



**INFRASTRUCTURE DESIGN & ENGINEERING GROUP
KEY DOCUMENT**

**INFRASTRUCTURE DESIGN CRITERIA
VOLUME C – COMMUTER INFRASTRUCTURE**

E/GD/09/130/VOLC/A1

CONTROLLED DOCUMENT

INFRASTRUCTURE DESIGN CRITERIA VOLUME C – COMMUTER INFRASTRUCTURE

Table of Contents

Chapter	Name	Total no. of Pages*
1	Commuter Infrastructure Requirements	13
2	Active Mobility Requirements	48
3	Electrical and Mechanical Requirements	25
4	Operation and Maintenance Requirements	65
5	Security Requirements - Not Available	-
6	Safety Guidelines	7

List of Annexes (references/attachments)

Annex	REFERENCES/ATTACHMENTS	Reference Chapter	Total no. of Pages*
A1	Typical Layout of Taxi Shelter	1.3	1
A2	Typical Section & Elevation of Taxi Shelter	1.3	1
A3	Typical Layout & Elevation of Taxi and Pick-up/Drop-off Shelter with high roof	1.3	1
A4	Typical Section of Taxi and Pick-up/Drop-off shelter with high roof	1.3	1
A5	Bus Stop Shelter Sign	1.2	1
A6	Bus Stop Shelter Notice Board for Bus Services Information (double sided)	1.2	1
A7	Bus Stop Shelter Notice Board for Bus Services Information (single-sided)	1.2	1
A8	Bus Stop Shelter Address Plate	1.2	1
A9	Bus Stop Shelter Height Limit Sign	1.2	1
A10	No Smoking Prohibition Sign	1.2	1
A11	Bus Stop Pole	1.2	1
A12	Bus Stop Shelter Notice Board for bus services Information (Sections)	1.2	1
A13	Taxi Shelter (Taxi Signs)	1.3	1
A14	Inventory of Taxi Signage Graphics	1.3	1

A15	Taxi Identity Sign for Taxi Stand or Taxi Stop Identity Differentiation	1.3	1
A16	Taxi Identity Sign for Taxi Stand or Taxi Stop	1.3	1
A17	Taxi Identity Sign for Taxi Stand or Taxi Stop (Floor Mounted Free Standing Type)	1.3	1
A18	Taxi Identity Sign for Taxi Stand or Taxi Stop (Ceiling of Shelter Roof)	1.3	1
A19	Taxi Identity Sign for Taxi Stand (Specification for Signplates)	1.3	1
A20	Display Size of Signs	1.3	1
A21	No Smoking Prohibition Sign	1.3	1
A22	Taxi Notice Board for Taxi Information	1.3	1
A23	Taxi Information Poster	1.3	1
A24	Taxi Stand & Pick-up/Drop-off Point Signs	1.3	1
A25	Pick-up/Drop-off Identity Sign	1.3	1
A26	Taxi Queue Here Sign	1.3	1
A27	Taxi Queue Arrow Sign	1.3	1
A28	Taxi Shelter Height Limit Sign	1.3	1
A29	Taxi Street Marker Sign	1.3	1
B1	Reference table	-	1
B2	Path Types	2.5.3	1
C1	Technical Specification for M & E Services	3	107
C2	M&E Services Drawings	3	18
D1	Lift Interface Requirements with CFEMS	4.4.2	2
D2	Protocol from RTU to Lift Controller and Lift Controller to RTU	4.2.2	5
D3	Monitoring Points in Detail	4.4.2	6
D4	UPS Current Sensor	4.2.2	1
D5	Error Code	4.4.2	1
D6	CRC Generation (To be Coordinated with CFEMS Contractor)	4.2.2	1
D7	Lift Monitoring Points by CFMS System	4.2.2	2
E	Security –Nil		
F	Legal Register for Safety, Health & Environmental Management	6	16

Checklists (Commuter Infrastructure)

Number	Name	Total no. of Pages*
Checklist 1	General Requirements for Bus Stop Shelter, Taxi/Pick-up/Drop-off shelter, Covered linkway Shelter, Pedestrian Overhead Bridge and Pedestrian Underpass	3
Checklist 2	Bus Stop Shelter/Bus Bay	4
Checklist 3	Taxi/Pick-up/Drop-off Shelter	2
Checklist 4	Covered Linkway Shelter	2
Checklist 5	Pedestrian Overhead Bridge	3
Checklist 6	Pedestrian Underpass	2
Checklist 7	Covered Walkway	3
Checklist 8	Floor Finishes (for floor tiles)	1

Checklists (M&E Services)

Number	Name	Total no. of Pages*
Checklist 1	Mechanical and Electrical Checklist	4

Checklists (Operation and Maintenance)

Number	Name	Total no. of Pages*
Checklist 1	Commuter Infrastructure-Structure (Maintenance Related)	15
Checklist 2	Commuter Facilities System (Maintenance Related)	1
Checklist 3	Commuter Infrastructure-Equipment of Mechanical System (Maintenance Related)	1

Checklists (Security)

Number	Name	Total no. of Pages*
Checklist 1	Commuter Infrastructure Security Checklist - Not Available	-

*Not inclusive of cover page

CHAPTER 1 – COMMUTER INFRASTRUCTURE REQUIREMENTS

Table of Contents

1.1	Commuter Infrastructure	2
1.1.1	General	2
1.2	Bus Stop Shelter	4
1.2.1	Design.....	4
1.2.2	Elements.....	5
1.2.3	Signage.....	6
1.2.4	Bus Bay.....	6
1.2.5	Sizing.....	6
1.3	Taxi/Pick-up/Drop-off Shelter.....	6
1.3.1	Design.....	6
1.3.2	Elements	7
1.3.3	Signage.....	7
1.4	Covered Linkway Shelter	8
1.4.1	Design.....	8
1.5	Pedestrian Overhead Bridge Shelter	8
1.5.1	Design.....	8
1.6	Pedestrian Overhead Bridge and Pedestrian Underpass	9
1.6.1	Location	9
1.6.2	Provision	9
1.6.3	Pedestrian Overhead Bridge Detailing.....	10
1.6.4	Pedestrian Underpass Detailing.....	10
1.7	Covered Walkway	11
1.7.1	Detailing	11

1.1 **Commuter Infrastructure**

1.1.1 General

- 1.1.1.1 All shelters shall be designed to provide adequate weather protection. They shall be modulated and built with lightweight structure, to give a sleek and elegant appearance. They shall be robust to withstand all weather conditions.
- 1.1.1.2 Where shelters, covered linkways, pedestrian overhead bridges, pedestrian underpasses or other transport facilities are connected, the design of the transport facilities and their respective covers shall be treated as a single entity, to maintain uniformity and consistency.
- 1.1.1.3 There shall be no structural connection to any existing facility. The roof structure of bus stop, taxi / pick-up/drop-off shelter and pedestrian overhead bridge shall be independent from any covered linkway.
- 1.1.1.4 Provide minimum 10mm thick aluminium honeycomb roof panel with 1mm thick top panel for shelters that are to be handed over to LTA. Polycarbonate, glass, metal roman tiles, clay tiles or Teflon shall not be used as roof material. False ceilings are not permitted.
- 1.1.1.5 The drainage design shall not create ponding on the floor. No channelling and discharging of surface water into the sheltered area.
- 1.1.1.6 The drainage design of the roof shall not allow stagnation and splashing into the sheltered area.
- 1.1.1.7 Floor finish at covered linkway shall be brushed cement screed. Floor finishes at bus stop shelter taxi /pick-up/drop-off shelter and pedestrian overhead bridge shall be granolithic finish, apart from those at underpasses and covered walkways, which may be tiled in line with the internal finish. The floor finish shall comply with the prevailing Singapore Standard SS485 “Specification for Slip Resistance classification of pedestrian surface materials” and with the prevailing ‘Code on Accessibility in The Built Environment’ for slip resistance. Checklist 8-Floor Finishes (for floor tiles) shall be submitted.
- 1.1.1.8 Floor finishes on sloped area shall be of rough textured finish.
- 1.1.1.9 Minimum headroom of shelter shall be 2.4m.
- 1.1.1.10 The lateral clearance between the outer edge of road kerb shall be:
 - 0.6m absolute to the roof eaves for covered linkway shelters, bus stop shelters and taxi/ pick-up/drop-off shelters to enable maximum shelter when boarding and alighting the bus/taxi (apart from shelters with high roof)

- 0.6m minimum to all other structures and roadside furniture (e.g., over ground boxes, lamp pole, traffic signs etc), except safety barriers.
- 1.1.1.11 The circulation space under shelters shall be levelled. Any difference in level shall be addressed with slope/ramp.
- 1.1.1.12 Steps are not permitted at the alighting and boarding area of the bus stop and taxi /pick- up/drop-off shelter, passageway of the pedestrian underpass, pedestrian overhead bridge deck and covered linkway. The periphery access to the infrastructure shall be barrier free.
- 1.1.1.13 For details of footpath and bus stop shelter, refer to LTA Standard Details of Road Elements (SDRE).
- 1.1.1.14 For details of cycling path, refer to LTA Code of Practice - Street Work Proposals Relating to Development Works, LTA Standard Details of Road Elements (SDRE) & Walking & Cycling Design Guide.
- 1.1.1.15 Ramp, step, handrail, nosing tile and tactile tile provisions shall comply with the prevailing 'Code on Accessibility in the Built Environment'.
- 1.1.1.16 For M&E provision, refer to details in Commuter Infrastructure Volume C, Chapter 3 of the M&E Services Requirements.
- 1.1.1.17 All materials and finishes shall comply with the Architectural Materials and Workmanship (M&W) Specifications and Materials & Workmanship Specification for Civil & Structural Works.
- 1.1.1.18 The interfacing and finishes of pedestrian overhead bridge, pedestrian underpass entrance structure, covered linkway, bus stop shelter, taxi shelter, pick-up/drop-off shelter and the adjacent facilities shall be designed to prevent rainwater from flowing and splashing onto the sheltered areas.
- 1.1.1.19 For placement of 'No Riding' signs at pedestrian overhead bridge, refer to details in Commuter Infrastructure Volume C, Chapter 2 of the Active Mobility Requirements.
- 1.1.1.20 All traffic signs shall comply with LTA's Traffic Management's requirements.
- 1.1.1.21 On application for plan approval, the Qualified Person shall submit the following information/documentation, where applicable:
- Provide digital-coloured photographs of the affected bus stop shelter / taxi shelter / pick-up shelter / pedestrian overhead bridge shelter / pedestrian underpass/covered linkway shelter.
 - The direction of surface drainage shall be indicated on the floor and roof plan.

- Road reserve line shall be indicated on the plans, elevations and sections.

- 1.1.1.22 Overhanging signage and equipment on pavements shall have a height clearance of 2.4m.
- 1.1.1.23 Anti-stick paint shall be applied to any newly built/installed commuter/road related facilities e.g., covered linkways, bus shelters, lampposts etc., 100m from MRT stations and bus interchanges.

1.2 Bus Stop Shelter

1.2.1 Design

- 1.2.1.1 To obtain boarding passenger data from Bus Operations (BOPS). The bus stop shelter shall not be smaller than the existing one. It shall be enlarged if the current passenger boarding figures warrant it.
- 1.2.1.2 Sizing of bus shelter shall be provided in accordance with Table 1.

Table 1

Boarding passengers per peak hour	Size of bus stop shelter (Width=3m)
200 or less	9 x 3
201-300	12 x 3
301-400	15 x 3
401-500	18 x 3
501-600	21 x 3
601-700	24 x 3
701-800	27 x 3
801-900	30 x 3
901-1000	33 x 3
Above 1000	36 x 3

- 1.2.1.3 The minimum bus stop shelter size at MRT/LRT stations shall be 12m x 3.6m.
- 1.2.1.4 For bus stop shelter with high roof, the roof shall extend over the bay to provide cover for boarding and alighting. The extended roof shall have a clear height of 4.8m clear from the finished road level. The roof eave shall setback 0.6m (absolute) from the main carriageway. To provide height limit sign at a clear height of 4.6m from the finished road level, according to Annex A9.
- 1.2.1.5 The line of sight of oncoming buses shall be maintained throughout the entire bus stop shelter.

- 1.2.1.6 Measures shall be taken to ensure the bus stop shelter is distinctive from any adjoining covered linkway.
- 1.2.1.7 Rainwater from bus stop shelter roof shall not fall onto roof of existing commuter infrastructure, within the road reserve.
- 1.2.2 Elements
 - 1.2.2.1 200mm wide yellow band, 1.5mm thick non-slip thermoplastic paint, to be drawn 125mm from outer face of the road kerb and shall be provided from end to end of bay. For those without bay, the band will cover only the paved portion of the bus stop area and is to be indicated on plan. The hot applied Thermoplastic Road Marking Materials shall comply with BS 3262.
 - 1.2.2.2 Provide one bench for each 3m length module of shelter. The bench dimensions shall be minimum 1.2m(L) x 0.33m(D) x 0.45m(H). The benches shall be designed to prevent water stagnation on the surface. At least one third of the benches shall be fitted with armrest. Benches are not permitted in front of notice boards/information panels.
 - 1.2.2.3 Provide rain screen at the rear of bus stop shelter. Refer to LTA Standard Details of Road Elements (SDRE).
 - 1.2.2.4 A clear passage with a minimum width of 1.8m shall be maintained between the benches and bollards.
 - 1.2.2.5 Provide double-sided bus stop noticeboard /information panel (minimum 2 numbers) according to Annex A6. Where there is site constraint, single-sided bus stop shelter noticeboard/information panel (minimum 2 numbers) can be provided, see Annex A7. The noticeboard/information panel shall be mounted on a minimum of 10mm thick tempered and laminated glass framed on all sides and shall be illuminated.
 - 1.2.2.6 Provide one number of 50mm diameter heavy-duty UPVC pipe electrical conduit with draw wires, (embedded underground) for advertisement panel. It shall be located from the OG box to advertisement panel, located at the downstream edge of the shelter. (For shelters to be handed over to LTA).
 - 1.2.2.7 Consult National Environment Agency (NEA) on the provision and placement of litter bin.
 - 1.2.2.8 Consult LTA Public Transport Promotion (PTP) on the provision, replacement or relocation of the bus stop pole at the bus stop.
 - 1.2.2.9 Consult LTA Road Safety Engineering (RSED) on the provision of safety bollards at the newly constructed bus stop.

1.2.2.10 Consult LTA Road Asset Regulation Licensing (RARL) on the bus stop shelter address.

1.2.2.11 Inform LTA Bus Information System (BIS) of the GPS Co-ordinates and linked bus stop distance.

1.2.3 Signage

1.2.3.1 Bus stop address plate shall be provided and fixed onto the side of bus stop roof and to face oncoming traffic. Refer to Annex A8. If the bus stop address plate is blocked by interfacing structure, the plate shall be placed at the front of the bus stop shelter roof, facing the road.

1.2.3.2 Provide bus stop indicator sign for bus stop outside MRT stations only. Refer to Transit Signage Manual.

1.2.3.3 Provide 'No Smoking' prohibition sign, according to Annex A10

1.2.4 Bus Bay

1.2.4.1 Refer to LTA Standard Details of Road Elements (SDRE) on design of Bus Bay.

1.2.5 Sizing

1.2.5.1 To obtain bus frequency data from Bus Operations (BOPS). Sizing of bus bay(s) to be provided in accordance with Table 2.

Table 2

Frequency of buses per peak hour:	Bus bay type:
1-39	One single bus bay
40-59	One double bus bay
60-79	One triple bus bay
80-99	Two double bus bays (with 10m separation on the straight kerb)
100 and above	One double bus bay plus one triple bus bays (with 10m separation on the straight kerb)

1.3 Taxi/Pick-up/Drop-off (PUDO) Shelter

1.3.1 Design

1.3.1.1 Consult Taxi Service (TSV) on the provision and number of taxi bays. Provide the same number of bays for passenger pick-up/drop off shelter.

- 1.3.1.2 The minimum width of low roof taxi/pick-up/drop-off shelter shall be 2.5m and length of the shelter shall correspond with the number of taxi and pick-up /drop-off bays. Refer to Annex A1.
- 1.3.1.3 For taxi/pick-up/drop-off shelter with high roof, the roof shall extend over the bay to provide cover for boarding. The extended roof shall have a clear height of 4.8m from the finished road level. The roof eave shall setback 0.6m (absolute) from the main carriageway. Refer to Annex A3 & A4. To provide height limit sign at clear height of 4.6m from the finished road level, according to Annex A28.
- 1.3.1.4 Provide a minimum of 3m buffer between the taxi bay and pick-up/ drop-off bay.
- 1.3.2 Elements
 - 1.3.2.1 Provide one number of 50mm diameter heavy duty UPVC electrical conduit with draw wires (embedded underground) for advertisement panel. It shall be located from the OG box to advertisement panel, at the downstream edge of the shelter (for shelters to be handed over to LTA).
 - 1.3.2.2 Provide at least two benches each at the taxi/ pick-up/drop-off shelter. The dimensions of each bench shall be 1.2m(L) x 0.33m (D) x 0.45m(H). The benches shall be designed to prevent water stagnation on the surface. At least one third of the benches shall be fitted with armrest.
 - 1.3.2.3 Where road kerb could not be provided at frontage of shelter, bollards at 0.6m absolute from the road edge shall be provided. A clear width of between 1.5m to 3.0m shall be maintained between the bollards.
- 1.3.3 Signage
 - 1.3.3.1 Provide a minimum of 2 numbers of taxi shelter noticeboards, according to Annex A22. They shall be placed beside the bench. The noticeboard (for taxi information) shall be mounted on a minimum of 10mm thick tempered and laminated glass framed on all sides and shall be illuminated.
 - 1.3.3.2 Provide taxi identity sign, pick-up/drop-off sign pole according to Annexes A24 and A25.
 - 1.3.3.3 Provide overhead taxi queue sign, according to Annex A26 at the head of the queue coinciding with the arrow queue sign on the floor.
 - 1.3.3.4 Provide colour contrast queue arrow sign (on the floor) according to Annex A27. It shall be of non-slip finish, placed on the floor in front of the first bench for queuing.
 - 1.3.3.5 Provide 'No-Smoking' prohibition sign according to Annex A21.

1.4 Covered Linkway Shelter

1.4.1 Design

- 1.4.1.1 Covered Linkway connecting MRT/LRT stations or other high traffic routes identified by the Authority shall have a minimum roof width of 3.6m. All other covered linkways shall have a minimum roof width of 2.4m.
- 1.4.1.2 The covered linkway connection shall not obstruct any bus stop shelter address plate, bus stop pole or taxi pole.
- 1.4.1.3 If the existing bus address plate is blocked by covered linkway, the plate shall be relocated to the front of the bus stop shelter roof, facing the road.
- 1.4.1.4 Covered linkway is preferred to be connected at the rear of the bus stop/taxi shelter, to maintain minimum encroachment onto the road reserve.
- 1.4.1.5 Columns of covered linkway connecting bus stop shelter shall not obstruct the view of oncoming buses.
- 1.4.1.6 Supporting columns of covered linkway shall not be placed at the centre of the covered linkway passage and impeding the path of users. Column placement shall be on one side of the footpath and shall be nearer to the development side, if without site constraint.
- 1.4.1.7 Supporting columns of shelter shall not obstruct future path and widening of pedestrian crossing.
- 1.4.1.8 The route of the covered linkway shall be levelled. If there is a level difference, it must be addressed with ramps. Steps are not permitted.
- 1.4.1.9 Floor finish of covered linkway shall match the surrounding existing finishes.
- 1.4.1.10 Rainwater from covered linkway shelter roof shall not fall onto any existing roof of commuter infrastructure, within the road reserve.
- 1.4.1.11 For covered linkway abutting cycling path and shared path under covered linkway, refer to Commuter Infrastructure Volume C, Chapter 2 of the Active Mobility Requirements.

1.5 Pedestrian Overhead Bridge Shelter

1.5.1 Design

- 1.5.1.1 Roof of pedestrian overhead bridge, not connecting to any amenities shall terminate 1.5m beyond the first step of the staircase.
- 1.5.1.2 Planting and irrigation systems related to pedestrian overhead bridge shelter shall be considered, in consultation with NParks.

1.6 Pedestrian Overhead Bridge and Pedestrian Underpass

1.6.1 Location

- 1.6.1.1 To take into consideration the visual impact on the environment and any existing or future planned works in the vicinity, when locating pedestrian overhead bridge.
- 1.6.1.2 Pedestrian underpass entrance structures shall be located at strategic positions and easily identifiable for access.
- 1.6.1.3 The designer shall ensure that there shall be a clear line of sight for pedestrian overhead bridge/pedestrian underpass and footpath users at its exit / entrance. Sufficient landing space shall be provided at the exit / entrance of pedestrian overhead bridge/pedestrian underpass and designed for the safety of pedestrians and cyclists.

1.6.2 Provision

- 1.6.2.1 All pedestrian overhead bridges and pedestrian underpasses shall have stair access.
- 1.6.2.2 Ramp access shall be provided on both sides of the road at pedestrian overhead bridge and pedestrian underpass, that are across expressway.
- 1.6.2.3 The route of staircases/ramps shall be designed in accordance with anticipated pedestrian flow/route, where possible.
- 1.6.2.4 The placement of pedestrian overhead bridge staircases shall take precedence over ramps unless there are site constraints where certain arrangements are permitted.
- 1.6.2.5 All pedestrian overhead bridge and pedestrian underpass entrance shall be covered. They shall be accessible to the public, at all times.
- 1.6.2.6 Pedestrian overhead bridge and pedestrian underpass connecting building complexes shall have separate access to the road reserve or a separate 24hours direct access from the development.
- 1.6.2.7 All pedestrian overhead bridge linking adjoining development, MRT/LRT station and bus interchange shall be barrier free.
- 1.6.2.8 All pedestrian railing/handrail shall be stainless steel Grade 316.
- 1.6.2.9 Safety railings of overall height of 1.1m shall be provided at the staircase and/or ramp and bridge deck for pedestrian overhead bridge or pedestrian underpass. A separate continuous handrail, however, shall be fixed at 0.9m high within the staircase and/or ramp connecting to the bridge deck or pedestrian underpass. Child handrail shall be provided continuously along the staircase and ramp at 0.7m high from the tread and ramp.

- 1.6.2.10 Vehicular impact guardrail structure and anti-climbing railings shall be provided in accordance with the LTA Standard Details of Road Elements (SDRE). Other appropriate safety barriers may be provided as determined based on site conditions.
- 1.6.2.11 Pedestrian underpass with less than 50metres length shall have natural ventilation and if more than 50 metres length shall have mechanical ventilation. It shall comply with the prevailing Singapore Standards (SS) and Fire Safety Requirements.
- 1.6.3 Pedestrian Overhead Bridge Detailing
 - 1.6.3.1 All pedestrian overhead bridge decks, staircases and ramps shall have a minimum clear width of 2.0m.
 - 1.6.3.2 Provide confirmation from the Authority for the width of pedestrian overhead bridge linking MRT station.
 - 1.6.3.3 Pedestrian overhead bridge over expressway shall have a minimum headroom clearance of 5.7m from the road surface. All other pedestrian overhead bridges shall have a minimum headroom clearance of 5.4m from the road surface.
 - 1.6.3.4 For POBs, where the structure is below 5.7m, fixtures such as claddings are not allowed. For POBs above 5.7m, if cladding were to be provided, the soffit of the beam and 300mm above the soffit of the beam shall not be cladded. The claddings shall be such that they can be removed easily and reinstalled subsequently to facilitate inspections/repair works.
 - 1.6.3.5 The designer shall take measures to prevent any overlooking into adjoining developments.
 - 1.6.3.6 All parts of the pedestrian overhead bridge drainage system shall be accessible for inspection and routine maintenance work.
 - 1.6.3.7 Planting restriction zone (vegetation of not more than 500mm high) to be specified in the Tree Affected Plan or Site Plan submitted to Nparks to ensure visibility over any proposed planting.
 - 1.6.3.8 Provide bridge number to all new pedestrian overhead bridge. To consult LTA, CFM for the details.
- 1.6.4 Pedestrian Underpass Detailing
 - 1.6.4.1 Tiles with smooth finish shall be provided to walls of underpass for easy maintenance.

1.6.4.2 All arrangements for flood protection shall comply with requirements of PUB (Drainage). The height of all openings shall be considered, and it shall include the vent openings.

1.6.4.3 Pedestrian underpasses within the CBD or connecting to MRT stations or with shops along one side shall have:

- Minimum clear width- 6.0m
- Minimum ceiling height- 3.0m
- Minimum headroom- 2.4m

Underpasses with shops along both sides shall have:

- Minimum clear width- 7.0m
- Minimum ceiling height- 3.0m
- Minimum headroom- 2.4m

All other underpasses shall have:

- Minimum clear width- 4.5m
- Minimum ceiling height- 3.0m
- Minimum headroom- 2.4m

1.6.4.4 All services shall be concealed, and proper access shall be provided for maintenance of services.

1.7 Covered Walkway

1.7.1 Detailing

1.7.1.1 Provide cross-sections and longitudinal sections of covered walkway to show the floor levels, walkway width, soffit height and weather protection devices.

1.7.1.2 Soffit height for covered walkway shall be 3.6m. Where higher ceiling height is desired, cladding can be provided at the edge of the covered walkway to achieve the 3.6m height measured from the covered walkway floor level to the underside of the cladding.

1.7.1.3 Increase soffit height are allowed subject to the following circumstances:

- a) The walkway width is increased correspondingly to match the proposed soffit height to maintain the same angle.
- b) At main entrances for articulation purposes.
- c) From the urban design point of view.

1.7.1.4 Width of covered walkway shall be provided in accordance with Tables 3 and 4.

Table 3: Standard Covered Walkway Width Requirements in Central Area

LOCATION OF THE SITE	ALONG MAIN STREET		ALONG SIDE STREET	
	Minimum overall width	Minimum clear width	Minimum overall width	Minimum clear width
Within Central Area	3.6m	3.0m	3.0m	2.4m

Table 4: Standard Covered Walkway Width Requirements Outside Central Area

LOCATION OF THE SITE	ALONG ROAD CATEGORIES 2 & 3 **		ALONG ROAD CATEGORIES 4 & 5 **	
	Minimum overall width	Minimum clear width	Minimum overall width	Minimum clear width
Within 400m of all MRT stations outside the central area (to the nearest street block)	3.6m	3.0m	2.4m	2.0m
All other areas not covered above	3.0m	2.4m	2.4m	2.0m

Covered walkways are to be provided within and along the periphery of buildings, abutting major and minor roads and all these pedestrian routes except for independent residential, industrial, religious and institutional buildings which are setback from the boundaries.

*** For roads with heavy vehicle and pedestrian traffic, a wider walkway width may be required by the Competent Authority, subject to evaluation.*

- 1.7.1.5 The level of the proposed covered walkway shall match the level of the open walkway, wherever possible.
- 1.7.1.6 Any drain in between the covered walkway and the open walkway shall be slabbed over, subject to PUB's approval.
- 1.7.1.7 The covered walkway shall be connected to the open walkway (i.e., 1.8m width footpath link).

- 1.7.1.8 Where open and covered walkway are separated by driveways, cut-kerb ramps with tactile and pedestrian crossing lines shall be introduced.
- 1.7.1.9 New and existing road kerb lines, drains and plantings are to be shown on plan.
- 1.7.1.10 All ramps to car parks shall begin after the line of the covered walkway.
- 1.7.1.11 Minimum platform level for the development from PUB shall be reflected. Ramps/ steps required due to level difference between the covered walkway and the platform arising from PUB minimum platform level shall be absorbed within the building.
- 1.7.1.12 Sufficient spot levels at entrances, covered walkways, footpaths, roads and neighbouring walkways are to be specified on plan.
- 1.7.1.13 All doors shall not open into the covered walkway.
- 1.7.1.14 Covered walkway surrounding the development and linking open walkway to adjoining properties shall be barrier-free.
- 1.7.1.15 Where tile floor finishes are used; Qualified Person shall comply with prevailing Singapore Standard SS485 “Specification for Slip Resistance classification of pedestrian surface materials”. It shall comply with the prevailing ‘Code on Accessibility in The Built Environment’, for slip resistance. Checklist 8-Floor Finishes (for floor tiles) shall be submitted.

Checklist 1 - General Requirements for Bus Stop Shelter, Taxi/Pick-up/Drop-off Shelter, Covered Linkway Shelter, Pedestrian Overhead Bridge and Pedestrian Underpass

(✓)Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.1.1	General			
1.1.1.1	All shelters shall be designed to provide adequate weather protection. They shall be modulated and built with lightweight structure, to give a sleek and elegant appearance. They shall be robust to withstand all weather conditions.			
1.1.1.2	Where shelters, covered linkways, pedestrian overhead bridges, pedestrian underpasses or other transport facilities are connected, the design of the transport facilities and their respective covers shall be treated as a single entity, to maintain uniformity and consistency.			
1.1.1.3	There shall be no structural connection to any existing facility. The roof structure of bus stop, taxi/pick-up shelter and pedestrian overhead bridge shall be independent from any covered linkway.			
1.1.1.4	Provide minimum 10mm thick aluminium honeycomb roof panel with 1mm thick top panel for shelters that are to be handed over to LTA. Polycarbonate, glass, metal roman tiles, clay tiles or Teflon shall not be used as roof material. False ceilings are not permitted.			
1.1.1.5	The drainage design shall not create ponding on the floor. No channelling and discharging of surface water into the sheltered area.			
1.1.1.6	The drainage design of the roof shall not allow stagnation and splashing into the sheltered area.			
1.1.1.7	Floor finish at covered linkway shall be brushed cement screed. Floor finishes at bus stop shelter taxi /pick-up/drop-off shelter and pedestrian overhead bridge shall be granolithic finish, apart from those at underpasses and covered walkways, which may be tiled in line with the internal finish. The floor finish shall comply with the prevailing Singapore Standard SS485 "Specification for Slip Resistance classification of pedestrian surface materials" and with the prevailing 'Code on Accessibility in The Built Environment' for slip resistance. Checklist 8-Floor Finishes (for floor tiles) shall be submitted.			

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.1.1.8	Floor finishes on sloped area shall be rough textured finish.			
1.1.1.9	Minimum headroom of shelter shall be 2.4m.			
1.1.1.10	The lateral clearance between the outer edge of the road kerb shall be: -0.6m absolute to the roof eaves for covered linkway shelters, bus stop shelters and taxi shelter/ pick-up shelters to enable maximum sheltered area (apart from shelters with high roof) -0.6m minimum for all other structures and roadside furniture (e.g., over ground boxes, lamp pole, traffic signs, etc) except safety barriers.			
1.1.1.11	The circulation space under shelters shall be levelled. Any difference in level shall be addressed with slope/ ramp.			
1.1.1.12	Steps are not permitted at the alighting and boarding area of the bus stop and taxi /pick- up/drop-off shelter, passageway of the pedestrian underpass, pedestrian overhead bridge deck and covered linkway. The periphery access to the infrastructure shall be barrier free.			
1.1.1.13	For details of bus stop shelter, refer to LTA Standard Details of Road Elements (SDRE).			
1.1.1.14	For details of cycling path, refer to LTA Code of Practice - Street Work Proposals Relating to Development Works, LTA Standard Details of Road Elements (SDRE) & Walking & Cycling Design Guide.			
1.1.1.15	Ramp, step, handrail, nosing tile and tactile tile provisions shall comply with the prevailing 'Code on Accessibility in the Built Environment'.			
1.1.1.16	For M&E provision, refer to details in Commuter Infrastructure, Volume C, Chapter 3 of the M&E Services Requirements.			
1.1.1.17	All materials and finishes shall comply with the Architectural Materials and Workmanship (M&W) Specifications and Materials & Workmanship Specification for Civil & Structural Works.			
1.1.1.18	The interfacing and finishes of pedestrian overhead bridge, pedestrian underpass entrance structure, covered linkway, bus stop shelter, taxi shelter, pick-up/drop-off shelter and the adjacent facilities shall be designed to prevent rainwater from			

Clause	Standard Requirements	Complied	Not Complied	Remarks
	flowing and splashing onto the sheltered areas.			
1.1.1.19	For placement of 'No Riding' signs at pedestrian overhead bridge, refer to details in Commuter Infrastructure Volume C, Chapter 2 of the Active Mobility Requirements.			
1.1.1.20	All traffic signs traffic signs shall comply with Traffic Management's requirements.			
1.1.1.21	On application for plan approval, the Qualified Person shall submit the following information/documentation, where applicable: - Provide digital-coloured photographs of the affected bus stop shelter. - The direction of surface drainage shall be indicated on the floor and roof plan. - Road reserve line shall be indicated on the plans, elevations and sections.			
1.1.1.22	Overhanging signage and equipment on pavements shall have a height clearance of 2.4m.			
1.1.1.23	Anti-stick paint shall be applied to any newly built/installed commuter/road related facilities e.g., covered linkways, bus shelters, lampposts etc., 100m from MRT stations and bus interchanges.			

Notes:

- All compliances shall be clearly reflected in the drawings. This Checklist shall be submitted with other relevant Checklists.
- The QP shall state the reasons for all non-compliances in the 'Remarks' column of the Checklist.

 Name of Qualified Person

 Signature of Qualified Person

 Date

Checklist 2 - Bus Stop Shelter / Bus Bay

INFORMATION ON BUS STOP SHELTER / BUS BAY

Address: <div style="border-bottom: 1px solid black; margin: 5px 0;"></div> <i>(e.g., Road Name B01)</i> Bus Stop Code No: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <i>(e.g. 12345 obtain from existing bus stop pole)</i>										
Table 1- Sizing of Bus Stop Shelter Provide: a) Boarding Patronage figures per peak hour = _____ pax / peak hr <i>(Write into Bus Operations (BOPS) for the required information)</i> b) Existing bus shelter size = _____										
	Boarding passengers per peak hour	Size of Bus Shelter (width = 3m)	Please (✓)			Boarding passengers per peak hour	Size of Bus Shelter (width = 3m)	Please (✓)		
	200 or less	9 x 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	601 - 700	24 x 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	201 - 300	12 x 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	701 - 800	27 x 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	301 - 400	15 x 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	801 - 900	30 x 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	401 - 500	18 x 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	901 - 1000	33 x 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	501 - 600	21 x 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	above 1000	36 x 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Note: The minimum bus shelter size at MRT / LRT stations shall be 12m x 3.6m.										
Table 2- Sizing of bus bay(s): Total Bus Frequency = _____ buses/peak hr <i>(Write into Bus Operations (BOPS) for the required information)</i>										
Frequency of buses per peak hour: Bus bay type:										
	1-39	One single bus bay								
	40-59	One double bus bay								
	60-79	One triple bus bay								
	80-99	Two double bus bays (with 10m separation on the straight kerb)								
	100 and above	One double bus bay plus one triple bus bay (with 10m separation on the straight kerb).								
Note: Refer to LTA Standard Design Road Elements (SDRE) for details on design of bus bays.										

(✓)Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.2.1	Design			
1.2.1.1	To obtain boarding passenger data from Bus Operations (BOPS). The bus stop shelter shall not be smaller than the existing one. It shall be enlarged, if the current passenger boarding figures warrant it.			
1.2.1.2	Sizing of bus shelter shall be provided in accordance with Table 1.			
1.2.1.3	The minimum bus stop shelter size at MRT/LRT stations shall be 12m x 3.6m.			
1.2.1.4	For bus stop shelter with high roof, the roof shall extend over the bay to provide cover for boarding and alighting. The extended roof shall have a clear height of 4.8m clear from the finished road level. The roof eave shall setback 0.6m (absolute) from the main carriageway. To provide height limit sign at a clear height of 4.6m from the finished road level, according to Annex 9.			
1.2.1.5	The line of sight of oncoming buses shall be maintained throughout the entire bus stop shelter.			
1.2.1.6	Measures shall be taken to ensure the bus stop shelter is distinctive from any adjoining covered linkway.			
1.2.1.7	Rainwater from bus stop shelter roof shall not fall onto roof of existing commuter facilities, within the road reserve.			
1.2.2	Elements			
1.2.2.1	200 mm wide yellow band, 1.5mm non-slip thick thermoplastic paint, to be drawn 125mm from outer face of the road kerb and shall be provided from end to end of bay. For those without bay, the band will cover only the paved portion of the bus stop area and is to be indicated on plan. The hot applied Thermoplastic Road Marking Materials shall comply with BS 3262.			
1.2.2.2	Provide one bench for each 3m length module of shelter. The bench dimensions shall be minimum 1.2m (L) x 0.33m (D) x 0.45m (H). The benches shall be designed to prevent water stagnation on the surface. At least one third of the benches shall be fitted with armrest. Benches are not permitted in front of notice boards/information panels.			
1.2.2.3	Provide rain screen at the rear of bus stop shelter. Refer to LTA Standard Details of Road Elements (SDRE).			
1.2.2.4	A clear passage with minimum width of 1.8m shall be maintained between the benches and bollards.			

(✓)Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.2.2.5	Provide double-sided bus stop notice board/information panel (minimum 2 numbers) according to Annex A6. Where there is site constraint, single-sided bus stop shelter noticeboard/information panel (minimum 2 numbers) can be provided, see Annex A7. The noticeboard/information panel shall be mounted on a minimum of 10mm thick tempered and laminated glass frames on all side and shall be illuminated.			
1.2.2.6	Provide one number of 50mm diameter heavy-duty UPVC pipe electrical conduit with draw wires, (embedded underground) for advertisement panel. It shall be located from the OG box to advertisement panel, located at the downstream edge of the shelter. (For shelters to be handed over to LTA).			
1.2.2.7	Consult National Environment Agency (NEA) on the provision and placement of litter bin.			
1.2.2.8	Consult LTA Public Transport Promotion (PTP) on the provision, replacement or relocation of bus stop pole at the bus stop.			
1.2.2.9	Consult LTA Road Safety Engineering (RSED) on the provision of safety bollards at the newly constructed bus stop.			
1.2.2.10	Consult LTA Road Asset Regulation Licensing (RARL) on the provision of the bus stop shelter address.			
1.2.2.11	Inform LTA Bus Information System (BIS) of the GPS Co-ordinates and linked bus stop distance.			
1.2.3	Signage			
1.2.3.1	Bus stop address plate shall be provided and fixed onto the side of bus stop roof and to face oncoming traffic. Refer to Annex A8. If the bus stop address plate is blocked by interfacing structure, the plate has shall be placed at the front of the bus stop shelter roof, facing the road.			
1.2.3.2	Provide bus stop indicator sign for bus stop outside MRT stations only. Refer to Transit Signage Manual.			
1.2.3.3	Provide 'No Smoking' prohibition sign, according to Annex A10.			
1.2.4	Bus Bay			
1.2.4.1	Refer to LTA Standard Details of Road Elements (SDRE) on design of Bus Bay.			

(✓)Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.2.5	Sizing			
1.2.5.1	To obtain bus frequency data from Bus Operations (BOPS). Sizing of bus bay(s) to be provided in accordance with Table 2.			

Notes:

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- To read in conjunction with Checklist 1- General Requirements (Clauses 1.1.1 – 1.1.1.23).
- All compliances shall be clearly reflected in the drawings. Checklists shall be submitted.
- The QP shall state the reasons for all non-compliances in the ‘Remarks’ column of the checklists.

Name of Qualified Person_____
Signature of Qualified Person_____
Date

Checklist 3 - Taxi / Pick-up/ Drop-off Shelter

(✓) Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.3.1	Design			
1.3.1.1	Consult Taxi Service (TSV) on the provision and number of taxi bays. Provide the same number of bays for passenger pick-up /drop-off shelter.			
1.3.1.2	The minimum width of low roof taxi/pick-up/drop-off shelter shall be 2.5m and length of the shelter shall correspond with the number of taxi and pick-up /drop-off bays. Refer to Annex A1.			
1.3.1.3	For taxi shelter with high roof, the roof shall extend over the bay to provide cover for boarding. The extended roof shall have a clear height of 4.8m from the finished road level. The roof eave shall setback 0.6m (absolute) from the main carriageway (refer to Annex 3 & 4. To provide height limit sign at clear height of 4.6m from the finished road level, according to Annex A28.			
1.3.1.4	Provide a minimum of 3m buffer between the taxi bay and pick-up/drop-off bay.			
1.3.2	Elements			
1.3.2.1	Provide one number of 50mm diameter heavy duty UPVC electrical conduit with draw wires (embedded underground) for advertisement panel. It shall be located from the OG box to advertisement panel, at the downstream edge of the shelter (for shelters to be handed over to LTA).			
1.3.2.2	Provide at least two benches each at the taxi and pick-up/drop-off shelter. The dimensions of each bench shall be 1.2m(L) x 0.33m (D) x 0.45m(H). The benches shall be designed to prevent water stagnation on the surface. At least one third of the benches shall be fitted with armrest.			
1.3.2.3	Where road kerb could not be provided at frontage of shelter, bollards at 0.6m absolute from the road edge shall be provided. A clear width of between 1.5m to 3.0m shall be maintained between the bollards.			
1.3.3	Signage			
1.3.3.1	Provide a minimum of 2 numbers of taxi shelter noticeboards, according to Annex A22. They shall be placed beside the bench. The noticeboard (for taxi information) shall be mounted on a minimum of 10mm thick tempered and laminated glass framed on all sides and shall be illuminated.			

(✓) Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.3.3.2	Provide taxi identity sign, pick-up/drop-off sign pole according to Annexes A24 and A25.			
1.3.3.3	Provide overhead taxi queue sign, according to Annex A26 at the head of the queue coinciding with the arrow queue sign on the floor.			
1.3.3.4	Provide colour contrast queue arrow sign (on the floor) according to Annex A27. It shall be of non-slip finish, placed on the floor in front of the first bench for queuing.			
1.3.3.5	Provide 'No-Smoking' prohibition sign according to Annex A21.			

Notes:

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- To read in conjunction with Checklist 1- General Requirements (Clauses 1.1 – 1.1.1.23).
- All compliances shall be clearly reflected in the drawings. Checklists shall be submitted.
- The QP shall state the reasons for all non-compliances in the 'Remarks' column of the Checklists.

Name of Qualified Person_____
Signature of Qualified Person_____
Date

Checklist 4 - Covered Linkway Shelter

(✓) Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.4.1	Design			
1.4.1.1	Covered linkway connecting MRT/LRT stations or other high traffic routes identified by the Authority shall have a minimum roof width of 3.6m. All other covered linkways shall have a minimum roof width of 2.4m.			
1.4.1.2	The covered linkway connection shall not obstruct any bus stop shelter address plate, bus stop pole or taxi pole.			
1.4.1.3	If the existing bus address plate is blocked by covered linkway, the plate shall be relocated to the front of the bus stop shelter roof, facing the road.			
1.4.1.4	Covered linkway is preferred to be connected at the rear of the bus stop/taxi shelter, to maintain minimum encroachment onto the road reserve.			
1.4.1.5	Columns of covered linkway connecting bus stop shelter shall not obstruct the view of oncoming buses.			
1.4.1.6	Supporting columns of covered linkway shall not be placed at the centre of the covered linkway passage and impeding path of users. Column placement shall be on one side of the footpath and shall be nearer to the development side, if without site constraint.			
1.4.1.7	Supporting columns of shelter shall not obstruct future path and widening of pedestrian crossing.			
1.4.1.8	The route of the covered linkway shall be levelled. If there is a level difference, it must be addressed with ramps. Steps are not permitted.			
1.4.1.9	Floor finish of covered linkway shall match the surrounding existing finishes.			
1.4.1.10	Rainwater from covered linkway shelter roof shall not fall onto any existing roof of commuter infrastructure, within the road reserve.			
1.4.1.11	For covered linkway abutting cycling path and shared path, refer to Commuter Infrastructure Volume C, Chapter 2 of the Active Mobility Requirements.			

