within the completed interchange. Recommendations for retrofitting measures within the existing infrastructure shall be included in the report.

The scope of the study shall include allowance for redundancy in the provision of escalators. Multiple scenarios shall be simulated and reported in which any one escalator is unavailable to cater for overhaul (Can't be used as a staircase).

2.2.3 Level of Service (LOS)

The Level of Service (LOS) shall be included as one of the pedestrian simulation outputs.

LOS ranges shall be as defined by J.J.Fruin (Pedestrian Planning and Design) and attached below;

Level of Service (LOS)	Density (m^2/Pedestrian)		
	Circulation Spaces	Staircases	Waiting Areas
A	> 3.3	> 1.9	> 1.2
B	2.3 - 3.3	1.4 – 1.9	0.9 – 1.2
C	1.4 – 2.3	0.9 – 1.4	0.7 – 0.9
D	0.9 – 1.4	0.7 – 0.9	0.3 – 0.7
E	0.5 – 0.9	0.4 – 0.7	0.2 – 0.3
F	< 0.5	< 0.4	< 0.2

Maximum LOS (per minute of the simulation):

- Corridors linking two transport facilities with no commercial facilities, transit facilities (eg ticket machines) or information signage on either side, includes no waiting areas, meeting areas or decision points and where there is only bidirectional flow (ie no cross flow) – shall not exceed LOS D. Time spent at LOS D may only be periodic across the peak period and shall be presented for the approval of the Authority.
- All other locations – shall not exceed LOS C.

2.3 Service Access

One access shall be provided for maintenance and/or refuse collection vehicles. A maintenance parking space shall be provided adjacent to an entrance containing a lift from concourse to street level and to the bin centre/point. Alternative access provisions may be proposed if seriously constrained by space

An additional loading and unloading bay shall be provided for facilities with a shopping level. This bay shall also be adjacent to an entrance containing a lift from concourse to street level.

Unsecured Service Access shall never be positioned below transport facility structure.

2.4 Emergency Access

See 'Public Safety' Section.

2.5 Equipment Access

2.5.1 General

Access shall be considered for any replacement of equipment and plant. This shall include allowance for clear door openings, access hatches, clear corridor passageways, demountable panels, hoisting facilities, additional equipment loads affecting structural members along the access route and anything else as identified in co-ordination with the equipment suppliers and Contractor.

Knock-out panels for equipment access are not acceptable.

Roller shutters are not acceptable for access in any trackside environment due to pressure variations causing the shutter to rattle.

Clear access paths from the equipment entry point to their installation point of an appropriate clear width, height and turning radiuses shall be provided. Clear corridor and door widths and heights shall be provided to accommodate all future foreseen equipment removal and installation.

2.5.2 Underground Stations

In general equipment access to the station concourse level is gained through a hatch from the trackway. This may be directly into the TVF Rooms if they are located at each end of the station above the trackway. Otherwise the access hatch may open into an alternative space and movement of the equipment to the TVF and other ancillary rooms shall be determined accordingly.

Access may also be provided by use of a shaft from the ground level.

Any access hatches from the trackway shall open directly above the station trackway and hoisting beams shall be provided at the soffit of the floor above, over the access hatch openings, to facilitate the transfer of equipment. The access hatch opening shall align with the track and shall not infringe into the buffer areas. The location of access hatches shall take into consideration the required circulation space around the opening for working and escape.

2.6 Cyclist Access

A bicycle parking area shall be provided as required. The Bicycle Parking shall not be provided within road reserve unless subject to Authorities approval.

There shall be no bicycle parking lots within 5m from any glazing entrance structure.

2.7 Taxi / Drop-off Access

Any taxi-stand and passenger drop-off points serving a particular transport facility shall be positioned as close as is feasible, given site constraints, to the designated disabled access entrance.

2.8 Access into future developments

Provision of knock-out panel for future development directly linking to the transport facility shall be considered. This future access shall be provided with sufficient space to allow for erection of hoarding and working in future.

3 PUBLIC SAFETY

3.1 General

Transport facilities shall be designed to assure all users that they are in a safe environment.

3.2 Fire

Monitoring devices, alarms, fire detection and suppression equipment shall be integrated into the facility as required by the current E&M Criteria.

Where transport facilities are integrated into other developments, they shall be provided with unique escape provisions.

Routes of escape shall be along main circulation routes rather than designated escape staircases where-ever possible.

All fire safety provisions in the Rapid Transit System shall be designed according to the requirements of the 'Standard for Fire Safety in Rapid Transit Systems'.

All fire safety provisions in other facilities, such as bus interchanges and depots, shall be designed according to the requirements of the Code of Practice for Fire Precautions in Buildings.

Dry powder extinguishers shall be used as the primary extinguisher for fighting all class of fire hazards. The extinguishers shall be distributed in compliance with the coverage and reach requirements under SS578 and located in common areas such as service corridors and public area where-ever possible. Should the reach from common areas not be sufficient, additional extinguishers at prominent locations within the rooms can also be provided.

Each room defined as an 'Electrical Room' shall be provided with a carbon dioxide or clean agent type extinguisher near the doorway within the room, the Carbon Dioxide or Clean gas agent extinguisher may, where certified, be used to supplement the coverage against class A and B fire hazards within the room.. For the Passenger Service Centre(PSC)/SMR a dry powder and carbon dioxide/clean agent type extinguisher shall be provided prominently shared within the rooms.

All fire extinguishers in public areas, PSC and TSO shall be recessed within the wall cladding/ furniture. Where extinguishers are required to be installed exposed (i.e. non-recessed) within public areas, they shall be housed within stainless steel cabinets with glass frontage. Fire extinguishers in non-public areas shall be installed exposed without cabinets.

3.3 Station Means of Escape

Station means of escape shall be provided as required in the Standard for Fire Safety in Rapid Transit Systems. In addition, it must be demonstrated that the means of escape provided are also able to meet future demand based on the optimum Station Occupant Load calculated as follows:

Optimum Station Occupant Load = 1 Crush Train Load for the peak direction + 1 Peak Train Load for each non-peak direction + Entraining Load of platform(s) based on occupant density of $0.9m^2$/pax

3.4 Emergency Access

Emergency access shall be provided in accordance with the requirements of the current edition of the Standard for Fire Safety in Rapid Transit Systems and the Code of Practice for Fire Precautions in Buildings.

3.5 Handrails and Railings

Barriers shall be provided at all abrupt changes of level greater than 450mm accessible to the public including at public area staircases and landings. These barriers shall be a minimum of 1.1m overall height measured vertically from the adjacent finished floor level or pitch line of a flight of stairs to the top of the highest continuous horizontal member.

All public area staircases shall include two handrails (one standard and one child) on both sides at 900mm and 700mm measured vertically from the pitch line of the staircase to the top of the handrail.

The design of railings terminating at an escalator shall be integrated and consistent with any escalator handrail. A proper interfacing detail is required to close the gap between both.

The fixing bracket to any handrail shall be on the underside and shall not impede the hand hold along the whole length of the railing.

Refer to the Civil Design Criteria Chapter 3 for requirements relating to live loads at handrailing and balustrades.

Handrails at ramps shall be continuous throughout the entire length (including beside any intermediate landings).

The clear width of a staircase shall be measured from the outside edge of the wall or balustrade and shall be clear of all projections except handrails which shall protrude no more than 105mm from the wall of balustrade.

Handrails and grab bars on the accessible route shall contrast with the colour of its background to aid visibility.

Central handrails on staircases shall break across all intermediate landings which have at least 1500mm depth as long as the central handrail extends 300mm into the landing at both ends (refer below for required handrail ends) leaving a clearance of at least 900mm. Side handrails shall be continuous across intermediate landings

Handrails ends shall turn down or return to the wall or balustrade with no open end.