Notes:

- The clause numbers are not in sequence, to tally with IDC, Volume C, Chapter 1 document.
- To read in conjunction with Checklist 1- General Requirements (Clauses 1.1.1 – 1.1.1.23).
- All compliances shall be clearly reflected in the drawings. Checklists shall be submitted.
- The QP shall state the reasons for all non-compliances in the 'Remarks' column of the Checklists.

Name of Qualified Person

Signature of Qualified Person

Date

Checklist 5 - Pedestrian Overhead Bridge

(✓) Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.5.1	Design			
1.5.1.1	Roof of pedestrian overhead bridge, not connecting to any amenities shall terminate 1.5m beyond the first step of the staircase.			
1.5.1.2	Planting and irrigation systems related to pedestrian overhead bridge shelter shall be considered, in consultation with N Parks.			
1.6.1	Location			
1.6.1.1	To take into consideration the visual impact on the environment and any existing or future planned works in the vicinity, when locating pedestrian overhead bridge.			
1.6.1.2	Pedestrian underpass entrance structures shall be located at strategic positions and easily identifiable for access.			
1.6.1.3	The designer shall ensure that there shall be a clear line of sight for pedestrian overhead bridge and footpath users at its exit / entrance. Sufficient pedestrian overhead bridge landing space shall be provided at the exit/entrance of pedestrian overhead bridge and designed for the safety of pedestrians and cyclists.			
1.6.2	Provision			
1.6.2.1	All pedestrian overhead bridges shall have stair access.			
1.6.2.2	Ramp access shall be provided on both sides of the road at pedestrian overhead bridge, that are across expressway.			
1.6.2.3	The route of staircases/ramps shall be designed in accordance with anticipated pedestrian flow /route, where possible.			
1.6.2.4	The placement of pedestrian overhead bridge staircases shall take precedence over ramps unless there are site constraints where certain arrangements are permitted.			
1.6.2.5	All pedestrian overhead bridge shall be covered. They shall be accessible to the public, at all times.			
1.6.2.6	Pedestrian overhead bridge connecting building complexes shall have separate access to the road reserve or a separate 24hours direct access from the development.			
1.6.2.7	All pedestrian overhead bridge linking adjoining development, MRT/LRT station and bus interchange shall be barrier free.			
1.6.2.8	All pedestrian railing/handrail shall be stainless steel Grade 316.			

(✓) Tick the appropriate column for all item

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.6.2.9	Safety railings of overall height of 1.1m shall be provided at the staircase and/or ramp and bridge deck for pedestrian overhead bridge. A separate continuous handrail shall be fixed at 0.9m high within the staircase and/or ramp connecting to the bridge deck. Child handrail shall be provided continuously along the staircase and ramp at 0.7m high from the tread and ramp.			
1.6.2.10	Vehicular impact guardrail structure and anti-climbing railings shall be provided in accordance with the LTA Standard Details of Road Elements (SDRE). Other appropriate safety barriers may be provided as determined based on site conditions.			
1.6.3	Detailing			
1.6.3.1	All pedestrian overhead bridge deck, staircase and ramp shall have minimum clear width of 2.0m.			
1.6.3.2	Provide confirmation from the Authority for the width of pedestrian overhead bridge, linking MRT station.			
1.6.3.3	Pedestrian overhead bridge over expressway shall have a minimum headroom clearance of 5.7m from the road surface. All other pedestrian overhead bridges shall have a minimum headroom clearance of 5.4m from the road surface.			
1.6.3.4	For POBs, where the structure is below 5.7m, fixtures such as claddings are not allowed. For POBs above 5.7m, if cladding were to be provided, the soffit of the beam and 300mm above the soffit of the beam shall not be cladded. The claddings shall be such that they can be removed easily and reinstalled subsequently to facilitate inspections/repair works.			
1.6.3.5	The designer shall take measures to prevent any overlooking into adjoining developments.			
1.6.3.6	All parts of the pedestrian overhead bridge drainage system shall be accessible for inspection and routine maintenance work.			
1.6.3.7	Planting restriction zone (vegetation of not more than 500mm high) to be specified in the Tree Affected Plan or Site Plan submitted to Nparks to ensure visibility over any proposed planting.			
1.6.3.8	Provide bridge number to all new pedestrian overhead bridge. To consult LTA, Commuter Facilities Management (CFM) for the details.			

Notes:

- The clause numbers are not in sequence, to tally with IDC, Volume C, Chapter 1 document.
- To read in conjunction with Checklist 1- General Requirements (Clauses 1.1.1 – 1.1.1.23).
- All compliances shall be clearly reflected in the drawings. Checklists shall be submitted.
- The QP shall state the reasons for all non-compliances in the ‘Remarks’ column of the Checklists.

Name of Qualified Person

Signature of Qualified Person

Date

Checklist 6 - Pedestrian Underpass

(✓) Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.6.1	Location			
1.6.1.2	Pedestrian underpass entrance structures shall be located at strategic positions and easily identifiable for access.			
1.6.1.3	The designer shall ensure that there shall be a clear line of sight for pedestrian underpass and footpath users at its exit / entrance. Sufficient pedestrian underpass landing space shall be provided at the exit/entrance of pedestrian underpass and designed for the safety of pedestrians and cyclists.			
1.6.2	Provision			
1.6.2.1	All pedestrian underpasses shall have stair access.			
1.6.2.2	Ramp access shall be provided on both sides of the road at pedestrian underpass that are across expressway.			
1.6.2.3	The route of staircases/ramps shall be designed in accordance with anticipated pedestrian flow/route, where possible.			
1.6.2.5	All pedestrian underpass entrance shall be covered. They shall be accessible to the public, at all times.			
1.6.2.6	Pedestrian underpass connecting building complexes shall have separate access to the road reserve or a separate 24hours direct access from the development.			
1.6.2.8	All pedestrian railing/handrail shall be stainless steel Grade 316.			
1.6.2.9	Safety railings of overall height of 1.1m shall be provided at the staircase and/or ramp of pedestrian underpass. A separate continuous handrail, however, shall be fixed at 0.9m high at ramp connecting to pedestrian underpass. Child handrail shall be provided continuously along the staircase and ramp at 0.7m high from the tread and ramp.			
1.6.2.10	Vehicular impact guardrail structure and anti-climbing railings shall be provided in accordance with the LTA Standard Details of Road Elements (SDRE). Other appropriate safety barriers may be provided as determined based on site conditions.			
1.6.2.11	Pedestrian underpass with less than 50metres length shall have natural ventilation and if more than 50 metres length shall have mechanical ventilation. It shall comply with the prevailing Singapore Standards (SS) and Fire Safety Requirements.			

(✓) Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.6.4	Detailing			
1.6.4.1	Tiles with smooth finish shall be provided to walls of pedestrian underpass for easy maintenance.			
1.6.4.2	All arrangements for flood protection shall comply with requirements of PUB (Drainage). The height of all openings shall be considered, and it shall include the vent openings.			
1.6.4.3	<p>Pedestrian underpasses within the CBD or connecting to MRT stations or with shops along one side shall have:</p> <ul style="list-style-type: none"> - Minimum clear width- 6.0m - Minimum ceiling height- 3.0m - Minimum headroom- 2.4m <p>Underpasses with shops along both sides shall have:</p> <ul style="list-style-type: none"> - Minimum clear width- 7.0m - Minimum ceiling height- 3.0m - Minimum headroom- 2.4m <p>All other underpasses shall have:</p> <ul style="list-style-type: none"> - Minimum clear width- 4.5m - Minimum ceiling height- 3.0m - Minimum headroom- 2.4m 			
1.6.4.4	All services shall be concealed, and proper access shall be provided for maintenance of services.			

Notes:

- The clause numbers are not in sequence, to tally with IDC, Volume C, Chapter 1 document.
- To read in conjunction with Checklist 1- General Requirements (Clauses 1.1.1 – 1.1.1.23).
- All compliances shall be clearly reflected in the drawings. Checklists shall be submitted.
- The QP shall state the reasons for all non-compliances in the 'Remarks' column of the Checklists.

Name of Qualified Person_____
Signature of Qualified Person_____
Date

Checklist 7- Covered Walkway

(Integrated with buildings)

(✓) Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
1.7.1	Detailing			
1.7.1.1	Provide cross-sections and longitudinal sections of covered walkway to show the floor levels, walkway width, soffit height and weather protection devices.			
1.7.1.2	Soffit height for covered walkway shall be 3.6m. Where higher ceiling height is desired, cladding can be provided at the edge of the covered walkway to achieve the 3.6m height measured from the covered walkway floor level to the underside of the cladding.			
1.7.1.3	Increased soffit height can be allowed in the following circumstances: a) The walkway width is increased correspondingly to match the proposed soffit height to maintain the same angle. b) At main entrances for articulation purposes. c) From the urban design point of view.			
1.7.1.4	Width of covered walkway shall be provided in accordance with Tables 3 & 4.			
1.7.1.5	The level of the proposed covered walkway shall match the level of open walkway wherever possible.			
1.7.1.6	Any drain in between the covered walkway and the open walkway shall be slabbed over subject to PUB approval.			
1.7.1.7	The covered walkway shall be connected to the open walkway (i.e., 1.8m footpath link).			
1.7.1.8	Where open and covered walkway are intercepted by driveways, cut-kerb ramps with tactile and pedestrian crossing lines shall be introduced.			
1.7.1.9	New and existing road kerb lines, drains and plantings are to be shown on plan.			
1.7.1.10	All ramps to car parks shall begin after the line of the covered walkway.			
1.7.1.11	Minimum platform level for the development from PUB shall be reflected. Ramps/ steps required due to level difference between the covered walkway and the platform arising from PUB minimum platform level shall be absorbed within the building.			
1.7.1.12	Sufficient spot levels at entrances, covered walkways, footpaths, roads and neighbouring walkways are to be specified			

(✓) Tick the appropriate column for all items

Clause	Standard Requirements	Complied	Not Complied	Remarks
	on plan.			
1.7.1.13	All doors shall not open into the walkway.			
1.7.1.14	Covered walkway surrounding the development and linking open walkway to adjoining properties shall be barrier free.			
1.7.1.15	Where tile floor finishes are used; Qualified Person shall comply with prevailing Singapore Standard SS485 “Specification for Slip Resistance classification of pedestrian surface materials”. It shall comply with the prevailing ‘Code on Accessibility in The Built Environment’, for slip resistance. Checklist 8-Floor Finishes (for floor tiles) shall be submitted.			

Table 3: Standard Covered Walkway Width Requirements in Central Area

LOCATION OF THE SITE	ALONG MAIN STREET		ALONG SIDE STREET	
	Minimum overall width	Minimum clear width	Minimum overall width	Minimum clear width
Within Central Area	3.6m	3.0m	3.0m	2.4m

Table 4: Standard Covered Walkway Width Requirements Outside Central Area

LOCATION OF THE SITE	ALONG ROAD CATEGORIES 2 & 3 **		ALONG ROAD CATEGORIES 4 & 5 **	
	Minimum overall width	Minimum clear width	Minimum overall width	Minimum clear width
Within 200m of all MRT stations outside the central area (to the nearest street block)	3.6m	3.0m	2.4m	2.0m
All other areas not covered above	3.0m	2.4m	2.4m	2.0m

Covered walkways are to be provided along the periphery of buildings abutting major and minor roads and all pedestrian routes except for independent residential, industrial, religious and institutional buildings which are setback from the boundaries.

** For roads with heavy vehicle and pedestrian traffic, a wider walkway width may be required by the Competent Authority subject to evaluation.

Notes:

- All compliances shall be clearly reflected in the drawings. Checklists shall be submitted.
- The QP shall state the reasons for all non-compliances in the ‘Remarks’ column of the Checklists.

Name of Qualified Person

Signature of Qualified Person

Date

Checklist 8 - Floor Finishes (for floor tiles)

Pursuant to The Street Works Act and its Regulations

Material Used: _____ (e.g., granite, homogeneous tiles etc)

(✓) Tick the appropriate box for all items

Item	Standard Requirements	Complied	Not Complied	Remarks
1.	The proposed finished floor shall provide a safe and hazard free environment. Any potential risks with appropriate mitigating measures shall be identified.			
2.	Submit full information on the proposed material for open walkways to be maintained by LTA. (brand/ country of origin/ name of manufacturer & supplier/ brochures/ product reference etc.)			
3.	Comply to Slip Resistance (Coefficient of friction for dry & wet.) SS485:2011 for "Slip resistance classification of public pedestrian surface materials".			
4.	Comply to surface hardness according to Moh's scale 7.			
5.	The material selected shall comply to the respective water absorption and compressive strength test requirements of a recognised regulatory body, e.g., Enterprise Singapore.			
6.	The material selected shall have joints that are adequately spaced to cater for movement to prevent debonding.			
7.	The material selected shall comply with any applicable URA Development Control requirements for the particular location.			

Notes:

- The QP shall state the reasons for all non-compliances in the 'Remarks' column.
- A separate checklist shall be completed and submitted for each separate material.
- Nothing shall be construed to exempt any person from otherwise complying with the provision of the Street Works Act and its Regulations, the rules made thereunder and all other written laws for the time being in force.
- Any standard used for compliance must be recognised by Enterprise Singapore.
- Test reports of floor materials are not required, to be submitted.

Name Of Qualified Person

Signature of Qualified Person

Date

CHAPTER 2 - ACTIVE MOBILITY REQUIREMENTS

Table of Contents

2.1 Active Mobility Requirements	3
2.1.1 General	3
2.2 Road Side Elements	3
2.2.1 Footpaths	4
2.2.2 Design	4
2.2.3 Materials	5
2.3 Cycling Path	5
2.3.1 Intra-town cycling paths	6
2.3.2 Cycling path with tiles finish	7
2.3.3 Inter-town cycling paths	7
2.3.4 Design	7
2.3.5 Materials	8
2.4 Pedestrian Priority Zone	9
2.4.1 Design	9
2.5 Standard Typologies Table	10
2.5.1 MRT station structure and cycling path	11
2.5.2 Commuter infrastructure and cycling path	12
2.5.3 Summary of standard width	13
2.6 Securing space for active mobility infrastructure	14
2.7 Lighting for active mobility public path	16
2.7.1 Placement of cycling path lamp posts	16
2.7.2 Design of cycling path lighting	17
2.8 Crossing features	17
2.8.1 Mid-block crossings	17
2.8.2 Provision criteria / guidelines	17
2.8.3 Design	18
2.9 Junction crossings	19
2.9.1 Provision criteria / guidelines	19
2.9.2 Design	19
2.10 Grade separated crossings	19
2.10.1 Pedestrian overhead bridge (POB) with cycling features	20
2.10.2 Cycling bridge	22
2.10.3 Footbridges	25
2.10.4 Underpass (underground links)	25
2.10.5 Lifts	25
2.11 Bicycle Parking	27
2.11.1 Bicycle Parking Provision	27
2.11.2 MRT / LRT Stations	28
2.11.3 Bicycle parking along roadside and backlane	29
2.12 Bicycle Parking Design	29
2.12.1 U-bar racks	30
2.12.2 Double tiered racks	31
2.12.3 Yellow bicycle parking boxes	32
2.12.4 Security and Fire Safety requirements	33
2.13 Signage	33
2.13.1 Wayfinding Signs	34

2.13.2	Bicycle Parking Signs (MRT stations)	34
2.13.3	Purpose.....	36
2.13.4	Obtaining Assets	36
2.13.5	Bicycle Parking Signs (other areas)	40
2.13.6	Sign Fixing	40
2.13.7	Material and construction	41
2.14	Mandatory Signs	42
2.14.1	No Riding Sign	42
2.14.2	Shared Track Sign	44
2.15	Advisory Signs	45
2.16	Wayfinding Mapboard	45
2.16.1	Design.....	45
2.16.2	Electrical Works	46

2.1 Active Mobility Requirements

2.1.1 General

- 2.1.1.1 Active Mobility is a form of transport that uses the physical activity of human being for the movement. The most well-known forms of active mobility are walking and cycling. Running, riding personal mobility devices (PMD) (e.g. kick scooter, e-scooter, unicycle, hoverboard, etc) and personal mobility aid (PMA) (e.g. wheelchair, motorised wheelchair, mobility scooter, etc) are also forms of active mobility.
- 2.1.1.2 This chapter aims to facilitate and improve the process of planning and designing active mobility infrastructures for e.g. cycling path at high conflict areas, designing bicycle parking space at MRT stations etc. It guides private developers, the building industry, consultants and government agencies in providing information covering planning, design considerations and implementation on various active mobility infrastructure and facilities integrating into the overall transport system.

2.2 Roadside Elements

2.2.1 Footpaths

- a) Typical footpaths range from 1.2m to 1.5m today. New standalone footpaths have been increased from 1.5m to 1.8m, which is sufficient for two typical wheelchair users to pass each other. However, where there is projected high pedestrian volume, footpath widths of more than 1.8m should be considered. Footpaths are classified as Type 2 public paths under Active Mobility Act. It has a maximum speed limit of 10kph. Please refer to Annex B2 for classification of Path Types.



New footpath

- b) Some footpaths may be adjacent to cycling paths (i.e. footpath that abuts directly next to 2m cycling path). At such locations, given that cycling paths may be used by pedestrians and wheelchair users to manoeuvre around

obstacles, a minimum of 1.5m is recommended as the dedicated width of the pedestrian footpath.



Footpath next to a cycling path

- c) However, when the cycling path is not directly abutting the footpath (e.g. separated by green verge in the middle) the footpath to be 1.8m wide.

2.2.2 Design

- a) Footpaths should be barrier-free and the footpath level to be consistent throughout for enhanced walking experience.



Consistent level of footpath with multiple accesses

2.2.3 Materials

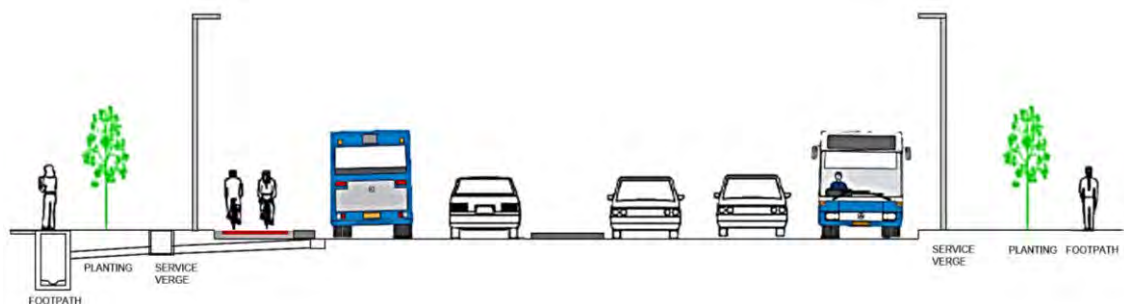
- a) Concrete is used for footpaths because it is skid resistant ($BPN \geq 45$) and durable. Good levelling and workmanship of floor finishes should be ensured.
- b) At central area, tiles are likely used for aesthetic purposes, but skid resistance must be maintained the same. At locations with estate upgrading, pebble wash or concrete with inprints footpaths may be implemented.

2.3 Cycling Path

- a) Cycling paths are dedicated paths designed to facilitate safer movement among pedestrians, cyclists & personal mobility device (PMD) users (include e-scooters, skate scooters). It is classified as Type 3 public path in Active Mobility Act. While it is catered for cyclists, PMD users and PAB (power assisted bicycles) riders, other users such as pedestrians and wheelchair users are also allowed on it. The maximum allowable speed limit is 25kph.

2.3.1 Intra-town Cycling Paths

- a) Intra-town cycling paths facilitate short distance trips within the town and connect cyclists to major public transport nodes (e.g. MRT stations, bus interchanges) & key amenities such as neighbourhood town centres.
- b) A minimum of 2m is recommended as the dedicated width of the cycling path (for bi-directional use). Please refer to Section 2.4 for the footpath and cycling path placement.
- c) Dedicated cycling paths should meet the minimum standards, as guided in the LTA Standard Details of Road Element (SDRE) - Chapter 21, along with an adjacent 1.5m footpath. Appropriate typology and junction treatment should be followed.
- d) Where segregated (split) cycling paths (SCP) are required, the path should be at least 2m wide and meet the minimum standards required, green verge separation, along with an adjacent 1.8m footpath. A minimum buffer of 0.6m is required to offset the cycling path from the kerb line. Appropriate junction treatment should be followed.



Segregated cycling path

2.3.2 Cycling paths with tiles finish

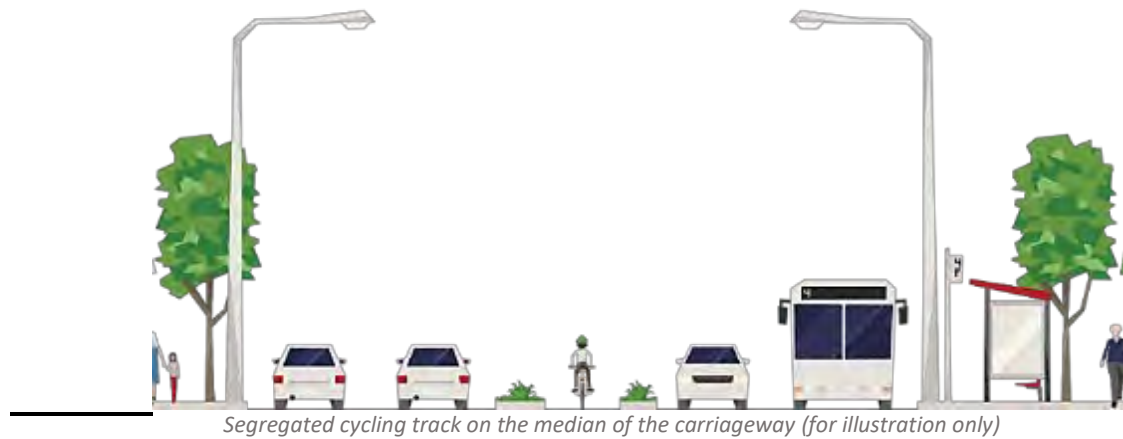
- a) Where the floor is of tile finish, two continuous solid red line is used to demarcate the cycling path. Yellow lines markings to be applied on red colour floor finishes only.



Two continuous solid red lines on a 2m cycling path with tiles finishing

2.3.3 Inter-town Cycling Paths

- a) Inter-town routes facilitate commuting, recreational and longer distance trips to connect people between towns, as well as to the city.
- b) Inter-town cycling paths to be at least 2.5m wide and meet minimum standards guidelines in the SDRE.
- c) Where segregated (split) cycling paths (SCP) are required, the path should be at least 2.5m wide and meet the minimum standards required. Similar to intra-town cycling paths, it should be separated from adjacent 1.8m footpath by a green verge. A minimum buffer of 0.6m is required to offset the cycling path from the kerb line. Appropriate junction treatment should be followed.
- d) Where centre median cycling tracks are required, the track should be at least 2.5m wide for any single direction and meet the minimum standards required. A centre median is not required to separate the opposing travelling directions on the cycling track. A minimum buffer of 0.6m is required to offset the cycling track from the fastest travelling lane on the road. Typology should only be employed for a meaningful stretch of travelling distance.



2.2.4 Design

- a) For cycling / shared path on same level as driveway / carriageway and having the same floor finishes, physical barriers (e.g. concrete kerb) shall be incorporated as an added safety precautionary measures to prevent motorist from travelling into the path.
- b) Where cycling path is within developments' private boundary, the cycling path treatments (e.g. markings, logos and signs) shall be clearly differentiated from LTA cycling path SDRE standard requirements (e.g. colour of the marking) so that the public & enforcement officers can easily differentiate between public & private paths. If the Developer wishes to adopt LTA cycling path SDRE standard requirements, Developer's own logo or name shall be incorporated on the cycling path marking, logos and signs.
- c) Cycling paths should be extended to the next signalised junction and not stop abruptly at bus-stops, development accesses, to allow cyclists to have a proper transition to footpaths.
- d) There should not be any sharp turns (<90 degree) along standalone cycling paths. Instead, a gentle taper with minimum turning radius of 6.5m or 18m and alignment following the kerb line where possible should be implemented.
- e) Any structure (e.g. signs, CCTV, POB beam, covered linkway etc.) that overhangs along the cycling/ shared path / footpath shall have a minimum clear height of 2.4m.
- f) Should there be any resting areas (usually comprises of bench / seat and wheelchair parking space) along the cycling path, the area shall be recessed and clear from the cycling path. Please refer to BCA Universal Design Guide for Public Places detailed requirements.

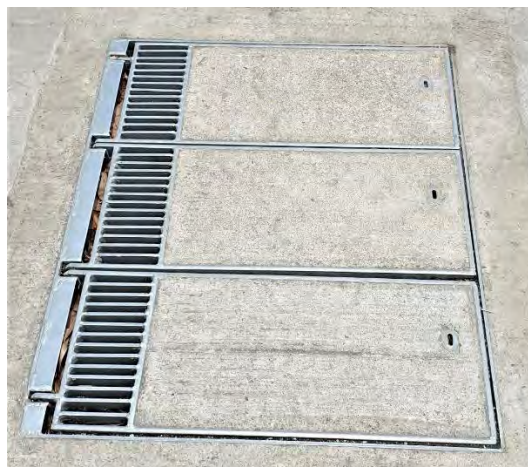
2.3.5 Materials

- a) Cycling paths are to be demarcated using high strength coating system with skid resistance ≥ 45 BPN and coloured with paint code RAL3011 (Red). Markings should be painted with RAL 1003 (Yellow).
- b) For concrete path, coating with coloured high strength coating system or equivalent (colour: RAL 3011 & RAL 1003) over the footpath with bicycle logos painted at intervals is to be applied.
- c) For path with tiles surface finishing, the cycling path is demarcated by 2 continuous solid line of 100mm with cyclist and pedestrian logos painted at regular intervals. The colour scheme is RAL 3011 or RAL 1003 with coloured high strength coating system or equivalent.



Cycling path demarcation and markings on tiles finishes

- d) Material use for the cycling / shared path shall comply with SS485:2011 – Specification for Slip Resistance Classification of Pedestrian Surface Materials (Coefficient of friction for dry & wet).
- e) Gratings on shared path shall be of concrete in-filled type. Please refer to LTA Standard Details of Road Element (SDRE) – Chapter 4 for the design and detail.



Typical concrete in-filled grating

- f) For cycling path with tiles finish, the grating in-filled shall match with the existing floor finishes for aesthetic purposes but skid resistance shall be maintained the same. Please refer to Section 2.1.2 for skid resistance requirements.



Typical in-filled grating matched with existing floor finishes

2.4 Pedestrian Priority Zone

2.4.1 Design

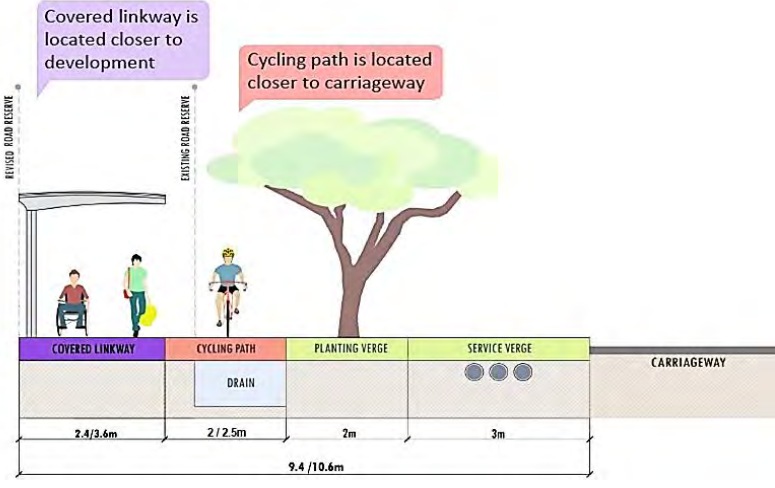
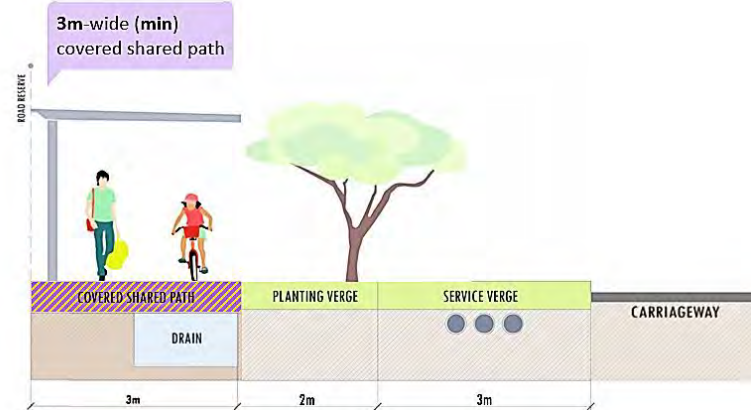
- a) A Pedestrian Priority Zone (PPZ) is a special zone applied in areas with high potential of conflict between active mobility users, usually implemented behind bus stops to inform cyclists that they should look out for pedestrians. PPZs will also be implemented at the waiting area of pedestrian crossings, taxi-stands, MRT entrances and pick-up drop-off points.
- b) Features of PPZ
- Beside the normal set (i.e. which is a set of 6 strips applied before and after crossing/access) of **rumble strips** to slow down the cyclists, additional rumble strips (i.e. a set of 3 strips) are also installed;
 - **No continuation of the red colour path** to alert cyclists that this is a high pedestrian conflict area;
 - **Continuous dash red line markings** to guide pedestrians and cyclists on where they should travel;
 - **“Give Way To Pedestrians” signs** before entrance into PPZ;
 - Addition supplementary **“SLOW” sign** may be used where necessary;
 - **“LOOK”** ground markings to highlight to pedestrians to look out for cyclists.

- c) Please refer to LTA Standard Details of Road Element (SDRE) - Chapter 21 for cycling path treatments and specifications of cycling path logos and markings.

2.5 Standard Typologies Table

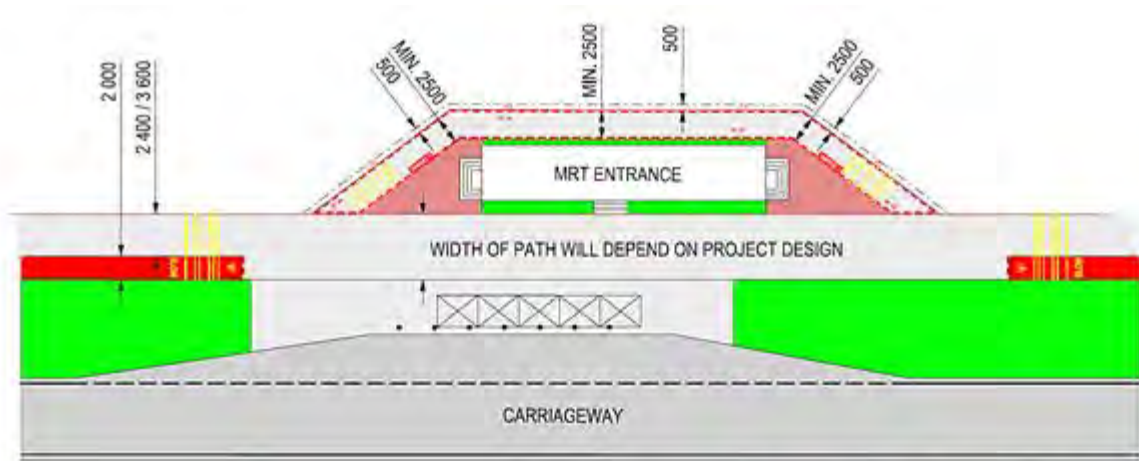
- a) Please refer to table below for the different typologies of cycling path.

Typology	Diagram	Description
Footpath and Cycling Path	<p>Footpath If there is an adjacent cycling path, the standard footpath is 1.5m wide and located closer to development</p> <p>Cycling Path Standard cycling path is 2m for intra-town routes and 2.5m for inter-town routes and located closer to carriageway</p> <p>REVISED ROAD RESERVE EXISTING ROAD RESERVE</p> <p>FOOTPATH CYCLING PATH PLANTING VERGE SERVICE VERGE CARRIAGEWAY</p> <p>1.5m 2m 2m 3m 8.5m</p> <p><i>Typical placement of cycling path and footpath (for illustration only)</i></p>	The placement of cycling path and footpath are according to the gradation of speeds with the cycling path closer to carriageway and footpath closer to developments.
Bus Stop and Footpath / Cycling Path	<p>ROAD RESERVE</p> <p>1.5m-wide footpath</p> <p>Cycling path behind bus stop is designated as Pedestrian Priority Zone</p> <p>FOOTPATH CYCLING PATH BUS STOP BUS BAY</p> <p>1.5m 2m</p> <p><i>Typical placement of cycling path & footpath behind bus stop (for illustration only)</i></p>	Where a bus stop is planned, the footpath or cycling path should be aligned behind the bus stop to create more space and to facilitate commuters boarding and alighting.

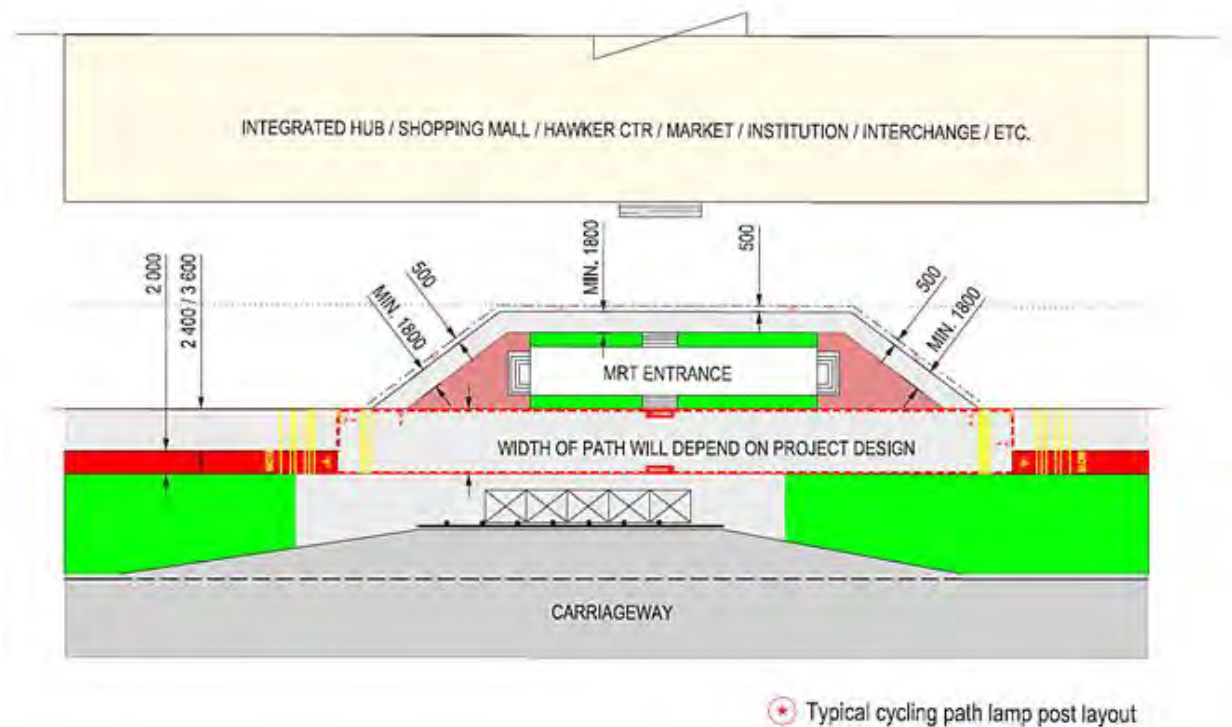
<p>Cycling Path and Covered Linkway</p>	 <p>Typical placement of cycling path and covered linkway (for illustration only)</p>	<p>Where there is covered linkway, the placement of covered linkway is closer to development.</p>
<p>Shared Covered Linkway and Cycling Path</p>		<p>Where there are space constraints to provide 2m dedicated cycling path next to covered linkway, a 3m shared covered linkway and shared path is to be provided.</p>

2.5.1 MRT station structure and Cycling Path

- Where MRT stations structures open up to face the carriageway and linking to bus stops, taxi stands / pick-up drop-off points, a minimum of 2.5m wide shared path / 1.8m wide footpath (for MRT structure that link to development) should be routed behind the station structure to facilitate commuters entering and exiting. An additional 0.5m wide shall also be catered for the provision of cycling path lamp posts routed behind the station structure. The design of the paths near to aboveground MRT structures shall respect the local context and topography and be located such that it does not obstruct or cause any line of sight issues between MRT commuters and the users in the surrounding pedestrian and cycling network. Designers have to take note that if the detour to the cyclists is too far, cyclists may still choose to use more direct route. The typology of footpath & cycling path will also be swapped (i.e. footpath is nearer to the carriageway instead of cycling path) if cycling path is routed behind the station box.
- Please refer to LTA Standard Details of Road Element (SDRE) - Chapter 21 for cycling path treatments and specifications of cycling path logos, markings and signs.



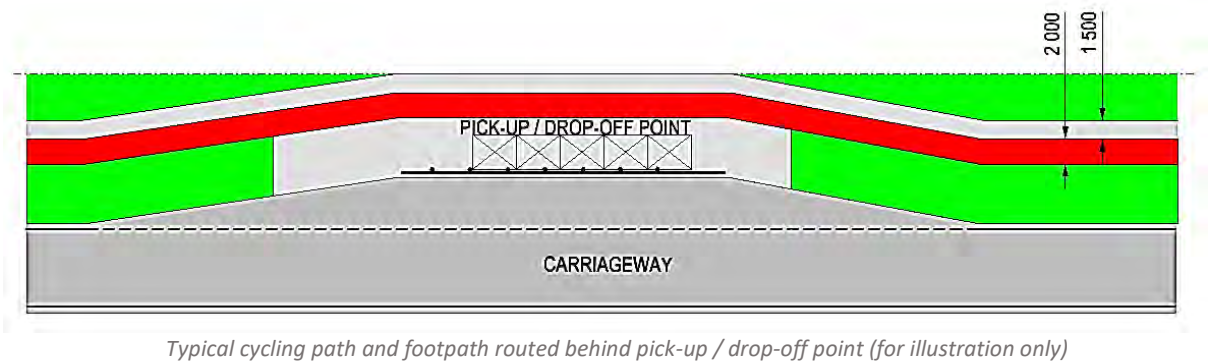
Typical space allocation for cycling path and footpath routed behind MRT station structure (for illustration only)



Typical space allocation for cycling path and footpath when MRT station structure link to development (for illustration only)

2.5.2 Commuter Infrastructure and Cycling Path

- a) Where there are facilities with commuter pick-up and drop-off expected, like taxi stands and pick-up drop-off points, cycling paths should be routed behind these facilities to minimise conflict points between pedestrians and cyclists.



2.5.3 Summary of standard width

- a) Active Mobility Act (AMA) governs the type of active mobility devices that is allowed on the different type of paths and the maximum allowable speed. Below is the table on the various public path (Please refer to Annex B2 for more details)

Element	Standard minimum width (m)	Type
Type 1	Varies	Pedestrian only path
Type 2	Typically 1.5 - 1.8	Footpath (max speed 10kph)
Type 3	2.0 (Intra-town) 2.5 (Inter-town) 4.8 for Cycling Bridge (1.8 for Footpath & 2.5 for Cycling Path + 0.5 buffer to railing)	Cycling path / shared path* (max speed 25kph) Nparks' PCN (park connectors)
	4.4 (2.4 for Covered Linkway & 2.0 for Cycling Path)	Covered linkway & Cycling path

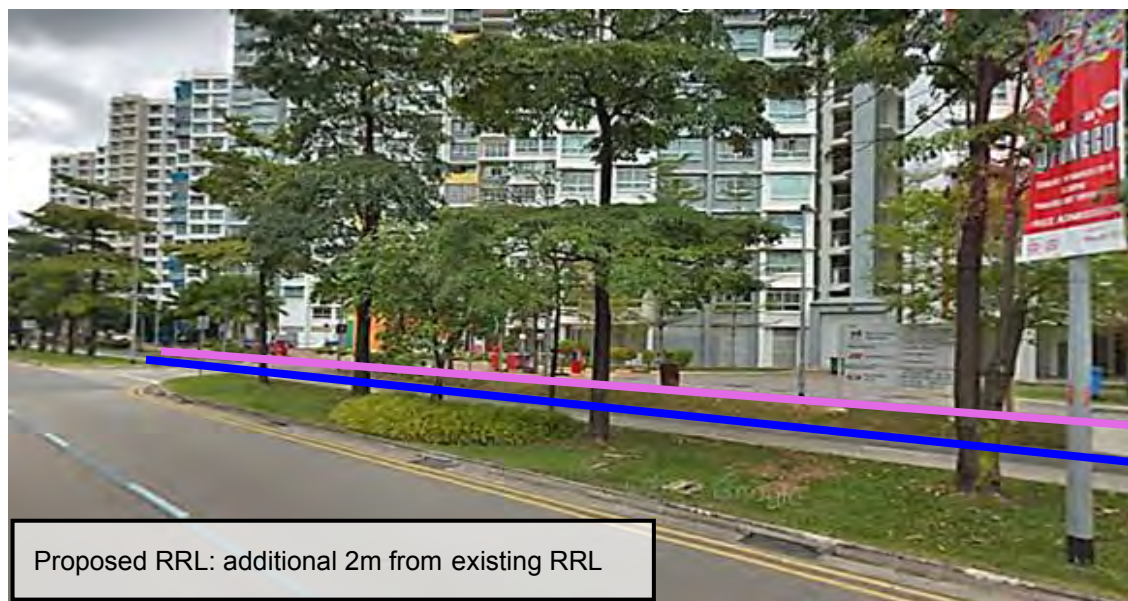
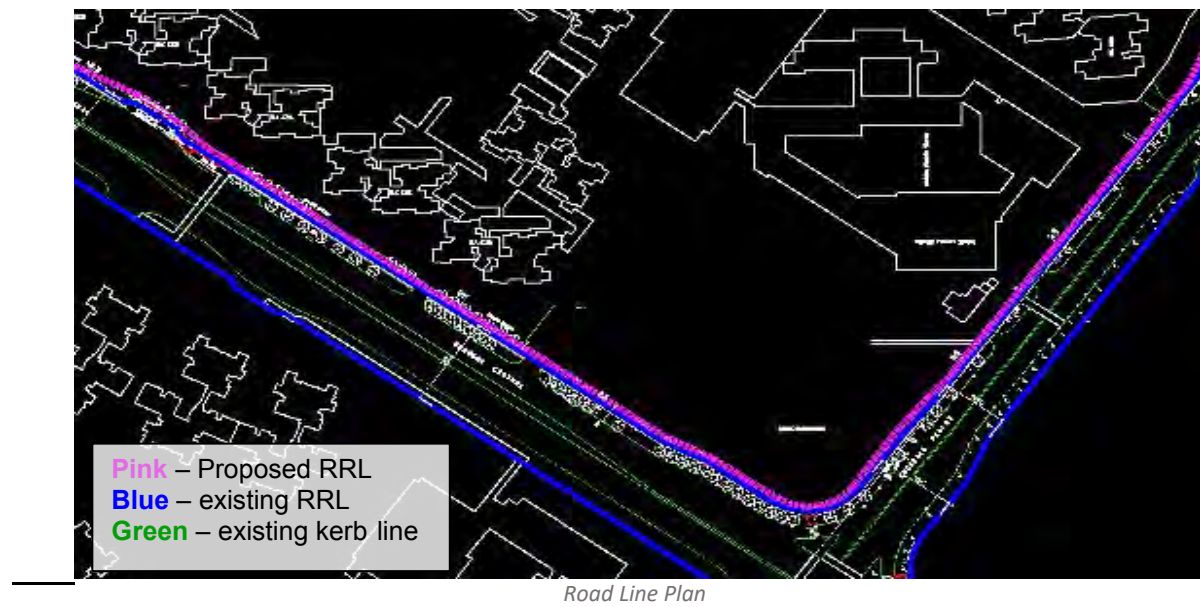
**Shared path does not have a clear demarcation line between footpath & cycling path. The maximum allowable speed limit is at 25km/h.*

2.6 Securing space for Active Mobility Infrastructure

2.6.1 Full standard side table with standard width shall be safeguarded with updated Road Line Plan.

<div>Major Arterial Road</div> <div><div>Appendix 8C - Roads in Residential Area for Public Housing</div><div>Major Arterial Roads</div><div><table><thead><tr><th>Number of Lanes</th><th>Central Divider (m)</th><th>Carriage-way (m)</th><th>Verge & Services (m)</th><th>Tree Planting (m)</th><th>Footpath Cum Drain (m)</th><th>Road Reserve (m)</th></tr></thead><tbody><tr><td>4</td><td>4.00</td><td>2 x 7.40</td><td>2 x 3.00</td><td>2 x 2.00</td><td>2 x 1.50</td><td>31.80</td></tr><tr><td>6</td><td>4.00</td><td>2 x 10.80</td><td>2 x 3.00</td><td>2 x 2.00</td><td>2 x 1.50</td><td>38.60</td></tr></tbody></table></div><div>Figure 8.7 Dual-Carriage Way Roads</div></div>	Number of Lanes	Central Divider (m)	Carriage-way (m)	Verge & Services (m)	Tree Planting (m)	Footpath Cum Drain (m)	Road Reserve (m)	4	4.00	2 x 7.40	2 x 3.00	2 x 2.00	2 x 1.50	31.80	6	4.00	2 x 10.80	2 x 3.00	2 x 2.00	2 x 1.50	38.60	<div>Proposed RRL to offset from existing kerbline</div> <div><div>1) Cycling path only : $6.5 + 2 = 8.5\text{m}$</div><div>2) Cycling path + covered linkway : $6.5 + 0.5 + 2.4 = 9.4\text{m}$</div><div>3) Bus shelter without bus-bay = $5 + 3.5 = 8.5\text{m}^*$</div><div>4) Bus shelter with bus-bay = $3.8 + 3.5 = 7.3\text{m}^*$</div><div>5) Bus shelter + cycling path + covered linkway = $3.8 + 2 + 2.4 = 8.2\text{m}^*$</div><div>6) Taxi shelter + cycling path + footpath = $3.1 + 2 + 1.5 = 6.6\text{m}^*$</div><div>7) Taxi shelter + cycling path + covered linkway = $3.1 + 2 + 2.4 = 7.5\text{m}^*$</div></div>
Number of Lanes	Central Divider (m)	Carriage-way (m)	Verge & Services (m)	Tree Planting (m)	Footpath Cum Drain (m)	Road Reserve (m)																
4	4.00	2 x 7.40	2 x 3.00	2 x 2.00	2 x 1.50	31.80																
6	4.00	2 x 10.80	2 x 3.00	2 x 2.00	2 x 1.50	38.60																
<div>Primary Access Road</div> <div><div>Primary Access Road</div><div><table><thead><tr><th>Number of Lanes</th><th>Central Divider (m)</th><th>Carriage-way (m)</th><th>Verge & Services (m)</th><th>Tree Planting (m)</th><th>Footpath Cum Drain (m)</th><th>Road Reserve (m)</th></tr></thead><tbody><tr><td>4</td><td>0.60</td><td>2 x 7.40</td><td>2 x 3.00</td><td>2 x 2.00</td><td>2 x 1.50</td><td>26.20</td></tr></tbody></table></div><div>Figure 8.8 Divided Two-Way Roads (4 Lanes)</div></div>	Number of Lanes	Central Divider (m)	Carriage-way (m)	Verge & Services (m)	Tree Planting (m)	Footpath Cum Drain (m)	Road Reserve (m)	4	0.60	2 x 7.40	2 x 3.00	2 x 2.00	2 x 1.50	26.20	<div>Proposed RRL to offset from existing kerbline</div> <div><div>1) Cycling path only : $5.4 + 2 = 7.4\text{m}$</div><div>2) Cycling path + covered linkway : $5.4 + 0.5 + 2.4 = 8.3\text{m}$</div></div>							
Number of Lanes	Central Divider (m)	Carriage-way (m)	Verge & Services (m)	Tree Planting (m)	Footpath Cum Drain (m)	Road Reserve (m)																
4	0.60	2 x 7.40	2 x 3.00	2 x 2.00	2 x 1.50	26.20																
<div>Primary Access Road</div> <div><div>Primary Access Road</div><div><table><thead><tr><th>Number of Lanes</th><th>Central Area (m)</th><th>Carriage-way (m)</th><th>Verge & Services (m)</th><th>Tree Planting (m)</th><th>Footpath Cum Drain (m)</th><th>Road Reserve (m)</th></tr></thead><tbody><tr><td>2</td><td>10.00</td><td>2 x 3.00</td><td>2 x 3.00</td><td>2 x 2.00</td><td>2 x 1.50</td><td>18.00</td></tr></tbody></table></div><div>Figure 8.9 Undivided Two-Way Roads</div></div>	Number of Lanes	Central Area (m)	Carriage-way (m)	Verge & Services (m)	Tree Planting (m)	Footpath Cum Drain (m)	Road Reserve (m)	2	10.00	2 x 3.00	2 x 3.00	2 x 2.00	2 x 1.50	18.00	<div>Proposed RRL to offset from existing kerbline</div> <div><div>1) Cycling path only : $4 + 2 = 6\text{m}$</div><div>2) Cycling path + covered linkway : $4 + 0.5 + 2.4 = 6.9\text{m}$</div></div>							
Number of Lanes	Central Area (m)	Carriage-way (m)	Verge & Services (m)	Tree Planting (m)	Footpath Cum Drain (m)	Road Reserve (m)																
2	10.00	2 x 3.00	2 x 3.00	2 x 2.00	2 x 1.50	18.00																

**Bus & taxi shelter safeguarding to apply accordingly to all types of road reserve*

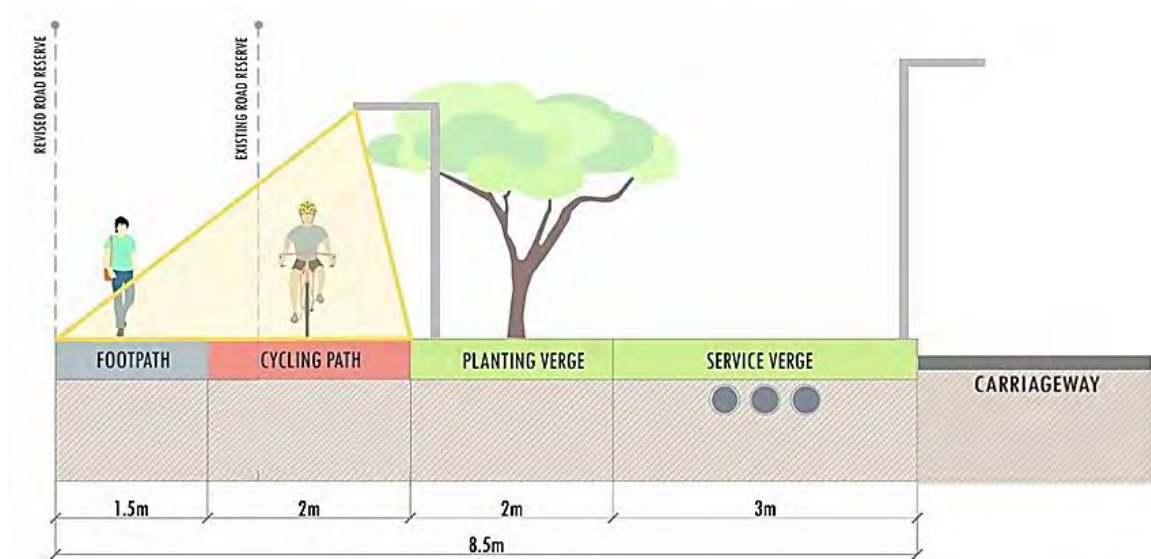


Road Line Plan – Site (for illustration only)

2.7 Lighting for Active Mobility Public Path

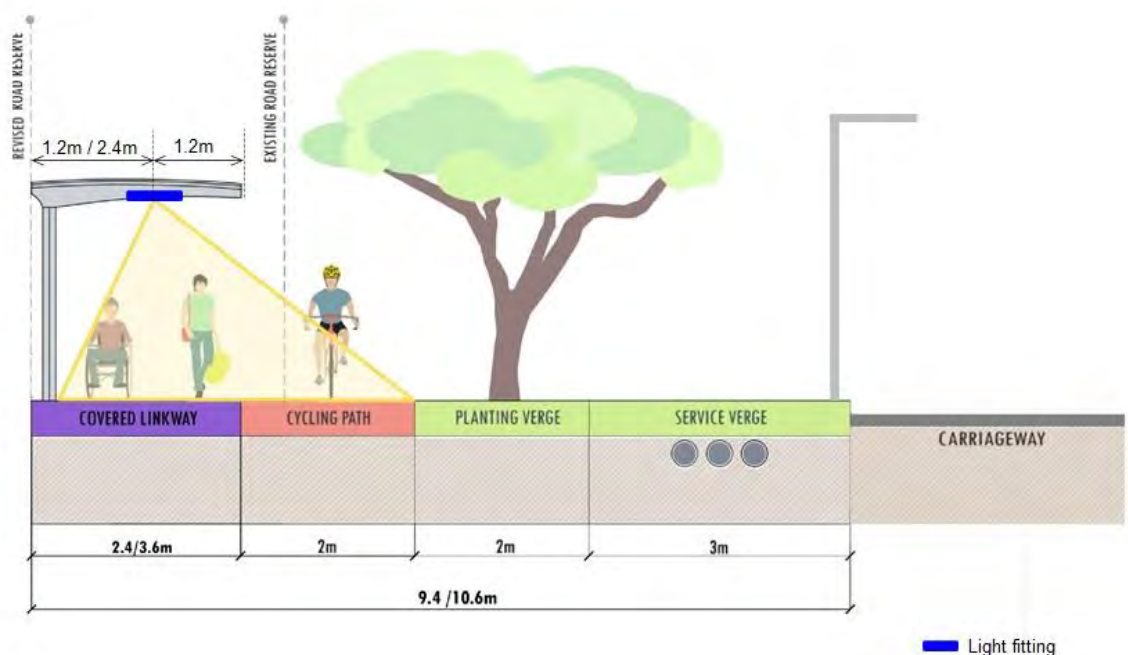
2.7.1 Placement of cycling path lamp posts

- a) Lamp posts abutting the edge of the cycling path, including cycling path behind MRT entrance (refer to diagram on Section 2.4.1), are placed along planting verge within road reserve between trees to avoid the tree roots. Other locations may be considered if there are land constraints, subject to case-by-case assessment. However, the location needs to be within state land and not alienated/private land (e.g. HDB/JTC land). Please refer to LTA Public Street Lighting Guidelines for cycling path lighting requirements as well as drawings and guidelines on the submission of design drawings.



Typical placement of cycling path lamp post along planting verge (for illustration only)

- b) Where a cycling path is next to a covered linkway, the lighting from the covered linkway shall be utilised to light up the cycling path. Please refer to IDC, Volume C, Chapter 3, Section 3.4.2 for lighting requirements.



Typical illuminance spill over from covered linkway to cycling path (for illustration only)

2.7.2 Design of cycling path lighting

- Please refer to LTA Public Street Lighting Guidelines for lighting requirements as well as drawings and guidelines on the submission of design drawings and also IDC, Volume C, Section 3, Mechanical & Electrical (M&E) Services Requirements.
- Where a cycling path is next to a covered linkway, the lighting is suggested to be shared between the cycling path and the covered linkway to minimise land required for dedicated lamp posts.

2.8 Crossing Features

2.8.1 Mid-Block Crossings

2.8.2 Provision Criteria / Guidelines

- Mid-block pedestrian crossings are usually implemented near key transport nodes, developments, amenities and between a pair of bus stops on opposite sides of the road that generate high volume of pedestrian activity. They can be designed as a one-stage or two-stage crossing depending on the road geometry, traffic volume and crossing span.
- One-stage design pedestrian crossing is perceived to be more convenient for pedestrians and cyclists as it has shorter waiting time. However, for wider roads with a wide centre divider, a two-stage crossing is catered so that the walking distance can be split with a break in between. This helps to

accommodate pedestrians with a slower walking pace without overly affecting the delay to vehicular traffic.

- c) All new mid-block crossings should be designed to have a bicycle crossing alongside the pedestrian crossing, since cyclists are allowed on footpaths.
- d) Where there is ongoing cycling path implementation and nearby development works, existing mid-block pedestrian crossing will be retrofitted with bicycle crossings.
- e) Where there is an existing wider crossing (e.g. >3m), additional 2m is required to cater for high pedestrian and cyclist's volume.

2.8.3 Design

- a) A dedicated bicycle crossing is 3m wide, identical to dimensions of a pedestrian crossing. Instead of a homogenous tactile tile, a “Look” box should be provided for cyclists to align themselves at the bicycle crossing waiting area. At the bicycle crossing area, the traffic signal should also show a bicycle logo signal linked to the pedestrian signal phasing.
- b) The bicycle crossing should be located at the side of pedestrian crossing (PC) which is most natural for cyclists and face minimal conflicts.
- c) Please refer to LTA Standard Details of Road Element (SDRE) – Chapter 21 for more details.
- d) Vegetation ahead of the crossings should be kept at low height (max. height of 0.5m). Stopping sight distance is dependent on the road speed limit (please refer to LTA Civil Design Criteria (CDC) – Chapter 10).



Typical Mid-Block Crossing

2.9 Junction Crossings

2.9.1 Provision Criteria / Guidelines

- a) Where there are cycling paths on both ends of a signalised traffic junction, the pedestrian crossing should be widened to 5m. This also applies to connecting zebra crossings across slip roads of junctions.
- b) Similar treatments are also applicable to connecting Park Connector.
- c) For treatment at unsignalized traffic junction, the raised zebra crossing should be widened to 4m.
- d) Please refer to LTA Standard Details of Road Element (SDRE) – Chapter 21 for more details.

2.9.2 Design

- a) Waiting area should be assessed and widened to ensure no overspill of pedestrians, cyclists & PMD users. This include removal of slip road to create more waiting space.
- b) Vegetation ahead of the crossings should be kept at low height (max. height of 0.5m). Stopping sight distance is dependent on the road speed limit (please refer to LTA Civil Design Criteria CDC – Chapter 10).

2.10 Grade Separated Crossings

2.10.1 Pedestrian Overhead Bridge (POB) with cycling features

2.10.1.1 Provision Criteria / Guidelines

- a) POBs are generally provided across wide lane roads (\geq dual 2) to facilitate safe pedestrian crossing movements across heavy traffic roads.
- b) POB is classified at Type 1 – pedestrian only path in Active Mobility Act (AMA). All new POB needs to be installed with “No Riding Sign”. Please refer to section 5.2.1 for more details on signs and placement of signs.



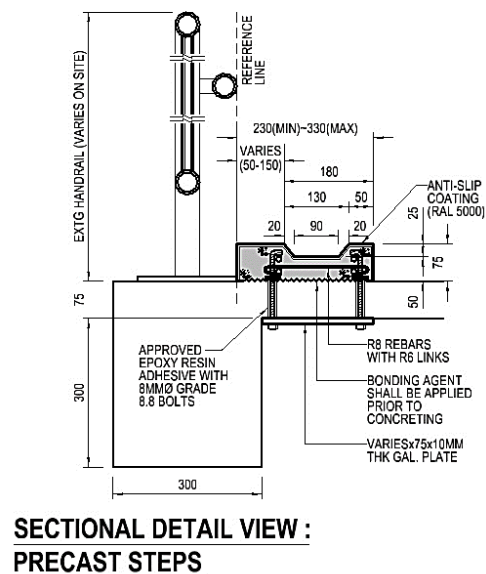
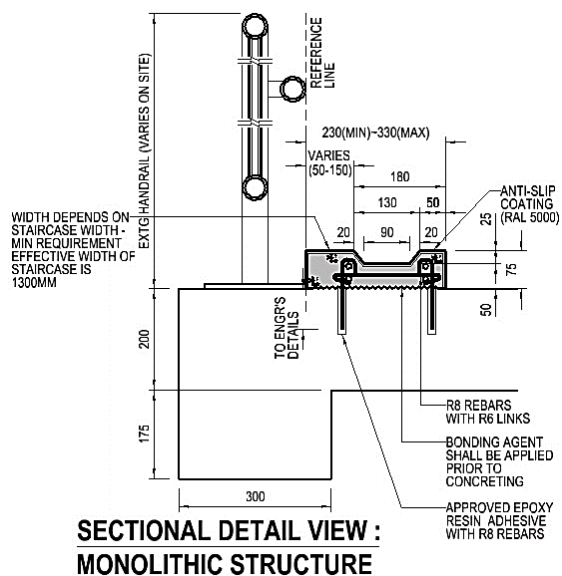
Typical POB across wide lane

2.10.1.2 Design

- a) For lifts to POB, please refer to section 3.3.5
- b) Existing or new staircase/lift landing of pedestrian overhead bridge sometimes hinder the sight distance of users. Where required existing footpath/ new POB should be designed with adequate sight distance & minimal conflict among users along the footpath. Where possible, 2m cycling path & 1.5m footpath should be designed to route behind the POB for cyclists / PMD users' convenience as well as for safety purpose.
- c) Sufficient landing area shall be provided when lift /ramp /stairs lead to cycling path / footpath. Please refer to BCA Code on Accessibility in The Built Environment for landing details and requirements.
- d) Bicycle wheeling ramps are implemented at locations where there is no at-grade crossings within 100m on either side of the POB, barrier-free ramp or lift. This also applies to staircases within developments.
- e) The recommended width of wheeling ramp varies between 230mm and 330mm. The remaining passable width of staircase after installation of the wheeling ramp should be at least 1500mm. The recommended width of the wheeling channel is 130mm and constructed in varying widths between 50mm and 150mm from the railing/low handrail to the avoid catching of pedals or handle bars. A smooth transition onto and off the ramp is recommended. Minimally, one side of the staircase shall be equipped with lower handrail.
- f) A smooth transition onto and off the ramp is recommended. Designer have to take into consideration the steepness of the POB.



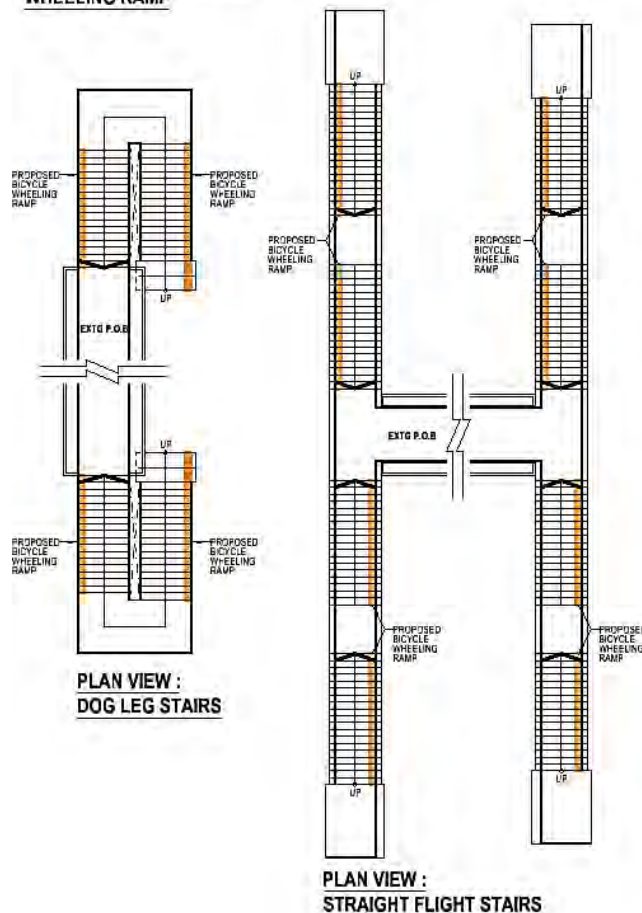
Typical Bicycle Wheeling Ramp at POB staircases



Bicycle Wheeling Ramp Sectional Details

- g) Straight legged staircases: The wheeling ramp is recommended to be placed on the right going up direction of the stairs as most cyclists are right-handed.
- h) Dog-legged staircases: The wheeling ramp is recommended to be placed on the outer side of the stairs since the constraint is the turning point at the inner part of the staircases.

**POSITIONING OF BICYCLE
WHEELING RAMP**



Positioning of bicycle wheeling ramp

2.10.1.3 Materials

- a) The surface of the wheeling ramp is recommended to have anti-slip finish of skid resistance within the range of 45 to 60 BPN to ensure sufficient grip on descend. Finishing colour is recommended to be blue RAL5000 or equivalent. Surface water runoff through the wheeling channel should also be taken into consideration to prevent water ponding.

2.10.2 Cycling Bridges

2.10.2.1 Provision Criteria / Guidelines

- a) To provide connectivity, cycling bridges can be used to overcome physical barriers, (e.g. canals, expressways and terrain differences). Unlike pedestrian overhead bridges that require cyclists to dismount and push their bicycles, cycling bridges provide seamless commuting for all users - cyclists, pedestrians, joggers, personal mobility device users and persons with disabilities.

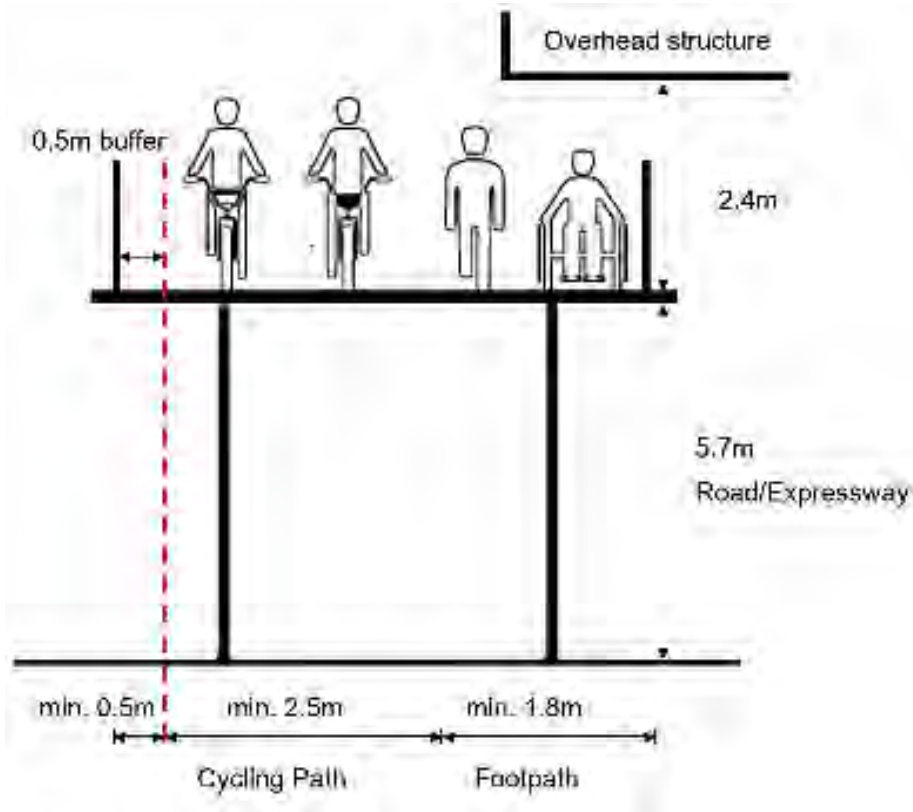


Cycling Bridge (for illustration only)

2.10.2.2 Design

- a) Cycling elevated structures are vertically separated from motor vehicle traffic (e.g. expressways, roads, rail tracks) or water bodies (e.g. river, canals).
- b) A minimum clear width of 4.8m for all elevated cycling structures is recommended - minimum 1.8m for pedestrians, 2.5m for cyclists and 0.5m buffer with demarcation. The design should take into consideration space allocated for railings.

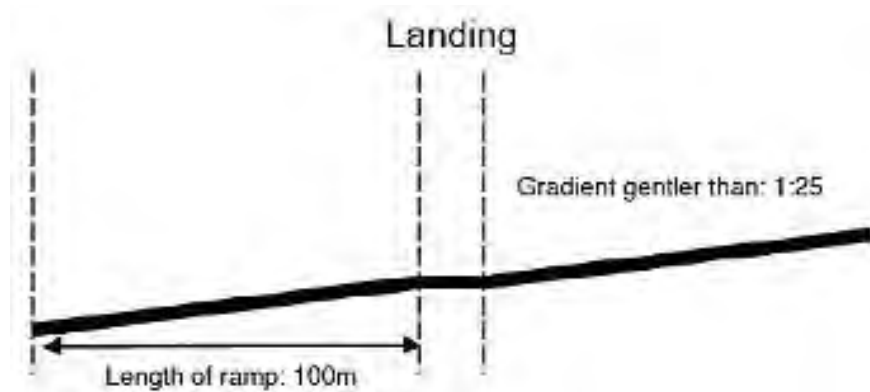
- c) The above standard provides necessary manoeuvring space to minimise conflicts between pedestrians and cyclists.
- d) Proper treatment (e.g. traffic calming measures) should be provided when the elevated structure merges onto the existing street. Safety sight distance to be taken into consideration to minimise potential conflicts.



Cycling elevated structure width and height requirements

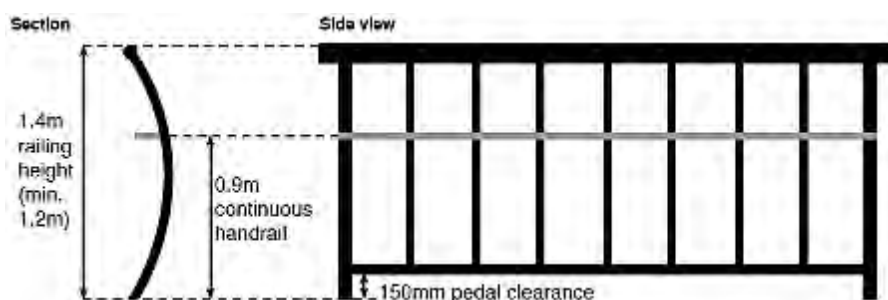
- e) Headroom clearance is the distance measured from the base of structure to the surface of ground. The minimum recommended headroom clearance of the cycling elevated structure over expressways and roads is 5.7m from the road surface. The bridge should also design for a full collision load on super structures in accordance with the latest NA to SS EN 1994 : 2009-2011 – Singapore National Annex to Eurocode – Design of Composite Steel and Concrete Structure.
- f) Please consult PUB on further guidelines for cycling bridges across canal.
- g) Vertical clearance is the minimum vertical distance from the floor of the cycling bridge to the overhead structures. Taking into consideration the average height of a cyclist and diameter of a bicycle wheel, the recommended minimum vertical clearance is 2.4m.
- h) The access ramp of the bridge is recommended to have a minimum 4.8m clear width. For ease of cycling up the ramp, a gradient gentler than 1:25 (4%) is recommended. A gradient break with a level landing of minimally 5m

is recommended for every 100m of ramp to allow at least two bicycles to rest abreast of one another.



Gradient of the ramp requirements

- i) All railings are recommended to be 1.4m high and should use stainless steel Grade 316 with a minimum buffer of 150mm pedal clearance at the bottom of the railing.
- j) A continuous handrail should also be provided along the staircase and ramp at 0.9m high from the thread and ramp.



Railing requirements

- k) The minimum radius of 18m is recommended to be applied using the design speed of 25km/hr.
- l) Drainage system should be designed such that surface runoff is properly discharged to drains to prevent water ponding. Effective drainage should continue to be provided for the area around and in the vicinity of these crossings.
- m) Continuous planting troughs are recommended to be provided on both sides of the cycling bridge with additional lateral buffer on top of the minimum 4.8m along the portions that cross over roads is recommended. Please consult NParks for more details on planting requirements. Measures such as calming devices (e.g. speed regulating strips), curve widening, signage, chevron marking, convex mirror and safe stopping sight distance should be considered in the design to address potential safety issues.

- n) To direct users to their destinations, wayfinding signage should be provided near decision points with multiple access or exit points, or when access points are difficult to locate.

2.10.3 Footbridges

- a) Footbridges are generally Type 2 public path, following the path type upstream & downstream. It has to be designed to be safe to use by pedestrians and cyclists with a minimum railing height of 1.4m with level difference & not overly steep gradient (1:12)

2.10.4 Underpass

- a) Connecting ramps to underpass is to be designed at 1:25 gradient and without sharp bends and blind corners.
- b) Measures such as calming devices (e.g. speed regulating strips), curve widening, signage, chevron marking, convex mirror and safe stopping sight distance should be considered in the design to address potential safety issues.



Typical ramp to underpass

2.10.5 Lifts

2.10.5.1 Bicycle lifts within RTS stations

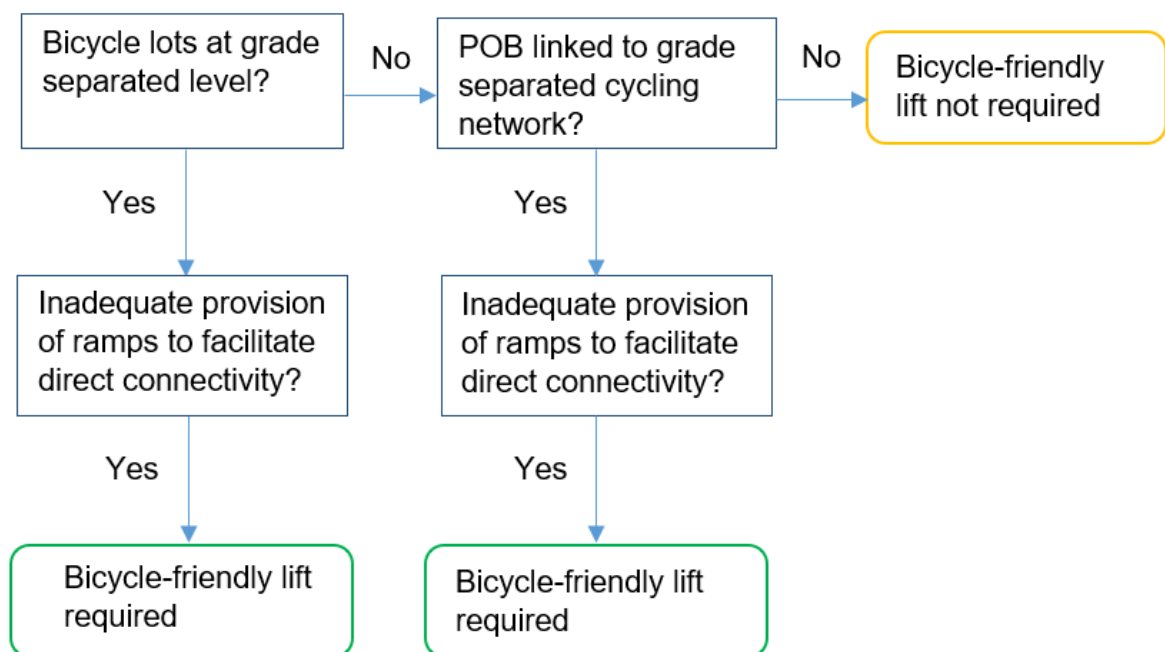
- a) A bicycle friendly lift shall be able to accommodate at least one horizontally standing bicycle. User-friendly access point from outside of development to bike parking and end-of-trip facilities.

2.10.5.2 Bicycle lifts at POBs linked to grade-separated bicycle lots or cycling network

- a) The provision of bicycle friendly lifts to a POB (pedestrian overhead bridge) requires few criteria as shown below

Bicycle friendly lift required when at least 1 set of these criteria are fulfilled	
<ul style="list-style-type: none"> Bicycle lots at grade-separated level <p>And</p> <ul style="list-style-type: none"> Inadequate provision of ramps to facilitate direct connectivity 	<ul style="list-style-type: none"> POB linked to grade-separated cycling network <p>And</p> <ul style="list-style-type: none"> Inadequate provision of ramps to facilitate direct connectivity

2.10.5.3 Flowchart for Bicycle Lifts at POBs linked to grade-separated bicycle lots or cycling network



2.11 Bicycle Parking

2.11.1 Bicycle Parking Provision

2.11.1.1 Provision Criteria / Guidelines

- a) Bicycle parking provisions at **MRT stations** is planned based on multiple factors : whether the stations are origin or destination stations, the number of dwelling units around the stations, among others.
- b) Origin / destination stations are identified primarily using net projected ridership, with origin stations situated typically in residential towns and destination stations in city central and industrial parks. Bicycle parking norms for the respective stations are scaled based on significant factors determined through regression analysis and these factors (like dwelling units, connectivity via cycling paths and worker dormitories). A range of bicycle parking provisions for origin and destination stations is indicated in the table below.
- c) The Authority should be consulted when proposing and determining the number of bicycle parking lots at MRT stations.

Station Class	No. of dwelling units	Bicycle Parking Lot Provisions
Origin Stations*	< 7000	250
	7000 - 20,000	550
	> 20,000	800
*within 1.5km radius of the MRT station plus additional 80 lots per foreign worker dormitory in the vicinity		

Station Class	No. of industrial buildings	Bicycle Parking Lot Provisions
Destination Stations*	< 20	130
	> 20	180
*plus additional 50 lots per foreign worker dormitory in the vicinity minus 80 lots if the station is integrated with a bus interchange		

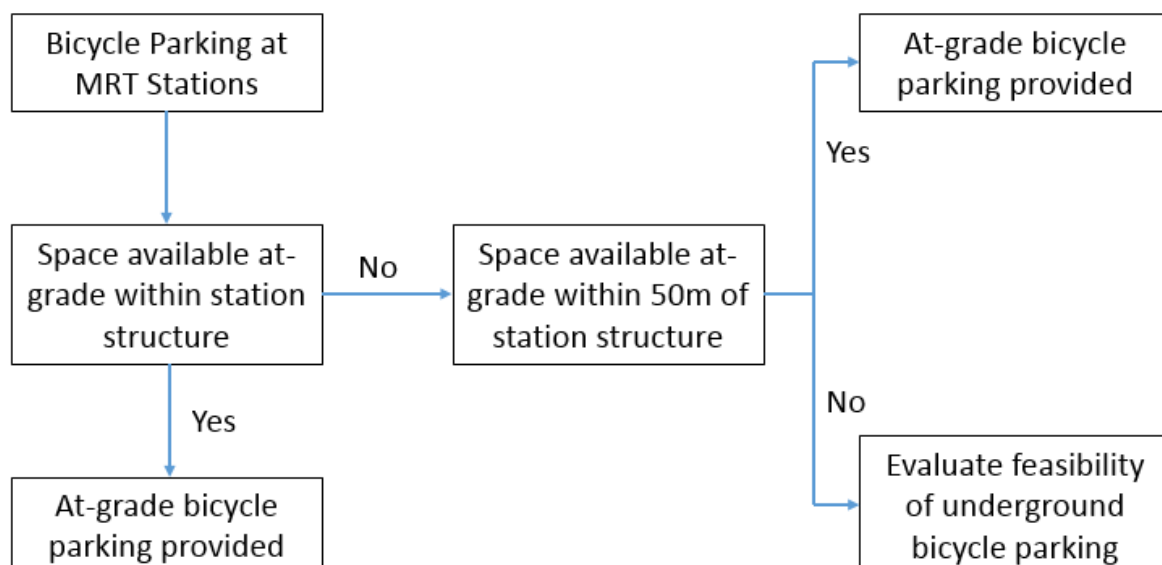
- d) The below standards should be conformed to when planning for bicycle parking lots at **Bus Interchanges**. Temporary bus interchanges are also recommended to provide the stipulated number of lots.

Location	Provision
Bus Interchanges	150 lots

- e) Bicycle parking standards for other developments can be found in LTA Code of Practice on Vehicle Parking Provision in Development Proposals.

2.11.2 MRT & LRT Stations

- a) Cyclists want to park as close to the station entrance / exit as possible and will not use bicycle racks if they are located too far away. Incidental spaces within the station boundaries should first be identified to construct racks before expanding outside the station boundaries and acquiring land.
- b) It is recommended to install bicycle racks within 50m from the visible station structure at grade around MRT stations. Where possible, the bicycle racks should be designed within the station maintenance boundary.
- c) The racks should also be spread out between the various station entrances to facilitate cyclists and to discourage indiscriminate parking. Designers should take into account the locations of the cycling paths, the surrounding land use, as well as other factors which affect where cyclists cycle from/to in determining where the bicycle lots should be. The bicycle bays should be designed to be accessible by nearby lifts or ramps if it is grade separated.
- d) Where bicycle lots are located underground due to the space constraints at-grade, at least 20% of the bicycle lot provisions have to be located at-grade.
- e) Locations where bicycle parking lots are proposed around MRT stations will be subjected to the Authority's acceptance.
- f) The flowchart below shows a guide to where bicycle parking lots should be placed.





Bicycle Racks within MRT Station boundary

2.11.3 Bicycle parking along roadside and backlane

- a) Bicycle parking is provided along back lane to complement vehicle parking conversion along shopfront. These parking are often not easily visible from main street hence directional signs are recommended to be placed along main roads to guide users.



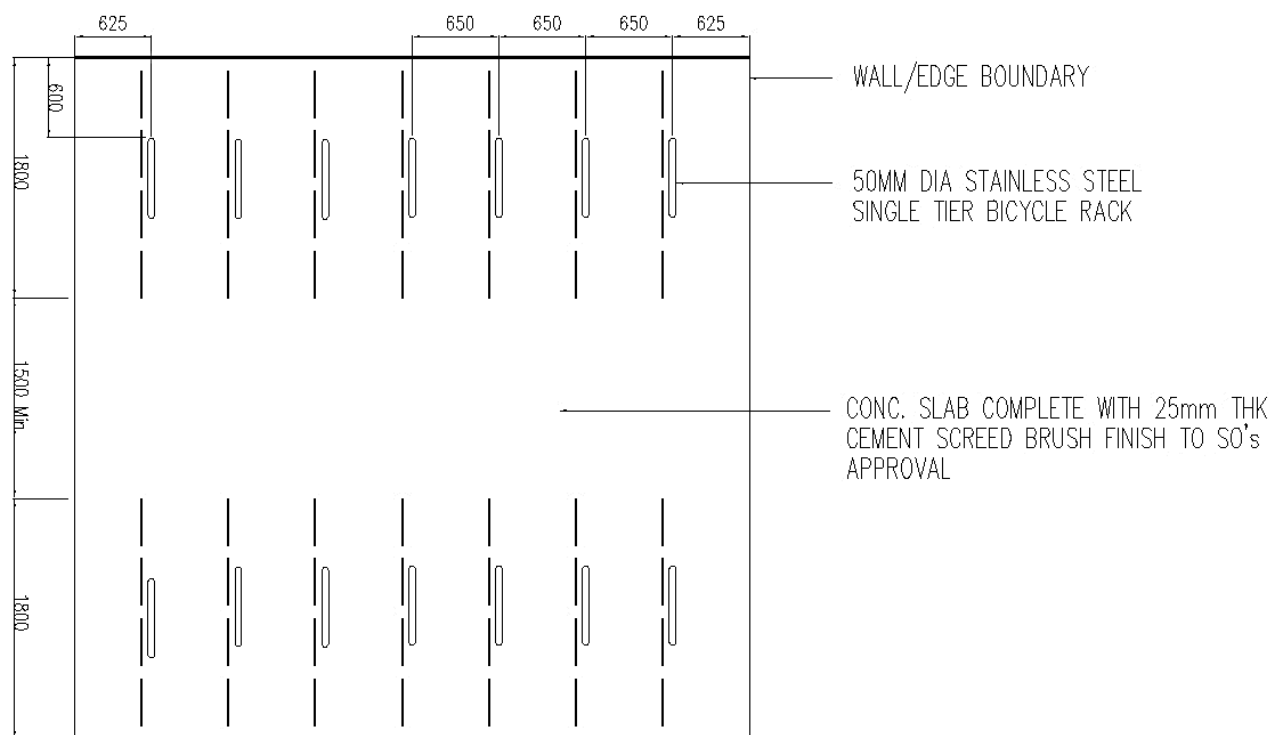
2.12 Bicycle Parking Design

- a) Designers should consider the vehicle and pedestrian movements when determining the location for the bicycle parking spaces. Where possible, the circulation route to the bicycle parking spaces should avoid key vehicular and pedestrian routes. Please refer to LTA Code of Practice on Vehicle Parking Provision in Development Proposals, for the details of safe bicycle parking spaces.
- b) To provide secured bike parking facilities, all racks should ideally allow users to lock a bicycle at 3 points: the front wheel, frame, and back wheel.
- c) Water ponding on the facilities is to be taken into consideration as ponding will promote mosquito breeding.
- d) Designers shall also design for adequate clearance for users to lock/unlock their bicycles to racks and to push in/out of the bicycle. Please refer to LTA Code of Practice on Vehicle Parking Provision in Development Proposals for the details of bicycle parking bays and racks.

- e) Lighting provision of average 30 lux and minimum 10 lux shall be provided within bicycle park.
- f) In general, cyclists are able to find bicycle parking lot within 400m coverage.

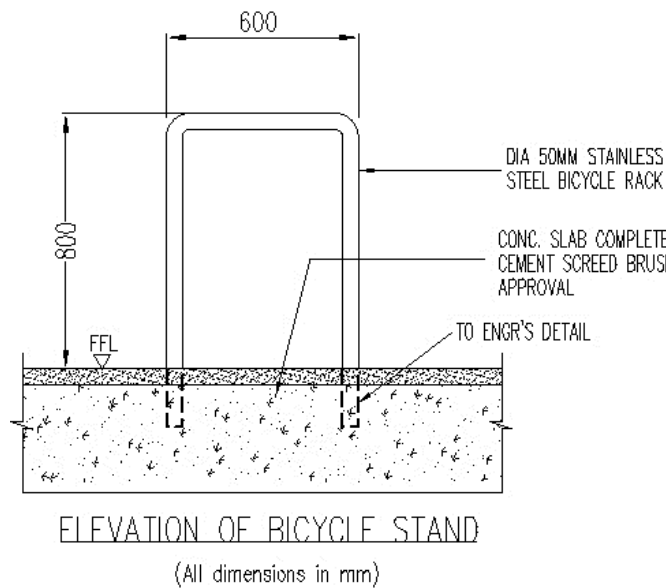
2.12.1 U Bar Racks

- a) U-bar racks, or Sheffield racks, are shaped in an inverted U anchored on the ground. Cyclists can rest their bicycle on the structure and chain it to any part of the rack. U-bar racks are spaced minimally 0.65m away from each other (centre to centre) and can accommodate 2 bicycles per rack. Such design is preferred due to simple design, installation & easy maintenance.