3.6 Slipping and trip hazards

The choice of floor finishes shall comply with the current edition of any Singapore Standard (SS) 485 'Slip Resistance Classification of Public Pedestrian Surface Materials'.

The following classification shall apply for the purposes of assessment in table E.1. of SS 485.

Facility area	Description in Standard
External paving, bus shelters	External colonade, walkways and pedestrian crossings.
External ramps	External ramps
Station entrances	External foyers hotel, office, public building
Internal ramps	Internal ramps
Lift lobbies below ground	Lift lobbies above external entry level
Toilets	Toilet facilities in offices, hotels, shopping centres
Underpasses, subways and passages	Undercover concourse areas of sports stadium
Bus interchange concourse	Undercover concourse areas of sports stadium
Station concourse	Shopping Centre excluding food court
Station platform	Shopping Centre excluding food court
Stair treads	External stair nosings

Trip hazards shall be avoided.

Where two floor materials meet, the floor shall be level across the junction to avoid any trip hazard.

Single risers at changes of level shall be avoided. There shall be a minimum of three.

All steps shall be fitted with non-slip grooved colour contrasting nosing tiles between 50mm and 65mm in width.

Rubber nosing strips, and metal inserts are not acceptable for both internal and external staircases.

All external stair treads shall be well drained to prevent water from ponding on the tread.

3.7 Avoidance of obstructions

Obstructions within public spaces shall be avoided in compliance with current edition of the Code on Accessibility in the Built Environment.

Wall mounted furniture and components, including handrail extensions, shall be located to minimise intrusion into the pedestrian flow areas.

3.8 Avoidance of Hazards

Lighting shall be provided in accordance with the requirements of the Room Data Sheets and Commuter Facility Check Lists. Areas of shadow shall be avoided and lighting shall be evenly spread particularly along ramps.

Clear line of sight shall be maintained as far as possible with an avoidance of recesses, hidden corners, and visual obstructions.

Sharp edges or corners shall be avoided**.**

Rough textured and reflective wall finishes shall be avoided where people come into contact with it.

Upstands shall be provided at the sides of all drops to prevent items rolling down and landing on people below.

Doors swinging out into the public area shall be avoided particularly across defined pedestrian routes.

Freestanding elements such as seats, signboards, art pieces shall not be positioned in circulation areas or pathways.

3.9 Road Safety

There shall be no shared routes between pedestrians and moving vehicles at all surface structures.

Kerb ramps shall not project into the road.

Pedestrian routes shall not pass behind reversing vehicles.

The lateral clearance between the outer edge of the road kerb and any element shall be minimum 0.6m.

3.10 Public Health

Adequate drainage and falls shall be provided to eliminate any possibility of ponding water adjacent to surface structures.

Anti-mosquito measures shall be taken in accordance with the requirements of ENV.

3.11 Weather Protection

Refer to *Weather Protection* Section

3.12 Visual Contrast

In general visual contrast for visibility of elements shall be attained by having a minimum of 30% luminance or brightness contrast. The use of colour contrast may also be used subject to the approval of the Authority. Ideally any contrasting colours used to distinguish elements for the visual impaired shall also have 30% brightness contrast.

Tactile warning tiles and tactile route indicators shall have 50% luminance or brightness contrast either between the studs and the floor tiles or the floor tiles with tactile and surrounding floor finishes.

Seats, sanitary fittings in the disabled toilet, grab bars, door handles, railings, end panels to phone booths and any elements used by the public shall contrast in colour or tone from their surroundings.

If an obstruction is inevitable it shall contrast with its surroundings.

The wall and floor in the public area shall use contrasting finishes.

There shall be a permanent tonal contrast between treads and nosing for all steps.

A detectable warning surface shall be provided across the entire width and offset by 300mm from the top and bottom of any ramp or staircase as defined by the Code on Accessibility in the Built Environment.

The detectable warning surface shall be using a material with colour contrast and different texture to the surrounding floor finishes, tripping hazard and slip resistance shall be addressed to the satisfaction of the Authority.

Colour contrast shall be provided at the intermediate landings of ramps and staircases, in lieu of detectable warning surface, as long as the intermediate landing is with a continuous handrail or does not lead to another path of travel.

The detectable warning surface shall be 600mm deep for staircases and shall be either 300 or 600mm deep for ramps depending on how it ties in with any adjoining staircase.

Should the ramp or staircase form part of the tactile route a 300mm deep tactile warning strips (studs) shall be used as the detectable warning surface. Tactile routes shall terminate at the top/bottom of the ramp at the tactile warning strip. The termination shall be kept 600mm off to the side of the same handrail.

4 VERTICAL CIRCULATION

4.1 General

Vertical circulation constitutes a major feature in the design of an underground or elevated transport systems.

4.2 Provision

Designers shall demonstrate that the provision of vertical circulation elements complies with the requirements of the current edition of the Standard for Fire Safety in Rapid Transit Systems and the Code of Practice for Fire Precautions in Buildings.

Designers shall also demonstrate that the provision of vertical circulation elements satisfies the time required to clear the public areas to avoid congestion.

The area occupied by vertical circulation elements shall not impinge on the circulation and waiting areas in peak conditions.

Vertical circulation elements shall be located to provide balanced distribution and facilitate convenient exiting of passengers within the transport facility.

Vertical circulation elements comprising stairs, escalators and lifts shall be provided to suit the demand needs of the facility.

Where transport facilities are integrated into other developments, vertical circulation requirements of the facilities shall be calculated separately from those provided in the integrated development.

All changes in level on Barrier free routes shall be addressed via use of passenger lifts or ramps.

4.3 Stairs and Ramps

All stairs and ramps shall as a minimum be in compliance with the Building Control Regulations and Code on Accessibility in the Built Environment.

Regarding the requirement for maximum 150mm riser and 300mm treads

- Commuter facilities fitted with lifts and escalators, and within Transport Facilities fitted with lifts between all levels: staircase gradient shall match any adjoining escalator or 30 degrees
- All other Commuter Facilities, and at Transport Facilities between street level and entrance (flood protection) level : comply with Code on Accessibility in the Built Environment

Landings for ramps and staircases shall be free from obstructions.

All ramps used as the public disabled access route into a transport facility shall be 1800mm clear width.

4.4 Escalators

Escalators shall be the primary means of moving passengers vertically within a station and bus interchanges integrated with developments.

Stairs shall be provided as an alternative to escalators.

Escalators should be grouped with stairs so that reverse peak flows can be accommodated from the same loading point. Staircase projection beyond the escalator length is to be avoided.

At transfer between transport facilities or nodes, escalators shall be provided between different platform and concourse levels in accordance with the projected passenger transfer figures**.**

For provision of escalators at commuter facilities refer to the commuter facilities checklists.

Specific maintenance access facilities shall be integrated within the ceiling/ wall finishes and highlighted in the maintenance strategy report wherever there are services or finishes more than 3 metres above any bank of 2 or more escalators, or where an escalator has no adjoining staircase.

There should be no protrusion within 300mm of the outer edge of the escalator handrail apart from any balustrade.

4.5 Lifts

Lifts shall be provided to ensure barrier free access to and between differing levels within a transport facility.

Designers shall consider the visual impact of a lift shaft within the transport facility. Barrier free accessible lifts shall open to a lift lobby space to allow for circulation of wheel chair bound commuters.

A minimum of 1 lift shall be provided from every entrance into the facility.

2 lifts shall be provided between each public accessible level and to each platform.