LAYOUT FOR SINGLE TIER BICYCLE RACK

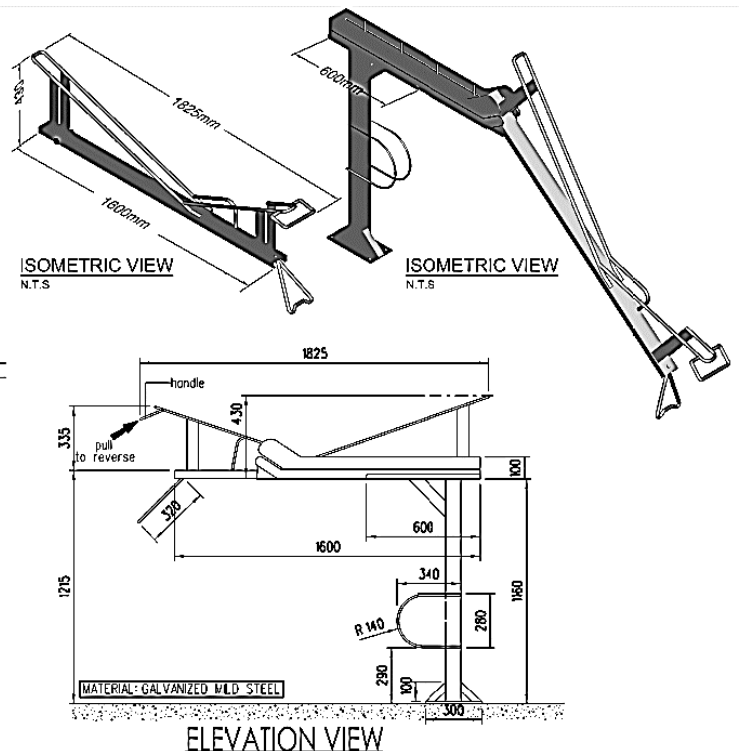
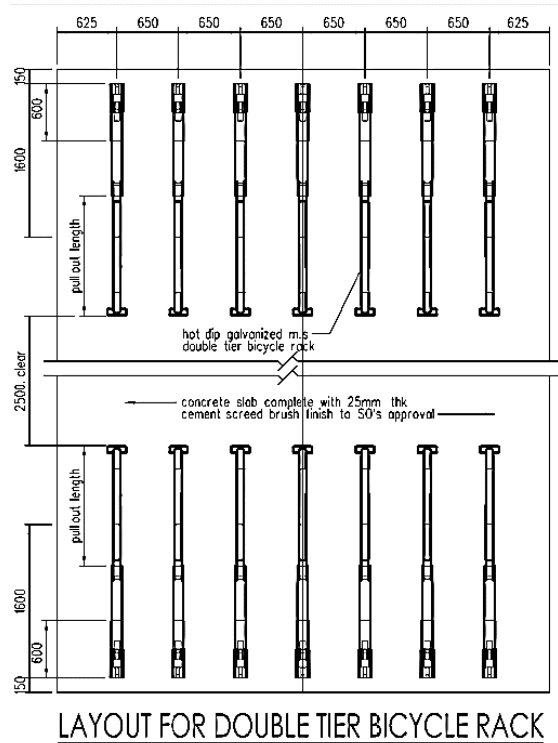
(All dimensions in mm)



Details of typical U Bar Racks

2.12.2 Double Tiered Racks

- a) Double tiered racks have a second elevated tier to accommodate another bicycle. Racks are usually spaced around 0.65m apart and can accommodate 2 bicycles per rack.

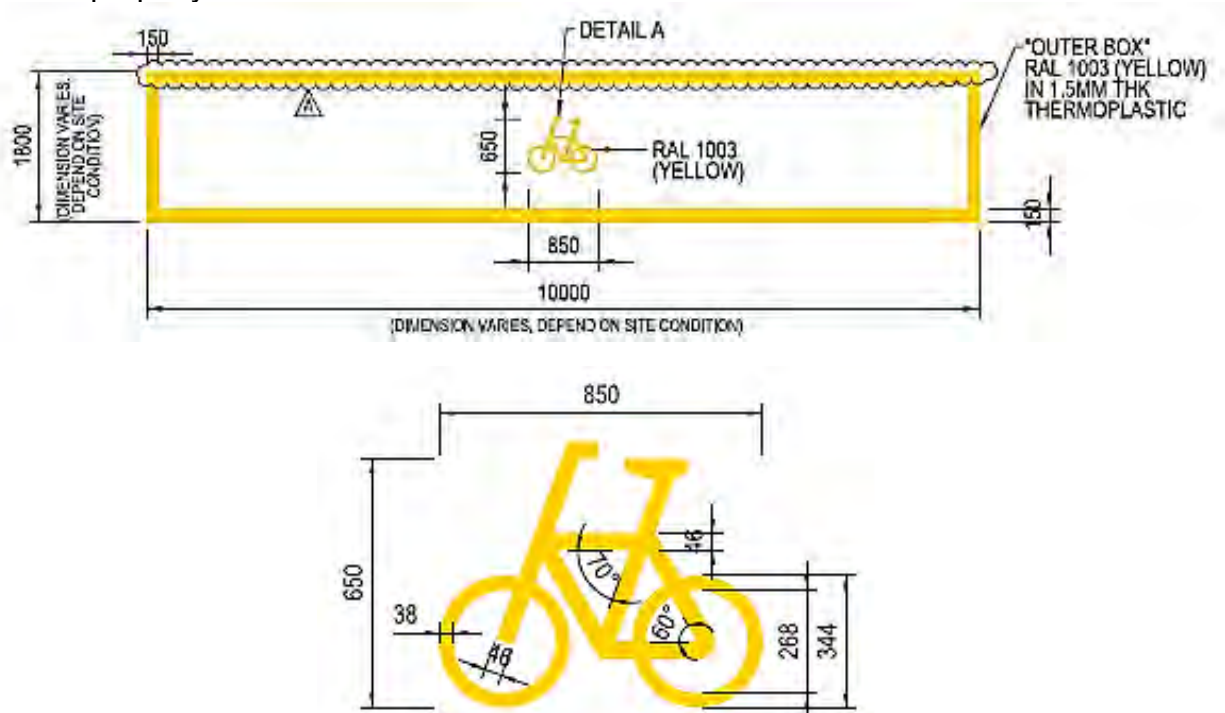




Details of typical Double Tiered Racks

2.12.3 Yellow Bicycle Parking Boxes (bike-sharing scheme)

- a) A yellow box is a designated bicycle parking zone for cyclists. It is a box marked with yellow thermoplastic paint. With the popularity of the bicycle sharing scheme in Singapore, the yellow box has provided a quick and cost effective method to implement more bicycle parking lots island wide quickly to reduce indiscriminate parking. Users are encouraged to line the bicycle properly in the box.



Details of Bicycle Parking Box

2.12.4 Security & Fire Safety Requirements

- a) Please refer IDC, Volume C, Section 5, Security Requirements, when designing bicycle parking facilities around commuter infrastructure.
- b) Generally, bicycle parking need not be sheltered. However, if shelter is provided, SCDF requirements have to be adhered.

2.13 Signage

2.13.1 Wayfinding Signs

- a) Adequate signage with location of nearby transport nodes e.g. MRT station / bus interchange / taxi stand / integrated hub, cycling paths / park connectors, entrances of the development, bicycle lots, end-of-trip facilities and related facilities are recommended to be provided to guide active mobility users moving within and around the development. Signage should be well positioned, visible and consist of a system of signs and graphics to provide active mobility users with directional information provided at development entrances and key decision making zones. For more details on wayfinding signage in development, please refer to Code of Practice on Street Work Proposals Relating to Development Works - Appendix 3D – Guide for Adequate Provision of Wayfinding Signage Within Development.
- b) Safety positioning of signages should be taken into consideration (e.g. away from footpath, no blindspot, etc)
- c) For bicycle parking, directional signs serve to direct cyclists to bicycle lots at MRT stations. The distance from the bicycle parking bay to the decision point where sign is placed should be calculated and incorporated into the directional sign. This signage should be placed when the bicycle parking lots are:
 - Hidden from visual sight from MRT entrance/exit
 - Hidden behind huge structures such as wall, thick greenery
 - Not located at grade level
 - Located more than 50m away from the bicycle parking bay next to MRT entrance/exit (current stations)
 - Presence of bicycle parking located at different entrance/exit, for example across the road
- d) Designers should also consider the location where this wayfinding signage should be placed. This allows for signage to effectively serve its purpose of guiding users to bicycle parking lots.

Signage should be:

- Placed within station boundary
- Mounted on existing pole or surface before considering to construct a new stand

- Placed at key decision-making points
- Placed along pre-determined pedestrian and cyclists flow - footpaths and shared paths
- Within cyclist's line-of-sight upon entering station
- Placed at consistent, predictable locations and heights

2.13.2 Bicycle Parking Signs (MRT stations)

- Signs to direct and indicate Bicycle Parking lots within or around MRT station vicinity.
- Application and placement of signs to be consulted and reviewed by LTA, Active Mobility Group.



Bicycle Park

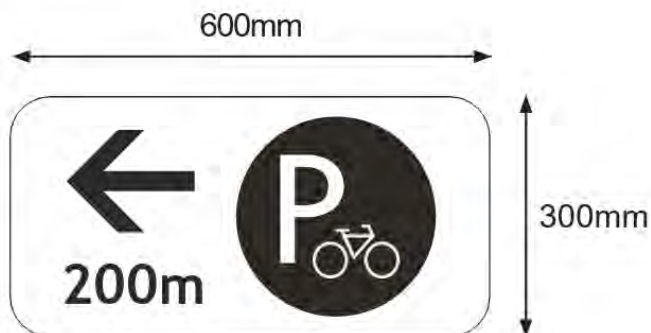
Bicycles are parked in this park at owners' risk and the Land Transport Authority (LTA) or its licensee, servants or agents undertake

no responsibility and shall not be liable in any manner whatsoever for any loss or damage of any bicycle, its accessories or contents howsoever such loss or damage be caused whether by negligence or otherwise of LTA, its licensee, servants or agents.



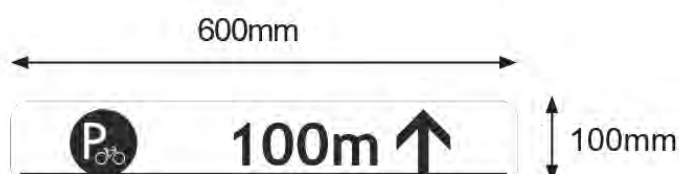
BP-D1

Mounted on lamppost/walls

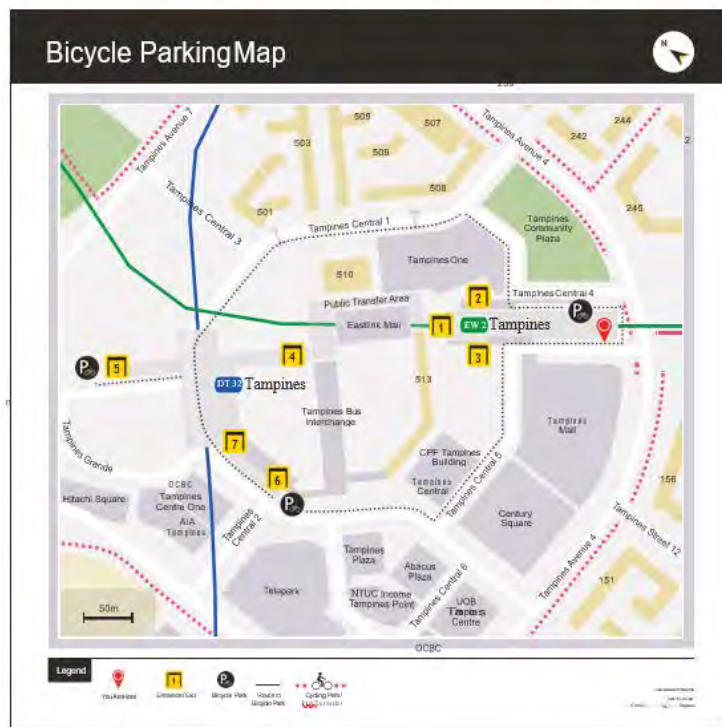


BP-D2

Mounted under sheltered walkways



Bicycle Parking Map (BP-M)



Material Size: 600mm x 600mm (Tentative)

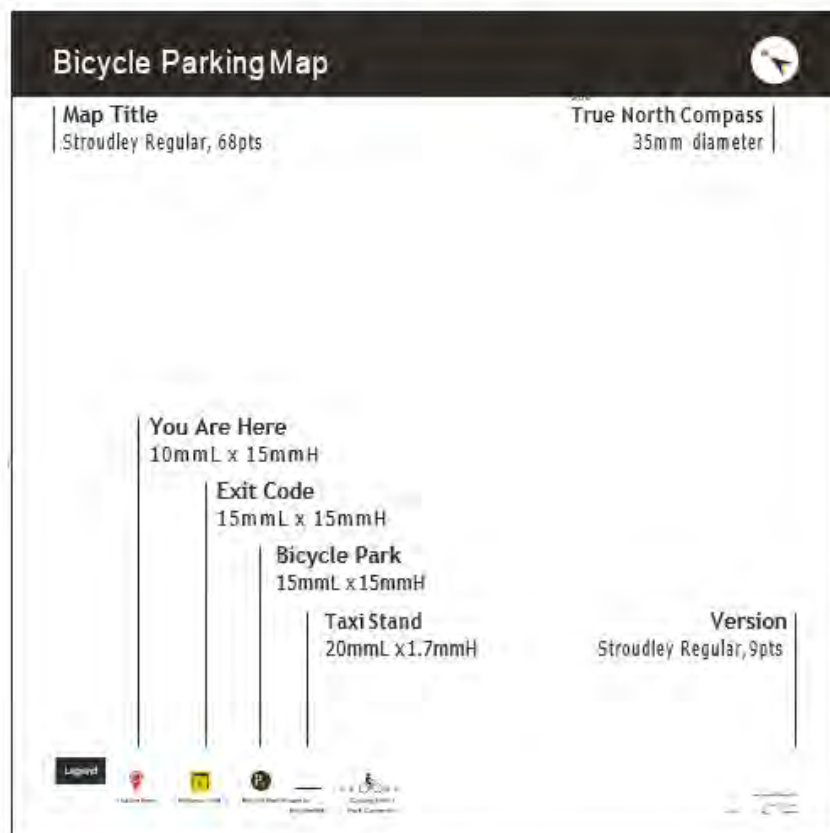
2.13.3 Purpose

- Provide cyclists an overview of the bicycle parking lots found at MRT station.
- Address the problem of underutilized bicycle lots at different exits.
- Each map is to be rotated to viewer's angle per location of map in station.
- Application and placement of signs to be consulted and reviewed by LTA, Active Mobility Group.

2.13.4 Obtaining Assets

- JPEG / PDF format – Contact Land Transport Authority, Active Mobility Group
- Regulation follow colour guide and elements in following pages.
- Do not extract elements to be used individually.
- Do not modify the colours and typeface of any elements on the map.
- Do not distort the map, always scale proportionately.

Bicycle Parking Map Header and Footer



Legend Header
Stroudley Regular, 50pts

Legend Texts
Stroudley Regular, 35pts

Copyright
Stroudley Regular, 9pts

Other Pictogram
Varies (L) x 15mmH

Cycling Path / Park Connector
44mmL x 15mmH















All dimensions based on
Material Size at 600mm x 600mm (Tentative)

Map Border
Grey Width/Thickness: 8.3mm
White Width/Thickness: 3.5mm

Underpass

Bicycle Parking Map Colours

Standardised colours for all elements on Bicycle Parking Maps.

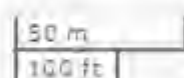
	Header/Texts/Bicycle Parking Picto & Route PMS Black C		Roads White
	MRT Station Box PMS Black C (Opacity: 30%)		HDB Residential Blocks / MSCP Profile Shape PMS 7499C
	Zone / District Names PMS Black C (Tint: 50%)		Private Residential Estates Boundaries e.g Condo, Apartment, Bangalows & etc. PMS 7499C (Tint: 50%)
	Exit Codes / Footer PMS 109C		Water C12 M2 Y3 K0
	You Are Here PMS 485C		Park / Garden / Fields PMS 580C
	Cycling Path / Park Connector PMS 205C		Schools/Institutions/Health Campus Boundaries PMS 580C (Tint: 50%)
	Map Scale (Box) PMS Black C (Opacity: 10%)		
	Land (Background) PMS 663C (Tint: 60%)		
	Map Border / OHB / UP / Commercial Building Profile Shape e.g Schools, Religious Places, Factories, Offices & etc. (Non-Residential Building) PMS 664C		

Bicycle Parking Map Content Entry Criteria

Provide graphical context of developments and bicycle parking lots surrounding station. The map base content shall be obtained from *OneMap.sg*. This criterion governs how much content can be shown on the map to ensure readability and clarity.

Criterion for Landmark to be featured on Bicycle Parking Map

Landmark must meet both criteria.

Basic Criteria	
Landmarks surrounding the bicycle parking bays (Using 50m distance marker based on <i>OneMap.sg</i>)	

+

Refer to Locality Map Content Entry Criteria 6.3.4

Note: No discrimination is intended for buildings not captured under the criteria listed.

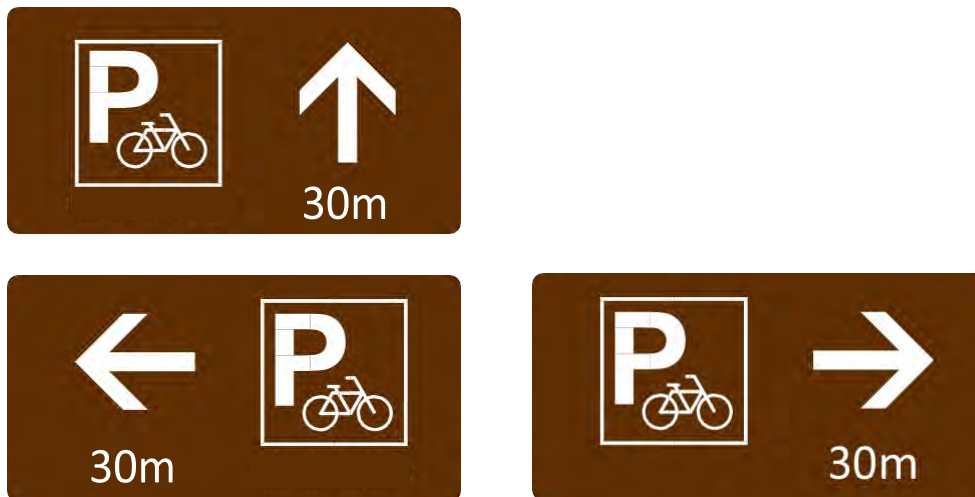
Updating of existing sign: LTA Active Mobility or Public Transport Operator shall update signs affected by changes in the vicinity (e.g. road name / building name change). For developers who wish to update signage content, kindly inform LTA and PTOs via respective feedback portals.

2.13.5 Bicycle Parking Directional Signs – (other areas)

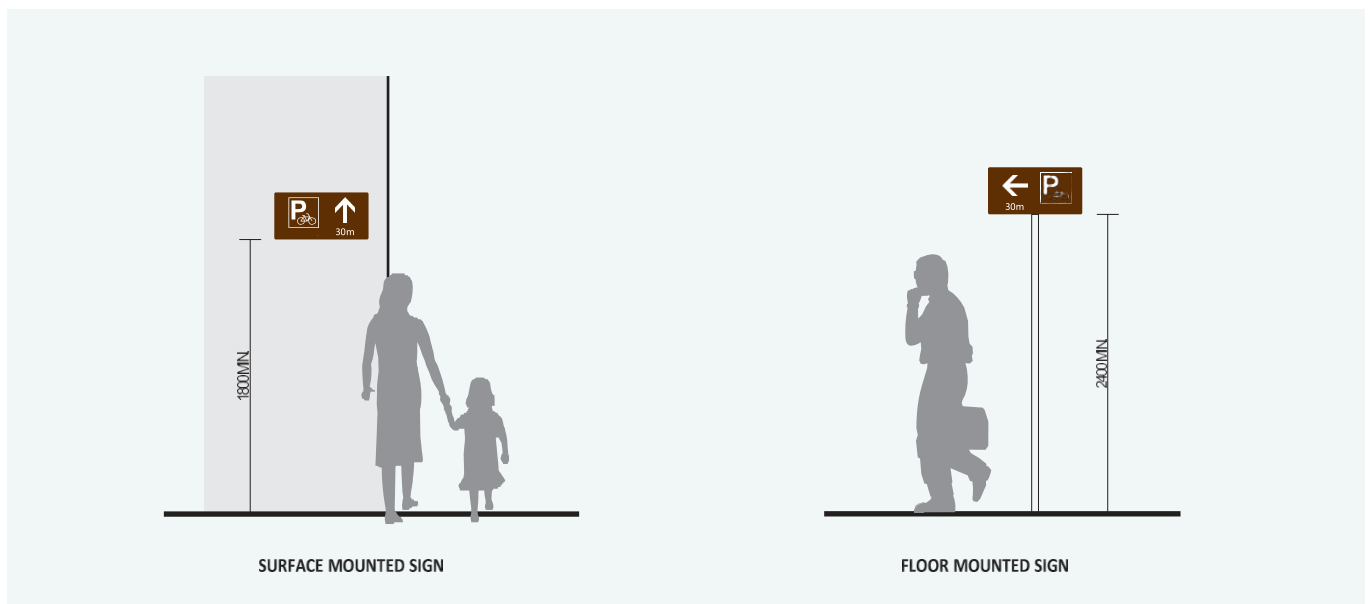
- These signs are directional signs to bicycle park facility area (for eg. backlane, roadside)
- Application and placement of signs to be consulted and reviewed by LTA, Active Mobility Group.

2.13.6 Sign Fixing

- To accommodate the different architectural environments into which the signage system will need to be applied, fixing details has been developed. These are :
 - (a) Surface mounted
 - (b) Floor mounted



Bicycle Park Directional Sign
Size : 600mm x 300mm



2.13.7 Material and Construction

- Sign is non-illuminated.
- (a) Sign-face panel :
 - Powder coated 2mm thk. Aluminium panel with silkscreened graphics.
- (b) Mounting :
 - Floor-mounted : Galvanised steel post
 - Surface mounted :
 - On smooth wall finish : Very high bond industrial acrylic foam based double-sided tape.
 - On plastered/concrete wall : S.S. screws and wall-plugs.

- On circular column/post or circular ceiling structure : use stainless steel buckle-tie and galvanised steel bracket (comply with Standard Details of Road Elements)
- On other metal surfaces: self-taping stainless steel screw or rivet.

(c) Artwork and graphics :

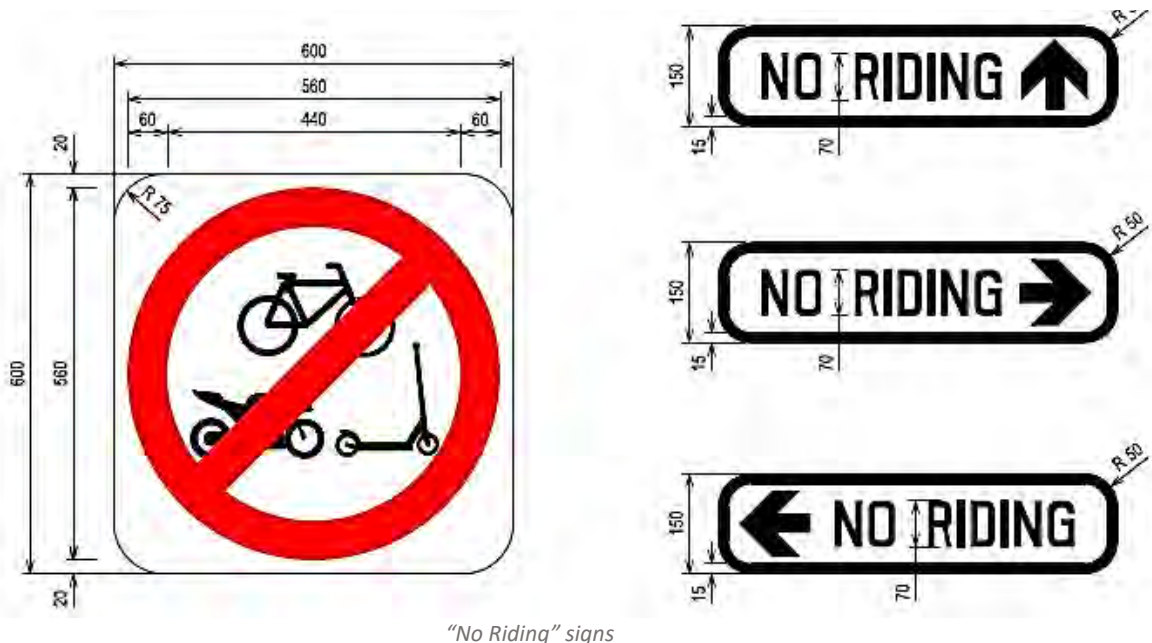
- Background in nut brown RAL 8011
- Pictogram facilities and arrow in white

2.14 Mandatory Signs

- a) “No Riding” signs should be installed at the start and end of pedestrian-only paths, or Type 1 paths where riding of PMDs or bicycles is not allowed.
- b) The arrow of the “No Riding” sign should always point towards the direction of the Pedestrian Overhead Bridge or into the pedestrian-only path. (e.g. footbridge).

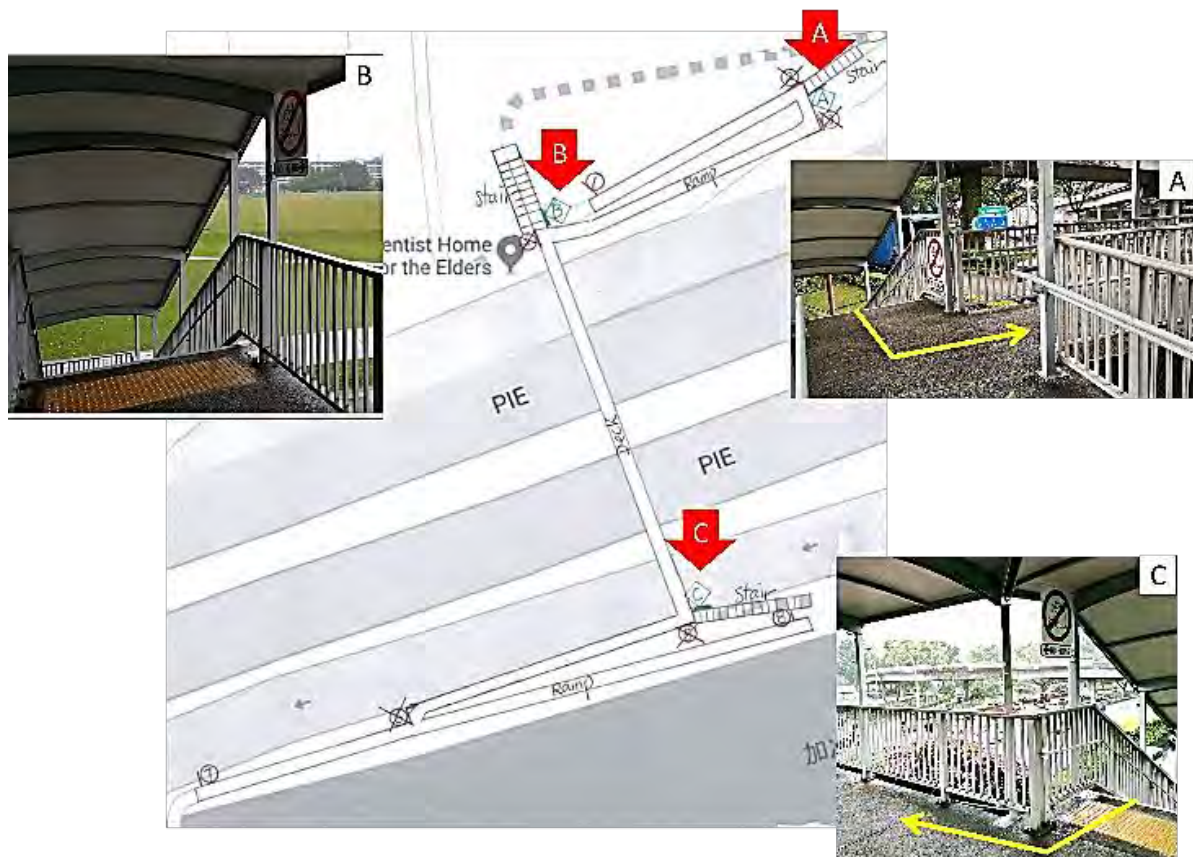
2.14.1 ‘No Riding’ Signs

- a) Signs can be installed on dedicated poles, railings or columns.



b) POBs with ramps:

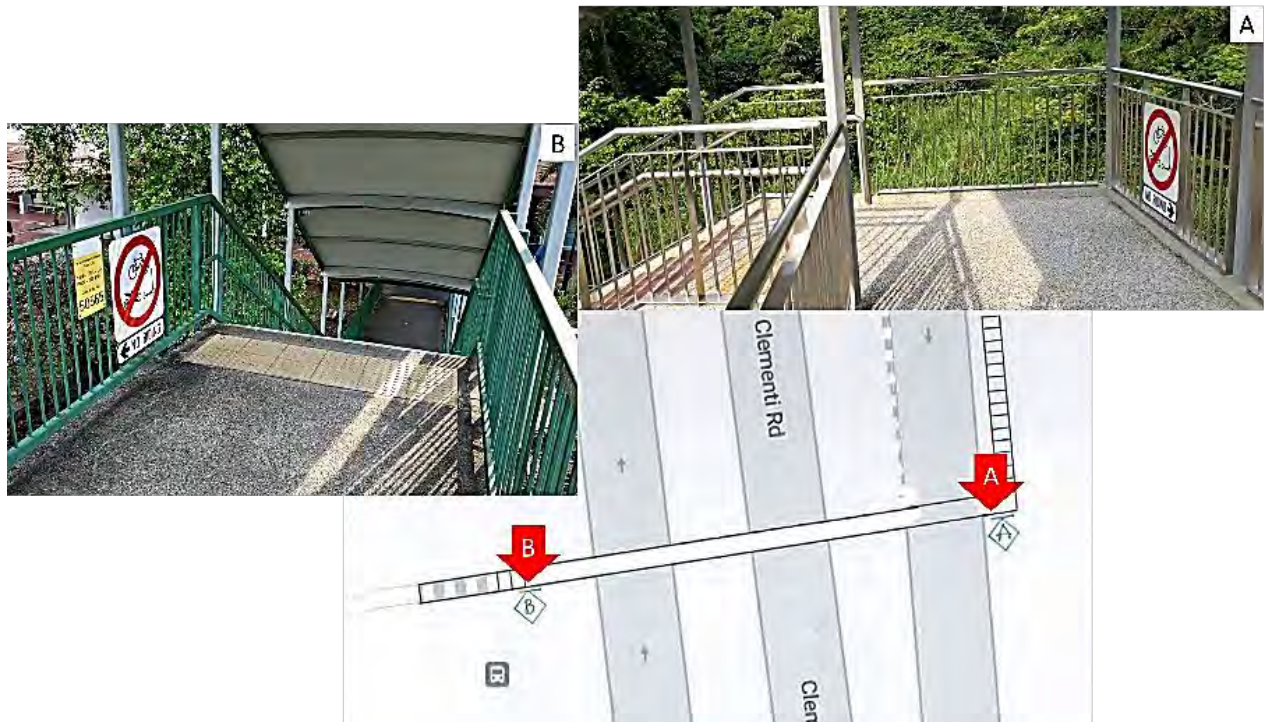
- Signs should be installed at the bottom of ramps.
- Signs should be installed at the top of staircases, preferably on the side of expected travel. Where possible, the positioning of the signs should be facing the users, to capture their attention.
- Signs should not be installed on the deck unless they are directly in front of the staircases.



Placement of "No Riding" sign at POB with Ramps

c) POBs without ramps:

- If there are only two sets of staircases, the signs should be installed on the deck facing the stairs if possible. Otherwise the signs should be installed on the railings of the deck at the top of the stairs.
- If there are more than two sets, the signs should be installed on the deck facing the stairs for the staircases at the extreme ends if possible. Otherwise the signs should be installed on the railing of the stairs.



Placement of "No Riding" sign at POB without Ramps

2.14.2 Shared track Signs

- a) Shared track signs are to be placed at the 2 ends of Type 3 shared path, together with start / end path markings.



Typical Shared Track sign at shared path

2.15 Advisory Signs

- a) These signs are placed along cycling path to provide guidance to active mobility users for harmonious usage on public path, eg Slow Down, Watch Out For Vehicles, Give Way To Pedestrians, Stay On Track, etc.
- b) Please refer to LTA's SDRE for more details.

2.16 Wayfinding Mapboards

- a) Wayfinding mapboards provide information to guide and orientate pedestrian and cyclist to navigate themselves within the cycling path route.



Typical Walking & Cycling Wayfinding Mapboard

2.16.1 Design

- a) The design of graphic layout & artwork should take into consideration the design concept, layout, typesetting and final artwork which includes pictures, graphics, illustrations, maps, charts, graphs and/ or any other forms of presentation that should be creatively integrated and easy to be understood for user's wayfinding.
- b) The base map shall be from the Singapore Land Authority (SLA).
- c) Asset criteria will be applied as the guideline to facilitate managing map content for way finding, from the user's point of view. All assets can potentially be moved, demolished etc. They can be split into two main categories:

- Base assets (always included)
 - Live assets (negotiable)
- d) The base assets shall include roads & road names, kerb details, pedestrian zones, cycling paths, footpaths, covered linkways, park connectors, building footprints, transport nodes, pedestrian/cyclist crossings, bicycle parking, named public gates and nameable body of water. To allow users to easily navigate the map, the base assets shall also include neighborhood names, well known road junctions, open & green space. The map base shall not be restricted to a 2-dimensional map and can consist of an axonometrical base plan.
- e) The live assets shall include key retail, visitor attractions, hospitals and clinics, civic and community buildings, educational buildings, place of worship, open spaces, car parks, public toilets, post offices, hotels & accommodations and public active frontage.
- f) The map shall be orientated in relation to the location of the mapboard and the user's point of view, such that map points in the same direction as the user as he reads the map. The Contractor to provide planner map (for the user to orientate himself and have an overview of the) and finder map (for the user to find his way to key developments nearby) to facilitate the wayfinding process.
- g) The planner map shall indicate the areas where the user can reach within 15 minutes by walking / cycling. The finder map shall provide indication showing the areas where the readers can reach within 5 minutes by walking / cycling.
- h) The layout and typesetting services (two official languages) for the name of assets shown in the map shall be provided.
- i) The design concept should be clear and easy to read. The prints of the proposed mapboards at 1:1 scale shall be provided.
- j) The final artwork of the wayfinding map shall be of sufficiently high resolution to cater for printing without compromising on picture quality i.e. printed material should not appear blur or pixelated.

2.16.2 Electrical Works

- a) The mapboard enclosure shall be weatherproof type to protect all the electrical fittings and associated components to be housed within the mapboards with IP rating 55.
- b) The mapboards shall be provided with internally illuminated with back-lit LED lighting.
- c) The final lighting design shall be in compliance with the latest edition of SS 599.
- d) One number of 10A MCB Type B inside the mapboards for mapboards lightings shall be provided.

- e) The power supply system for the mapboards from existing cycling path lightings shall be provided.

CHAPTER 3 – ELECTRICAL AND MECHANICAL REQUIREMENTS

Table of Contents

3.1	Introduction and Design Objectives	3
3.1.1	General	3
3.1.2	Related Design Standards, Codes and Regulations	3
3.1.3	Submission Requirements	3
3.1.4	Design Objectives	6
3.2	Bus Stop Shelter	7
3.2.1	Design Criteria for Electrical Distribution System	7
3.2.2	Design Criteria for Lighting System	8
3.2.3	Design Criteria for Lightning Protection System	9
3.2.4	Design Criteria for Earthing System and Equipotential Bonding	9
3.3	Taxi / Pick-up and Drop-off (PUDO) Shelter	10
3.3.1	Design Criteria for Electrical Distribution System	10
3.3.2	Design Criteria for Lighting System	10
3.3.3	Design Criteria for Lightning Protection System	10
3.3.4	Design Criteria for Earthing System and Equipotential Bonding	11
3.4	Covered Linkway	11
3.4.1	Design Criteria for Electrical Distribution System	11
3.4.2	Design Criteria for Lighting System	11
3.4.3	Design Criteria for Lightning Protection System	12
3.4.4	Design Criteria for Earthing System and Equipotential Bonding	12
3.5	Pedestrian Overhead Bridge (POB)	13
3.5.1	Design Criteria for Electrical Distribution System	13
3.5.2	Design Criteria for Lighting System	14
3.5.3	Design Criteria for Lightning Protection System	15
3.5.4	Design Criteria for Earthing System and Equipotential Bonding	15
3.5.5	Design Criteria for Manual Irrigation System	15
3.5.6	Design Criteria for Escalator (Where Applicable)	15
3.5.7	Design Criteria for Passenger Lift (Where Applicable)	16
3.6	Pedestrian Underpass (PUP)	16
3.6.1	Design Criteria for Electrical Distribution System	16
3.6.2	Design Criteria for Lighting System	18
3.6.3	Design Criteria for Lightning Protection System	19
3.6.4	Design Criteria for Earthing System and Equipotential Bonding	19
3.6.5	Design Criteria for Pumped Drainage System	19
3.6.6	Design Criteria for Escalator (Where Applicable)	19

3.6.7 Design Criteria for Air-Conditioning and Mechanical Ventilation System (ACMV)	20
3.6.8 Design Criteria for Equipment Noise and Vibration	23
3.6.9 Design Criteria for Fire Protection System	23
3.6.10 Design Criteria for Passenger Lift (Where Applicable)	25

3.1 Introduction and Design Objectives

3.1.1 General

3.1.1.1 This chapter, defines the criteria and requirements for the design, supply, installation, addition & alteration, testing and commissioning of the Electrical and Mechanical requirements for Commuter Infrastructure (CI).

3.1.1.2 The Authority shall be highlighted of any contradiction or conflicts within the criteria set out hereafter. In addition, the Authority shall be notified and acceptance shall be sought for any change or new requirements that may arise during the works.

3.1.1.3 The design of the M&E Services shall be in accordance with Technical Specification for M&E Services and M&E Services Drawings as shown in Annex C1 and Annex C2 respectively.

3.1.1.4 Related Design Standards, Codes and Regulations Unless otherwise stated, the M&E services works for commuter infrastructure shall be governed by all applicable local regulations, codes, standards and requirements issued by all relevant authorities having jurisdiction, which shall include but not limited to the following:

- Public Utilities Board (PUB)
- SP Services Ltd (SPSL)
- SP PowerGrid Ltd (SPPG)
- Singapore Civil Defence Force (SCDF)
- Building and Construction Authority (BCA)
- Ministry of Sustainability and the Environment
- National Environment Agency (NEA)
- National Parks Board (NParks)
- Energy Market Authority (EMA)
- Land Transport Authority (LTA)
- Enterprise Singapore

3.1.1.5 Where there are discrepancies or conflicts between the above, the attention of the Authority shall be sought for final decision. Compliance with this criteria shall not preclude the need to obtain full clearance and approval from the Authority's Development and Building Control Division (DBC), the Authority and all authorities having jurisdiction.

3.1.2 Submission Requirements

3.1.2.1 Pre-Submission Consultation

- a. Pre-submission consultation with the Authority may be applied through the Development and Building Control Division (DBC) where submission involves non-compliance to this criteria; Application for approval or waiver or modifications shall be submitted to the Authority through the DBC.

- b. All relevant Authorities Having Jurisdiction (AHJ) such as NParks, PUB, SPPG, SPSL, LTA, etc shall be pre-consulted before embarking on the design of the commuter facilities. All such pre-consultation shall be minuted and these minutes shall be submitted to the Authority and AHJ as records.

3.1.2.2 Design Submission

- a. Two (2) sets of the documents listed below shall be submitted, in the appropriate format, when seeking approval from the Authority and prior to commencement of works.
- b. All drawings and calculations shall be certified by the Qualified Person (QP) / Professional Engineer (PE). For electrical installation, it shall be certified by a Licensed Electrical Worker (LEW) of appropriate grade.

No works shall commence until approval of the subject design and relevant waiver is obtained from the Authority in writing.

General

- M&E Checklist for bus stop shelter, Taxi / Pick-up and Drop-off (PUDO) shelter, pedestrian overhead bridge (POB) and covered linkway
- Site and layout plan showing the source of intake power supply, water supply and demarcation of maintenance boundary of LTA and other development / agencies (if any)

Electrical Installation

- Single line diagrams for the electrical installation
- Lighting and power layout plans including schematic diagrams showing the OG Box layouts and cable routing plans
- Earthing system schematics and layout plans
- All electrical calculations to substantiate selection of plant and equipment. The submission shall include circuit breaker and cable sizing, fault level calculations, discrimination setting between various breakers and etc
- Catalogues with all relevant test reports / certificates of compliance from accredited testing facilities to demonstrate compliance with specified and performance requirements
- Lighting design simulation reports to substantiate that the design is in accordance with the design criteria and specified requirements
- Lightning Protection System design in accordance to the latest edition Code of Practice, SS 555
- Equipotential Bonding System in accordance to SS 638

Mechanical System Installation

- Air-conditioning and Mechanical Ventilation System Design
- Fire Protection System Design
- Pumped Drainage System Design
- Manual Irrigation System Design
- Lift and Escalator System Design

- All services routing, installation detail and sizes
- Properly dimensioned layout diagrams showing the location of equipment
- Equipment installation details
- Control and monitoring system and strategy for the mechanical system
- Calculations including cooling load calculation, mechanical ventilation calculations, pump capacity sizing, operating pumping head and pump operating levels (start/stop, alarm level, etc), fan pressure calculations, cable sizing, voltage drop calculations, motor starter capacity, etc.
- Calculations on the mounting, inertia blocks vibration isolations and noise controls
- Structural equipment bases, supports and tank details
- Catalogues, technical specifications and relevant test reports / certificates of compliance from accredited testing facilities for the proposed equipment, materials and accessories

3.1.2.3 Amendment Submission

The Authority shall be notified of any deviations from the approved plans and the revised plans shall be submitted for the Authority's approval before any deviation works commenced.

3.1.2.4 Completion of Works

Upon completion of the M&E services works, visual inspections and all necessary testing and commissioning shall be performed to demonstrate compliance with the design and specified requirements. The test results which shall be endorsed by the QP shall be submitted for the Authority's approval. Instruments used for the tests shall have a valid calibration certificate. The calibration certificates shall be submitted together with the test results. The tests which shall be conducted shall include but not limited to the following:

- a. Lighting System Lighting Level measurement (LUX) on site.
- b. Electrical System Tests
 - Insulation voltage test with appropriate insulation tester
 - Electrical earth resistance and earth loop impedance
 - Continuity on the conductor & joints
 - Polarity and phase sequence
- c. Lightning Protection System Tests complying with SS 555.
- d. Mechanical System Tests
 - Individual Equipment and System Performance
 - Air and Water Balancing
 - Hydraulic
 - Pump Test
 - Operation and Control Function Tests
 - Noise Level Measurement

The Authority shall be given at least 7 days advanced notice of any joint inspection or tests. The Designer shall rectify all defects identified during the joint inspections and a final joint inspection to certify the clearance of all defects shall be arranged.

The Contractor shall also be responsible to apply and obtain the Permit-To-Operate from BCA for lifts and escalators with at least three months validity.

3.1.2.5 As-Built Documentation Submission

Two (2) sets of the as-built drawings, testing and commissioning results endorsed by the QP and operation and maintenance (O&M) manuals for the electrical and mechanical installations, shall be submitted to the Authority, prior to handing over to the commuter facility to the Authority. These shall include but not limited to the following:

Electrical Installation

- As-built electrical single line diagrams
- As-built lighting and power layout plans / As-built Earthing system schematics and layout plans / As-built Lightning protection system layout plans
- Testing and commissioning results of the lighting level and electrical installation
- Testing and commissioning results of the Lightning Protection System and certificate of supervision for Lightning Protection is in accordance with the latest edition of Code of Practices, SS 555

Mechanical Installation

- As-built mechanical services plans
- Testing and commissioning results of the mechanical services and related electrical installation
- Approved mechanical services plans to authorities
- Verification of the proper functioning of the equipment and system
- Verification on the performance of the installed equipment and system meeting the specified design life
- All tests required by the relevant authorities

3.1.3 Design Objectives

3.1.3.1 The Authority has determined a set of design objectives for commuter infrastructure which all Designer/QP shall meet. These objectives do not exclude any additional design standards or criteria that may be required to suit the needs of the particular locations.