Where the lift is required as the main facility for vertical circulation, and not just to provide barrier free access, additional capacity shall be accommodated by increasing the size, providing multiple lifts and providing independent entry and exit doors at each level.

The lift door jamb shall be flush with the adjoining wall finishes and shall be co-ordinated as consistent across all facilities covered under the same lift supply contract. The number of variants in the depth to cater for different shaft types should be agreed at an early stage in the design process.

4.6 Numbering and Naming Levels

Level numbering and naming shall be determined and agreed with the Authority at the initial stage of design and shall consider both labelling during construction and the labelling for operation, including signage.

4.6.1 Level Numbering

Allocation of level numbers to basements and floors follow the standard practice for Singapore. Grade or Ground floor is Numbered '01', one floor above ground is Numbered '02', Basement 1 is 'B1', Basement 2 is 'B2' etc.

A level is distinguished by having spaces which are independent to those above or below. If a space is attached to spaces above or below, the space is considered part of the adjoining level. Cable chambers, ceiling access voids, landings, staircase transfers and underplatform spaces are considered part of the adjoining level and are identified on plan not by different level numbers but by different sublevel names.

Levels are not necessarily only those accessible by the public but may be for the housing of plant or other services. This would be represented by a two or more jump in the public areas level numbering.

If there is a planned or existing adjoining development which has established levels. The same numbering shall be carried across into the station at the equivalent levels. This will avoid complications in signage at later stages.

4.6.2 Level Naming

The Level Names shall compose of three components;

- Firstly the term 'Level'
- Secondly the level number: '01', '02', 'B1', 'B2' etc.
- Thirdly a level or sublevel name.

Some levels may need to be identified at several different heights/depths due to the overlap of different compartments within the same level number (eg. Level B1 may consist of an escalator landing, staircase transfer corridor and horizontal vent shaft all overlapping across different heights and requiring different sets of plans and therefore different names). These sublevels shall be identified by the use of different names suited to the function of the sublevel and not by introducing new level numbers. The following are the names for use in identifying levels and sublevels in the facility:

Platform, Concourse, Upper Platform & Concourse, Upper Platform, Lower Platform, Overhead Bridge, Street, Underpass, Paid Link, Plant Room, Underplatform, Escalator Landing, Cable Chamber, Staircase Transfer, Vent shaft, Roof.

A typical example for an underground station is; 'Level 03 Roof', 'Level 02 Vent Shaft', 'Level 01 Street', 'Level B1 Concourse', 'Level B2 Platform', 'Level B2 Underplatform'

5 COMPONENTS

5.1 General

All functional elements mounted to the wall, ceiling or floor are considered as components.

The layout of all components shall be such that they present a controlled and co-ordinated appearance on completion of the works.

The housing and support structures of any component shall reflect the functionality of the component whilst being integrated with the surrounding architecture.

The designer shall ensure that the component provision is not over specified.

The location and mounting of components must be co-ordinated with layout and choice of finishes.

5.2 Component accessibility

Refer to *Accessibility* and *Ease of Maintenance* for general access and maintenance of components.

The position and height of all components shall comply with the Authorities requirements and any relevant codes.

Only components that are used by the public are required to comply with the current edition of the Code on Accessibility in the Built Environment.

A clear level floor space of 900mm x 1200mm shall be provided in front of any components designated for use by members of the public with disabilities.

5.3 Wall mounted components

Wall mounted components include, but are not limited to, control panels, sockets, switches, phones, push buttons, extinguishers, break-glasses, signage, advertising, services outlets, service counters, speakers, light fittings, access hatches, and hose reels.

All wall-mounted components within the public area may be mounted on designated services panels. These shall be flush where possible and co-ordinated with adjacent wall finishes.

Elevations shall be used to demonstrate the relative location of all wall components along with any wall cladding joint lines, doors and relevant surrounding features such as landscaping and railings.

5.4 Floor mounted components

Floor mounted components include, but are not limited to; seating, signage, advertising, stand alone extinguishers, barriers, gates, ticket machines, ATMs, post boxes, other service machines, phones and bins.

Where possible all floor mounted components positioned against a wall shall be changed to wall mounted. Alternatively front accessed floor mounted services that back onto a wall should be recessed into a niche within the wall. This niche shall allow for tolerances in the component's dimensions as agreed with the Authority. Wall cladding used around any recessed components shall be designed for easy replacement given future changes to the component dimensions.

Any unavoidable gaps between floor mounted components to any neighbouring wall or component shall not exceed 50mm or the components shall be kept at least 1m apart (apart from at the gateline – refer to chapter 17).

Floor mounted components shall be grouped at a common location and integrated where feasible.

Seating shall only be provided at designated waiting areas such as platforms, bus stops, taxi stands and bus interchange concourses unless particularly identified by the Authority.

5.5 Ceiling mounted components

Ceiling mounted components include, but are not limited to, speakers, sprinklers, detectors, lighting, signage, visual information displays, LCX, antennas, smoke curtains, roller shutters, ventilation grilles, and diffusers.

All ceiling components shall be fully co-ordinated with the ceiling layout and located to minimise penetrations through the ceiling fabric.

Reflected ceiling plans shall be used to demonstrate the relative position of components along with the ceiling grid, access panels and ceiling support structure.

Ceiling mounted signage or visual displays shall be located such that passenger's view are not blocked or obscured by obstacles or have glare from sunlight or lighting and are easily reached for maintenance. Any displays above fare gates should be 1 to 2 metres away from the edge of the gates on the paid side.

6 ARTWORK

6.1 General

The Authority may, at its discretion engage artists to provide specialist pieces of artwork for incorporation into the fabric of the transport facility.

The Designer will be expected to collaborate with any artist so employed and to modify his design, if required, to suit the incorporation of the artwork.

The position and integration of artwork relative to components and finishes shall be considered. Refer to *Components* and *Materials and Finishes* sections.

7 E&M INTERFACES

7.1 General

E&M interfaces includes considerations for positioning, mounting, service routing, and maintaining of all E&M items within the facilities.

All services (including all pipes, cables, trunking and conduits) shall be concealed from public areas.

Refer to *Components, Ease of Maintenance,* and *Fare Collection* Sections

7.2 Service routing

The designer shall produce a service routing strategy.

There shall be no penetration, transverse crossing, etc of services not serving the transport facility within the entire envelope of the facility including from the base slab to the underside of the soffit slab. Double slabs may be introduced above or below the transport facility with independent access for separation of services if required and agreeable by the Authority and the service owner.

The distribution of services within the transport facility shall follow designated service routing zones. Allowances shall be made for easy access to services within these zones.

Service zones may run above suspended ceilings or behind wall cladding but shall avoid any double height space. Particular attention shall be paid to the co-ordination of ceiling and wall support structures with the layout of services at these locations.

Services or fittings directly above escalators shall be avoided. If possible any services and fitting should be located adjacent to escalators and proven to be serviceable without access or support directly from the escalator.

No M&E services are allowed to route through the protected shaft or fire essential rooms (refer to room datasheets) unless they are serving these areas or rooms.

Kerbs, 100mm from Finished Floor Level, shall be provided for E&M service penetration floor opening as co-ordinated with E&M service providers unless otherwise qualified by the E&M service providers. Clashes with equipment to be considered.

The depth of all electrical and service closets, if provided, shall not exceed 750mm depth. Otherwise, the space will be treated as a habitable room. Buildability, accessibility and maintainability of the services and components located inside the service closets shall be considered. Service closets shall not drop directly above the trackway. Closets, if required for fire dry riser pipes and pump and drainage systems, shall be located near to the pipes entry point in station and areas to be served in order to keep routing shortened.