3.1.3.2 For lighting requirements to Commuter Infrastructure, the following lighting provisions and maximum allowable power budget shall apply:

Description	Lighting Provisions	Maximum Allowable Power Budget

		Average Lux Level	Uniformity Ratio	
POB	Staircase	30	0.25	2.5 W/m ²
	Deck/Ramp	10	0.25	
	Lift Lobby	50	0.25	
Covered Linkways	High Covered Linkways	30	0.4	2.5 W/m ²
	Low Covered Linkways	10	0.25	2.5 W/m
Bus Stop Shelter / Taxi / PUDO Shelter		30	0.3	2.5 W/m ²
Pedestrian Underpass		100	0.25	2.5 W/m ²
Bicycle Parking Areas		30 lux with min.10 lux to meet security requirements	-	1.8 W/m ²

3.1.3.3 The lighting design shall have minimum glare for the commuters / motorist complying with SS531.

3.2 Bus Stop Shelter

3.2.1 Design Criteria for Electrical Distribution System

3.2.1.1 The electrical installation shall be designed in compliance to SS 638.

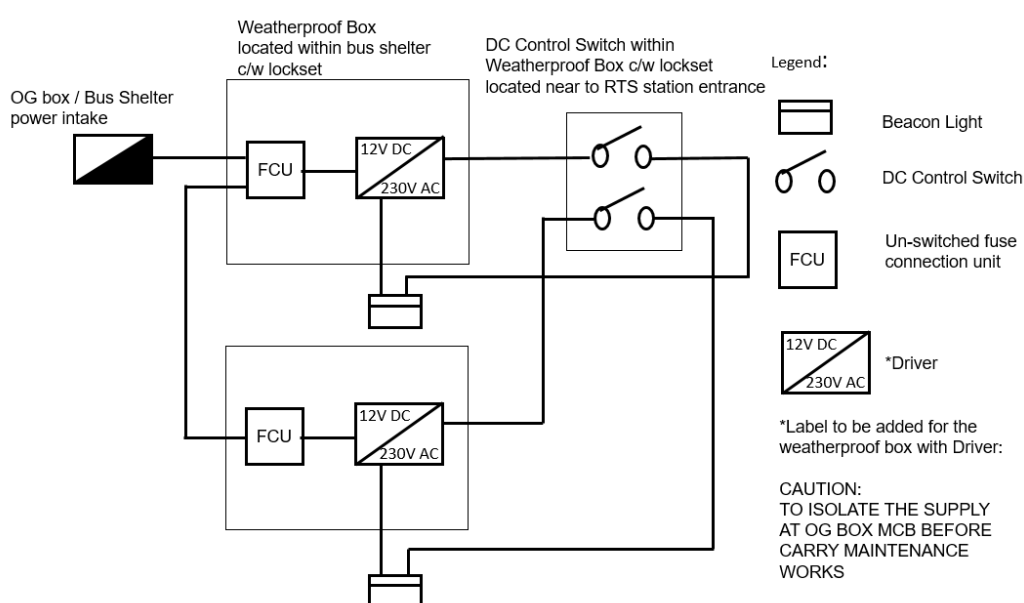
3.2.1.2 The design of the electrical installation shall be as per shown in the latest revision of drawing no: L/ROAD/MES/SD/1003. Where a bus stop shelter is located adjacent to a POB and/or covered linkways, the design of the electrical installation shall be as per shown in the latest revision of drawing no: L/ROAD/MES/SD/1002. The OG Box shall be located next to the bus stop shelter downstream of traffic flow and not blocking pedestrian walkway.

3.2.1.3 For bus stop shelters located near Rapid Transit System (RTS) stations and maintained by station operator, power supply shall be taken from the station switchboard complete with sub-metering. The power supply for bus stop shelters maintained by developer shall be taken from the developer's installation. Dedicated power intake OG Box from power utility shall be provided for bus stop shelter that is maintained by LTA.

3.2.1.4 Separate circuits from bus stop shelter power intake shall be designated for advertisement panels, bus stop shelter beacon lights, information panels, bus arrival panel and bus stop shelter lightings.

3.2.1.5 Lighting system shall be designed with alternate circuiting.

3.2.1.6 Beacon lights shall be provided for bus stop shelters that are near to RTS station entrances.



Schematic of bus stop shelter beacon light installation for bus stop shelter linking to RTS station entrance

3.2.1.7 For bus stop shelter not linking to RTS station entrance via POB or covered linkways, the control switches of beacon lights shall be located at bus stop shelter.

3.2.1.8 For bus stop shelter linking to RTS station entrance via POB or covered linkways, the control switches shall be located at the first column of the covered linkway nearest to the RTS station entrance and within LTA's maintenance boundary.

3.2.2 Design Criteria for Lighting System

3.2.2.1 Light fitting shall be LED type. No up-lighters shall be used in the lighting design.

3.2.2.2 Information panel lighting shall be LED strip (IP65) of colour temperature 4000K, with aluminium housing to fill the interior of the information panel to provide uniform illumination of 200 lux.

3.2.2.3 The LED light fitting shall be weatherproof, designed to IP65, vandal proof, minimum IK06, ultra-violet (UV) stabilized and aesthetically acceptable. The LED lamp shall have a colour-rendering index of 80 to 89 with colour temperature of 3000K.

3.2.2.4 All lighting systems shall be controlled via a programmable timer with RS232 interface with a bypass switch.

3.2.3 Design Criteria for Lightning Protection System

3.2.3.1 The lightning protection system for the bus stop shelter shall be designed in compliance to SS 555.

3.2.3.2 The metal roof of min. 10mm thickness aluminium honeycomb roof panel complete with min. 1mm aluminium thickness at top panel shall be used as part of lightning protection system.

3.2.3.3 All exposed metal parts such as metal railings, lighting poles, bus signage poles, notice boards, advertisement panel etc. within 2-metre radius of the bus stop shelter perimeter shall be bonded to the lightning protection system of the bus stop shelter.

3.2.3.4 All metal structures shall be bonded to the rebars of the floor slab by means of a purpose made weld.

3.2.3.5 The lightning protection system shall be electrically continuous. Where the bus stop shelter is connected to any CI or adjacent structure, PE (electrical) shall be responsible to ensure that the lightning protection bonding is adequately provided between the existing structure and the bus stop shelter.

3.2.3.6 All lightning earth pits shall be planted within road reserve line and LTA's maintenance boundary. It shall not be located at pedestrian walkway.

3.2.4 Design Criteria for Earthing System and Equipotential Bonding

3.2.4.1 The earthing system requirements shall be designed in accordance with SS 551.

3.2.4.2 Earth electrode complete with hot-dipped galvanised lid earth pit haunched in concrete with provisions made for drainage shall be provided to connect to the main earthing terminal in the OG Box.

3.2.4.3 All earth electrodes shall be planted within road reserve line and LTA's maintenance boundary. It shall not be located at pedestrian walkway.

3.2.4.4 All exposed metal parts shall be equipotentially bonded in accordance with SS 638.

3.3 Taxi / Pick-up and Drop-off (PUDO) Shelter

3.3.1 Design Criteria for Electrical Distribution System

3.3.1.1 The electrical installation shall be designed in compliance to SS 638.

3.3.1.2 The design of the electrical installation shall be as per shown in the latest revision of drawing no: L/ROAD/MES/SD/1003. Where a Taxi / PUDO shelter is located adjacent to a POB and / or covered linkways, the design of the electrical installation shall be as per shown in the latest revision of drawing no: L/ROAD/MES/SD/1002. The OG Box shall be located next to the Taxi / PUDO shelter downstream of traffic flow and not blocking pedestrian walkway.

3.3.1.3 For Taxi / PUDO shelters located near RTS stations and maintained by station operator, power supply shall be taken from the station switchboard complete with sub-metering. The power supply for Taxi / PUDO shelters maintained by developer shall be taken from the developer's installation. Dedicated power intake OG Box from power utility shall be provided for Taxi / PUDO shelters that are maintained by LTA.

3.3.1.4 Separate circuits from Taxi / PUDO shelter power intake shall be designated for advertisement panels and Taxi / PUDO shelter lightings.

3.3.2 Design Criteria for Lighting System

3.3.2.1 Light fitting shall be LED type. No up-lighters shall be used in the lighting design.

3.3.2.2 The LED light fitting shall be weatherproof, designed to IP65, vandal proof, designed to minimum IK06, ultra-violet (UV) stabilized and aesthetically acceptable. The LED lamp shall have a colour-rendering index of 80 to 89 with colour temperature of 3000K.

3.3.2.3 All lighting systems shall be controlled via a programmable timer with RS232 interface with a bypass switch.

3.3.3 Design Criteria for Lightning Protection System

3.3.3.1 The lightning protection system for the Taxi / PUDO shelter shall be designed in compliance to SS 555.

3.3.3.2 The metal roof of min. 10mm thickness aluminium honeycomb roof panel complete with min. 1mm aluminium thickness at top panel shall be used as part of lightning protection system.

3.3.3.3 All exposed metal parts such as metal railings, lighting poles, Taxi / PUDO signage poles etc. within 2-metre radius of the Taxi / PUDO shelter perimeter shall be bonded to the lightning protection system of the Taxi / PUDO shelter.

3.3.3.4 All metal structures shall be bonded to the rebar of the floor slab by means of a purpose made weld.

3.3.3.5 The lightning protection system shall be electrically continuous. Where the Taxi / PUDO shelter is connected to any CI or adjacent structure, PE (electrical) shall be responsible to ensure that the lightning protection bonding is adequately provided between the existing structure and the Taxi / PUDO shelter.

3.3.3.6 All lightning earth pits shall be planted within road reserve line and LTA's maintenance boundary. It shall not be located at pedestrian walkway.

3.3.4 Design Criteria for Earthing System and Equipotential Bonding

3.3.4.1 Earthing requirements shall be designed in accordance with SS 551.

3.3.4.2 Earth electrode complete with hot-dipped galvanised lid earth pit haunched in concrete with provisions made for drainage shall be provided to connect to the main earthing terminal in the OG Box.

3.3.4.3 All earth electrodes shall be planted within road reserve line and LTA's maintenance boundary. It shall not be located at pedestrian walkway.

3.3.4.4 All exposed metal parts shall be equipotentially bonded in accordance with SS 638.

3.4 Covered Linkway

3.4.1 Design Criteria for Electrical Distribution System

3.4.1.1 The electrical installation shall be designed in compliance to SS 638.

3.4.1.2 The design of the electrical installation shall be as per shown in the latest revision of drawing no: L/ROAD/MES/SD/1002. Where a covered linkway is located adjacent to existing bus stop / Taxi / PUDO shelter, the design of the electrical installation shall be as per shown in the latest revision of drawing no: L/ROAD/MES/SD/1004. The OG Box shall not block pedestrian walkway.

3.4.1.3 For covered linkways located near RTS stations and maintained by station operator, power supply shall be taken from the station switchboard complete with sub-metering. The power supply for covered linkway maintained by developer shall be taken from the developer's installation. Dedicated power intake OG Box from power utility shall be provided for covered linkways that are maintained by LTA.

3.4.1.4 Lighting system shall be designed with alternate circuiting.

3.4.2 Design Criteria for Lighting System

3.4.2.1 Light fitting shall be LED type. No up-lighters shall be used in the lighting design.

- 3.4.2.2 The LED light fitting shall be weatherproof, designed to IP65, vandal proof, designed to minimum IK06, ultra-violet (UV) stabilized and aesthetically acceptable. The LED lamp shall have a colour-rendering index of 80 to 89 with colour temperature of 3000K.
- 3.4.2.3 All lighting systems shall be controlled via a programmable timer with an RS232 interface with a bypass switch.
- 3.4.2.4 For covered linkways with cycling path next to the covered linkway, the lightings of the covered linkways shall illuminate both covered linkway and cycling path next to the covered linkway as shown on IDC Vol. C Chapter 2. If the cycling path is not abutting to covered linkways, dedicated lightings shall be provided in accordance with LTA Public Street Lighting System Guidelines.
- 3.4.3 Design Criteria for Lightning Protection System
- 3.4.3.1 The lightning protection system for the covered linkway shall be designed in compliance to SS 555.
- 3.4.3.2 The metal roof of min. 10mm thickness aluminium honeycomb roof panel complete with min. 1mm aluminium thickness at top panel shall be used as part of lightning protection system.
- 3.4.3.3 All exposed metal parts such as metal railings, lighting poles, bus signage poles etc. within 2-metre radius of the covered linkway perimeter shall be bonded to the lightning protection system of the covered linkway.
- 3.4.3.4 All metal structures shall be bonded to the rebar of the floor slab by means of a purpose made clamp or weld.
- 3.4.3.5 The lightning protection system shall be electrically continuous. Where the covered linkway is connected to any CI and or adjacent structure, PE (electrical) shall be responsible to ensure that the lightning protection bonding is adequately provided between the existing structure and the covered linkway.
- 3.4.3.6 All lightning earth pits shall be planted within road reserve line and LTA's maintenance boundary. It shall not be located at pedestrian walkway.
- 3.4.4 Design Criteria for Earthing System and Equipotential Bonding
- 3.4.4.1 Earthing requirements shall be provided in accordance with SS 551.
- 3.4.4.2 Earth electrode completes with hot-dipped galvanised lid earth pit haunch in concrete with provisions made for drainage shall be provided to connect to the main earthing terminal in the OG Box.

3.4.4.3 All earth electrodes shall be planted within road reserve line and LTA's maintenance boundary. It shall not be located at pedestrian walkway.

3.4.4.4 All exposed metal parts shall be equipotentially bonded in accordance with SS 638.

3.5 Pedestrian Overhead Bridge (POB)

3.5.1 Design Criteria for Electrical Distribution System

3.5.1.1 The electrical installation shall be designed in compliance to SS 638.

3.5.1.2 The design of the electrical installation shall be as per shown in the latest revision of drawing no: L/ROAD/MES/SD/1002. Where a POB is located adjacent to existing bus stop / Taxi / PUDO shelter, the design of the electrical installation shall be as per shown in the latest revision of drawing no: L/ROAD/MES/SD/1004. For POB with provisions for lifts, the design of the electrical installation shall be as per shown in the latest revision of drawing no: L/ROAD/MES/SD/1005. For POB linking to RTS stations and maintained by station operator, power supply shall be taken from the station switchboard complete with sub-metering. The power supply for POB maintained by developer shall be taken from the developer's installation. Dedicated power intake OG Box from power utility shall be provided for POB that is maintained by LTA.

3.5.1.3 Lighting system shall be designed with alternate circuiting and intelligent lighting detection system (ILDS).

3.5.1.4 For POB with escalators, the following electrical provisions shall be made where applicable (electrical fittings and accessories used for outdoor, wet and dusty areas shall be minimum of IP65 rating):

- a. 3 nos. DP isolators of appropriate rating shall be provided for CFEMS (RTU), CCTV and as a spare isolator respectively.
- b. 1 no. 4P isolator of appropriate rating for the escalator controller.
- c. 1 no. 13A switch socket outlet and 1 no. light fitting shall be provided within each escalator controller closet.
- d. 1 no. light fitting and 1 no 13A switch socket outlet shall be provided in each of the top and bottom escalator pits.
- e. A separate sub-kWh meter shall be provided to monitor the energy consumption of escalators.

3.5.1.5 Interface requirements for Commuter Facility Equipment Monitoring Services (CFEMS) shall refer to Chapter 4.

3.5.1.6 Where the developer constructs a Pedestrian Overhead Bridge that is linked or adjacent to existing bus stop / Taxi / PUDO shelter, the following additional design criteria shall apply:

- a. The pedestrian overhead bridge and/or linkways shall take their electrical supply from the existing OG Box should spare capacity is available as per shown in the latest revision of drawing no: L/ROAD/MES/SD/1004. In the event where spare capacity is not available, new OG Box shall be provided.
- b. The cables from the existing OG Box to the POB OG Box installation shall be of multi-core armoured cable. All connection cables shall be laid underground with 100mm diameter heavy duty uPVC pipe haunch in concrete.
- c. The electrical installation of the pedestrian overhead bridge and/or linkways shall be designed in accordance to the design criteria for the appropriate commuter facility as set out in this document.

3.5.2 Design Criteria for Lighting System

3.5.2.1 Light fitting shall be LED type. No up-lighters shall be used in the lighting design.

3.5.2.2 The approved type of light fitting shall be designed to IP65, vandal proof, minimum IK06, ultra-violet (UV) stabilized and aesthetically acceptable. The LED lamp shall have a colour-rendering index of 80 to 89 with colour temperature of 3000K.

3.5.2.3 All lighting systems shall be controlled via a programmable timer with RS232 interface unit with a by-pass switch.

3.5.2.4 For a covered POB, the lighting system shall be integrated with an ILDS such that:

- a. From 12am to 7am, minimum 1 no. light fitting shall be switched “ON” at every entrance, every stair / ramp landing and subsequent light fitting at every 15 meter interval. Upon detection of pedestrian, all other lightings shall be automatically switched “ON” by the detection system. The final arrangement and design shall be submitted for Authority’s approval.
- b. The sensors of the ILDS shall be positioned such that it is capable of detecting pedestrian and immediately switch “ON” the other light fittings and switch “OFF” when no pedestrian is detected after a preset time of 10 minutes. The timing shall be adjustable from 0 to 30mins.
- c. The motion sensors shall be located at every entrance / exit of POB and at the mid-point of the POB deck such that any pedestrians coming from any entrance to the POB and on the POB deck will be detected.

3.5.2.5 The ILDS design shall be of fail-safe design such that in the event of sensor failure, the lighting control shall revert to timer control.

3.5.3 Design Criteria for Lightning Protection System

3.5.3.1 The lightning protection system to the POB shall comply with SS 555.

3.5.3.2 The metal roof of min. 10mm thickness aluminium honeycomb roof panel complete with min. 1mm aluminium thickness at top panel shall be used as part of lightning protection system.

3.5.3.3 The handrails of the POB shall be bonded to the lightning protection system of the POB.

3.5.3.4 All metal structures shall be bonded to the rebar of the floor slab by means of a purpose made clamp or weld.

3.5.3.5 The lightning protection system shall be electrically continuous. Where the POB is connected to any CI or adjacent structure, PE (electrical) shall be responsible to ensure that the lightning protection bonding is adequately provided between the existing structure and the POB.

3.5.3.6 All lightning earth pits shall be planted within road reserve line and LTA's maintenance boundary. It shall not be located at pedestrian walkway.

3.5.4 Design Criteria for Earthing System and Equipotential Bonding

3.5.4.1 Earthing requirements shall be provided in accordance with SS 551.

3.5.4.2 Earth electrode completes with hot-dipped galvanised lid earth pit haunch in concrete with provisions made for drainage shall be provided to connect to the main earthing terminal in the OG Box.

3.5.4.3 All earth electrodes shall be planted within the road reserve line and LTA's maintenance boundary. It shall not be located at pedestrian walkway.

3.5.4.4 All exposed metal parts shall be equipotentially bonded in accordance with SS 638.

3.5.5 Design Criteria for Manual Irrigation System

3.5.5.1 Manual irrigation system shall be designed in accordance with National Parks' requirements.

3.5.6 Design Criteria for Escalator (Where Applicable)

3.5.6.1 Design Requirements

When escalators are required, they shall be designed in accordance with the requirements as stipulated in the Technical Specifications.

3.5.6.2 Automatic Starting and Stopping Operation

- a. The escalator shall operate in two modes: Continuous Operation with Energy Saving (standby speed) and Energy Saving (standby speed/standby stop). The escalator shall be in continuous operation with energy saving (standby speed) during pre-set timing e.g. 6am to 12 am mid-night. A timer switch shall be incorporated to adjust this pre-set timing. After this timing, the escalator shall be in continuous operation with energy saving (standby speed/standby stop). The pre-set timing shall be confirmed with the POB operator.
- b. In addition, photoelectric cells capable of detecting at various angles, which incorporate a time delay, shall be provided to ensure that nobody is riding on the escalator at the time of the switch-on or switch-off. This shall be subject to the Authority's acceptance.

3.5.6.3 Provision of Commuter Facility Equipment Monitoring Services (CFEMS)

Where escalators are provided at the POB, the CFEMS shall be provided in accordance with this document.

3.5.7 Design Criteria for Passenger Lift (Where Applicable)

3.5.7.1 Design Requirements

The lifts shall be designed in accordance with the requirements as stipulated in the Technical Specifications.

3.5.7.2 Provision of Commuter Facility Equipment Monitoring Services (CFEMS).

Where lifts are provided at the POB, CFEMS shall be provided in accordance with this document.

3.5.7.3 Ventilation of the Lift Machinery and Lift Shaft

Minimum total 2.4 m² free openings complete with weatherproof louvres shall be located and distributed along the external lift shaft on the opposite sides for cross ventilation of the lift shaft / machinery. Any other proposed area is subject to the Authority's approval.

3.6 Pedestrian Underpass (PUP)

3.6.1 Design Criteria for Electrical Distribution System

3.6.1.1 The electrical installation shall be designed in compliance to SS 638.

- 3.6.1.2 For PUP linking to RTS station and maintained by station operator, power supply shall be taken from the station switchboard complete with sub-metering. The power supply for PUP maintained by developer shall be taken from the developer's installation. Dedicated power intake OG Box from power utility and a separate DB located at the PUP shall be provided for PUP that is maintained by LTA.
- 3.6.1.3 All distribution board (DBs) shall not be accessible to the public and placed in a recessed lockable cabinet at the underpass.
- 3.6.1.4 Sub circuits shall be run in Galvanized Iron (G.I.) conduits. All conduit systems shall be directly terminated to the equipment. All conduit systems shall be concealed.
- 3.6.1.5 Lighting system shall be designed with alternate circuiting and ILDS.
- 3.6.1.6 For PUP with escalators, the following electrical provisions shall be made where applicable (electrical fittings and accessories used for outdoor, wet and dusty areas shall be minimum of IP65 rating):
- a. 1 no. fused connection unit of appropriate rating shall be provided for signage and advertising panel lighting.
 - b. 3 nos. DP isolators of appropriate rating shall be provided for CFEMS (RTU), CCTV and as a spare isolator respectively.
 - c. 1 no. 4P isolator of appropriate rating for the controller and 1 no. 13A switch socket outlet and 1 no. light fitting shall be provided within each escalator controller closet. 1 no. light fitting and 1 no 13A switch socket outlet shall be provided in each of the top and bottom escalator pits.
 - d. 1 no. DP isolator of appropriate rating shall be provided to supply UPS for escalator combs lights. UPS to be installed in escalator controller closet, if applicable.
 - e. A DB shall be provided to serve 1 no. 4P isolator of appropriate rating for the lift control panel, 1 no. DP isolator of appropriate rating for the UPS unit (for car top lighting, lift management system, car top switch socket outlet), lift pit lighting, lift pit switch socket outlet and lift shaft lighting.
 - f. 1 no. 4P isolator of appropriate rating shall be provided for each motor control centre DB.
 - g. 1 no DP isolator of appropriate rating shall be provided for Fire Pump control panel.
 - h. 1 no 13A Fuse Connection Unit shall be provided inside each fire alarm panel.

- i. 1 no 4P isolator of appropriate rating shall be provided at the sump or ejector pump control panel.
- j. A separate sub-kWh meter shall be provided for the escalator. All circuits shall be properly labelled in the OG Box and DBs.

3.6.2 Design Criteria for Lighting System

3.6.2.1 Light fitting shall be LED type. No up-lighters shall be used in the lighting design.

3.6.2.2 The LED lamp shall have a colour-rendering index of 80 to 89 with colour temperature of 4000K in the PUP. It shall be designed to IP65, vandal proof, minimum IK06, ultra-violet (UV) stabilized and aesthetically acceptable. For lighting that is not exposed to weather and provided with false ceiling, it shall be designed with minimum IP4X.

3.6.2.3 Emergency lighting shall be of minimum 1 lux for the operational duration of 1 hour and shall be provided in accordance with SS 563.

3.6.2.4 All lighting systems shall be controlled via programmable timers with RS232 interface. The timers shall be supplied inclusive of a bypass switch. Underpass entrance lighting shall be controlled separately from the underpass lighting circuits.

3.6.2.5 For a PUP, the lighting system shall be integrated with an ILDS such that:

- a. At all times, minimum 1 no. light fitting shall be switched “ON” at every entrance, every stair / ramp landing and subsequent light fitting at every 15 metre interval. Upon detection of pedestrian, all other lightings shall be automatically switched “ON” by the detection system. The final arrangement and design shall be submitted for Authority’s approval.
- b. The sensors of the ILDS shall be positioned such that each sensor is capable of detecting pedestrian and immediately switch “ON” the other light fittings and switch “OFF” when no pedestrian is detected after a preset time of 10 minutes. The timing shall be adjustable from 0 to 30mins.
- c. The motion sensors shall be located at every entrance / exit of PUP and at the mid-point of the PUP such that any pedestrians coming from any entrance to the PUP and in the PUP will be detected.

3.6.2.6 The ILDS design shall be of fail-safe design such that in the event of sensor failure, the lighting control shall revert to timer control.

3.6.3 Design Criteria for Lightning Protection System

3.6.3.1 The lightning protection system to the PUP shall comply with SS 555.

3.6.3.2 The metal roof of min. 10mm thickness aluminium honeycomb roof panel complete with min. 1mm aluminium thickness at top panel shall be used as part of lightning protection system where applicable.

3.6.3.3 All metal structures shall be bonded to the rebar of the floor slab by means of a purpose made clamp or weld where applicable.

3.6.3.4 The lightning protection system shall be electrically continuous, where the PUP entrances are connected to any CI or adjacent structure. PE (electrical) shall be responsible to ensure that the lightning protection bonding is adequately provided between the existing structure and the PUP entrances.

3.6.3.5 All lightning earth pits shall be planted within road reserve line and LTA's maintenance boundary. It shall not be located at pedestrian walkway.

3.6.4 Design Criteria for Earthing System and Equipotential Bonding

3.6.4.1 Earthing requirements shall be provided in accordance with SS 551.

3.6.4.2 Earth electrode complete with hot-dipped galvanised lid earth pit haunch in concrete with provisions made for drainage shall be provided to connect to the main earthing terminal in the OG Box.

3.6.4.3 All earth electrodes shall be planted within the road reserve line and LTA's maintenance boundary. It shall not be located at pedestrian walkway.

3.6.4.4 All exposed metal parts shall be equipotentially bonded in accordance with SS 638.

3.6.5 Design Criteria for Pumped Drainage System

3.6.5.1 Pumped drainage system shall be provided at the underpass for the collection and disposal of wastewater from the washing of underpass and storm water. The water shall be positively drained via channels and drains by gravity to the drainage sump. The water shall be pumped from the sump to the external storm water drain.

3.6.5.2 Auxiliary contacts to the Interfaced Terminal Board (ITB) for the connection to the Commuter Facilities Equipment Monitoring Services (CFEMS) shall be provided in accordance with CFEMS requirements in Chapter 4.

3.6.6 Design Criteria for Escalator (Where Applicable)

3.6.6.1 Design Requirements

When escalators are required, they shall be provided to link all levels in the PUP. The escalators shall be designed in accordance with the requirements as stipulated in the Technical Specifications.

3.6.6.2 Automatic Starting and Stopping Operation

- a. The escalator shall operate in two modes: Continuous Operation with Energy Saving (standby speed) and Energy Saving (standby speed/standby stop). The escalator shall be in continuous operation with energy saving (standby speed) during pre-set timing e.g. 6am to 12 am. A timer switch shall be incorporated to adjust this pre-set timing. After this timing, the escalator shall be in continuous operation with energy saving (standby speed/standby stop). The pre-set timing shall be confirmed with the PUP operator.
- b. In addition, photoelectric cells capable of detecting at various angles, which incorporate a time delay, shall be provided to ensure that nobody is riding on the escalator at the time of the switch-on or switch-off. This shall be subject to the Authority's acceptance.

3.6.6.3 Provision of Commuter Facility Equipment Monitoring Services (CFEMS)

Where escalators are provided at the PUP, CFEMS shall be provided in accordance with this document.

3.6.7 Design Criteria for Air-Conditioning and Mechanical Ventilation System (ACMV)

3.6.7.1 General Requirements

- a. PUP shall be naturally or mechanically ventilated or air-conditioned. Mechanically ventilated PUP shall comply with the requirements in the section "Mechanically Ventilated PUP". Air-conditioned PUP shall comply with the requirements in the section "Air-conditioned PUP".
- b. For the design of the air-conditioning and mechanical ventilation (ACMV) system for PUP, the following outdoor conditions shall be assumed:

Dry Bulb temperature	:	32°C
Wet Bulb temperature	:	26°C
- c. The ACMV system for the PUP shall comply with the relevant regulations, codes of practice, standards and requirements of the authorities having jurisdiction of the works.
- d. The ACMV system shall be energy efficient, safe and easy to operate.
- e. All equipment, components and services installed outdoors or exposed to weather shall be of weatherproof design and resistant to corrosion and ultra-violet (UV).

- f. All floor-mounted equipment and services shall be mounted on plinths or stumps.
- g. The equipment and services shall be located so that they are concealed from view by the public. The equipment and services shall also not be located where they are accessible to the public and are subject to damage or vandalism. They must be easily access for maintenance without obstructing the access path of the commuters.
- h. Openings for outdoor air intakes and exhaust discharge shall be shielded from weather and insects and shall be provided with louvres of weatherproof design and construction. An insect screen constructed of hot dipped galvanised steel wires not larger than 10mm mesh shall be provided behind the louver openings.
- i. Control panels, cabinets and plantrooms provided for the ACMV equipment shall be lockable. 3 sets of keys shall be provided. The control panels, cabinets and plantrooms shall be adequately ventilated to prevent excessive heat build-up so that the operation of the equipment is not affected.
- j. Unless otherwise specified, the ACMV equipment, materials, installation, testing and commissioning shall also comply with National Productive and Quality Specifications (NPQS), Mechanical Specifications issued by the Building Control Authority to the acceptance of the Authority.
- k. All plantrooms shall be adequately sized so that there will be sufficient space for proper operation, maintenance, and future replacement of the equipment. A water tap, floor trap and weatherproof power point shall be provided in the plantroom for cleaning and maintenance of the equipment.
- l. The ACMV system for the pedestrian underpass shall be independent from that of the adjacent RTS station or development.
- m. A means of emergency switching off the ACMV equipment shall be provided adjacent to the equipment when they are located remotely from the MCC or local control panel from which they take the power supply.
- n. Supply air outlets/exhaust air inlets shall be adequately distributed to ensure no stagnation of air within the underpass.

3.6.7.2 Air-conditioned PUP

- a. For air-conditioning PUP, the design indoor condition shall be based on the following:
 - Dry-bulb temperature: 27°C*
 - Relative Humidity: 55%
 - Number of occupants: 3m² per person
 - Minimum fresh air supply: 5.5 l/s per person

* For PUP with commercial spaces or connected to air-conditioned commercial building, the design dry-bulb temperature shall be 25°C

- b. Air-conditioning for the PUP shall be provided by means of air-cooled split-type or variable refrigerant flow (VRF) air-conditioning system with ducted type evaporator units or floor-mounted air handling units housed in plantrooms for ease of access for cleaning maintenance. Each underpass shall be served by at least two sets of air-conditioning units. The capacity of each air-conditioning unit shall be such that in the event of failure of one unit, the remaining unit(s) shall at least provide half the total required cooling load.
- c. A weatherproof electrical isolator of appropriate rating shall be provided adjacent to each condensing unit.
- d. Air-curtains shall be provided at the exit and entrance to the underpass to minimise air exchange between the air-conditioned and non air-conditioned spaces.
- e. The control system shall allow both automatic and manual operation of the air-conditioning units and air curtains. Programmable timers shall be provided for automatic starting and stopping of the equipment. In the event of failure of one unit, the other unit(s) shall continue to operate. Manual/Off/Auto selector switches and start/stop push buttons shall be provided. LEDs shall be provided on the control panel to indicate the status of the incoming power supply and status and alarm of the equipment. The control panel for the equipment shall be placed in the plantroom.
- f. The thermostats for the air-conditioning units shall be located where the public cannot tamper with them. Provision for adjustment of thermostat settings of the air-conditioning units shall be made available in the plantroom.
- g. Prefilters shall be provided for fresh air intake of the air-conditioning system. The air handling units shall be provided with primary and secondary filters.
- h. Sufficient supply air outlets shall be provided to ensure proper air distribution.
- i. Refrigerant for the air-conditioning units shall have Ozone Depletion Potential (ODP) of zero or Global Warming Potential (GWP) of less than 100 such as HFC-134a. CFC and HCFC refrigerants will not be acceptable.
- j. All condensate drainpipes for the air-conditioning units(s) shall be concealed and connected to the nearest floor trap. The condensate drainpipes and the floor traps shall be insulated to prevent condensation.

3.6.7.3 Mechanically Ventilated PUP

- a. The mechanical ventilation system shall provide a safe and thermally acceptable environment in the pedestrian underpass.
- b. The mechanical ventilation system for the pedestrian underpass shall provide a minimum air change rate of 10 times per hour and an average air velocity of 0.8 m/s within the occupied areas of the underpass.
- c. Each underpass shall be provided with at least two sets of fans. The capacity of each set of fans shall be such that in the event of failure of one set(s), the remaining set shall at least provide half the ventilation capacity.
- d. The ventilation system shall ensure no stagnation of air within the underpass.
- e. Facility shall be provided with the ability to automatically switch off the fans when the underpass is not occupied (e.g. provision of motion detector). The design shall incorporate feature to ensure the fans do not start-stop more than 8 times in one hour. Manual/Off/Auto selector switches and start/stop push buttons shall be provided. LEDs shall be provided on the control panel to indicate the status of the incoming power supply and status and alarm of the fans. The control panel for the fans shall be placed in the plantroom, where applicable, or in a recessed lockable cabinet in the underpass.

3.6.7.4 Provision of Commuter Facility Equipment Monitoring Services (CFEMS)

Where ACMV systems are provided at the PUP, CFEMS shall be provided in accordance with this document.

3.6.8 Design Criteria for Equipment Noise and Vibration

3.6.8.1 The sound pressure levels anywhere in the pedestrian underpass, due to the operation of any ACMV equipment but excluding all extraneous sources, shall not exceed 55 dBA when measured at a height of 1.5m above the finished floor level.

3.6.8.2 The external noise levels shall comply with the NEA's guidelines and requirements.

3.6.8.3 All mechanical equipment shall be mounted on vibration isolators in accordance with the manufacturers' recommendation or where necessary to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

3.6.8.4 Acoustic enclosures for fans shall be designed such that they can be easily dismantled for maintenance access to the fan motors.

3.6.9 Design Criteria for Fire Protection System

3.6.9.1 General

- a. PUP linked to and form part of a RTS station shall comply with the requirements stipulated in the Code of Practice for Fire Precautions in Rapid Transit Systems (CPFPRTS).
- b. PUP with or without commercial spaces shall comply with requirements of SCDF.
- c. PUP with commercial spaces shall be provided with an independent Fire Protection System.

3.6.9.2 Automatic Fire Alarm System

- a. The fire alarm system shall comply with SS 645. The system shall be connected to a fire station through an approved alarm monitoring company.
- b. The Main Alarm Panel (MAP) shall be easily accessible by Firemen. Mimic panels shall be provided next to the MAP. The MAP shall be able to send a fire alarm signal to Commuter Facility Equipment Monitoring Services (CFEMS) via an Interfacing Terminal Box (ITB) as specified in this document.
- c. Fire-rated shutter / swing door (used as fire separation) installed at the boundary adjacent to a development shall comply with requirements of SCDF. The status of the shutter / door shall be sent to the FCC of the adjacent commercial building and PUP respectively. Provisions shall be made to receive commercial building alarm status and to send a fire alarm signal to CFEMS via an Interfacing Terminal Box (ITB) as specified in this document.

3.6.9.3 Automatic Fire Sprinkler System

- a. The fire sprinkler system shall comply with the requirements of SS CP52 Code of Practice for Automatic Fire Sprinkler System.
- b. For an independent auto fire sprinkler system, the sprinkler pumps and control panels shall be housed in the sprinkler pump room.
- c. External ladders of aluminium alloy type or stainless steel type and internal ladders of stainless steel type shall be provided for the tank. The hand railing for the ladder shall extend above the tank to facilitate easy access.

3.6.9.4 Fire Hose Reel System

- a. The fire hose reel system shall comply with the requirements of SS 575 Code of Practice for Fire Hydrant Systems and Hose Reel System.
- b. Wherever possible, the hose reel system shall be fed direct from the PUB mains.

3.6.9.5 Fire Extinguishers

Fire extinguishers shall be provided in accordance with SS 578 Code of Practice for Use and Maintenance of Portable Fire Extinguishers and SS EN 3 series Specification for Portable Fire Extinguishers.

3.6.9.6 Provision of Commuter Facility Equipment Monitoring Services (CFEMS)

Where Fire Protection systems are provided at the PUP, CFEMS shall be provided in accordance with this document.

3.6.10 Design Criteria for Passenger Lift (Where Applicable)

3.6.10.1 Design Requirements

When lifts are required, they shall be provided to link all levels in the PUP. The lifts shall be designed in accordance with the requirements as stipulated in the Technical Specifications.

3.6.10.2 Provision of Commuter Facility Equipment Monitoring Services (CFEMS)

Where lifts are provided at the PUP, the CFEMS shall be provided in accordance with this document.

3.6.10.3 Ventilation of the Lift Machinery and Lift Shaft

Minimum two number of 0.15 m² free openings complete with weatherproof louvres shall be located on the opposite sides at the top of the lift shaft for ventilation of the lift machinery.

**CHECKLIST 1 - M&E SERVICES CHECKLIST - FOR BUS STOP SHELTER, TAXI /
PICK-UP DROP-OFF (PUDO) SHELTER, PEDESTRIAN OVERHEAD BRIDGE
(POB) AND COVERED LINKWAY**

Project: _____

(√) Tick the appropriate box for all items

Standard Requirements	Yes	NA	Remarks
1. General			
1.1. Drawings are in A1 series.	<input type="checkbox"/>		
1.2. Site plan, location plan and layout plans showing road reserve line and LTA's maintenance boundary are included.	<input type="checkbox"/>		
1.3. The proposed installations provided are within LTA's maintenance boundary.	<input type="checkbox"/>		
1.4. Electrical installations above PUB drains are complied with PUB's requirements.	<input type="checkbox"/>		
1.5. Design calculations with design parameters and acceptance criteria are included.	<input type="checkbox"/>		
1.6. Technical data, catalogues, relevant test certificates / certificates of compliance from accredited testing facilities for proposed equipment, cables, materials and accessories are included.	<input type="checkbox"/>		
1.7. All electrical drawings, documents and design calculations are endorsed by Licensed Electrical Worker (LEW).	<input type="checkbox"/>		
1.8. All lightning protection system drawings, documents and design calculations are endorsed by Electrical Professional Engineer (PE).	<input type="checkbox"/>		
1.9. Responses to LTA's previous comments are attached.	<input type="checkbox"/>		
1.10. All additions / deletions / amendments are clouded.	<input type="checkbox"/>		
1.11. Commuter facilities M&E requirements stated in LTA's Infrastructure Design Criteria (IDC) Volume C Chapter 3 are complied with.	<input type="checkbox"/>		
2. Electrical Distribution			

Standard Requirements	Yes	NA	Remarks
2.1. Design of the electrical distribution is complied with LTA's IDC requirements and drawings.	<input type="checkbox"/>		
2.2. Single line diagrams for OG box and / or distribution board are included.	<input type="checkbox"/>		
2.3. Electrical loading and cable sizing calculations are included.	<input type="checkbox"/>		
2.4. OG box details showing plan view, front view, back view, internal view, external view, sections and elevations are included.	<input type="checkbox"/>		
2.5. Type B MCB are provided for all outgoing circuits.	<input type="checkbox"/>		
2.6. Surge protection device is provided as per LTA's IDC requirements.	<input type="checkbox"/>		
2.7. SPPG approved OG box location complete with the route of SPPG incoming cables are included.	<input type="checkbox"/>		
2.8. OG box is not in the path of commuter walkway and line of sight of commuters looking at the oncoming traffic (e.g. obstructing the sight of arrival bus)	<input type="checkbox"/>		
2.9. HD uPVC pipes for installation of armoured cables from the OG box to the proposed commuter facilities are provided with straight run or with gradual long bends.	<input type="checkbox"/>		
2.10. HD uPVC pipes complete with draw wires with straight run or with gradual long bends are provided for advertisement panel for bus shelters.	<input type="checkbox"/>		
3. Lighting Design and Light Fittings			
3.1. No up-lighters are to be provided.	<input type="checkbox"/>		
3.2. Lighting level simulation reports with lux plots (one meter apart) and dimensions of simulated areas correspond to the lighting layout plans are included.	<input type="checkbox"/>		
3.3. Lighting levels and uniformity ratio measured at the ground level are complied with LTA's IDC requirements.	<input type="checkbox"/>		
3.4. The maximum allowable power budget is complied with LTA's IDC requirements.	<input type="checkbox"/>		

Standard Requirements	Yes	NA	Remarks
3.5. LED type light fittings of weatherproof IP65, vandal proof minimum IK06, ultra-violet (UV) stabilised and colour rendering index of 80 to 89 with colour temperature between 2700K and 3000K are provided.	<input type="checkbox"/>		
3.6. Lighting layout plans and sections with detailed cable routes from the OG box to the respective light fittings are included.	<input type="checkbox"/>		
3.7. The layout arrangement of light fittings are generally in line with LTA's IDC drawings.	<input type="checkbox"/>		
3.8. Alternate lighting circuits are provided.	<input type="checkbox"/>		
3.9. High covered linkway lighting circuits are complied with LTA's IDC drawings.	<input type="checkbox"/>		
3.10. Covered POB is provided with intelligent lighting detection system are complied with LTA's IDC requirements.	<input type="checkbox"/>		
3.11. Cross-sectional mounting details of the proposed light fitting to demonstrate ease of maintenance is provided.	<input type="checkbox"/>		
4. Lightning Protection System			
4.1. The lightning protection system is designed in compliance to SS 555.	<input type="checkbox"/>		
4.2. Lightning protection layout plans, sections and installations details, such as lightning bonding, earth pit, etc. are included.	<input type="checkbox"/>		
4.3. Minimum 10mm thick aluminium honey comb roof panels complete with minimum 1 mm thick top panel are provided as air termination system for the lightning protection system.	<input type="checkbox"/>		
4.4. The roofs are bonded to the support posts and support posts are connected to earth pits as per LTA's IDC drawings.	<input type="checkbox"/>		
4.5. All exposed metal parts, such as metal railings, bus signage poles, notice boards, etc. within 2m radius of the commuter facilities perimeter are bonded to the lightning protection system.	<input type="checkbox"/>		
4.6. All metal structures are bonded to the rebar of the floor slab by means of a purpose made clamp or weld. Location of bonding and typical bonding details are provided.	<input type="checkbox"/>		

Standard Requirements	Yes	NA	Remarks
4.7. Each commuter facilities structures for POB, covered linkway, bus shelters, etc. are provided with an independent lightning protection system, including earth pits.	<input type="checkbox"/>		
4.8. The lightning protection system between two or more commuter facilities structures, such as POB, covered linkway, bus shelters, etc. are bonded and electrically continuous.	<input type="checkbox"/>		
4.9. Earth pits are not in the path of commuter walkway.	<input type="checkbox"/>		
5. Earthing System and Equipotential Bonding			
5.1. Earthing requirements is provided in accordance to SS 551.	<input type="checkbox"/>		
5.2. Equipotential bonding are provided in accordance to SS 638 for all exposed metal parts and metallic street furniture.	<input type="checkbox"/>		
5.3. Equipotential bonding layout plans, sections and cable route to OG box are included.	<input type="checkbox"/>		

Qualified Person (QP)

Date

Note: Please tick in appropriate box for all items.

This checklist is to be submitted for every submission / re-submission.

CHAPTER 4 – OPERATION AND MAINTENANCE REQUIREMENTS

Table of Contents

4.1	Introduction.....	2
4.1.1	Design for Operations and Maintainability (DfOM)	2
4.2	Commuter Infrastructure (Structure)	4
4.2.1	General Requirements.....	4
4.2.2	Bus Stop Shelter/ Taxi Shelter/ Pick-up/ Drop-off Shelter.....	5
4.2.3	Covered Linkway Shelter	11
4.2.4	Pedestrian Overhead Bridge.....	16
4.2.5	Pedestrian Underpass	21
4.2.6	Footpath/ Cycling Path.....	23
4.2.7	Inspection and Taking Over.....	27
4.3	Commuter Facilities (Electrical)	29
4.3.1	Commuter Facilities System	29
4.3.2	Inspection and Taking Over.....	39
4.4	Commuter Infrastructure (Equipment or Mechanical System)	41
4.4.1	General	41
4.4.2	Commuter Facility Equipment Monitoring Services (CFEMS) ..	50
4.4.3	Inspection and Taking Over.....	65

4.1 Introduction

4.1.1 Design for Operations and Maintainability (DfOM)

Maintainability measures the ease and ability of which maintenance actions or activities can be conducted. A lack of maintainability considerations at the onset of a municipal infrastructure project often generates unavoidable maintenance demands that can result in higher upkeep costs and labor needs.

Design for Operations and Maintainability (DfOM) emphasizes the significance of integrating operations and maintenance experience in the planning, designing and implementation phases to achieve the following objectives as stated in the table below.

Objectives	Examples
Ease of maintenance	<ul style="list-style-type: none"> • Ease of rectification and replacement of structural members. • Standardisation of structural members.
A safe environment for commuters' usage and maintenance works to be performed	<ul style="list-style-type: none"> • Provision of dedicated and proper maintenance access points incorporated during the design stage. • Provision of safe and hazard free environment (i.e. slip and trip prevention).
Economy of maintenance	<ul style="list-style-type: none"> • Minimizing maintenance intervention through the usage of durable, robust and longer-lasting materials. • Minimizing the footprint of future maintenance works to be carried out.
Clarity in the maintenance boundaries and Commuter Infrastructures to be managed by various maintenance agencies	<ul style="list-style-type: none"> • Proper demarcation of maintenance boundaries at the interfaces of Commuter Infrastructures managed by various maintenance agencies to avoid any present and future ambiguities.

Holistic design	<ul style="list-style-type: none">• Carrying out a holistic site assessment during the design stage to prevent any future maintenance issues especially at the interfaces of Commuter Infrastructures managed by various maintenance agencies (i.e. mitigation of surface runoff from adjacent land onto footpaths).
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Table 1: Design for Operations and Maintainability (DfOM) Objectives

The design criteria put forth in this document for various aspects of the LTA Commuter Infrastructures. Therefore, the O&M requirements have been based on the principles stated in the preceding two paragraphs.

4.2 Commuter Infrastructure (Structure)

4.2.1 General Requirements

- 4.2.1.1 All design and construction shall comply with LTA's latest Standard Details of Road Elements (SDRE), Material & Workmanship (M&W) Specifications, Civil Design Criteria (CDC), Infrastructure Design Criteria (IDC), Code of Practice (COP), BCA's Code on Accessibility and any other Specifications by other relevant Authorities. The design shall be based on the prevailing regulatory and technical requirements. Any deviation to the standards during planning, designing and implementation phases must be highlighted to the respective parties.
- 4.2.1.2 For LTA's considerations to maintain, all Commuter Infrastructures must meet the following criteria:
- ✓ To be located within Public Street/ State Land
 - ✓ To serve as a need for Transport Nodes
 - ✓ To be 24/7 Accessible for Public
 - ✓ To ensure no Duplicated Crossings (i.e. POB, At-Grade Crossings and Underground Crossings)
 - ✓ To comply with all LTA's Standards and Codes of Practise or Guidelines
- 4.2.1.3 Any encroachment into a private land must be highlighted to LTA and plan for its ownership, regularization and maintenance. Land alienated to other Statutory Board is a private land, as per Street Works Act.
- 4.2.1.4 All proposed floor finishes must provide a safe and hazard-free environment. All potential risks must be identified early and to be addressed with appropriate mitigating measures.
- 4.2.1.5 All Commuter Infrastructures shall be designed as independent structures and not connected to any adjacent structures. This is to establish a clear ownership and maintenance responsibilities of the Commuter Infrastructures.
- 4.2.1.6 Any Pedestrian Overhead Bridge (POB) equipped with mechanical systems shall be monitored by Commuter Facility Equipment Monitoring Services (CFEMS) or equivalent monitoring system. Please refer to clause 4.4.2 for the details of CFEMS requirements.
- 4.2.1.7 Any Pedestrian Underpass (PUP) equipped with electrical and/ or mechanical systems shall be monitored by Commuter Facility Equipment Monitoring Services (CFEMS) or equivalent monitoring system. Please refer to clause 4.4.2 for the details of CFEMS requirements.

4.2.2 Bus Stop Shelter/ Taxi Shelter/ Pick-up/ Drop-off Shelter

4.2.2.1 Design and Detailing

- a. Shelter shall be designed as an independent structure and not connected to any adjacent structure. This is to establish a clear ownership and maintenance responsibilities of the Commuter Infrastructures.



Figure 1: An Example of a Dependent Structure Connected to an Adjacent Structure, a Pick-up Shelter is Structurally Dependent on Adjacent Structure via Tie Rods

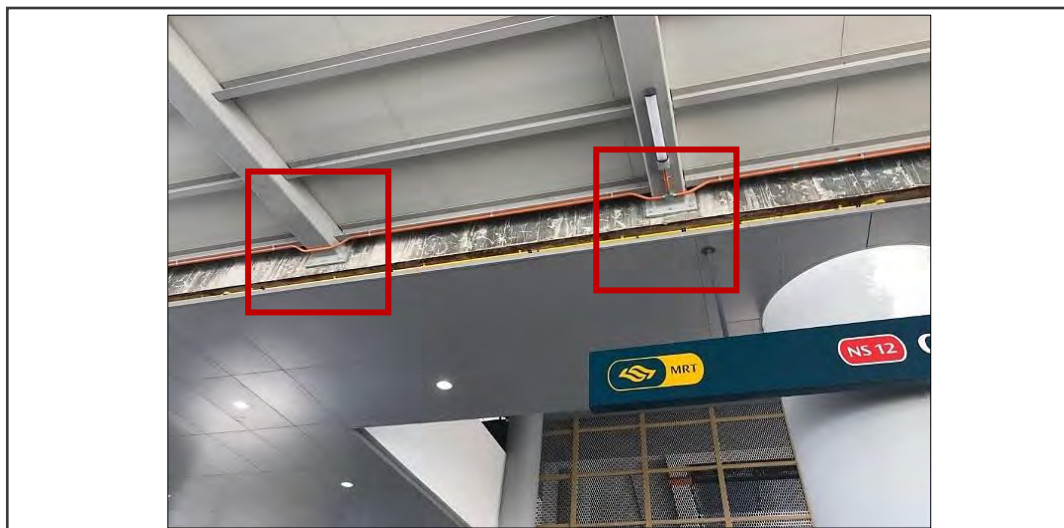


Figure 2: An Example of a Dependent Structure Connected to an Adjacent Structure, Beam Connections of a Shelter are Structurally Dependent on Adjacent Structure

- b. Foundation of shelter shall be structurally independent from any drain structure below. This is to establish a clear ownership and maintenance responsibilities of the Commuter Infrastructures. LTA only considers the maintenance of the top slabs/ surface finishes of drains within the Public Street/ State Land, designated as footpath/ shared path/ cycling path.

- c. Design of shelter shall be modularised with demountable parts consisting of bolts and nuts connection. Welded joint connection and on-site welded joint connection are not recommended as the connections could shear off due to external forces if the welding is not carried out properly.

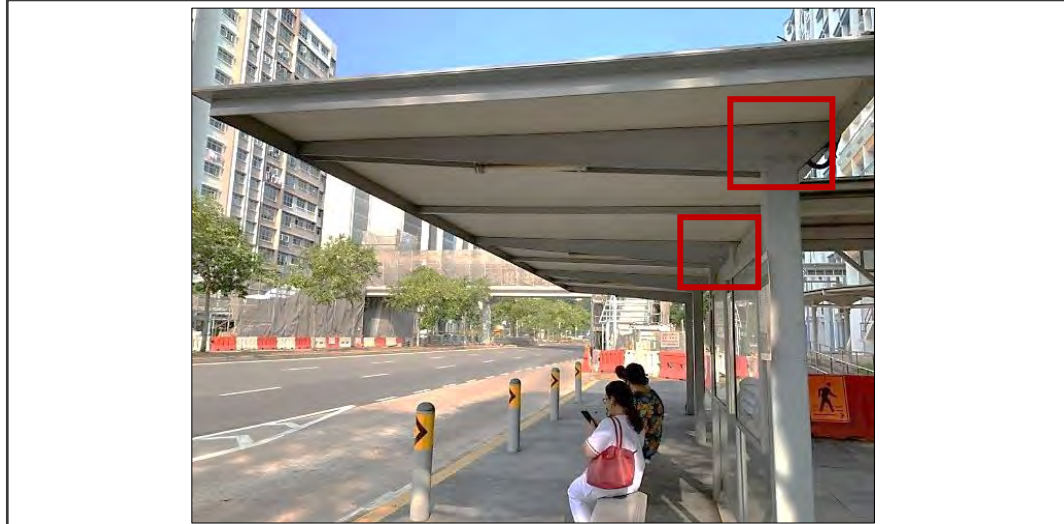


Figure 3: Modularised Design with Demountable Parts (Bolts and Nuts Connection)

- d. Vertical member joint of column shall be avoided. For any other structural joint, such connection shall be designed and endorsed by a Professional Engineer.
- e. Cladded roof and false ceiling of shelter are not recommended as it would be difficult to monitor the health of internal structural members covered by the cladded roof and false ceiling (i.e. corrosion).



Figure 4: Cladded Roofs of Pick-up Shelter and Bus Stop Shelter are Not Recommended

- f. Roof shall be designed with a sufficient gradient for an effective water run-off. Please refer to IDC, Volume C, Chapter 1 of Commuter Infrastructure Requirements for the design of shelter roof.

- g. For standardization, a mono-pitched roof is preferred, and roof profile shall be designed with a minimum of 3° fall for drainage and self-cleansing purposes.
- h. Roof shall be sloped towards the back of bus stop shelter so that the water run-off from the roof will be channelled towards the back of shelter and into the public drains behind the bus stop shelter or to the roadside drop inlet chambers (DICs) from the sides of bus stop shelter. This is to prevent commuters from having to walk through a curtain of rainwater during alighting/ boarding the bus. Please refer to IDC, Volume C, Chapter 1 of Commuter Infrastructure Requirements for the design of shelter roof.

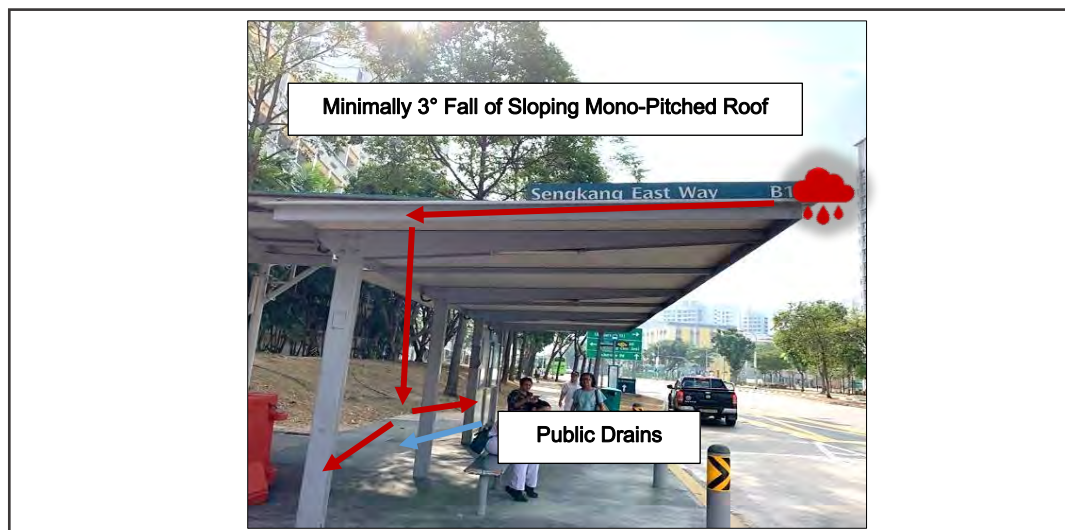


Figure 5: Minimally 3° Fall of Sloping Mono-Pitched Roof of Bus Stop Shelter

- i. Granolithic platform underneath shelter shall be graded effectively to ensure no water stagnation and a proper water discharge towards the road and subsequently, towards the adjacent roadside DICs. Please refer to LTA Standard Details of Road Elements (SDRE) for the gradient of bus stop shelter platform.

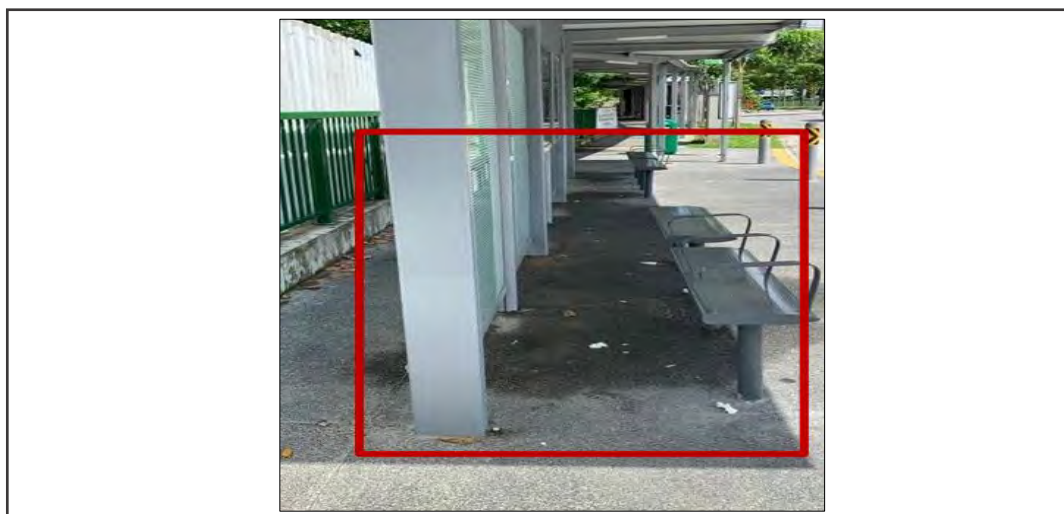


Figure 6: An Example of Water Stagnation on Granolithic Platform underneath Bus Stop Shelter

- j. For standardization, steel members of columns are preferred to be of Rectangular or Square Hollow Section (RHS or SHS).
- k. A proper drainage (i.e. cut-off drains) shall be provided within the adjacent higher ground to drain off the surface run-off from the adjacent higher grounds into the public drains and to prevent it from flowing onto the public walkway and shelter platform. The drainage is to be maintained by the adjacent Land Owner as the surface run-off originates from their respective land sites. No cut-off drains shall be designed within the public street and where cut-off drains are unavoidable due to the site constraints, construction of any cut-off drains within public street have to be built to PUB's standards and cleared with PUB before construction for their maintenance.



Figure 7: Cut-off Drains behind Bus Stop Shelter



Figure 8: An Example of No Cut-off Drains Behind Bus Stop Shelter,
Surface Run-off from Adjacent Higher Grounds Flowing onto Platform underneath Bus Stop Shelter

- l. All pre-designed holes for services/ wirings/ connections shall be treated appropriately for corrosion and they shall be sealed if they are not utilized.

4.2.2.2 Interfaces

- a. A proper interfacing element (i.e. flashing, open channel) between the proposed Commuter Infrastructure and the existing adjacent Commuter Infrastructure shall be provided. This is to prevent any water from splashing onto the shelter platform.



Figure 9: Proper Interfacing and Element between Proposed Commuter Infrastructure and Existing Commuter Infrastructure

- b. A proper interfacing element (i.e. flashing, open channel) shall be designed and installed on Commuter Infrastructures with sealant applied. This is to prevent from any water ingress/ leakage.
- c. A proper discharge from the open channel shall be designed and installed to direct the water run-off towards to nearest sump/ turf/ side table. This is to prevent the water run-off from being discharged onto the shelter platform/ walkway, causing ponding and inconvenience to commuters.

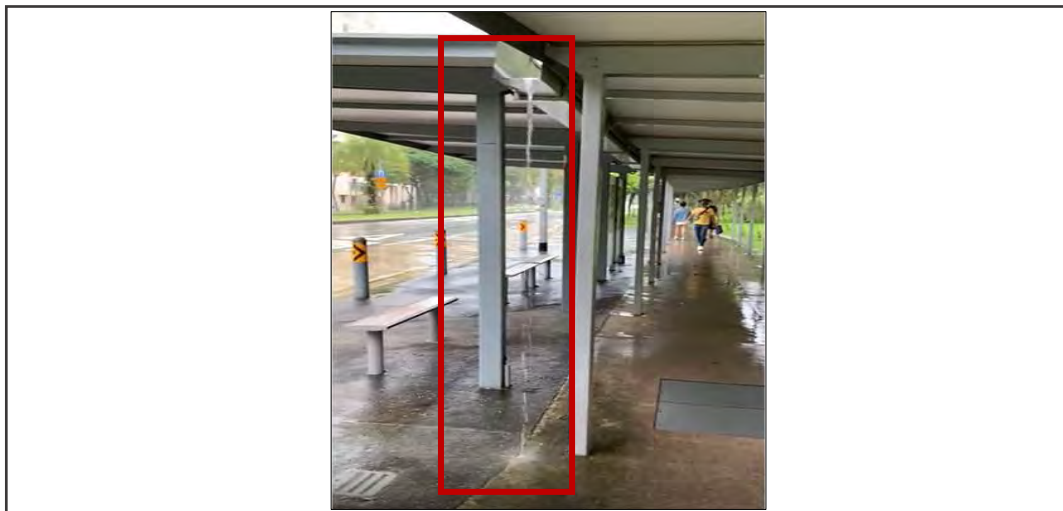


Figure 10: An Example of Water Discharging onto Public Walkway (No Proper Drainage is Provided)

- d. All mounting of system/ equipment onto any Commuter Infrastructure and Facility shall be of a non-destructive design (i.e. No drilling fixing for CCTV, lightings).

4.2.2.3 Materials

- a. Anti-stick coating shall be provided on columns of shelter. This is to prevent public from sticking any illegal advertisements on the shelter columns.



Figure 11: An Example of Sticker Residues on Column of Bus Stop Shelter (Unightly)

- b. The usage of extensive transparent and translucent roofing materials that are prone to discoloration and weathering shall be minimized.
- c. Materials used for roof shall withstand exposure to external weathering.

4.2.3 Covered Linkway Shelter

4.2.3.1 Design and Detailing

- a. Shelter shall be designed as an independent structure and not connected to any adjacent structure. This is to establish a clear ownership and maintenance responsibilities of the Commuter Infrastructures.
- b. Foundation of shelter shall be structurally independent from any drain structure below. This is to establish a clear ownership and maintenance responsibilities of the Commuter Infrastructures. LTA only considers the maintenance of the top slabs/ surface finishes of drains within the Public Street/ State Land designated as footpath/ shared path/ cycling path.
- c. Design of shelter shall be modularised with demountable parts consisting of bolts and nuts connection. Welded joint connection and on-site welded joint connection are not recommended as the connections could shear off due to external forces if the welding is not carried out properly.

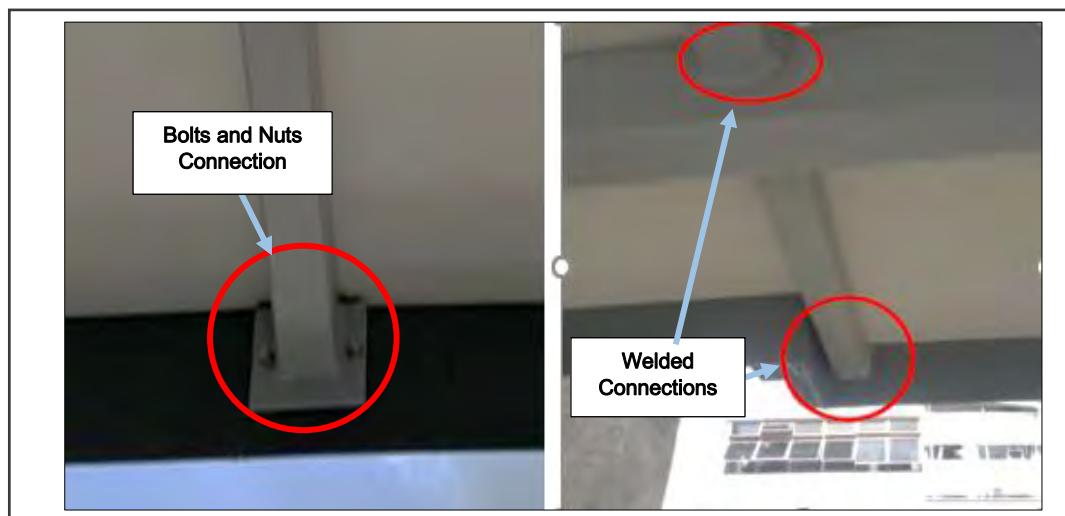


Figure 12: Bolts and Nuts Connections are Preferred, and Welded Connections are Not Recommended

- d. Vertical member joint of column shall be avoided. For any other structural joint, such connection shall be designed and endorsed by a Professional Engineer.

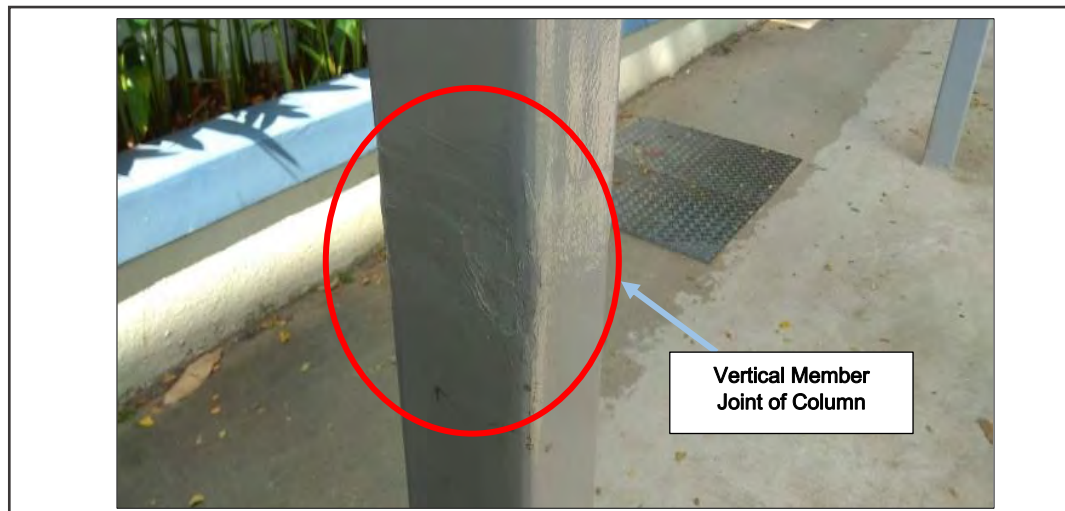


Figure 13: Vertical Member Joint of the Column Shall be Avoided

- e. Cladded roof and false ceiling of shelter are not recommended as it would be difficult to monitor the health of internal structural members covered by the cladded roof and false ceiling (i.e. corrosion).

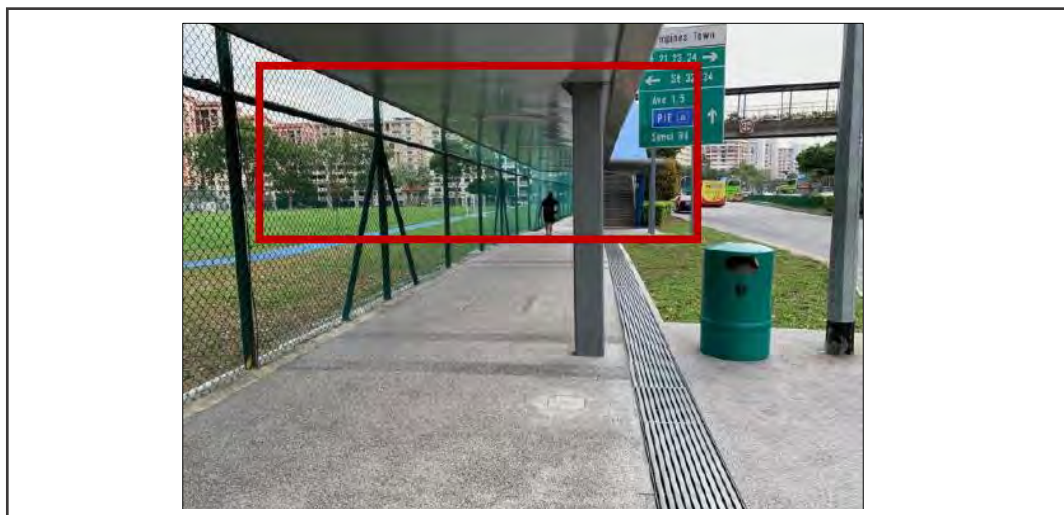


Figure 14: Cladded Roof of Covered Linkway Shelter are Not Recommended

- f. Roof shall be designed with a sufficient gradient for an effective water run-off. Please refer to IDC, Volume C, Chapter 1 of Commuter Infrastructure Requirements for the design of the shelter roof.
- g. For standardization, a mono-pitched roof is preferred, and roof profile shall be designed with a minimum of 3° fall for drainage and self-cleansing purposes.
- h. Roof shall be sloped towards the road so that water run-off from the roof will be channeled towards adjacent roadside DICs.

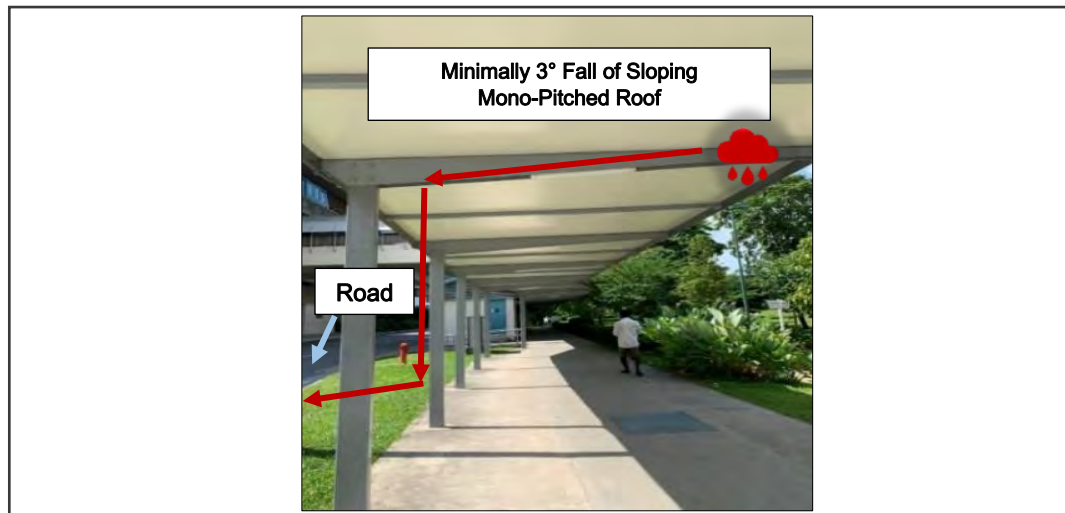


Figure 15: Minimally 3° Fall of Sloping Mono-Pitched Roof of Covered Linkway

- i. Footpath underneath shelter shall be graded effectively to ensure no water stagnation and a proper water discharge towards road and subsequently, towards roadside DICs. Please refer to LTA Standard Details of Road Elements (SDRE) for the gradient of footpath.



Figure 16: Examples of Water Stagnation on Footpath underneath Covered Linkway Shelter

- j. Gutters are not recommended due to potential chokage and mosquito breeding.
- k. For standardization, steel members of columns are preferred to be of Rectangular or Square Hollow Section (RHS or SHS).



Figure 17: An example of Rectangular Hollow Section (RHS) of Columns Steel Members

- I. A proper drainage (i.e. cut-off drains) shall be provided within the adjacent higher ground to drain off the surface run-off from the adjacent higher grounds into the public drains and to prevent it from flowing onto the public walkway and shelter platform. The drainage is to be maintained by the adjacent Land Owner as the surface run-off originates from their respective land sites. No cut-off drains shall be designed within the public street and where cut-off drains are unavoidable due to the site constraints, construction of any cut-off drains within public street have to be built to PUB's standards and cleared with PUB before construction for their maintenance.
- m. All pre-designed holes for services/ wirings/ connection shall be treated appropriately for corrosion and they shall be sealed if they are not utilized.



Figure 18: All Unutilised Pre-Designed Holes Shall Be Sealed

4.2.3.2 Interfaces

- a. A proper interfacing element (i.e. flashing, open channel) between the proposed Commuter Infrastructure and the existing adjacent Commuter Infrastructure shall be provided. This is to prevent any water from splashing onto the shelter platform.
- b. A proper interfacing element (i.e. flashing, open channel) shall be designed and installed on Commuter Infrastructures with sealant applied. This is to prevent from any water ingress/ leakage.

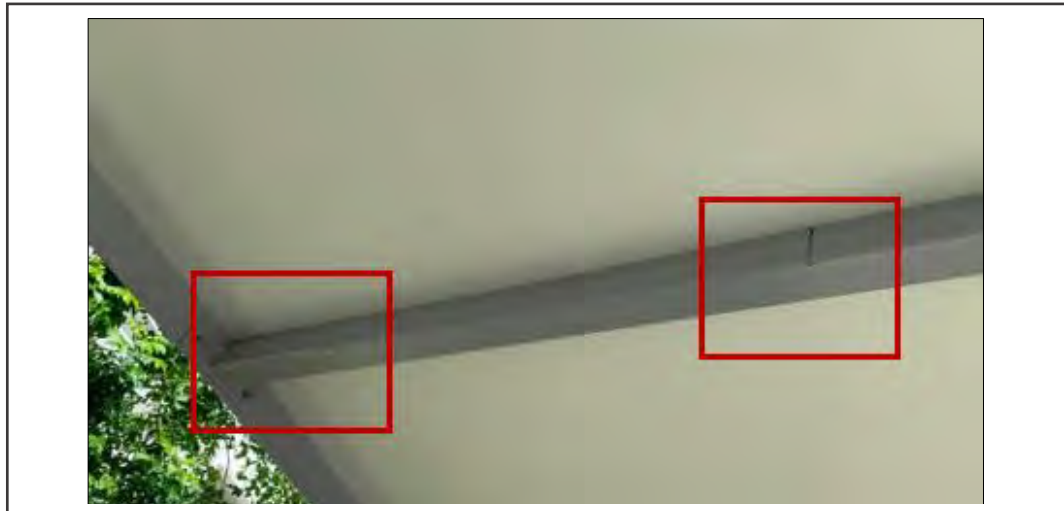


Figure 19: An Example of Water Ingress/ Leaking on Connections of Covered Linkway Shelter

- c. A proper discharge from the open channel shall be designed and installed to direct the water run-off towards to nearest sump/ turf/ side table. This is to prevent the water run-off from being discharged onto the shelter platform/ walkway, causing ponding and inconvenience to commuters.
- d. All mounting of system/ equipment onto any Commuter Infrastructure and facility shall be of a non-destructive design (i.e. No drilling fixing for CCTV, lightings).

4.2.3.3 Materials

- a. Anti-stick coating shall be provided on columns of shelter. This is to prevent public from sticking any illegal advertisements on the shelter columns.
- b. The usage of extensive transparent and translucent roofing materials that are prone to discoloration and weathering shall be minimized.
- c. Materials used for the roof shall withstand exposure to external weathering.

4.2.4 Pedestrian Overhead Bridge

4.2.4.1 Design and Detailing

- a. Reinforced concrete POB and lift shafts are preferred as they are more durable and robust.
- b. Foundation of Pedestrian Overhead Bridge (POB) shall be structurally independent from any drain structure below. This is to establish a clear ownership and maintenance responsibilities of the Commuter Infrastructures.
- c. Roof shall be designed with a sufficient gradient for an effective water-runoff and self-cleansing purposes.
- d. 4.5m Height Restriction Signs shall be installed at strategic locations along the POB to ensure visibility to motorists.



Figure 20: 4.5m Height Restriction Sign Installed Strategically on a POB

- e. All pre-designed holes shall be sealed if they are not utilized.



Figure 21: All Unutilised Pre-Designed Holes Shall be Sealed

- f. All ground floor and flat surfaces exposed directly or indirectly to weather shall be designed with a sufficient gradient to drain off the water into the drains.
- g. POB deck shall not have a valley point that will result in water stagnation.



Figure 22: POB Deck Shall Not Be a Valley Point

- h. Cladded roof and false ceiling of shelter are not recommended as it would be difficult to monitor the health of internal structural members covered by the cladded roof and false ceilings (i.e. corrosion).
- i. Gutters are not recommended due to potential chokage and mosquito breeding.
- j. A proper drainage (i.e. cut-off drains) shall be provided within the adjacent higher ground to drain off the surface run-off from the adjacent higher grounds into the public drains and to prevent it from flowing onto the public walkway and shelter platform. The drainage is

to be maintained by the adjacent Land Owner as the surface run-off originates from their respective land sites. No cut-off drains shall be designed within the public street and where cut-off drains are unavoidable due to the site constraints, construction of any cut-off drains within public street have to be built to PUB's standards and cleared with PUB before construction for their maintenance.



Figure 23: Cut-off Drains Surrounding POB Lift Shaft

- k. Rain downpipes are not allowed to be concealed within and they shall be exposed.
- l. Red triangle markings shall be provided on the surface of POB deck soffit to indicate the lowest point.
- m. Tactile tiles/ nosing tiles shall not be installed over expansion joints.
- n. Tactile tiles/ nosing tiles shall be installed effectively to eliminate a customized cutting of tactile tiles. This is for the ease of replacement of tactile tiles/ nosing tiles.
- o. Tactile tiles/ nosing tiles shall be of colour contrast. Please refer to LTA Standard Details of Road Elements (SDRE).

4.2.4.2 Interfaces

- a. For demarcation of boundaries of different maintenance agencies, separate POB shelter column/ foundation shall be provided at the intersection of different maintenance agencies.
- b. A proper interfacing element (i.e. flashing, open channel) shall be designed and installed on Commuter Infrastructures with sealant applied. This is to prevent from any water ingress/ leakage.



Figure 24: Sealant Applied on Interfacing Element

- c. All mounting of system/equipment onto any Commuter Infrastructure and facility shall be of non-destructive design (i.e. no drilling fixing for CCTV, lightings).

4.2.4.3 Materials

- a. All pedestrian railings shall be made of stainless-steel Grade 316.
- b. Anti-stick coating shall be provided on columns of shelter to prevent public from sticking illegal advertisements on the columns.
- c. Anti-corrosion painting shall be provided on welded joint connections at shelter roof members.



Figure 25: Examples of Corroded Welded Joint Connections at Shelter Roof Members

- d. Materials used for the roof shall withstand exposure to external weathering.

- e. Metal nosing tiles (i.e. steel) are not recommended as they provide less colour contrast with the staircase flooring and it could be slippery, causing slip and fall to pedestrians.



Figure 26: Metal Nosing Tiles (i.e. Steel) are Not Recommended

- f. Durable and stain resistant floor finishes shall be used.

4.2.5 Pedestrian Underpass

4.2.5.1 Design and Detailing

- a. The Pedestrian Underpass shall be of a structurally independent structure. This is to establish a clear ownership and maintenance responsibilities of the Commuter Infrastructures.
- b. The drainage shall be designed outside the cladded walls for an easy access to carry out maintenance/ cleaning of the drains.
- c. The gradient of the floor at the entrance/ exit and within the pedestrian underpass shall be designed for an effective discharge of water.

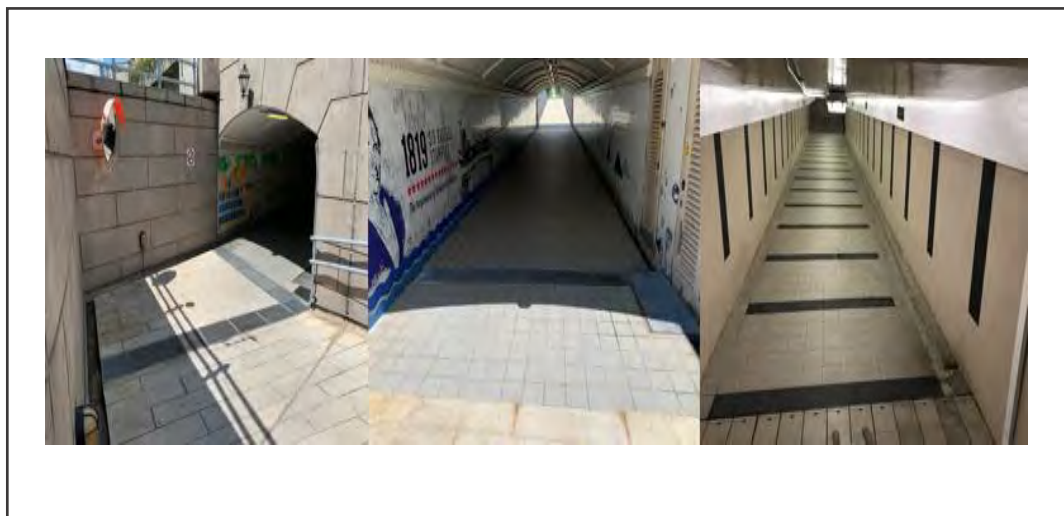


Figure 27: Entrances and Exits of Underpasses

- d. The ceiling and wall panels shall be easily mounted and removed. A full detail or instruction on its mounting and removal shall be provided. This is to facilitate the structural inspection and maintenance works.
- e. Cladded walls and false ceilings are not recommended. However, if unavoidable, an inspection/ maintenance access at appropriate intervals shall be provided. This is to facilitate the structure inspection and maintenance works.

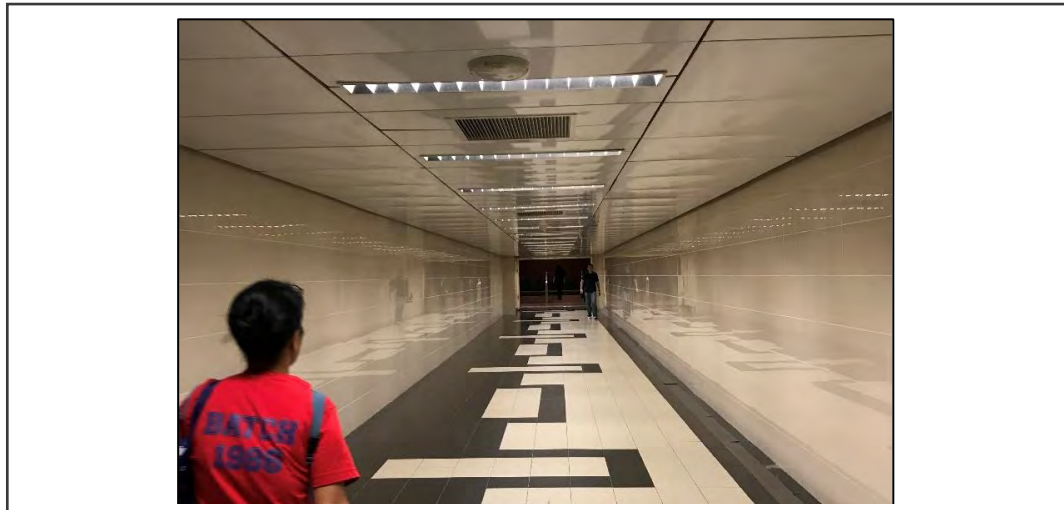


Figure 28: Cladded Ceiling of Underpass

4.2.5.2 Interfaces

- a. The roof structure at the entrance/ exit of pedestrian underpass shall be designed for an effective discharge of water. This is to prevent from any water ingress and stagnation on the roof.
- b. All mounting of system/ equipment onto any Commuter Infrastructure and Facility shall be of a non-destructive design (i.e. no drilling fixing for CCTV, lightings).

4.2.5.3 Materials

- a. All pedestrian railings shall be made of stainless-steel Grade 316.
- b. Metal nosing tiles (i.e. steel) are not recommended as they provide less colour contrast with the staircase flooring and it could be slippery, causing slip and fall to pedestrians.
- c. Durable and stain resistant floor finishes shall be used.
- d. All proposed materials shall be of a non-slip nature, especially where they will be used on areas that may be affected by the wet weather.

4.2.6 Footpath/ Cycling Path

4.2.6.1 Design and Detailing

- a. Footpath/ cycling path shall be higher than the adjacent planting verge. This is to prevent the water from backflowing onto the footpath/ cycling path, resulting in water stagnation/ siltation on the footpath/ cycling path and gratings.



Figure 29: An Example of Adjacent Planting Verge Being Higher than Footpath, Resulting in Water Stagnation

- b. Gradient of footpath/ cycling path shall be designed for an effective discharge of water towards the road. All water stagnant on footpath/ cycling path shall be eliminated. Please refer to refer to LTA Standard Details of Road Elements (SDRE) for the gradient of footpath/ cycling path.
- c. For footpath/ cycling path to be constructed next to existing trees, measures such as to provide sufficient space and to use appropriate materials shall be taken. This is to minimize tree root heave and footpath damage, caused by the existing nearby trees.



Figure 30: Footpath beside Existing Trees Catering to a Sufficient Space for Tree Roots

- d. Footpath/ cycling path shall not have upstand kerb at both ends. This is to prevent from any tripping hazard to pedestrians.



Figure 31: An Example of Footpath with Upstand Kerbs at Both Ends

- e. Footpath/ cycling path shall comply to the stipulated skid resistance of minimum 45 BPN. Please refer to LTA Standard Details of Road Elements (SDRE).
- f. A proper drainage (i.e. cut-off drains) shall be provided within the adjacent higher ground to drain off the surface run-off from the adjacent higher grounds into the public drains and to prevent it from flowing onto the public walkway and shelter platform. The drainage is to be maintained by the adjacent Land Owner as the surface run-off originates from their respective land sites. No cut-off drains shall be designed within the public street and where cut-off drains are unavoidable due to the site constraints, construction of any cut-off drains within public street have to be built to PUB's standards and cleared with PUB before construction for their maintenance.

- g. Gratings/ tactile tiles shall not be designed and installed on a slope/ steep terrain/ ramp. This is to prevent from any slipping/ tripping hazard to pedestrians.
- h. Tactile tiles shall be installed on slope not steeper than 1 in 40.
- i. Tactile tiles shall be installed with a 300 mm setback from the footpath edge. Please refer to LTA Standard Details of Road Elements (SDRE).



Figure 32: An Example of a 300mm Set back of Tactile Tiles from Footpath Edge

- j. Tactile tiles shall be installed effectively to eliminate a customized cutting of tactile tiles. This is for the ease of replacement of tactile tiles.
- k. Tactile tiles/ nosing tiles shall be of sufficient colour contrast. Please refer to LTA Standard Details of Road Elements (SDRE).
- l. Tactile tiles shall maintain their durability and stipulated skid resistance requirement to withstand wear and tear within their shelf-life period. Please refer to LTA Standard Details of Road Elements (SDRE).