7.3 Wet Services routing

No electrical, communications or signalling rooms shall be located adjacent to the water tanks or diaphragm walls, if unavoidable double walls shall be provided adjacent to the water tanks and dry walls adjacent to the diaphragm walls. This is to prevent potential water seepage and damage to the equipment.

No electrical, communications or signalling rooms shall be located on the base slab of the station box.

Water pipes not serving electrical and/or electronic rooms shall not pass through these rooms.

When planning room layouts, particular care is needed to avoid locating wet rooms that will require sanitary and drainage pipework, e.g. toilets, above electrical plantrooms. If this is not possible, the wet room shall be positioned to overlap above adjacent non-electrical room areas so that the floor traps and associated waste pipes penetrate the floor slab outside the electrical rooms.

No wet services (including those liable to condensation, e.g condensate drains, etc) are to be routed above or immediately in front of any operationally critical devices (Eg Electrical panels, PSDs, Escalators, AFC Devices).

Floor traps, pipes, drains and pits shall be designed and positioned to suit the drainage of all sanitary waste, seepage, waste cleaning water, hose reel and condensate water.

7.4 Service routing in Rail Facilities

Service routing in rail facilities shall be in compliance with the Standard For Fire Safety In Rapid Transit Systems.

When planning room layouts at the floor level direct above platform level (typically concourse level) particular care is need to avoid locating rooms that will require sanitary and drainage pipework, e.g public or staff toilets to be installed at high level directly above the track. Every effort should be made to ensure that sanitary and drainage pipeworks are located at the side of the track and no pipeworks shall be located directly above the track.

No dry or wet riser pipework shall be embedded in concrete. Where such pipework is required to cross-over the track, the pipework shall have the shortest possible route and designed such that no flanges or joint shall exist above the track..

Appropriate means shall be provided to mitigate against objects falling onto the tracks (e.g. double slab to segregate between the services and the track)

Designated risers are to be provided for all services routing up to entrance level or ground level structures. Any direct penetration of E&M services through the station roof or side wall below street level shall not be permitted..

7.5 Services in staff areas (excluding plant rooms)

Wall mounted services within offices and areas with false ceiling (non-public) shall be enclosed or painted to match the wall finish. Wall mounted services within areas with tiled walls shall be concealed.

The designer shall ensure that the locations of the concealed services and equipment are coordinated with the furniture layout

7.6 Lighting

The Designer shall define the architectural lighting concept which shall be integrated with and enhance the overall architectural design intent. This shall extend to all public areas accessible and visible to the public within the transport facility.

The architectural lighting concept shall contribute to the design objectives of clarity in the passenger route and support the identification of key transport facility functions such as Service Counters, Ticket Machines, gatelines, vertical circulation elements, platforms, and entrance/exit routes. The 'lit' environment shall ensure an atmosphere of safety.

Glare and dazzle shall be avoided by determining the relative position and angle of lighting sources to the public and the reflectivity of finishes.

Lighting levels are defined in the MRT Station Room Datasheets or CF Architectural Checklists.

Each light shall contribute to attaining the required light level. Switching any of the individual lights off means that the light level is no longer achieved.

The designer shall consider the ease of maintenance in his lighting design strategy. Where double volume ceilings are located over the staircases and escalators, ceiling mounted lighting design shall be avoided unless the maintainability of the lighting system is demonstrated in the maintenance strategy.

7.7 Double Slab

Reinforced concrete double slab areas within the stations (including trackways) may be provided to facilitate the routing of E&M services over protected routes and trackways, and to relieve congested areas over protected rooms and other plant rooms. All double slab areas, wherever required, shall be reinforced concrete, unless specified otherwise by the Authority.

Wherever double slabs are used, the buildability, accessibility and maintainability of the services and components located inside the double slabs shall be considered. Compartmentation, access and design of any double slab shall comply with all fire regulations.

For stations, the function of the double slab includes use as an air plenum or protection to segregate the services routed within the protected areas, such as Exit Passageways, Firemen / Exit Staircases and / or Fire Essential Rooms etc. Double slabs shall be planned well in advanced commencing at preliminary design stage.

For station trackways, localised double slab may be introduced at the soffit above tracks for segregation purpose and/ or to facilitate the crossing of services (examples: pipes, ducting, cable trays and trunkings etc). Access to the localised double slab areas from either side of the double slab shall be provided. The design of the double slab shall not affect the system performance of the tunnel ventilation system.

8 FINISHES AND MATERIALS

8.1 General

All materials used shall comply with the Material and Workmanship specification.

Finishes within the transport facility shall be robust, durable and suitable for their purpose.

All materials chosen for use in finishes shall be vandal resistant, and easily cleaned and maintained. In addition the materials shall have low maintenance requirements over their life span.

All materials used shall comply with the Standard For Fire Safety in Rapid Transit Systems and the Code of Practice for Fire Precautions in Buildings.

Designers are encouraged to work with a limited palette of materials within public areas and to strive for simple and functional detailing.

Materials used above ground shall all be corrosion and stain resistant with particular attention to resistance to fungal growth due to the humid atmosphere and water absorption from rain.

Finishes shall not require cyclical painting or re-coating unless a set period after which re-coating is required is agreed with the Authority. Access for replacement and ongoing maintenance shall be achievable by commonly available means.

Finishes shall not require customised cleaning equipment.

Particular finishes requirements are identified in following section of the ADC.

8.2 Exposed Concrete

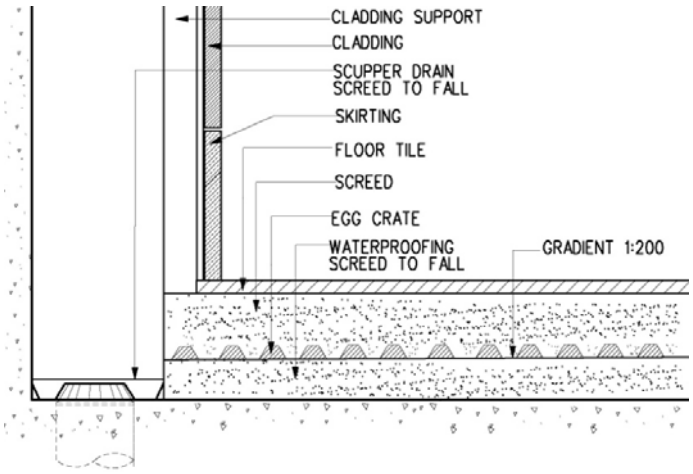
Where no specific finish has been identified, any exposed concrete, including inside shafts, ducts and closets, shall, as a minimum, be finished with an anti-dust coating.

8.3 Waterproofing requirements

Particular attention is required to ensure that the floor, wall and ceiling finishes in areas in direct contact with ground, are dry.

In addition seepage walls with drainage facilities are to be provided along any perimeter walls in direct contact with the ground. In rooms containing electronic and electrical equipment except electrical cable chamber in underplaform level, occupied staff rooms, and all public areas, the dry lining to such walls shall be constructed using non-combustible materials, which shall be unaffected by moisture, provision being made for the ventilation of the cavity. Access panels shall be provided on these walls to allow regular and easy access to the drainage outlet points.

Underfloor drainage systems integrated with the waterproofing system shall be incorporated into public areas directly above any base slab to remove the possibility of any seepage reaching the floor tiles. The system shall use an egg crate medium sandwiched within the floor screeding with a gradient to allow any water to flow and be discharged into an adjoining seepage drain.



All wet rooms shall be provided with water-proofing membrane.

8.4 Glazing

Refer to *Glazing Design Criteria*.

8.5 Tiling

There shall be no tiling above 3m height.

Exposed walls above tile finishing are to be finished with skim coat and paint.

8.6 Doors and Hatches

8.6.1 Identification

Wall doors and hatches shall be identified separately under the following categories:

- Security and Fire Doors, Hatches and Gates
- Cladding Hatches and Doors
- Access Hatches
- CD Doors.

Door and hatch requirements shall be specified during the design process using Building Information Modeling (BIM) software and displayed for review using 'Door Data Plans'.

The information shall be transferred to a ‘Door Schedule’ for procurement of the doors and hardware. All door schedules shall be divided by level with the schedule for security and fire doors, hatches and gates further divided into Rooms, Closets and Staircases. The designer shall specify on the relevant drawings that detailed shop drawings and schedules for both doors and ironmongery shall be provided by the suppliers to meet the technical requirements specified for the door.

The format of both the Door Schedules and Door Data Plans shall be as advised by the Authority.

All doors connected with the fire escape routes shall be identified on the fire escape route plan and Door Data Plan for coordination with SWC which require the EM locks of the AMS system to unlock and release during fire mode.

8.6.2 Door Swing

Door openings and direction of door swing shall be properly designed so as to avoid clashes when two or more sets of doors need to be opened / accessed at the same time.

Any doors, or active leaf of a double door, when open to 90 degrees that causes obstruction to an escape route shall close with the direction of escape.

All cable chamber access hatches shall be openable by one person. Facilities to hold open the hatch to be provided.

Active leaf of any double door to be identified on plan. Active leaf to be scheduled based on the side the hinges of the active leaf are on when facing the door from the pull side of the door.. Diagram to define the active leaf to be included on all door schedule submissions and drawings.

8.6.3 Security and Fire Doors, Hatches and Gates

All doors shall have a clear height of minimum 2.2m measured from the finished floor level to the underside of the frame.

All doors shall be self-closing if they are for entry into a room.

Application of door hardware shall comply with the SFSRTS or Fire Code as applicable.

All doors used by the public shall comply with the Code on Accessibility in the Built Environment.

Kick plates shall only be applied to push side of wooden doors to toilets, cleaning and cooking facilities or as identified by the Authority.

Flush bolts for doors or bolts for gates shall be used to secure all inactive leaf top and bottom. The top bolt shall extend so that the lever or knob is below 2m height from FFL.

Door, floor or wall stops shall be provided for any active leaf of a door which is obstructed in its swing up to 170^{o}.

Door handles for pressurized rooms of AHU, TVF, UPEF/SEF, Generator, their connected air plenums and the doors within the stations for TV shafts, VE and VS shafts shall be of heavy duty type and are capable of withstanding the air pressure during their opening and closing operations.

Self closing devices shall be fixed on the non-public side for all doors backing onto public areas (typically parallel arm is required if the door is swinging out).

All lever handles and pull handles shall be secured to their cover plates or escutcheon/rose and not just via the spindle.

Vision panels shall not be provided at any doors between public and nonpublic areas unless stipulated in the SFSRTS.

8.6.4 Cladding Hatches and Doors

All maintenance and equipment cladding hatches and covers, including cladding doors to all ducts and closets in the public areas but excluding cladding hatches to all fire fighting equipment shall be designed and finished to integrate and match with the station architectural finishes.

All cladding hatches and doors shall be locked using a common cam lock apart from if fire fighting equipment are housed behind. One key shall be able to open all cladding hatches within each individual transport facility. 5 keys shall be provided.

All recesses, niches or closets to house fire fighting equipment in the public area shall be designed with no left over space or access to the rear of cladding Any hatch at the opening to the recess, niche or closet shall be across the full frontage to the opening and fully transparent in accordance to CPTED principles. If transparency is not achievable the use of a reverse latch with key operated closing and self opening hinge can be used on agreement with the Authority.

Cladding hatches and doors include all hinged cladding panels for access to CD facilities, concealed doors and scupper drain inspection points.

8.6.5 Access Hatches

All Access Hatches are hinged elements for access below floors, behind walls and above ceilings. They shall not be lockable apart from using allen key and need not be fire rated. Should other locking or fire rating be required refer to section 'Security and Fire Doors, Hatches and Gates'.

All access hatches shall be lightweight designed for one-man operation.

Access hatches shall be provided for all sealed spaces and shall be secured using a key lock when opening to public accessible areas. The key lock shall be under a common key for the station together with other access hatches. Non-public area hatches need not be secured with a key lock.

8.7 Floor finishes

Refer to *Floor Finishes Checklist*.

The Finished Floor Level (FFL) of electrical rooms shall be 50mm higher than the highest point of the adjacent sprinkler protected room/corridor's FFL. A slope no steeper than 1:10 shall be used to address the change in height.

Intermittent highlights with reduced slip resistance to that required in section 3.6 is permissible for internal flooring more than 30m from unsheltered areas to the Authority's acceptance.

8.8 False Ceiling

There shall be no extensive use of fixed false ceilings which do not allow easy disassembly and panel replacement. Such ceilings shall be restricted to corner treatments, pelmets and junctions.

Ceiling access hatches shall be provided where regular inspection of detectors or other devices in the ceiling void is required.

8.9 Cavity Wall

Refer to the Civil Design Criteria – Chapter 11 for design of seepage drain and application of cavity wall.

Cavity walls shall be provided to fully enclose the earth backed external wall and associated seepage drains in the designated areas.

8.9.1 Access

All Cavity walls shall comprise either demountable or removable wall panels mounted on a metal frame which allows access at all locations of the seepage drain and external wall for rectification works.

- Demountable panels (eg for public area cladding systems)shall allow easy demounting and remounting of individual wall panels using mechanical fixings
- Removable panels (eg for dry wall systems) shall allow the panels to be removed and then replaced and in the case of dry wall partitions patched up to original condition.

Inspection access hatches of at least 600mm width by 1800 mm height shall be provided at the cavity wall at a maximum interval of 4.8m centre to centre and to coincide with every floor waste position.

Access doors and hatches need not be provided with locks when within the non-public area but shall incorporate a Wall Hatch (WH) lock when opening to public areas (Refer to Room Datasheets ADC Section 3.1).

8.9.2 Materials

All metal framing for the cavity wall shall use hot dipped galvanised steel as a minimum.

For public areas the cavity wall may be formed using the public area wall cladding.

All cavity wall shall use external grade materials that are unaffected by moisture and maintain their performance when wet.

9 STREETSCAPE

9.1 General

Commuter facilities shall be laid out according to priority with bus facilities taking prime locations, private pick-up (if any need is identified) second and taxi facilities third where feasible. Taxis queuing at the entrance to the taxi bay, if at a potentially popular pick-up location, to be considered.

Shelters, canopies and sheltered linkways to use a common design language where possible with special consideration of their interfacing. Potential links to interfacing developments to be identified early.

Refer to ADC Section 4 - Commuter Facilities Design Requirements for specific requirements.

9.2 Environment

The designer shall ensure compliance with all requirements and undertake all mitigation measures as required by the National Environment Agency.

Any element of the transport facility shall not present a negative environmental impact to its surrounding especially adjacent public spaces or buildings.

The designer shall ensure that any exhaust air complies with relevant authority's requirements and does not cause inconvenience to pedestrians or the general public. Measures to prevent exhaust air/smoke/heat (generated by the cooling towers, air vents, exhaust emissions and the like) from affecting the use of existing or future developments shall be proposed.

9.3 Landscaping

All planting used shall be low maintenance and hardy unless specifically agreed otherwise with the land owner.

The landscaping arrangement shall be reflected together with the maintenance boundaries of the respective land owners on plan for approval by all concerned.