4.2.6.2 Interfaces

- a. For an extension of footpath width, a proper interfacing (i.e. dowel bar) between the existing footpath and new footpath shall be provided. This is to eliminate any differential level on the footpath in the future.



Figure 33: Examples of No Proper Interfacing (i.e. No Dowel Bars Installed) Between the Existing Footpath and New Footpath, Resulting in the Differential Footpath Level

- b. Gradient of the new footpath/ cycling path shall be designed in conjunction with the existing gradient of the adjoining footpath.

4.2.6.3 Material

- a. Anti-slip coating shall be applied on all existing closed and modified metal gratings.
- b. Durable and stain resistant floor finishes shall be used.
- c. All proposed materials shall be of a non-slip nature, especially where they will be used on areas that may be affected by the wet weather.

4.2.7 Inspection and Taking Over

During the joint site inspection, visual and physical check shall be performed by the Developer to confirm the accuracy of the submission. The Developer shall rectify/ address all the major and minor defects highlighted during the inspection and provide clear rectification photographs of highlighted defects with time stamp.

4.2.7.1 Handing Over Documents

- a. As-built, structural and architectural drawings and approved plans of Proposed Street Work/ Development with Commuter Infrastructure shall be provided in digital format. The Developer shall ensure that all drawings/ documents are endorsed by the relevant QP.
- b. Detailed, roof, floor and cross-sectional view plans showing the Proposed Street Works/ Developments, including the details of Commuter Infrastructure (i.e. Road Reserve Line (RRL), annotations, maintenance boundaries, materials, dimensions, connections) shall be provided in digital format.
- c. Progress photographs showing the installation work of Commuter Infrastructure such as roof connection details shall be provided in digital format.
- d. Asset Master Record Input Form (AMRIF) and Inventory Record Form shall be provided in digital format.
- e. Taking over letters from PUB (Drainage), Nparks (Turving) and NEA (Cleaning), where applicable shall be provided in digital format.
- f. GIS layers as per the LTA Data Hub Data Collection Specifications, in true coordinates on SVY 21 system, for all types of assets constructed/ redeveloped/ removed/ relocated as part of the project shall be provided.
- g. The checklist for Commuter Infrastructure – Structure (Maintenance Related) (refer to Checklist 1 of IDC, Volume C, Chapter 4) shall be filled up and submitted in digital format during the design submission stage.

4.2.7.2 Spares and Warranty

- a. For any unique products/ special finishes, 5% spares of the total quantity shall be provided.
- b. All proposed materials (i.e. sealant, roof panels, high strength coating for cycling path, painting, protective coating, tiles) must be readily available in the local market with appropriate warranties and guarantees, where applicable. Full details of the proposed materials

(i.e. supplier catalogues, warranties etc.) shall be provided in digital format.

- c. All warranty schedule of proposed materials shall comply with the latest LTA's Materials and Workmanship Specification for Architectural Works (i.e. 10 years period for sealants, 5 years period for paintwork, 10 years period for powder coating system, 10 years period for aluminium paneling system).

4.3 Commuter Facilities (Electrical)

4.3.1 Commuter Facilities System

4.3.1.1 Over Ground Box (OG-Box)

- a. The OG-Box shall setback at least 1000mm measured from the road kerb within the street reserve to minimise the risk of vehicle collision causing damage to the OG-Box. The OG-Box shall not be obstructed by any structure or planting. There shall be at least 500mm clearance for both front and rear-panel door opening for corrective and preventive maintenance.

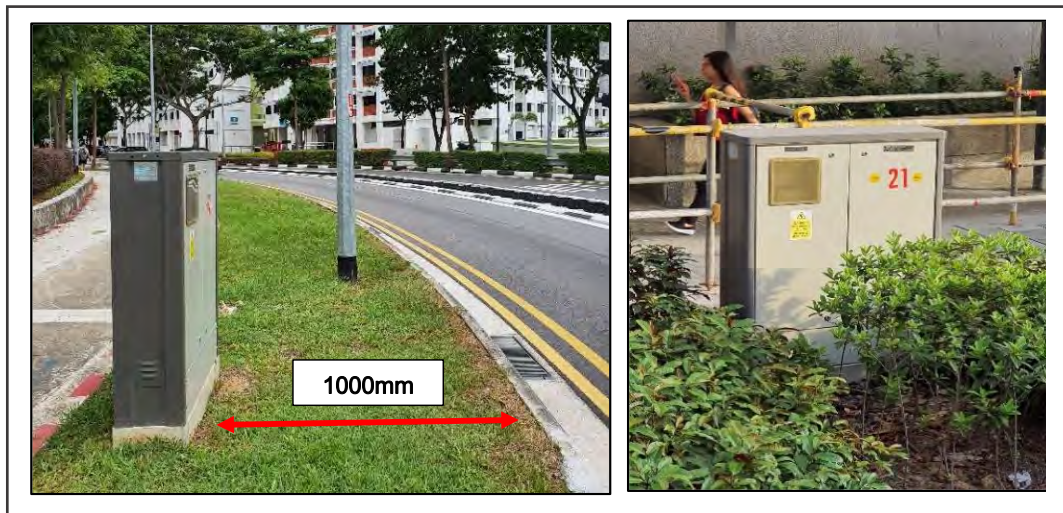


Figure 34: Clearance shall be at least 1000mm from Road Kerb, Panel Access shall not be Blocked by Planter or Shrub

- b. The OG-Box installation shall not be in the middle of the path (i.e. barrier free access BCA - BFA compliance) and not blocking commuter movement. It shall not be blocking drivers' view of oncoming vehicles if the OG-Box is located near the traffic junctions/ zebra crossings.



Figure 35: OG Box Position shall Not Block Commuter Movement or be in the Middle of the Walkway

- c. The OG-Box concrete plinth shall have a height of 400mm from Finished Floor Level (FFL) to prevent damage to electrical components during flooding. For the same reason, the concrete plinth shall not have any gaps between the foundation joints and properly covered to prevent rodents' entry. The OG-Box shall be constructed on stable ground and shall be filled up with sufficient washed sand to prevent water stagnation which may cause mosquito breeding.

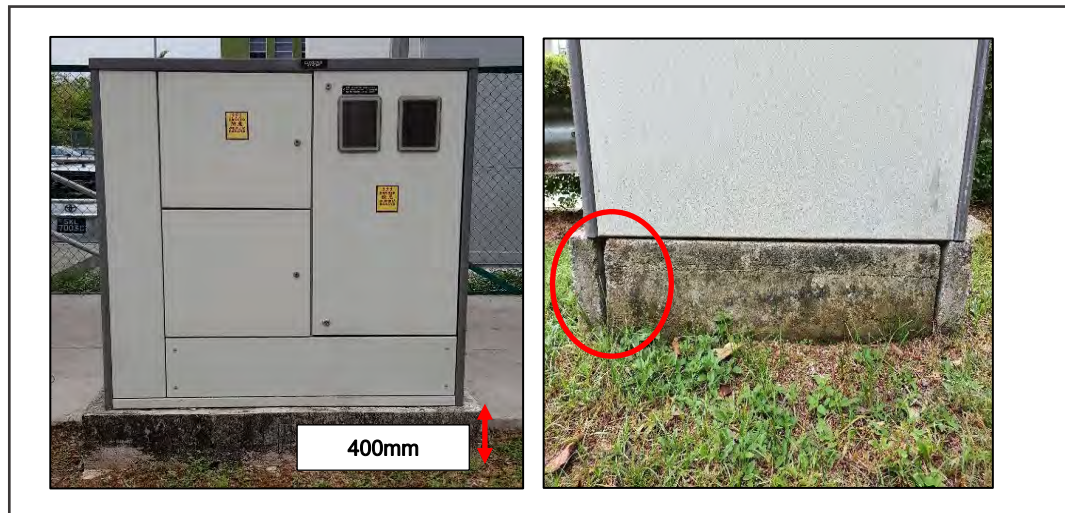


Figure 36: An Example of Adequate Concrete Plinth Clearance from the Floor Level and Unsealed Gap

- d. The OG-Box Single Line Diagram endorsed by a qualified electrical Professional Engineer (PE) shall be housed and protected within a A4 size plastic protective sheet so that qualified workers accessing the electrical distribution system will have the updated and accurate knowledge of the electrical circuitry and wiring while carrying out corrective and preventive maintenance. A 'Danger' notice shall be provided, sticking on the inside and outside of each door of the OG-Box to serve as a warning to the public of the risk of electrical shock. The programmable timer shall be housed within an enclosure (IP66) with a surge suppressor to protect against lightning surge. The programmable timer can be bypassed with a bypass switch for turning 'On' the lighting in the daytime for corrective and preventive maintenance.

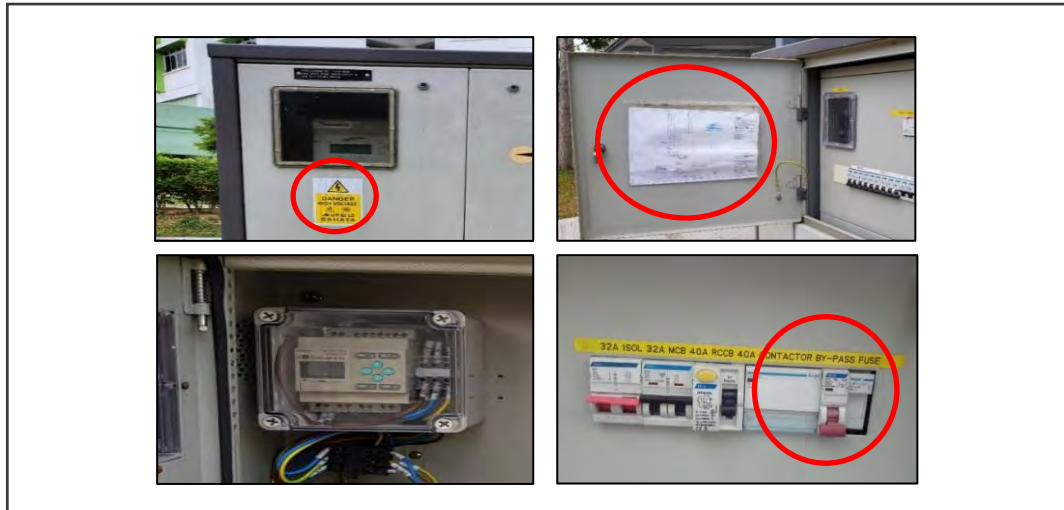


Figure 37: Single Line Diagram, Warning Sticker, Timer Enclosure and Bypass Switch must be Present

- e. A space of 220mm (W) X 320mm (H) X 200mm (D) shall be reserved in the OG-Box for the Lighting Control Box Controller (LCBC) installation and there shall be provision of door panel sensor to alert unauthorized access.

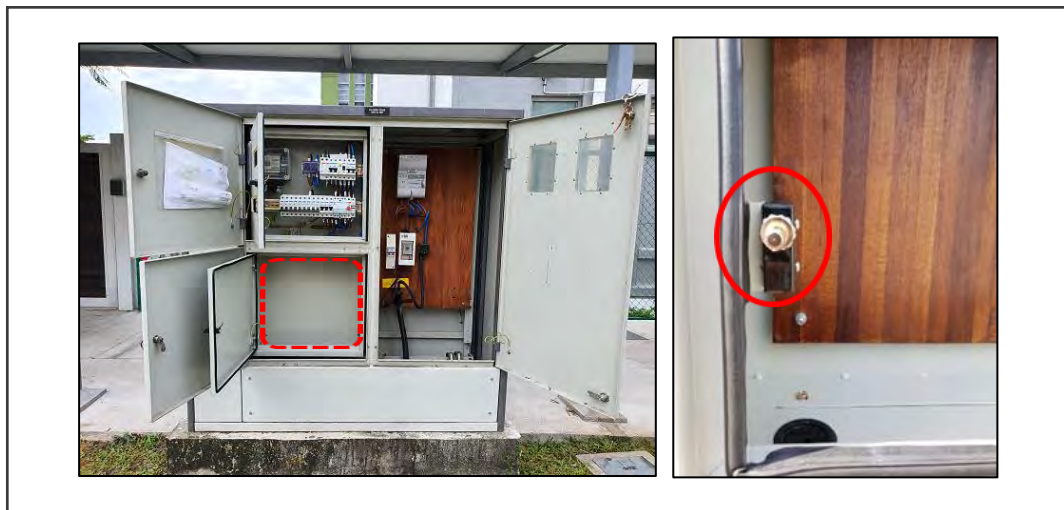


Figure 38: Provision of Space and Door Sensor

- f. For OG-Box installed near traffic junction, pitch roof shall be provided to prevent the public from littering.

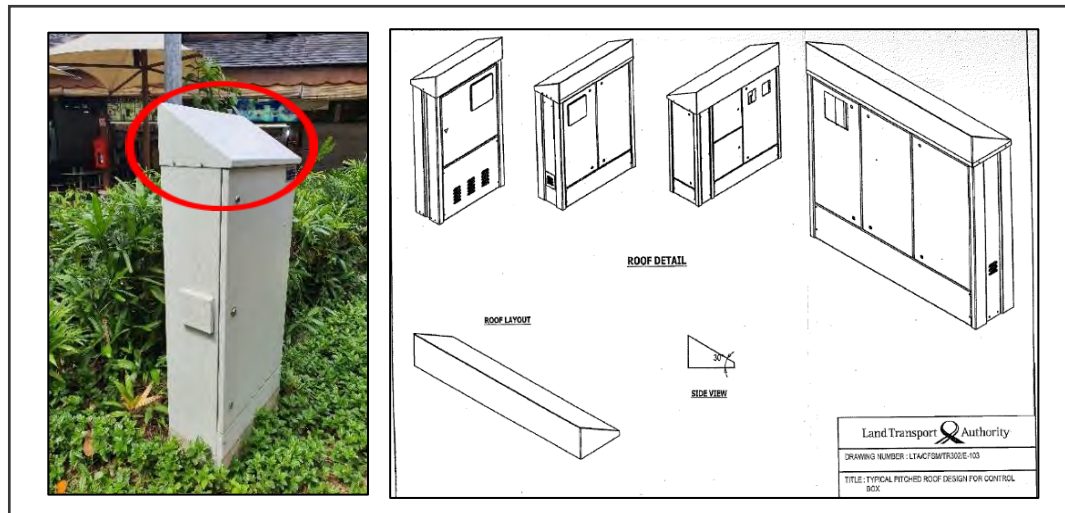


Figure 39: Pitch Roof Design

4.3.1.2 Lightning Protection System (LPS)

- a. The lightning protection system for each facility (i.e. separate LPS for Covered linkway and the connected Overhead Bridge) shall be a standalone system such that any removal of its adjacent facilities shall not affect the electrical integrity of the existing system. This is to avoid the need to add additional earth pits due to alteration works.
- b. All exposed metal parts such as lighting poles, bus signage poles, bus information panels, advertisement panel and etc. within 2 metre radius of the facilities shall be equipotential bonded to the lightning protection system of the facilities to protect the commuter from electrical hazards.

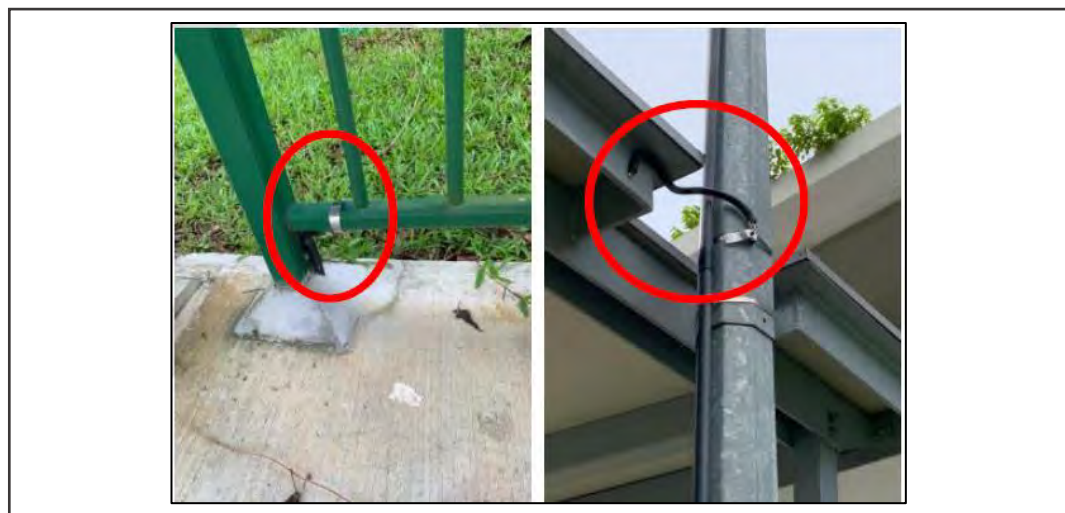


Figure 40: Equipotential Bonding at Handrail and Lamp Pole within the 2 Metre Radius

- c. The BI-metallic connector shall be installed at high level. Any surface mounted down conductor copper tape shall be encased in uPVC pipe up to 1500mm height. This will prevent vandalism and tampering of the lightning protection system.

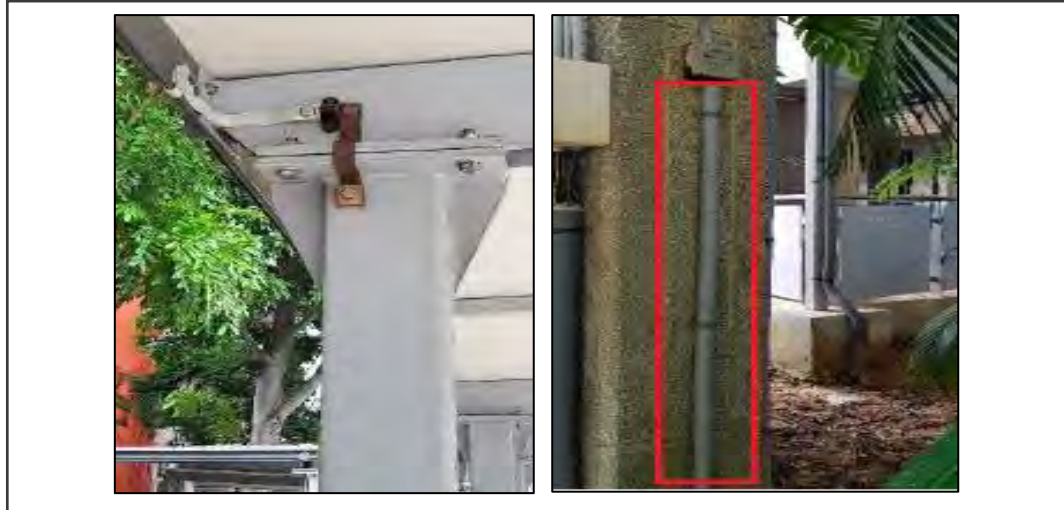


Figure 41: Connector Mounted at High Level and Protected by PVC Pipe

4.3.1.3 Earth Pit

- a. The earth pits shall be located within street reserve and shall not encroach into private land and carriageway. For ease of locating the earth pits, it shall be encased in concrete to prevent earth pits from sinking or being covered by planting.
- b. The earth pits shall be topped up with sufficient washed sand to prevent water stagnation which may cause mosquito breeding. The earth pits' chamber shall be level or flat with FFL to prevent tripping hazard to commuters.
- c. PVC tag shall be engraved with appropriate wording for easy identification of different facility type. i.e. "COVERED LINK WAY LIGHTING. DO NOT REMOVE".
- d. The earth rod shall be visible at the ground level within earth chamber for ease of carrying out earth loop impedance test. An earth safety tag shall also be installed as a means to warn public against removing or disconnecting the earth rods.



Figure 42: Encase with Concrete and Earthing Rod with Tag

4.3.1.4 Lightning Pit

- a. The lightning pits shall be located within street reserve and shall not encroach into private land and carriageway. For ease of locating the lightning pits, it shall be encased in concrete to prevent lightning pits from sinking or being covered by planting.
- b. The lightning pits shall be topped up with sufficient washed sand to prevent any water stagnation which may cause mosquito breeding. The earth pits' chamber shall be level or flat with FFL to prevent tripping hazard to commuters.
- c. PVC tag shall be engraved with "LIGHTNING PITS". DO NOT REMOVE" to be installed on the lightning pits' plate cover for easy identification.
- d. The earth rod shall be visible at the ground level within earth chamber for ease of carrying out earth loop impedance test. An earth safety tag shall also be installed as a means to warn public against removing or disconnecting the earth rods.



Figure 43: Encase with Concrete and Lightning Rod with Tag

4.3.1.5 Lighting Fixture (Sheltered Facilities)

- a. The light fixture shall be protruding more than 20mm (via a mounting plate within the rafter) but not more than 30mm for ease of replacement during corrective and preventive maintenance. At the same time, to ensure the light throw from the light fitting shall not be obstructed by the structure framework (i.e. rafter).

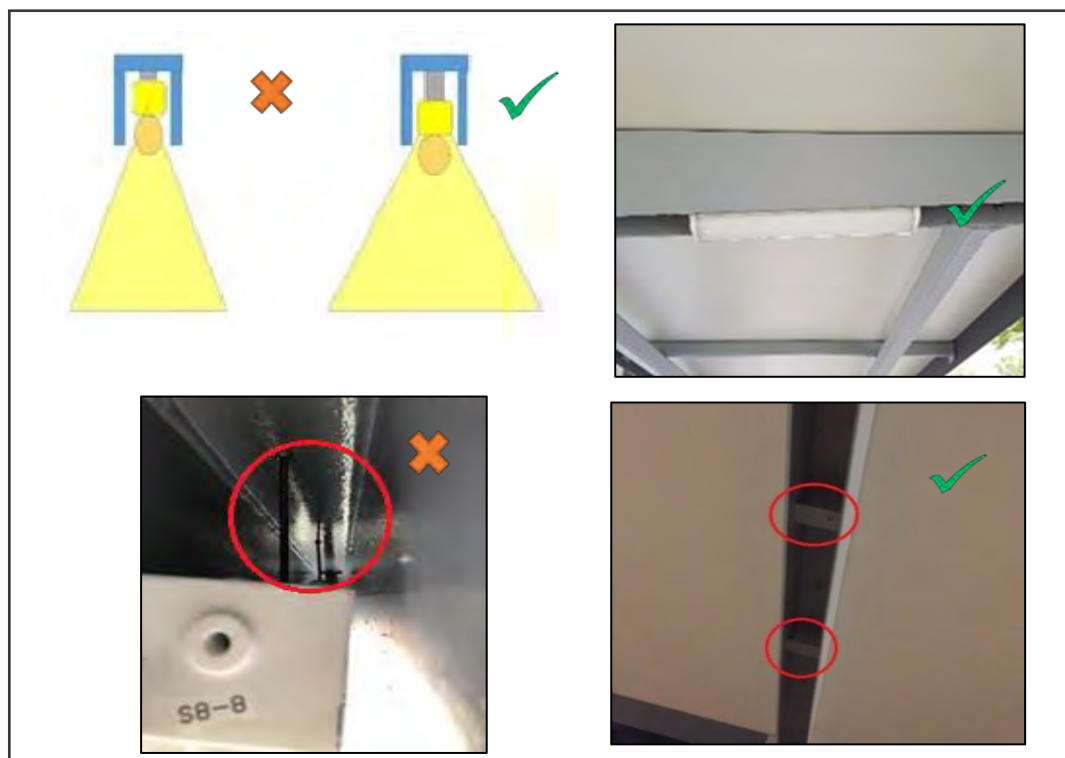


Figure 44: Proper Protruding and Mounting Method

- b. The light fixture shall not be recessed type due to challenges in maintenance and costly spare parts.



Figure 45: Easy Access of Lights Fixture

4.3.1.6 Lighting System (Footpath and Cycling Path)

a. LED Lantern

- i. The maximum weight of the LED lantern shall not exceed 20kg to facilitate one-man-operation maintenance works.
- ii. The LED lantern component compartment shall be top opening. The opening shall always be flipped and remain upright for ease of replacement of components during corrective and preventive maintenance.
- iii. The LED lantern shall have a head room clearance of minimum 500mm (i.e. under viaduct).



Figure 46: Sufficient Head Space for Top Opening

b. Planted Pole

- i. The bitumen coating for the planted pole shall be exposed 200mm and lower section of the pole door opening shall be 300mm above FFL as a guide to ensure all pole types are planted to sufficient depth for structural stability.
- ii. Lamp pole shall be clearly numbered using one (1) set of green label (colour code 4097) and a round sticker bearing a black arrow against a yellow background that indicates the direction of the nearest OG-Box for ease of identification of ownership. Information plate shall be affixed onto the pole to indicate the lamp pole manufactured year and pole height details etc.



Figure 47: Sufficient Planting Depth, Data Plate and ID

c. Flange Mounted Pole

- i. For Flange Mounted pole type installed at turf area. The concrete foundation shall be exposed about 50mm to 100mm above FFL to facilitate corrosion detection test and address soil settlement concerns. The lower section of the pole door opening shall be 300mm above FFL as a guide to ensure all pole types are planted to enough depth for structural stability.
- ii. For Flange Mounted pole type installed at concrete surface. The concrete foundation shall be flushed with the FFL, and the Nuts as well as J-bolt shall be covered by grouting

means. This will prevent tripping hazard to commuters.

- iii. Two sets of washers and nuts shall be provided for each J-bolt to interlock the pole firmly to the foundation.
- iv. High strength non-shrink cementitious grout shall be used to fill up the gaps between the pole base plate and the foundation for pole levelling.



Figure 48: Double Locking Nuts and Haunching of Footing

- v. Pole door cover shall be hinged type secured with C-Clips. This will always ensure the pole door remain interlocked for contractor to carry out works safely to the cut-out unit during maintenance and rectification. The cable entries at cut-out unit shall be properly secured with rubber gasket to prevent pest entry causing public light out due to potential pest electrocution.



Figure 49: Pole Door Opening, C-clip and Rubber Gasket

4.3.2 Inspection and Taking Over

During the joint site inspection, visual and physical check shall be performed by the Developer to confirm the accuracy of the submission. Inspection shall include insulation voltage test, earth loop impedance test, continuity test on the conductor, motion sensor test and earth resistance test results for Lightning Protection System. Developer shall continue to clear any defect picked up during the inspection.

4.3.2.1 Handing Over Documents

- a. Developer shall provide at least 2 sets of Operation and Maintenance (O&M) manuals, for LTA contractor to carry out maintenance after taking over the facilities.
- b. Photographs showing the installation work such as excavation work, trench depth, underground pipes laying, pole installation etc shall be provided in digital format as and when requested during the handing and taking over inspection.
- c. The checklist for Commuter Facilities System (Maintenance Related) (refer to Checklist 2 of IDC, Volume C, Chapter 4) shall be filled up and submitted in a digital format during the design submission stage.

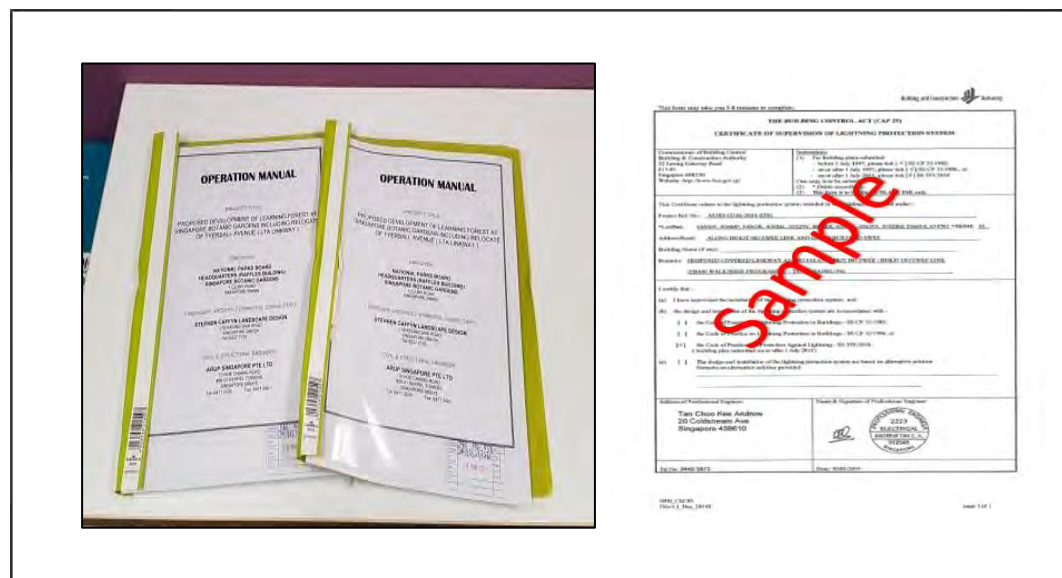


Figure 50: Operation Manual Sample

4.3.2.2 Spares and Warranty

- a. For light fixtures and decorative poles which is not widely available, the developer shall provide 3 complete sets of spares (pole, arm, lantern) or 5% of the total quantity, whichever is higher.
- b. Developer shall provide deed of warranty for the LED lantern (minimum of 7 years) and light fixture (minimum of 5 years) from the supplier for future replacement.



Figure 51: Spares and Warranty

4.4 Commuter Infrastructure (Equipment or Mechanical System)

4.4.1 General

The following Design for Maintainability criteria will be applicable for all Commuter Facility Equipment (CFE) maintained by Vertical Transport and Tunnel E&M (VTT) Division.

CFE includes and is not limited to the following: passenger lift; escalator; pump system; mechanical ventilation system; air-conditioning system; firefighting system and closed-circuit television system. All CFE is required to be monitored by VTT's CFE monitoring system. The current monitoring system is the Commuter Facility Equipment Monitoring Services (CFEMS).

4.4.1.1 Access for Maintenance

- a. Arrange site layout to facilitate easy removal and replacement of any components in any event when parts replacement is required.
- b. Ensure access provisions are suitable and safe for maintenance personnel carrying tools, equipment and component parts.
- c. Ensure visual contact between the equipment and equipment panel/ closet for maintenance contractor to work safely.
- d. Provide proper means of access to externally mounted M&E installation (Figure 52) and its related accessories for maintenance works.



Figure 52: Example of Externally Mounted Power Isolator for CFE System

4.4.1.2 Material & Finishes

- a. Wherever possible and appropriate, label and mark M&E elements and services for easy identification.
- b. Ensure that mechanical equipment closets are adequately IP-rated and waterproofed to prevent ingress of water and possible short-circuit.
- c. Equipment/ components with no weatherproof option should be appropriately covered/ sheltered.

4.4.1.3 Design & Detailing

- a. Minimise the use of proprietary parts in the design. If proprietary parts are unavoidable, ensure that spares are available throughout the design lifespan of the equipment.
- b. Ensure the design enables simple maintenance methods such as easy diagnostic checks, installation and disassembly/ assembly of components.
- c. Prepare as-built drawings showing equipment layout, routing of major M&E services and concealed services routing for end users' future reference and maintenance purposes. The as-built drawings should also include plumbing, sanitary, landscape and outdoor services where applicable.
- d. Power points (with lockable box enclosure) are to be provided at a suitable location for servicing tools to be connected during maintenance. Design circuit points that can be disconnected where necessary.
- e. Comply with any law, regulation or by-law as well as codes of practice and standards applicable to the Works. Local regulations, codes of practice and standards shall be the latest version at the time of the Contractor's Works. British/ EC Standards or equivalent shall be adopted where local standards do not exist. (i.e. BCA maintenance outcomes).

4.4.1.4 Passenger Lift

- a. Provide adequate space for maintenance around all work areas (Figure 53) in accordance to the manufacturer's requirements.



Figure 53: Example of Adequate Space for Maintenance at Lift Landing

- b. Provide a storage closet/ room (Figure 54) for contractor to store barricades, spares, etc. for maintenance works (minimum 2m x 2m).



Figure 54: Example of Storage Closet for Lift Maintenance Works

4.4.1.5 Escalator

- a. Provide adequate space for maintenance (Figure 55) around all work areas in accordance to the manufacturer's requirements. Provide adequate space for storage of steps during annual maintenance.

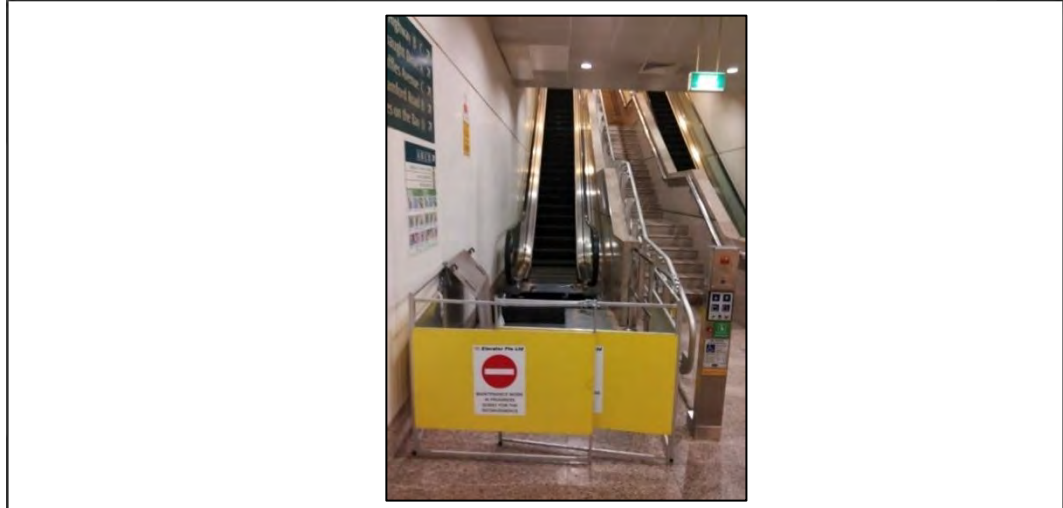


Figure 55: Example of Adequate Space at Escalator Landing

- b. Provide a storage closet/ room (minimum 2m x 2m) for contractor to store barricades, spares, etc. for maintenance works (Figure 56).



Figure 56: Example of Storage Closet below Escalator

4.4.1.6 Pump System

- a. Provide adequate space (Figure 57) for maintenance around all work areas in accordance to the manufacturer's requirements.

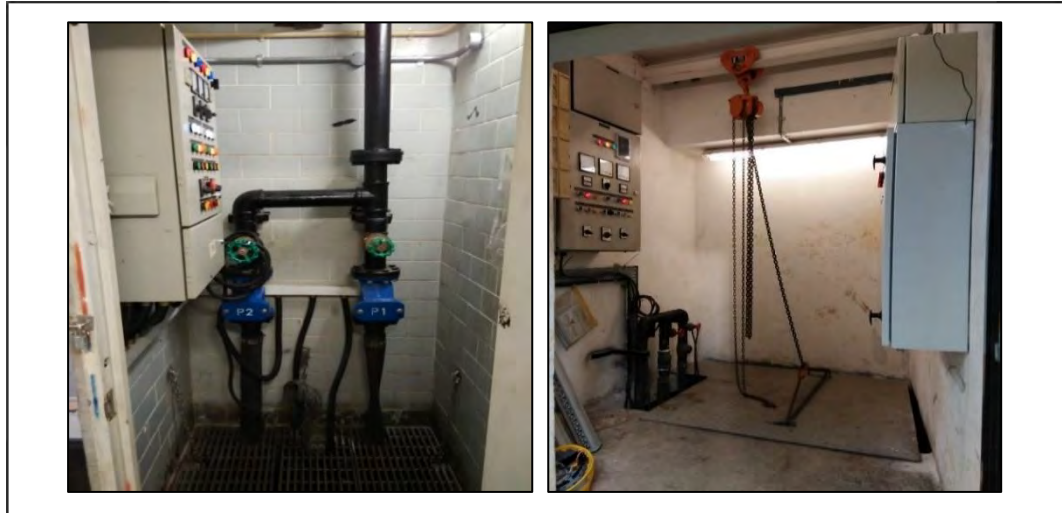


Figure 57: Example of Adequate Space for Maintenance of Pump System

- b. Provide sufficient LED lighting for equipment and its related accessories (i.e. pump controller closet, sump pit).
- c. Provide roller shutter doors of sufficient sizing to allow for easy removal and installation of pumps during maintenance.
- d. Provide lifting facilities and equipment to enable easy lifting of the pumps (Figure 58). Provide adequate automatic mechanisms (i.e. motors) for lifting equipment in three axes (XYZ) to facilitate pump removal for maintenance and servicing purpose to the nearest loading/ unloading bay within the pump facilities room.



Figure 58: Example of an Overhead Crane for Lifting Pumps

- e. Ensure clear, unobstructed access to the pump house for vehicular movements to aid easy removal and installation of pumps during maintenance.
- f. Provide ramp during design of the pump house for the ease of maintenance of the pump system.
- g. Where controller panels are used, design and size them such that one person can easily handle them.
- h. Ensure the inlet point is sufficiently sized to allow water to enter the sump pit without causing any bottleneck during heavy rainfall and is able to prevent items from entering the sump pit and choking the pump.
- i. Ensure the outlet point is easily accessible for routine inspection (Figure 59) and debris/ cement removal, if necessary.



Figure 59: Example of Checking of Pump Outlet for Pump Servicing

4.4.1.7 Mechanical Ventilation System

- a. Provide adequate space for maintenance around all areas in accordance to the manufacturer's requirements.
- b. Provide ceiling access panels near ventilation and air conditioning equipment to facilitate inspection/ maintenance of services.
- c. Provide sufficient LED lighting for equipment and its related accessories (i.e. controller closet).
- d. Where ceiling panels are used, they should be designed to prevent sagging and withstand wind loads. Panels should be sized such that they can be easily handled by one person.
- e. Avoid ductworks/pipe installations onto M&E room floors (Figure 60) to minimise tripping hazards and damage due to stepping.



Figure 60: Installations on the Floor are a Tripping Hazard

- f. Provided ducts with opening to facilitate cleaning of ducts during the routine maintenance at an interval of maximum 10 metres.

4.4.1.8 Air-Conditioning System

- a. Provide adequate space for maintenance around all areas in accordance to the manufacturer's requirements.
- b. Provide ceiling access panels near ventilation and AC equipment to facilitate inspection/ maintenance of services.
- c. Access provisions must be suitable and safe for maintenance personnel carrying tools, equipment and component parts.
- d. Provide sufficient LED lighting for equipment and its related accessories (i.e. controller closet).
- e. Where ceiling panels are used, they should be designed to prevent sagging and withstand wind loads. Panels should be sized such that they can be easily handled by one person.
- f. Provide flood mitigation measures (such as sump pump) for M&E rooms located at basements.
- g. Avoid ductworks/ pipe installations onto M&E room floors to minimise tripping hazards and damage due to stepping.
- h. Avoid placing AHU / FCU directly above critical equipment such as battery banks, server racks, electrical panels, etc. (Figure 61).



Figure 61: FCU Positioned Directly above Battery Bank

- i. Provide dampers/ vibration isolators to equipment prone to vibration transmittance (i.e. ducted FCU).
- j. Provide ducts with opening (Figure 62) to facilitate cleaning of ducts during routine maintenance at an interval of maximum 10 metres.



Figure 62: AC Duct Opening

- k. Provide water point to facilitate cleaning of AC filters (Figure 63).



Figure 63: Water Point with Hose for AC Filter Cleaning

4.4.1.9 Firefighting System

- a. Provide adequate space for maintenance around all areas in accordance to the manufacturer's requirements.
- b. Provide sufficient LED lighting for equipment and its related accessories.

4.4.1.10 Closed-Circuit Television (CCTV) System

- a. Provide adequate space for maintenance around all areas in accordance to the manufacturer's requirements.
- b. Provide sufficient LED lighting for equipment and its related accessories.
- c. Provide means of shelter or equivalent to facilitate preventive and corrective maintenance works during wet weather condition.

4.4.2 Commuter Facility Equipment Monitoring Services (CFEMS)

Interfacing with CFEMS

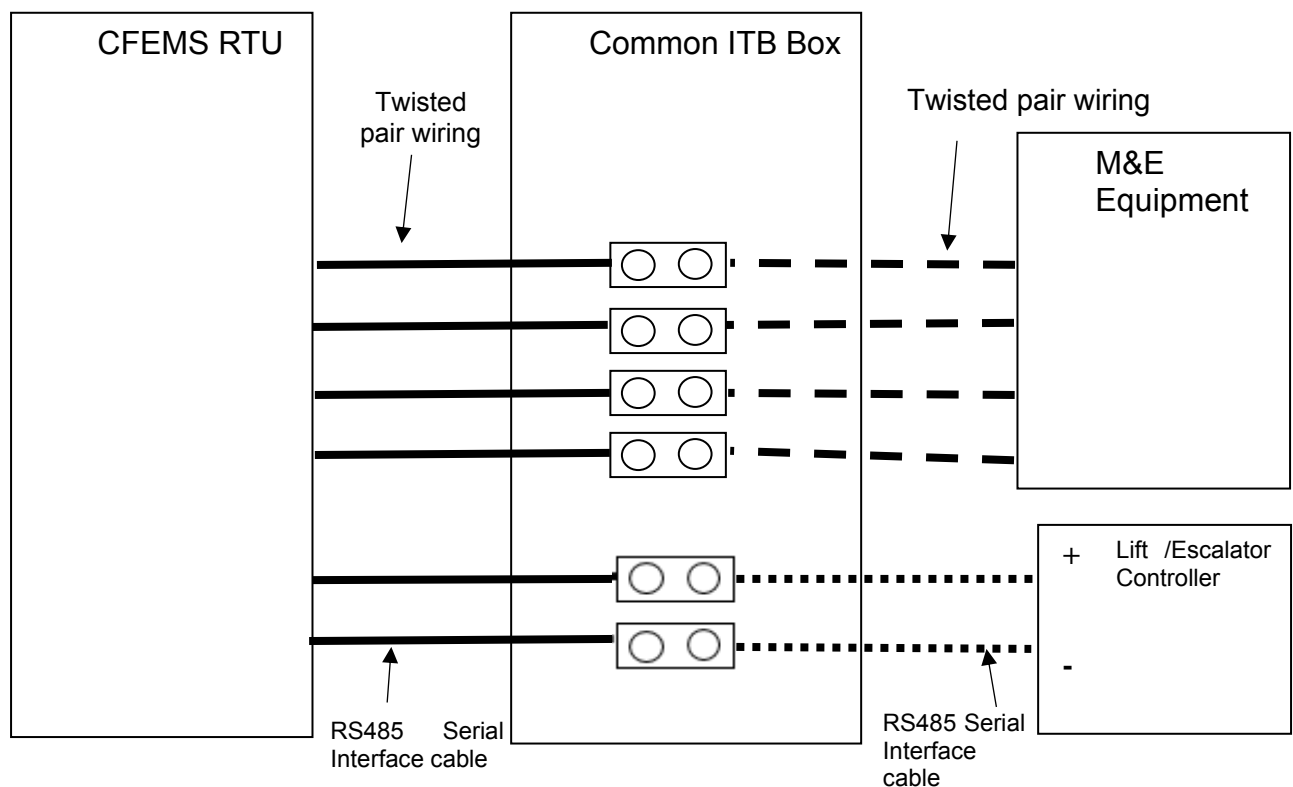
Table of Contents

1.1	General	52
1.2	CFEMS Field Equipment.....	53
1.3	Equipment Status Monitoring	55
1.4	Level Switches	55
1.5	Voltage Transducers	55
1.6	Schedule of Points	55
1.7	Testing and Commissioning	59
1.8	Enclosures	61
1.9	Connection to CFEMS (Applicable to Maintenance Contractor Only)	61
1.10	CCTV System Requirements (For Lift and Escalator Only)	62

INTERFACING WITH COMMUTER FACILITY EQUIPMENT MONITORING SERVICES (CFEMS)

1.1 General

- a) Where Commuter Facility Equipment Monitoring Services (CFEMS) is provided, the contractor shall source from qualified vendors to supply and install CFEMS, all equipment signals shall interface with the CFEMS system via CFEMS panel consisting of:
 - Interface Terminal Boards (ITBs)
 - Remote Terminal Unit (RTU) and its associated components
- b) The contractor shall provide attendance for testing and commissioning of CFEMS system which will be carried out by the CFEMS Vendor. Please see the diagram below showing the typical setup for CFEMS.