Application of fencing, paving, irrigation, planting and turfing shall be in accordance with the requirements of Chapter 12 of the Civil Design Criteria.

10 INTERFACING DEVELOPMENTS

10.1 General

The designer shall produce a development interface report outlining the interface arrangements and designs for all future and existing developments.

10.2 Future Developments

Where facilities will form part of a future development, special consideration shall be given to the design to enable the facilities to be integrated into the development and remain functional while this is being carried out.

The transport facility shall be flexible to work stand alone and integrated with any future developments.

10.3 Safety

Developments proposed above and/or adjacent to a transport facility shall be designed and constructed such that they do not endanger the transport system structure nor operation. The safety and convenience of the travelling public shall be protected at all times in the design and construction of the development, without any disruption to the service being provided.

10.4 Regulatory

If the development is adjacent to or above a rail transport system the developer shall comply with the current edition of the following

- Code Of Practice For Railway Protection
- Rapid Transit Systems (Development And Building Works In Railway Corridor And Railway Protection Zone) Regulations
- Guide To Carrying Out Restricted Activities Within Railway Protection And Safety Zones
- Building Control Act
- Standard For Fire Safety In Rapid Transit Systems

The developer shall comply with the transport system operator's rules and regulations when working in, on, or near the transport system.

Compliance with these criteria does not preclude the developer from having to obtain full clearance from any other statutory submissions and approvals authorities, for his proposal. The developer shall submit plans and the required documents for release of planning and building plan approval to URA, BCA and DBC for clearance.

10.5 Design

Where entrances into the transport facility are replaced or diverted as a result of the development the developer shall consult the Authority to ensure that the passenger flows, escape route and vent shafts are not compromised by the new entrance configuration.

Developments proposed above or adjacent to a transport facility shall be designed such that the identity of the transport system is not compromised. The transport system shall have a distinct and separate identity to that for the development.

Where the entrances into the transport facility are via the development, the right of access to the transport facility shall be maintained during the operational hours of the transport facility or any neighbouring transport facility connected there-of. The design layout of both the development and transport facilities shall take this into consideration.

11 SIGNAGE AND ADVERTISING

11.1 General

All signage and advertising shall be considered within the overall components strategy in particular in relation to any information displays. Refer to *Components* section.

For all signage pertaining to roads refer to traffic management requirements.

Ensure visibility and functionality of all signage.

11.2 Operational signage

Each transport facility shall be provided with public area signage which will support passenger orientation, provide direction, and where required, detailed transit information.

Both the quality and location of signage shall be optimised and shall be compliant with the standards set out in the Authority's Signage Design Guidelines Manual (DGM).

Non-public area signage shall also be designed in compliance with the DGM.

All component signage shall, as far as possible, be integrated with the component or housing.

11.3 Facility Identification

Entrances into facilities shall be easily identifiable. Entrance identification and signage shall be provided in accordance with the Authority's Signage Design Guidelines Manual. The Designer shall co-ordinate the location of these with those serving adjacent developments.

Facility: includes bus stops, pedestrian overhead bridges, underpasses, bus terminals/interchanges, stations etc.

11.4 Statutory signage

The design shall include the identification and location of all necessary statutory signage, including emergency signs, which may be in addition to those required by the Authority for the safe operation of the railway or bus system.

11.5 Room Sign Plates

Room sign plates shall be provided for all doors to rooms and cabinets apart from those designated as 'Exit Only for Staff' (Doors designated as exit only for public shall continue to have plates) and access hatches (apart from to tanks). Rooms classified as "Electrical Room", "Plant Room" or "Shaft" or the Police Room/Command Centre facing public areas shall have room name plates with the room number only (no room name).

12 ACOUSTIC DESIGN

12.1 General

This section establishes the acoustical requirements for public spaces, office spaces, and mechanical equipment.

The acoustical design objective is to engender a desirable environment, physiologically and psychologically safe and comfortable for all occupants, free from harsh reverberation and excessive transport generated noises, and to permit clear intelligibility of aural announcements.

12.2 Layout

The location of vending machines, mechanical equipment and other noise producing devices should take into consideration their contribution to the overall noise level. The finishes at these sites shall be selected for maximum acoustical absorption.

Partitions, barriers, vestibules, doors and finishes should be considered as ways of reducing noise generated within public spaces.

12.3 Interior public spaces

Interior public spaces shall be provided with adequate sound absorptive treatment, taking into consideration architectural details such as finishes, shape and the volume of major spaces, to satisfactorily attain design reverberation times (RT). The RT are predicated on intelligibility of speech communication both face to face and through any public address system, and shall be provided as follows.

The RT 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 RT at 1 kHz shall not exceed 1.6 seconds.

The background noise level in interior public areas from traffic/train events, mechanical equipment and exterior noises shall be controlled to provide a comfortable acoustical atmosphere. Background sounds shall not interfere with the clarity of public announcement messages or normal voice communication at distances up to 3.0m. Particularly, sound control shall be provided at:

- Platforms: to minimise effects of train noise.
- Bus Interchange concourses : to minimise effects of bus noise.

The acoustical treatment of all public spaces must be designed to provide comfortable psychoacoustic environments. Clear comprehension of public address announcements is vital.

The ambient noise level in interior public spaces shall not exceed the recommended ambient sound levels as listed under SS 553. Sufficient insulation shall be provided between noise sources and the public areas to achieve these levels.

12.4 Staff Offices

Consideration of worker comfort must be taken in the acoustical design within staff offices. Acoustical ceilings, carpeting (where practical) and other treatments may be employed to attain a desirable acoustic environment. Partition construction must be adequate to isolate such spaces from train, traffic and mechanical equipment noises and provide an ambient noise level that does not exceed the recommended ambient sound levels as listed under SS 553 for general offices.

12.5 Noise Damping

Partitions and the floor/ceiling construction surrounding mechanical equipment rooms shall preclude any objectionable noise transmission. In most cases construction rated for a ST-50 Sound Transmission Class will be adequate.

Mechanical equipment located near public spaces shall be mounted on suitable spring or rubber-in-shear vibration isolation systems. The selection of the mounting type and static deflection shall be based on the equipment characteristics and location.

12.6 Interfacing developments

Noise transmission from mechanical equipment to surrounding commercial and residential properties shall be considered and noise control mufflers, attenuator and/or barriers introduced, if required to meet NEA's Code of Practice on Pollution Control and Guidelines on Boundary Noise Limits for Centralised Air Conditioning and Ventilation System in Non-industrial Buildings.

13 WEATHER PROTECTION

13.1 Flood prevention

Refer to the Civil Design Criteria, Chapter 12.

13.2 Drainage

A drainage channel of sufficient volume for the collection and disposal of water shall be provided adjacent to the top of all stairs, escalators and lifts connecting to any underground facility. This drainage channel shall be connected to the external (independent) drainage system. Any exception shall require the Authority's approval.

Where required gutter channels and down-pipes shall be provided in accordance with the National Environment Agency requirements.

All drainage shall be in accordance with PUB requirements. There shall be no ponding.

The size of any channel shall effectively discharge rainwater without causing any overflowing, stagnation and mosquito breeding.

All rainwater channels shall be laid to fall and shall not cause any ponding or splashing onto the commuters' sheltered area.

13.3 Dust

Recessed Floor mats shall be provided at least 2 metres long across the full width of public entrances between external areas and any air-conditioned area unless the entrance is considered relatively minor and under direction from the Authority.

These mats shall be located under cover and at the outer threshold of the facility, which is typically entrance doors or the top of escalators for entrances into underground facilities.

All recessed entrance floor mats to include drainage.

13.4 Rain

Facilities shall offer protection against inclement weather.

Components and equipment shall be protected from wind driven rain.

Where minor entrances(including for public, staff or escape) to underground facilities are open to the sky, the following drainage requirements will be adopted:

- 6hr (280mm) of rainfall storage capacity.
- 100 year stormwater return period shall be used to design the pumps.

Where open top vent shafts are provided, the shaft concept shall be designed in such a way that the rainwater is drained off by gravity. If not possible, the less preferred types requiring pumped drainage will be considered provided the following design criteria are adopted :

- 24 hours (530mm) of rainfall storage capacity
- 100 year stormwater return period shall be used to design the pumps.

13.5 Sun

Shelters shall be designed to minimise radiant heat and avoid significant heat buildup.

Use of trees is encouraged in the landscaping design as a means to provide additional shading to the shelters.

Designers are encouraged to consider natural ventilation and air flows.

14 SECURITY

14.1 General

The designer shall use a self policing design such as "Crime Prevention Through Environmental Design" (CPTED) principles to reduce dead ends, corners and dark areas.

Security requirements for particular rooms can be found in the Room Datasheets and CF Architectural Checklists.

14.2 Personal Security

The view from closed circuit television cameras shall not be obstructed.

All areas must be designed to be well-lit with minimal blind-spots for optimum CCTV coverage.

Transport facilities shall be detailed to eliminate ledges on which litter might be deposited together with overhangs and recesses which might be used to conceal terrorist devices.

All public accessible receptacles shall be locked where applicable. For those that must remain unlocked (e.g. fire extinguishers, hose reels) a see-through design shall be considered or tamper-proof devises installed to prevent and/or detect placement of suspicious objects.

Abrupt changes of direction shall be avoided wherever possible with mirrors provided if required to enable members of the public to identify what exists 'round the corner'.

Recesses and Niches shall be avoided.

Any unavoidable flat surfaces above 1.6m shall be sloped to prevent any object being placed out of view.

Any post box / letter box shall be:

- located above ground away from areas where people are likely to congregate
- not located facing general commuter traffic
- not located near any glass panels, plant rooms, gas pipelines, critical facilities or critical columns of buildings.

14.3 Blast Protection

Security concerns regarding material specified shall also address blast protection safety for commuters.

In general, simple geometrics are preferred:

- All external walls or façade shall by straight without recesses.
- Re-entrant corners and overhangs shall be avoided as they are likely to trap the shock wave and amplify the effect of any blast.
- If curved surfaces are used, convex shapes shall be preferred over concave shapes.
- Columns shall be placed either behind any external wall or façade or flushed with it.
- Key structural elements shall not be exposed to public accessible areas.
- Stand-off distances to access roads shall be proposed and maintained around any key operational or structural elements.

14.4 Human Barriers

14.4.1 General

Human barriers shall be provided at the following boundaries:

- At any entrance into a facility. This would be at street level for entrances to elevated or underground stations.
- Between public and staff areas.
- Between spaces occupied by different disciplines such as between common staff areas and particular plant rooms.
- Between areas which are required to be open to the public for 24hours and areas which need to be closed off such as underpasses or overhead bridges running through facilities.
- Between areas designated for commercial use and those for the operation of the transport facility.

All human barriers across pedestrian flow routes shall be capable of being operated from a locked control panel within the transport facility and shall also incorporate remote opening from any control rooms (PSC or OCC for rail facilities) and an automatic timer.

All human barriers shall include an interface to the E&M equipment for the access management system of the facility.

All human barriers shall preferably fully enclose the facility (floor to ceiling). If not then the barrier shall have a minimum height of 3m without handhold or foothold and shall incorporate anti-climbing design, including at any adjoining structures.

All human barriers shall have no opening greater than 150mm.

14.4.2 Entrance Doors

For above ground transport facilities the human barrier may be combined with any air-con separation doors.

Any recessed track or raised guide for entrance doors/gates which may result in tripping hazards should be avoided where possible.

14.4.3 Shutters/Grilles

Fire shutters shall not be used as security shutters.

The reset device for fire shutters at public areas shall be extended to an accessible height (1.5m to 1.8m) and concealed within openable wall cladding.

Security shutters at retail shops shall be manual shutters rather than motorised shutters.

The manual chain for both fire and security shutters/grilles shall be:

- Accessible from 1.2 to 1.5m height
- Hung against a wall at non-public areas
- Concealed within openable wall cladding in public areas

14.5 Traffic Barriers

Barriers, designed against a 7.5 tonne vehicle travelling at 48 km/h to standard PAS68:2010 (with not more than 1 metre penetration of the hostile vehicle) or equivalent ,shall be in place so that vehicles do not have access into the transport facility from the road. (E.g. Staircases, Planter Boxes, Stone Benches, Bollards).

All Boarding and Alighting bays at Bus Interchanges or Bus Shelters shall have crash-rated barriers or bollards designed to a minimum rating of Bollard V/7500/48/90/1A (in accordance to the PAS68:2010 standard) or equivalent, with retro reflective sheet.

All parking, loading and unloading areas around facility shall include removable locked barriers at the entrance from the road designed against a 7.5 tonne vehicle travelling at 48km/h to standard PAS68:2010 (with not more than 1 metre penetration of the hostile vehicle) or equivalent.

Clear spacing between the barriers shall not exceed 1.2m.

14.6 Layout

The transport facility layout shall be such as to:

- Provide a bypass facility to security barriers across pedestrian flow routes, including as part of any access management system at-least at one location, preferably adjacent to the maintenance parking space.
- Minimise the number of rooms opening into areas that are designated 24 hour access.
- Keep operational and fares equipment such as ticket machines within the secure operational area of the facility.

Rooms with different security requirements shall be arranged so that each room has its own access from a common area. Only in the case where adjoining rooms have the exact same security requirements can one room be accessible via the adjoining room, in which case the dividing door shall allow free passage.

All room security requirements shall be confirmed with the Authority while developing the layout.

15 COSTS

15.1 General

Demonstrate that the design of transport facilities and choice of materials has taken consideration of lifetime costs and that they provide value for money to the people of Singapore.

Station box size and footprint shall be minimised to ensure economy of construction and minimised land use.

16 EASE OF MAINTENANCE

16.1 General

Design the transport facility for durability and robustness for the purpose of maintenance. The designer shall ensure that all parts of the transport facility, including components provided by the System Wide Contractors, are accessible for carrying out cleaning and maintenance work.

The Designer shall be responsible for ensuring that all maintenance access is provided in accordance with the latest edition of the Workplace Safety and Health (WSH) Regulations.

16.2 Design

The maintenance access to all services or equipment and maintenance boundaries shall be coordinated with the E&M Consultant and other interfacing contractors.

Avoid the installation of any services requiring maintenance or finishes requiring regular cleaning at a height greater than: 4 metres above level ground or 3 metres above staircases.

Ensure there is no installation of any services requiring maintenance or finishes requiring regular cleaning at a height greater than 3 metres above escalators.

At high void areas consideration shall be given to mount lights at low level within reach by an A frame ladder either on; the surrounding walls, posts, a services boom or staircase/ escalator balustrade.

Avoid the need for the use of scaffold towers, personnel lifts or track based hanging access systems to access services or carry out regular cleaning.

Ensure clear access through any ceiling void is provided to reach any services that require regular maintenance.

Ensure adequate ceiling void space are designed to house both the services and any crawl-ways/catwalk within the ceiling.

16.3 Strategy

The designer shall provide a maintenance strategy and access report, which demonstrate how cleaning and maintenance work is to be carried out efficiently. This strategy shall be presented in a comprehensive report, which shall include:

- The frequency and method of access to each of the items identified.
- Maintenance materials and equipment which should be retained within the facility for the day to day cleaning and maintenance of the facility.
- All items of equipment necessary to achieve maintenance access together with the storage space required to accommodate them within the facility. The storage space so identified shall contain all necessary hooks, shelves, and services necessary to store and maintain the maintenance access equipment.
- Safety equipment such as fall arrest systems and their operating procedures
- Details of all specialist tools required for the operation of access panels.
- Panels inspection including fixings and seepage etc.
- Power requirement for motorised access equipment (if required).
- Safe access/ launching methodology to the fixed maintenance access equipment (if required)
- Demonstration of services and associated components replacement from the fixed maintenance access equipment (if required)
- An access path demonstrating how the proposed equipment can be manoeuvred to the respective designated maintenance locations (if required)

16.4 Maintenance Access Equipment (if required)

The designer shall demonstrate where and why access to any services and regular cleaning beyond the limits set under section 16.2 is unavoidable. High level access using maintenance access equipment that is either; fixed, portable, or deliverable to each staging/launching location in the facility may be included in the maintenance strategy subject to sufficient demonstration on accessibility and upon agreement of the Authority. Otherwise the designer shall take all necessary steps to lower the services and design for low level access for all regular cleaning.

Additional restrictions for MRT stations:

- Only tower scaffold and personnel lifts (if required) will be provided by a separate contract to be awarded by the Authority at a later date
- Other mobile maintenance access equipment besides tower scaffold and personnel lifts shall not be considered within MRT station.
- Any proposed maintenance equipment that is fixed to or integrated with the finishes or in addition to the tower scaffold and personnel lift, shall be included and provided under the respective civil contracts (e.g. catwalk).

Maximum platform height for tower scaffold or personnel lifts shall be defined at each location with reference to the base dimensions, clear footprint available (for outriggers) and bracing points. Use of tower scaffold or personnel lifts for access through any spaces narrower than 1.5m shall not be considered.

The limits of use of the tower scaffold shall be certified by a qualified person. The designer may refer to the following provisional maximum platform height for access using tower scaffold as a guide during design subject to later verification:

Example Location	Minimum clear footprint available	Provisional Maximum Platform Height
Staircase (narrow)	<1.5m width	2.0m
Staircase (no central railing)	1.5m - 1.9m width	4.5m
Staircase (with central railing)	2.1m - 2.9m width	
Staircase (no central railing)	2m width	6m
Staircase (with central railing)	≥ 3m width	
Open area (narrow)	2m x 2m	5.5m
Open area (general)	3.5m x 3.5m	10m

16.5 Floor, Ceiling and Wall Finishes

All access panels shall be designed to be removed/opened by one man.

Access panels shall be integrated with the surrounding finishes.

All replacement parts shall be easily available to facilitate repair and replacement in future.

No access panels shall be located in fire protected areas defined in the SFSRTS.

The position of cladding access hatches to scupper drain to be coordinated with floor trap locations behind cladding.

Hinged downwards access panels shall be integrated into the ceiling system where access is required on a yearly or more frequent basis.

16.6 Maintenance Boundary

The designer is to work closely with the Authority in identifying the maintenance boundary of the transport facility. The maintenance boundary shall then be clearly indicated on the Site Plan and submitted to the Authority.

All E&M services and facilities not serving the transport facility shall be located outside the maintenance boundary with independent access.

For stations the designer shall consider the Maintenance Guidelines for Rapid Transit System Operators when defining the boundary.

17 FARE COLLECTION

17.1 Layout

Designers shall ensure that the Ticketing Machines , the Passenger Service Centre (PSC), and, where provided, the Ticket Office and other Service Counters, are all prominently visible to commuters entering the transport facility.

Planning of areas associated with the fare system shall address the requirements of the following activities:

- Passenger waiting
- Ticket sales office.
- Ticket purchase from machine
- Ticket purchase by people with disabilities from service counters.
- Queuing to enter/exit at the AFC gate(s).
- Passengers seeking information about trains, buses, destinations and the surrounding neighbourhood.
- The use of public telephones, ATMs and other facilities.
- Transfer from escalators and lifts, serving street and platform, at subsurface control areas.
- Staff accommodation.
- Retail concessions, advertising.
- Refuse collection.
- Circulation space and connections between the transport facility and adjacent developments.
- Orientation to way out and station platform or bus bays.

Waiting space for passengers shall avoid conflicting with station AFC gatelines and service counter location.

17.2 Service Counters

The AFC gates and ticket machines shall be clearly visible from the Passenger Service Centre (PSC) or other Service Counters.

For stations : The PSC shall be located at the AFC gates in the most suitable position for supervising the movement of passengers within the concourse area, the gates and the ticket machines.

17.3 Ticket / Add Value Machines

The ticket / add value machines shall be located to avoid congestion

The machines shall be located to permit servicing without seriously impeding passenger movement

The relative location of the machines and the AFC store shall take into account the security requirement for cash handling. Ensure a stepless route between these two location.

For stations: the location of machines shall also avoid the creation of reverse flows to the Automated Fare Collection (AFC) gates.

Provision shall be made for future machines to be added as the number of passengers using the facility increases.

For rear access ticket machines a Fare Equipment Room (FER) is required.

For front access ticket machines a Fare Equipment Closet (FEC) is required

For the GTMs in the remote fareline, a recess area shall be created between two GTMs for the installation of Help(Epax linked) phone for passenger communication with PSC.

17.4 Station AFC Gates

A single gateline is operationally preferred but split gatelines may be provided if the site specific passenger catchment and flow justifies.

Run-off queuing spaces in the concourse paid area from the AFC gatelines should be directed towards exit routes where possible.

Queuing provision at the PSC, Ticket Sales Office (where provided), and ticket machines shall avoid conflict with the entry/exit routes to the gatelines.

The AFC gates shall be located to provide direct entry to the stairs and escalators leading towards platform level, avoiding cross flows of passengers. Designers must note that the AFC gates are designed to permit reverse flows to suit peak demand.

AFC gates must not be installed across structural movement joints. Ensure no metallic flooring are installed at the AFC gateline areas.

The AFC gates demarcate between the free and paid areas of the station and shall both be clearly visible to passengers, and permit the maximum passenger circulation space, within both areas.

Provisions shall be made for future AFC gates to be added when the number of passengers using the facility increases.

As a guide, a clear unobstructed zone of 6.0m should be maintained on either side of the AFC gates, and no signage shall be placed directly above the gates. Where this zone overlaps with any other suggested clear zone the cumulative distance provided should be 80% of the total.

One automatic fare gate in each gate line shall be available at all times for entering and exiting wheelchair bound passengers, plus those with luggage or prams. This gate shall have a minimum unobstructed width of 900mm. The wide gate shall be clearly identified using the international disabled symbol. The wide gate shall be located so that it can be supervised at all times either directly from the Passenger Service Centre, or by the use of CCTV. The location of the wide fare gate shall be placed near the entrance/exit of the paid lift as a priority. The objective is to ensure that all passengers can safely pass through the gate line between the paid and unpaid areas of the station without assistance.

17.5 Station Service Gates

A hinged service gate of minimum clear width 1200mm shall be provided between PSC/Remote booth and AFC gateline.

Both the service gate and the barrier railing are required to be centrally installed along the AFC gate array and terminate with a typical gap of 100mm to the first AFC gates.

The hinged service gate width may be included in any calculation of gate opening widths for escape purposes.

If the hinged service gate is designed as part of the emergency escape route it shall have an automatic locking device which shall comply with the Standard for Fire Safety in Rapid Transit Systems.