Note: Twisted pair wiring to be voltage-free.

Interfacing diagram between CFEMS and M&E Equipment / Lift/ Escalator

Interfacing diagram between CFEMS Contractor & Contractors (M&E Equipment / Lift)

1.2.CFEMS Field Equipment

1.2.1. Electrical Requirements

- a) The electrical requirements for the CFEMS field equipment is as follows:
The isolators should be housed inside the CFEMS closet.
 - (i) 1 no. of 20A single phase power supply isolator (For RTU)
 - (ii) 1 no. of 20A single phase power supply isolator (For CCTV System)
 - (iii) 1 no. of 20A single phase power supply isolator (For Spare)

1.2.2 Remote Terminal Unit

- a) The remote site RTU (Field RTU) shall be housed in a panel with easy access for maintenance work with at least 25% spare panel space for future expansion.

1.2.3 Cabling and Wire Terminations

For M&E equipment:

- a) Solderless and screwless techniques shall be the preferred means of terminating conductors. Crimping or other standard industry practice may also be used.
- b) All wire and cable terminals shall be properly numbered and labelled with descriptions of their functional purpose.
- c) All cables used for CFEMS interfacing shall be as follows:
 - (i) Digital Input (DI) and Digital Output (DO), Digital Alarm (DA):
0.6mm diameter, single twisted pair screen signal cable
- d) All cable screens for DI and AO shall be left floating at the equipment (auxiliary contacts, sensors etc) and shall be terminated in a common screen terminal on the terminal block.
- e) The developer shall supply, install and terminate cables from M&E equipment to the ITB in the CFEMS panel.

For Lift:

- f) The developer shall supply, install and terminate RS485 cables from the Lift controller panel to the CFEMS ITB.
- g) The lift travelling cable provided by the contractor shall meet the following specifications:

Construction:

- (i) 4 highly flexible PVC (polyvinyl chloride) insulated stranded cores for power application
- (ii) 8 pairs of highly flexible PE (polyethylene) or PVC insulated stranded cores, each pair screened individually by an aluminium-laminated tape
- (iii) 2 coaxial video cables
- (iv) PVC outer sheath

Electrical Data:

Power Cores

Rated voltage : 300/500V

Cross Sectional Area (n x mm²) : 4 x 1.50

Screened Cores

Rated voltage : 300/300V

Nominal Capacity : 100 pF/m (f=1 MHz)

Nominal Impedance : 75 ohm (f=1 MHz)

Nominal Attenuation : <4.7 dB/100m (f=1 MHz)

Cross Sectional Area (n x mm²) : 8 x 2 x 0.50

Coaxial video cable

Nominal Capacity : 67 pF/m (f=5 MHz)

Impedance : 75 ± 3 ohm/m (f=5M Hz)

Nominal Attenuation : <3.6 dB/100m (f= 5 MHz)

Thermal Properties:

Operating Temperature Range : 10°C to 70°C

Standard : In accordance with BS (British Standards) 6977 or UL (Underwriters Laboratories) 62 or EN (European Standard) 50214

1.3 Equipment Status Monitoring

Equipment status monitoring points shall be in the form of voltage free, normally open contacts. All signals sent by any monitoring point shall be latched in order to ensure that the signal is able to be received by CFEMS. All equipment status monitoring points must be electrically isolated from power circuits.

1.4 Level Switches

Level switches shall be of magnetic type or other approved non-electrical type, for sensing of low liquid level in the tank. Switches shall have the snap action SPDT type contacts rated at 1.2/230V AC.

1.5 Voltage Transducers

Voltage transducers shall have an output of between 4 to 20 mA.

1.6 Schedule of Points

The CFEMS points to be provided, but not limited to, by the respective Contractors to be monitored are as follows:

1 RTU Panel

- Maintenance Key ON/OFF

2 M&E CF key switch status

- Maintenance Key ON/OFF

3 Lift key switch status

- Maintenance Key ON/OFF

4 Escalator key switch status

- Maintenance Key ON/OFF

5 Lift System

- For the CFEMS points, please refer to lift interface requirements with CFEMS (Annex D7)

6 Closed Circuit Television System (CCTV)

- Main incoming supply status (230V AC)
- DVR Power status (12V DC)
- DVR Fail Alarm
- Hard disk full alarm
- Hard disk malfunction alarm
- Image loss alarm
- Camera supply status
- Camera trip alarm

7 Pump System

- Incoming supply status
- Individual pump power status
- Individual pump ON/OFF status

- Individual pump running status
- Individual pump trip alarm
- Individual pit high water level alarm
- Individual pit low water level alarm
- Incoming supply status for water level sensor(s)

8 Air Conditioning System (AC)

- Incoming supply status
- Individual AHU/PEU power status
- Individual CU/PEU ON/OFF status
- Individual CU/PEU trip alarm
- Individual CU/PEU temperature reading
- Overall space temperature reading

9 Mechanical Ventilation System (MV)

- Incoming supply status
- Individual MV power status
- Individual MV ON/OFF status
- Individual MV trip alarm

10 Escalator Status

- Escalator ON/OFF status
- Escalator Up direction status
- Escalator Down direction status
- Escalator Maintenance status

Escalator Controller

- Incoming power supply ON/OFF status
- Phase reverse/loss alarm
- Earth leakage alarm
- PCB board communication fault alarm
- Safety circuit Opened alarm
- Inverter fault alarm
- Inverter no run signal alarm
- UPS fault alarm

Escalator Drive Unit

- Main drive chain fault alarm
- Motor overload alarm
- Motor overheat alarm
- Motor overspeed alarm
- Motor reverse direction alarm
- Motor inconsistent speed alarm
- Gearbox oil level low alarm
- Mechanical brake status alarm
- Mechanical brake pad status alarm
- Auxiliary brake status alarm

- Auxiliary brake pad status alarm
- Exceed permitted stopping distance alarm

Escalator Handrail system

- Handrail speed -15% alarm, left
- Handrail speed -15% alarm, right
- Handrail inconsistent speed alarm, left
- Handrail inconsistent speed alarm, right
- Handrail tension/ Broken alarm, left
- Handrail tension/ Broken alarm, right
- Handrail inlet safety switch alarm, upper left
- Handrail inlet safety switch alarm, upper right
- Handrail inlet safety switch alarm, lower left
- Handrail inlet safety switch alarm, lower right

Steps and step chain

- Missing step alarm, upper
- Missing step alarm, lower
- Step sag safety switch alarm, upper
- Step sag safety switch alarm, lower
- Step chain tension alarm, left
- Step chain tension alarm, right
- Step upthrust safety switch alarm, upper
- Step upthrust safety switch alarm, lower

Landing and comb plate

- Floor plate opened alarm, upper
- Floor plate opened alarm, lower
- Comb plate safety switch alarm, upper left
- Comb plate safety switch alarm, upper right
- Comb plate safety switch alarm, lower left
- Comb plate safety switch alarm, lower right
- Flood sensor alarm

Decking

- Emergency stop alarm, upper
- Emergency stop alarm, middle
- Emergency stop alarm, lower
- Skirt panel safety switch alarm, upper left
- Skirt panel safety switch alarm, upper right
- Skirt panel safety switch alarm, middle left
- Skirt panel safety switch alarm, middle right
- Skirt panel safety switch alarm, lower left
- Skirt panel safety switch alarm, lower right
- Motion sensor fault alarm, upper
- Motion sensor fault alarm, lower

11 Generator System

- Genset main incoming supply status
- Genset battery charger fail alarm
- Genset run status
- Genset failure alarm
- Genset Auto/Manual status
- Genset day tank low fuel alarm
- Genset day tank high fuel alarm
- Genset storage tank low fuel alarm
- Genset storage tank high fuel alarm
- Genset high temperature alarm
- Genset low oil pressure alarm
- Genset overload alarm
- Genset overcurrent alarm
- Genset earth fault trip alarm
- Genset earth failure alarm
- Individual Phase Voltage Reading

12 Uninterruptible/Emergency Power Supply (UPS/EPS) System

- UPS/EPS online status
- UPS/EPS on battery
- UPS/EPS on bypass mode status
- Inverter Fault Alarm
- Rectifier Fault Alarm
- Maintenance Bypass Status
- UPS/EPS summary alarm
- Mains Failure
- Low battery voltage alarm
- Battery non charging alarm
- Battery breaker trip alarm
- Temperature Monitoring alarm
- Manual Transfer Switch alarm (if any)

13 Battery Condition Monitoring System (for UPS/EPS)

- Voltage discharging/charging alarm
- Current discharging/charging alarm
- Exceed allowable battery temperature alarm
- Exceed allowable ambient temperature alarm
- Exceed allowable Cell resistance reading alarm

14 Fire Alarm System

- Fire alarm activated
- Fire alarm system incoming supply

15 Heat/ Smoke detection System

- Heat/ Smoke detection alarm activated
- Heat/ Smoke detection system incoming supply

16 Clean Gas Detection System

- Clean gas cylinder low pressure detected
- Clean gas system activated
- Clean gas panel summary trip alarm

17 Electrical System

- Powergrid main incoming supply alarm (3 phases)

18 Lighting System*

- Individual lighting circuit outgoing trip alarm (7pm to 7am)
- Outgoing RCCB trip alarm for motion sensor circuitry

* Contractor to submit Single Line Diagram to LTA for quantity of lighting points to be monitored.

1.7 Testing and Commissioning

The Contractor shall carry out the following tests:

- (a) CFEMS field equipment test
- (b) End-To-End-Test

1.7.1 CFEMS Field Equipment Test

The Contractor shall coordinate with the CFEMS contractor to carry out all necessary tests to verify that all equipment connected to the RTU at the CFEMS field equipment can be monitored before the start of End-to-End Test. This shall include the following;

- (a) Verify via point-to-point test for all connections between field equipment ITB and RTU.
- (b) Verify the correct operation of all functions including hardware and software function (RTU program etc) from the field equipment to the wireless modem.

1.7.1 End-to-End Test

- (a) End-To-End test is carried out to verify the proper functioning of the CFEMS from the HMI GUI at the CFEMS backend system to the field equipment. This shall include the following;
 - (i) Activation by the Contractor of the field equipment to produce a status change that can be seen at the CFEMS backend system for DI points.
 - (ii) Activation by the Contractor of the field equipment to produce an alarm that can be seen at the CFEMS backend system for DA points.
- (b) The Contractor shall coordinate with CFEMS Contractor for the test schedule and testing.

- (c) The Contractor shall review all test procedures to be produced by the CFEMS Contractor.

1.8. Enclosures

1.8.1 Enclosures include equipment panels that houses CFEMS field equipment and Interface Terminal Box (ITB).

1.8.2 As a minimum, enclosures shall be made of 1.6mm electro-galvanised sheet metal with a surface finished of epoxy polyester coating.

1.8.3 The CFEMS panel to be provided by the developer and supplied by the CFEMS contractor shall be sized to a width of 600mm, height of 800mm and depth of 300mm.

1.8.4 The ITB to be provided shall be sized to a width of 600mm, height of 300mm and depth of 200mm.

1.8.5 The IP Code rating as specified in IEC 60529 shall be used for degrees of protection for all enclosures installed in the following areas;

- (a) IP55 for enclosures that are installed indoors.
- (b) IP65 for enclosures that are installed outdoors.

1.8.6 All metal enclosures shall be resistant to or protected against corrosion and rust.

1.8.7 The terminal blocks inside the enclosures shall meet the required standards of IEC 60 947-7-1.

1.8.8 All enclosures shall be labelled and the termination blocks inside the enclosures numbered.

1.8.9 Cables in the enclosures shall be labelled at both ends.

1.9 Connection to CFEMS (Applicable to Maintenance Contractor Only)

The Contractor shall provide PC or Notebook to be connected to the backend of the CFEMS Contractor to receive alarms detected by the CFEMS for their respective service. The Contractor shall subscribe to 4G/3G mobile broadband wireless service from any Telco to connect and receive the alarms from the CFEMS backend. The CFEMS contractor shall load a program into the PC for the Contractor to view the alarm cases. The minimum configuration of the PC is as follows:

- The latest CPU or equivalent (minimum)

- 2GB RAM on board (minimum)
- 250GB Hard Disk (minimum)
- Monitor
- Operating System (MS-Windows 7 and above)
- CD ROM and USB
- Sound card + Speakers (optional)
- Anti-virus software

Training will be provided by the CFEMS Contractor to help the Contractor operate the application.

1.10 CCTV System Requirements (For Lift and Escalator Only)

The CCTV system for CF equipment at commuter facilities shall comprise the following:

- (a) CCTV camera(s) with housing to be installed at locations to be decided by the Superintending Officer;
- (b) A standalone digital video recording system to be installed within enclosure with lockset;
- (c) Ensuring compatibility to current CFEMS system;
- (d) Software and hardware devices for management of CCTV system;
- and
- (e) Associated components

The CCTV system shall be equipped with a backup battery system. The backup battery shall ensure that in the event of a power failure, the CCTV system shall continue to function for a minimum of two (2) hours without any deterioration or degradation of its performance.

1.10.1 The CCTV system cameras shall be dome-shaped, vandal-proof, of charge coupled device (CCD) 1/3" format, PAL colour system and shall be equipped with character generator capable of producing at least 16 user-defined alphanumeric characters for identification of the viewed areas.

1.10.2 The Contractor shall propose the location to install the CCTV system cameras which shall provide sufficient surveillance coverage and shall be subjected to the acceptance of the Superintending Officer.

1.10.3 The CCTV system cameras shall utilise varifocal lenses. The maximum aperture for the lens shall be at least f/1.4 and the aperture size range shall be such that the depth of field is not less than 2 m to infinity.

1.10.4 The CCTV system cameras shall have sufficient dynamic range to operate under varying conditions throughout the day, including bright sunlight and various lighting conditions. The CCTV system cameras shall be able to operate and produce usable pictures under a lighting level of 0.1 lux.

1.10.5 The CCTV system cameras shall be of day and night type and meet the following minimum specifications:

- (a) Video Output : 1 Vpp Composite video signal with 0.3V sync pulse
- (b) Video Impedance : 75 Ω
- (c) Horizontal Resolution : ≥ 540 TVL (colour mode)
- (d) S/N Ratio : > 48 dB (AGC off)
- (e) Minimum illumination : 1 lux at colour mode
: 0.1 lux at black/white mode
- (f) Ambient Temperature : Environmental ambient temperature of at least $+45^{\circ}\text{C}$
- (g) Other Features : Automatic white balance
- (h) Automatic iris control
- (i) Automatic light control / Electronic light control
- (j) Automatic beam control
- (k) Automatic gain control
- (l) Automatic black level adjustment
- (m) Lens flare compensation
- (n) Backlight compensation
- (o) Electronic shutter function

1.10.6 If digital camera is proposed, the digital camera conforming to Profile S specifications of ONVIF shall be provided. The digital cameras shall have performance similar to that specified in Clause 1.10.5, and subject to review and acceptance.

1.10.7 The CCTV system cameras shall be easily accessible for maintenance purpose.

1.10.8 The CCTV system cameras shall avoid facing direct or reflected light sources. In the event that a camera would inevitably face a strong light source or direct sunlight permanently, filters shall be used to reduce the glare and to protect the camera from permanent damage.

1.10.9 The CCTV system cameras shall be housed in protective housings. The housings shall be designed to allow sufficient ventilation and heat dissipation for the cameras.

1.10.10 The housings for the CCTV system cameras shall be vandal resistant, and shall be sealed to at least IP54.

1.10.11 The camera cables between camera housing and main trunking shall be protected by flexible metal conduit. The flexible conduit, cables and bracket interface shall be easily removed and reinstated for maintenance.

1.10.12 Openings of ceiling panels for CCTV system camera mounting shall be covered with trimmers, etc. to improve their aesthetic appearance. The design and finishes of the trimmers and camera enclosure shall be subject to review and acceptance.

1.10.13 The DVR shall record the images of the CCTV system camera(s) continuously and the images shall be recorded for at least ninety (90) days, at a minimum of 6 frames per second and at a resolution of at least 704 x 576 pixels.

1.10.14 The DVR shall be equipped with a RJ-45 Ethernet port (or other interface port, subject to review and acceptance) for local and remote DVR configuration and management, viewing of live and recorded images, and retrieval and archival of recorded images using personal computer/notebook.

1.10.15 Viewing of live and recorded images from the DVR shall be compatible with current CFEMS viewing software/ platform.

1.10.16 The DVR shall also be equipped with at least the following functions and facilities:

- (a) Replay and normal play;
- (b) Still field;
- (c) Fast forward;
- (d) Rewind;
- (e) Stepping frame;
- (f) Visual search – forward and reverse;
- (g) Speed search and stop;
- (h) Search between user defined date/time periods;
- (i) Simultaneous record, replay and view of captured images;
- (j) Event and alarm logs;
- (k) 24-hour time and date stamp/identification;
- (l) Removable internal storage medium for external monitoring; and
- (m) An authentication mechanism to be proposed, and subject to review and acceptance, to ensure the integrity of all recorded images by allowing detection of any alteration or tampering made on the recorded images.

1.10.17 The Digital Video Recorder (DVR) shall be installed within an enclosure sealed to at least IP54.

1.10.18 Electrical requirements for the DVR will be 1 number of 20A single phase power supply isolator.

1.10.19 The Contractor shall provide portable terminals such as laptops that are equipped with all necessary software, licenses and connecting cables for the management and configuration of the CCTV, including anti-virus software.

1.10.20 The portable terminal that is equipped with all necessary software, licences and connecting cables for the management and configuration of the CCTV system, including anti-virus software.

1.10.21 The portable terminal for management and configuration of the CCTV shall have the following functions:

- (a) Control and management functions specified in Clause 1.10.6 for the DVR;

- (b) Select and playback selected live and recorded images from the DVR in various display formats, i.e. full screen and quad display;
- (c) Download of selected recorded images from the DVR to archival media i.e. CD-R, thumb-drive, etc. It shall be possible to playback these downloaded archived images using open-source media player such as VLC media player.

Table 2 below shows Appendices and Table for CFEMS for reference.

Annex D1	Lift Interface Requirements with CFEMS
Annex D2	Protocol from RTU to Lift Controller and Lift Controller to RTU
Annex D3	Monitoring Points in Detail
Annex D4	UPS Current Sensor
Annex D5	Error Code
Annex D6	CRC Generation (To Be Coordinated with CFEMS Contractor)
Annex D7	Lift Monitoring Points by CFEMS system

Table 2

4.4.3 Inspection and Taking Over

During the joint site inspection, visual and physical check as well as test runs shall be performed by the Developer to confirm the accuracy of the submission. The Developer shall rectify any defects picked up during the inspection.

4.4.3.1 Handing Over Documents

- a. Operation & Maintenance (O&M) Manual
- b. As-built Drawings
- c. Single Line Diagrams (SLDs) & Control Drawings
- d. Testing & Commissioning (T&C) Report
- e. Maintenance Records (where applicable)
- f. Permit to Operate (PTO) – For lifts and escalators only
- g. The checklist for Commuter Infrastructure – Equipment or Mechanical System (Maintenance Related) (refer to Checklist 3 of IDC, Volume C, Chapter 4) shall be filled up and submitted during the design submission stage.

The Developer shall ensure that all drawings and calculation documents are endorsed by the relevant QP.

4.4.3.2 Spares and Warranty

- a. For components and parts which are not widely available, the developer shall provide spares with a quantity of 5% of the total number of components/parts used in the project.
- b. The developer shall provide a defects liability period (DLP) of 12 months, starting from the date of completion of T&C.

Checklist 1:

COMMUTER INFRASTRUCTURE (STRUCTURE) CHECKLIST FOR COVERED LINKWAY SHELTER/ BUS STOP SHELTER/ TAXI SHELTER/ PICK-UP/ DROP-OFF SHELTER

Commuter Facilities Management (Maintenance Related)

Project: _____

(✓) Tick the appropriate column for all items

Standard Requirements		Yes	NA	Remarks
1.0	General			
1.1	All design and construction shall comply with LTA's latest Standard Details of Road Elements (SDRE), Material & Workmanship (M&W) Specifications, Civil Design Criteria (CDC), Infrastructure Design Criteria (IDC), Code of Practice (COP), BCA's Code on Accessibility and any other Specifications by other relevant Authorities. The design shall be based on the prevailing regulatory and technical requirements. Any deviation to the standards during planning, designing and implementation phases must be highlighted to the respective parties.			
1.2	For LTA's considerations to maintain, all Commuter Infrastructures must meet the following criteria: <ul style="list-style-type: none"> To be located within Public Street/ State Land To serve as a need for Transport Nodes To be 24/7 Accessible for Public To ensure no Duplicated Crossings (i.e., POB, At-Grade Crossings and Underground Crossings) To comply with all LTA's Standards and Codes of Practice or Guidelines 			
1.3	Any encroachment into a private land must be highlighted to LTA and plan for its ownership, regularization and maintenance. Land alienated to other Statutory Board is a private land, as per Street Works Act.			
1.4	All proposed floor finishes must provide a safe and hazard-free environment. All potential risks must be identified early and to be addressed with appropriate mitigating measures.			
2.0	Design and Detailing			
2.1	Shelter shall be designed as an independent structure and not connected to any adjacent structure. This is to establish a clear ownership and maintenance responsibilities of the Commuter Infrastructures.			
2.2	Foundation of shelter shall be structurally independent from any drain structure below. This is to establish a clear ownership and maintenance responsibilities of			

	the Commuter Infrastructures. LTA only considers the maintenance of the top slabs/ surface finishes of drains within the Public Street/ State Land, designated as footpath/ shared path/ cycling path.			
2.3	Design of shelter shall be modularised with demountable parts consisting of bolts and nuts connection. Welded joint connection and on-site welded joint connection are not recommended as the connections could shear off due to external forces if the welding is not carried out properly.			
2.4	Vertical member joint of the column shall be avoided. For any other structural joint, such connection shall be designed and endorsed by a Professional Engineer.			
2.5	Cladded roof and false ceiling of shelter are not recommended as it would be difficult to monitor the health of internal structural members covered by the cladded roof and false ceiling (i.e. corrosion).			
2.6	Roof shall be designed with a sufficient gradient for an effective water run-off.			
2.7	For standardization, a mono-pitched roof is preferred, and roof profile shall be designed with a minimum of 3° fall for drainage and self-cleansing purposes.			
2.8	Roof shall be sloped towards the back of bus stop shelter so that the water run-off from the roof will be channelled towards the back of shelter and into the public drains behind the bus stop shelter or to the roadside drop inlet chambers (DICs) from the sides of bus stop shelter. This is to prevent commuters from having to walk through a curtain of rainwater during alighting/ boarding the bus.			
2.9	For covered linkway shelter, roof shall be sloped towards the road so that water run-off from the roof will be channelled towards adjacent roadside DICs.			
2.10	Public walkway/ granolithic platform underneath shelter shall be graded effectively to ensure no water stagnation and a proper water discharge towards the road and subsequently, towards the adjacent roadside DICs.			
2.11	Gutters are not recommended due to potential chokage and mosquito breeding.			
2.12	For standardization, steel members of columns are preferred to be of Rectangular or Square Hollow Section (RHS or SHS).			
2.13	A proper drainage (i.e. cut-off drains) shall be provided within the adjacent higher ground to drain off the surface run-off from the adjacent higher grounds into the public drains and to prevent it from flowing onto the public walkway and shelter platform. The drainage is to be maintained by the adjacent Land Owner as the surface run-off originates from their respective land sites. No cut-off drains shall be designed within the public street and where cut-off drains are unavoidable due to the site constraints, construction of any cut-off drains within public street have to be built to PUB's standards and cleared with PUB before construction			

	for their maintenance.			
2.14	All pre-designed holes for services/ wirings/ connections shall be treated appropriately for corrosion and they shall be sealed if they are not utilized.			
3.0	Interfaces			
3.1	A proper interfacing element (i.e. flashing, open channel) between the proposed Commuter Infrastructure and the existing adjacent Commuter Infrastructure shall be provided. This is to prevent any water from splashing onto the shelter platform.			
3.2	A proper interfacing element (i.e. flashing, open channel) shall be designed and installed on Commuter Infrastructures with sealant applied. This is to prevent from any water ingress/ leakage.			
3.3	A proper discharge from the open channel shall be designed and installed to direct the water run-off towards to nearest sump/ turf/ side table. This is to prevent the water run-off from being discharged onto the shelter platform/ walkway, causing ponding and inconvenience to commuters.			
3.4	All mounting of system/ equipment onto any Commuter Infrastructure and Facility shall be of a non-destructive design (i.e. No drilling fixing for CCTV, lightings).			
4.0	Materials			
4.1	Anti-stick coating shall be provided on columns of shelter. This is to prevent public from sticking any illegal advertisements on the shelter columns.			
4.2	The usage of extensive transparent and translucent roofing materials that are prone to discoloration and weathering shall be minimized.			
4.3	Materials used for the roof shall withstand exposure to external weathering.			
5.0	Inspection and Taking Over			
5.1	Handing Over Documents			
5.1.1	As-built, structural and architectural drawings and approved plans of Proposed Street Work/ Development with Commuter Infrastructure shall be provided in digital format. The Developer shall ensure that all drawings/ documents are endorsed by the relevant QP.			
5.1.2	Detailed, roof, floor and cross-sectional view plans showing the Proposed Street Works/ Developments, including the details of Commuter Infrastructure (i.e. Road Reserve Line (RRL), annotations, maintenance boundaries, materials, dimensions, connections) shall be provided in digital format.			
5.1.3	Progress photographs showing the installation work of Commuter Infrastructure such as roof connection details shall be provided in digital format.			
5.1.4	Asset Master Record Input Form (AMRIF) and Inventory Record Form shall be provided in digital			

	format.			
5.1.5	Taking over letters from PUB (Drainage), Nparks (Turfig) and NEA (Cleaning), where applicable shall be provided in digital format.			
5.1.6	GIS layers as per the LTA Data Hub Data Collection Specifications, in true coordinates on SVY 21 system, for all types of assets constructed/ redeveloped/ removed/ relocated as part of the project shall be provided.			
5.2	Spares and Warranty			
5.2.1	For any unique products/ special finishes, 5% spares of the total quantity shall be provided.			
5.2.2	All proposed materials (i.e. sealant, roof panels, high strength coating for cycling path, painting, protective coating, tiles) must be readily available in the local market with appropriate warranties and guarantees, where applicable. Full details of the proposed materials (i.e. supplier catalogues, warranties etc.) shall be provided in digital format.			
5.2.3	All warranty schedule of proposed materials shall comply with the latest LTA's Materials and Workmanship Specification for Architectural Works (i.e. 10 years period for sealants, 5 years period for paintwork, 10 years period for powder coating system, 10 years period for aluminium panelling system).			

Notes:

- All compliances shall be clearly reflected in the drawings. This Checklist shall be submitted with other relevant Checklists. This Checklist shall be submitted for every submission/re-submission.
- The QP shall state the reasons for all non-compliances in the 'Remarks' column of the Checklist.

 Name of Qualified Person

 Signature of Qualified Person

 Date

**COMMUTER INFRASTRUCTURE (STRUCTURE) CHECKLIST FOR
PEDESTRIAN OVERHEAD BRIDGE**

Commuter Facilities Management (Maintenance Related)

Project: _____

(✓) Tick the appropriate column for all items

Standard Requirements		Yes	NA	Remarks
1.0	General			
1.1	All design and construction shall comply with LTA's latest Standard Details of Road Elements (SDRE), Material & Workmanship (M&W) Specifications, Civil Design Criteria (CDC), Infrastructure Design Criteria (IDC), Code of Practice (COP), BCA's Code on Accessibility and any other Specifications by other relevant Authorities. The design shall be based on the prevailing regulatory and technical requirements. Any deviation to the standards during planning, designing and implementation phases must be highlighted to the respective parties.			
1.2	For LTA's considerations to maintain, all Commuter Infrastructures must meet the following criteria: <ul style="list-style-type: none"> To be located within Public Street/ State Land To serve as a need for Transport Nodes To be 24/7 Accessible for Public To ensure no Duplicated Crossings (i.e., POB, At-Grade Crossings and Underground Crossings) To comply with all LTA's Standards and Codes of Practice or Guidelines 			
1.3	Any encroachment into a private land must be highlighted to LTA and plan for its ownership, regularization and maintenance. Land alienated to other Statutory Board is a private land, as per Street Works Act.			
1.4	All proposed floor finishes must provide a safe and hazard-free environment. All potential risks must be identified early and to be addressed with appropriate mitigating measures.			
2.0	Design and Detailing			
2.1	Reinforced concrete POB and lift shafts are preferred as they are more durable and robust.			
2.2	Foundation of Pedestrian Overhead Bridge (POB) shall be structurally independent from any drain structure below. This is to establish a clear ownership and maintenance responsibilities of the Commuter Infrastructures.			
2.3	Roof shall be designed with a sufficient gradient for an effective water-runoff and self-cleansing purpose.			

2.4	4.5m Height Restriction Signs shall be installed at strategic locations along the POB to ensure visibility to motorists.			
2.5	All pre-designed holes shall be sealed if they are not utilized.			
2.6	All ground floor and flat surfaces exposed directly or indirectly to weather shall be designed with a sufficient gradient to drain off the water into the drains.			
2.7	POB deck shall not have a valley point that will result in water stagnation.			
2.8	Cladded roof and false ceiling of shelter are not recommended as it would be difficult to monitor the health of internal structural members covered by the cladded roof and false ceilings (i.e. corrosion).			
2.9	Gutters are not recommended due to potential chokage and mosquito breeding.			
2.10	A proper drainage (i.e. cut-off drains) shall be provided within the adjacent higher ground to drain off the surface run-off from the adjacent higher grounds into the public drains and to prevent it from flowing onto the public walkway and shelter platform. The drainage is to be maintained by the adjacent Land Owner as the surface run-off originates from their respective land sites. No cut-off drains shall be designed within the public street and where cut-off drains are unavoidable due to the site constraints, construction of any cut-off drains within public street have to be built to PUB's standards and cleared with PUB before construction for their maintenance.			
2.11	Rain downpipes are not allowed to be concealed within and they shall be exposed.			
2.12	Red triangle markings shall be provided on the surface of POB deck soffit to indicate the lowest point.			
2.13	Tactile tiles/ nosing tiles shall not be installed over expansion joints.			
2.14	Tactile tiles/ nosing tiles shall be installed effectively to eliminate a customized cutting of tactile tiles. This is for the ease of replacement of tactile tiles/ nosing tiles			
2.15	Tactile tiles/ nosing tiles shall be of colour contrast.			
3.0	Interfaces			
3.1	For demarcation of boundaries of different maintenance agencies, separate POB shelter column/ foundation shall be provided at the intersection of different maintenance agencies.			
3.2	A proper interfacing element (i.e. flashing, open channel) shall be designed and installed on Commuter Infrastructures with sealant applied. This is to prevent from any water ingress/ leakage.			
3.3	All mounting of system/equipment onto any Commuter Infrastructure and facility shall be of non-destructive design (i.e. no drilling fixing for CCTV, lightings).			

4.0	Materials			
4.1	All pedestrian railings shall be made of stainless-steel Grade 316.			
4.2	Anti-stick coating shall be provided on columns of shelter to prevent public from sticking illegal advertisements on the columns.			
4.3	Anti-corrosion painting shall be provided on welded joint connections at shelter roof members.			
4.4	Materials used for the roof shall be able to withstand exposure to external weathering.			
4.5	Metal nosing tiles (i.e. steel) are not recommended as they provide less colour contrast with the staircase flooring and it could be slippery, causing slip and fall to pedestrians.			
4.6	Durable and stain resistant floor finishes shall be used.			
5.0	Inspection and Taking Over			
5.1	Handing Over Documents			
5.1.1	As-built, structural and architectural drawings and approved plans of Proposed Street Work/ Development with Commuter Infrastructure shall be provided in digital format. The Developer shall ensure that all drawings/ documents are endorsed by the relevant QP.			
5.1.2	Detailed, roof, floor and cross-sectional view plans showing the Proposed Street Works/ Developments, including the details of Commuter Infrastructure (i.e. Road Reserve Line (RRL), annotations, maintenance boundaries, materials, dimensions, connections) shall be provided in digital format.			
5.1.3	Progress photographs showing the installation work of Commuter Infrastructure such as roof connection details shall be provided in digital format.			
5.1.4	Asset Master Record Input Form (AMRIF) and Inventory Record Form shall be provided in digital format.			
5.1.5	Taking over letters from PUB (Drainage), Nparks (Turving) and NEA (Cleaning), where applicable shall be provided in digital format.			
5.1.6	GIS layers as per the LTA Data Hub Data Collection Specifications, in true coordinates on SVY 21 system, for all types of assets constructed/ redeveloped/ removed/ relocated as part of the project shall be provided.			
5.2	Spares and Warranty			
5.2.1	For any unique products/ special finishes, 5% spares of the total quantity shall be provided.			
5.2.2	All proposed materials (i.e. sealant, roof panels, high strength coating for cycling path, painting, protective coating, tiles) must be readily available in the local market with appropriate warranties and guarantees.			

	where applicable. Full details of the proposed materials (i.e. supplier catalogues, warranties etc.) shall be provided in digital format.			
5.2.3	All warranty schedule of proposed materials shall comply with the latest LTA's Materials and Workmanship Specification for Architectural Works (i.e. 10 years period for sealants, 5 years period for paintwork, 10 years period for powder coating system, 10 years period for aluminium panelling system).			

Notes:

- All compliances shall be clearly reflected in the drawings. This Checklist shall be submitted with other relevant Checklists. This Checklist shall be submitted for every submission/re-submission.
- The QP shall state the reasons for all non-compliances in the 'Remarks' column of the Checklist.

 Name of Qualified Person

 Signature of Qualified Person

 Date

COMMUTER INFRASTRUCTURE (STRUCTURE) CHECKLIST FOR PEDESTRIAN UNDERPASS

Commuter Facilities Management (Maintenance Related)

Project: _____

(✓) Tick the appropriate column for all items

Standard Requirements		Yes	NA	Remarks
1.0	General			
1.1	All design and construction shall comply with LTA's latest Standard Details of Road Elements (SDRE), Material & Workmanship (M&W) Specifications, Civil Design Criteria (CDC), Infrastructure Design Criteria (IDC), Code of Practice (COP), BCA's Code on Accessibility and any other Specifications by other relevant Authorities. The design shall be based on the prevailing regulatory and technical requirements. Any deviation to the standards during planning, designing and implementation phases must be highlighted to the respective parties.			
1.2	For LTA's considerations to maintain, all Commuter Infrastructures must meet the following criteria: <ul style="list-style-type: none"> To be located within Public Street/ State Land To serve as a need for Transport Nodes To be 24/7 Accessible for Public To ensure no Duplicated Crossings (i.e., POB, At-Grade Crossings and Underground Crossings) To comply with all LTA's Standards and Codes of Practice or Guidelines 			
1.3	Any encroachment into a private land must be highlighted to LTA and plan for its ownership, regularization and maintenance. Land alienated to other Statutory Board is a private land, as per Street Works Act.			
1.4	All proposed floor finishes must provide a safe and hazard-free environment. All potential risks must be identified early and to be addressed with appropriate mitigating measures.			
2.0	Design and Detailing			
2.1	The Pedestrian Underpass shall be of a structurally independent. This is to establish a clear ownership and maintenance responsibilities of the Commuter Infrastructures.			
2.2	The drainage shall be designed outside the cladded walls for an easy access to carry out maintenance/ cleaning of the drains.			
2.3	The gradient of the floor at the entrance/ exit and within the pedestrian underpass shall be designed for an effective discharge of water.			

2.4	The ceiling and wall panels shall be easily mounted and removed. A full detail or instruction on its mounting and removal shall be provided. This is to facilitate the structural inspection and maintenance works.			
2.5	Cladded walls and false ceilings are not recommended. However, if unavoidable, an inspection/ maintenance access at appropriate intervals shall be provided. This is to facilitate the structure inspection and maintenance works.			
3.0	Interfaces			
3.1	The roof structure at the entrance/ exit of pedestrian underpass shall be designed for an effective discharge of water. This is to prevent from any water ingress and stagnation on the roof.			
3.2	All mounting of system/ equipment onto any Commuter Infrastructure and Facility shall be of a non-destructive design (i.e. no drilling fixing for CCTV, lightings).			
4.0	Materials			
4.1	All pedestrian railings shall be made of stainless-steel Grade 316.			
4.2	Metal nosing tiles (i.e. steel) are not recommended as they provide less colour contrast with the staircase flooring and it could be slippery, causing slip and fall to pedestrians.			
4.3	Durable and stain resistant floor finishes shall be used.			
4.4	All proposed materials shall be of a non-slip nature, especially where they will be used on areas that may be affected by the wet weather.			
5.0	Inspection and Taking Over			
5.1	Handing Over Documents			
5.1.1	As-built, structural and architectural drawings and approved plans of Proposed Street Work/ Development with Commuter Infrastructure shall be provided in digital format. The Developer shall ensure that all drawings/ documents are endorsed by the relevant QP.			
5.1.2	Detailed, roof, floor and cross-sectional view plans showing the Proposed Street Works or Developments, including the details of Commuter Infrastructure (i.e. Road Reserve Line (RRL), annotations, maintenance boundaries, materials, dimensions, connections) shall be provided in digital format.			
5.1.3	Progress photographs showing the installation work of Commuter Infrastructure such as roof connection details shall be provided in digital format.			
5.1.4	Asset Master Record Input Form (AMRIF) and Inventory Record Form shall be provided in digital format.			
5.1.5	Taking over letters from PUB (Drainage), Nparks (Turving) and NEA (Cleaning), where applicable shall			

	be provided in digital format.			
5.1.6	GIS layers as per the LTA Data Hub Data Collection Specifications, in true coordinates on SVY 21 system, for all types of assets constructed/ redeveloped/ removed/ relocated as part of the project shall be provided.			
5.2	Spares and Warranty			
5.2.1	For any unique products/ special finishes, 5% spares of the total quantity shall be provided.			
5.2.2	All proposed materials (i.e. sealant, roof panels, high strength coating for cycling path, painting, protective coating, tiles) must be readily available in the local market with appropriate warranties and guarantees, where applicable. Full details of the proposed materials (i.e. supplier catalogues, warranties etc.) shall be provided in digital format.			
5.2.3	All warranty schedule of proposed materials shall comply with the latest LTA's Materials and Workmanship Specification for Architectural Works (i.e. 10 years period for sealants, 5 years period for paintwork, 10 years period for powder coating system, 10 years period for aluminium panelling system).			

Notes:

- All compliances shall be clearly reflected in the drawings. This Checklist shall be submitted with other relevant Checklists. This Checklist shall be submitted for every submission/re-submission.
- The QP shall state the reasons for all non-compliances in the 'Remarks' column of the Checklist.

 Name of Qualified Person

 Signature of Qualified Person

 Date

COMMUTER INFRASTRUCTURE (STRUCTURE) CHECKLIST FOR FOOTPATH/ CYCLING PATH

Commuter Facilities Management (Maintenance Related)

Project: _____

(✓) Tick the appropriate column for all items

Standard Requirements		Yes	NA	Remarks
1.0	General			
1.1	All design and construction shall comply with LTA's latest Standard Details of Road Elements (SDRE), Material & Workmanship (M&W) Specifications, Civil Design Criteria (CDC), Infrastructure Design Criteria (IDC), Code of Practice (COP), BCA's Code on Accessibility and any other Specifications by other relevant Authorities. The design shall be based on the prevailing regulatory and technical requirements. Any deviation to the standards during planning, designing and implementation phases must be highlighted to the respective parties.			
1.2	For LTA's considerations to maintain, all Commuter Infrastructures must meet the following criteria: <ul style="list-style-type: none"> To be located within Public Street/ State Land To serve as a need for Transport Nodes To be 24/7 Accessible for Public To ensure no Duplicated Crossings (i.e., POB, At-Grade Crossings and Underground Crossings) To comply with all LTA's Standards and Codes of Practice or Guidelines 			
1.3	Any encroachment into a private land must be highlighted to LTA and plan for its ownership, regularization and maintenance. Land alienated to other Statutory Board is a private land, as per Street Works Act.			
1.4	All proposed floor finishes must provide a safe and hazard-free environment. All potential risks must be identified early and to be addressed with appropriate mitigating measures.			
2.0	Design and Detailing			
2.1	Footpath/ cycling path shall be higher than the adjacent planting verge. This is to prevent the water from backflowing onto the footpath/ cycling path, resulting in water stagnation/ siltation on the footpath/ cycling path and gratings.			
2.2	Gradient of footpath/ cycling path shall be designed for an effective discharge of water towards the road. All water stagnant on footpath/ cycling path shall be eliminated.			
2.3	For footpath/ cycling path to be constructed next to			

	existing trees, measures such as to provide sufficient space and to use appropriate materials shall be taken. This is to minimize tree root heave and footpath damage, caused by the existing nearby trees.			
2.4	Footpath/ cycling path shall not have upstand kerb at both ends. This is to prevent from any tripping hazard to pedestrians.			
2.5	Footpath/ cycling path shall comply to the stipulated skid resistance of minimum 45 BPN.			
2.6	A proper drainage (i.e. cut-off drains) shall be provided within the adjacent higher ground to drain off the surface run-off from the adjacent higher grounds into the public drains and to prevent it from flowing onto the public walkway and shelter platform. The drainage is to be maintained by the adjacent Land Owner as the surface run-off originates from their respective land sites. No cut-off drains shall be designed within the public street and where cut-off drains are unavoidable due to the site constraints, construction of any cut-off drains within public street have to be built to PUB's standards and cleared with PUB before construction for their maintenance.			
2.7	Gratings/ tactile tiles shall not be designed and installed on a slope/ steep terrain/ ramp. This is to prevent from any slipping/ tripping hazard.			
2.8	Tactile tiles shall be installed on slope not steeper than 1 in 40.			
2.9	Tactile tiles shall be installed with a 300 mm setback from the footpath edge.			
2.10	Tactile tiles shall be installed effectively to eliminate a customized cutting of tactile tiles. This is for the ease of replacement of tactile tiles.			
2.11	Tactile tiles/ nosing tiles shall be of sufficient colour contrast.			
2.12	Tactile tiles shall maintain their durability and stipulated skid resistance requirement to withstand wear and tear within their shelf-life period.			
3.0	Interfaces			
3.1	For an extension of footpath width, a proper interfacing (i.e. dowel bar) between the existing footpath and new footpath shall be provided. This is to eliminate any differential level on the footpath in the future.			
3.2	Gradient of the new footpath/ cycling path shall be designed in conjunction with the existing gradient of the adjoining footpath.			
4.0	Materials			
4.1	Anti-slip coating shall be applied on all existing closed and modified metal gratings.			
4.2	Durable and stain resistant floor finishes shall be used.			
4.3	All proposed materials shall be of a non-slip nature, especially where they will be used on areas that may			

	be affected by the wet weather.			
5.0	Inspection and Taking Over			
5.1	Handing Over Documents			
5.1.1	As-built, structural and architectural drawings and approved plans of Proposed Street Work/ Development with Commuter Infrastructure shall be provided in digital format. The Developer shall ensure that all drawings/ documents are endorsed by the relevant QP.			
5.1.2	Detailed, roof, floor and cross-sectional view plans showing the Proposed Street Works/ Developments, including the details of Commuter Infrastructure (i.e. Road Reserve Line (RRL), annotations, maintenance boundaries, materials, dimensions, connections) shall be provided in digital format.			
5.1.3	Progress photographs showing the installation work of Commuter Infrastructure such as roof connection details shall be provided in digital format.			
5.1.4	Asset Master Record Input Form (AMRIF) and Inventory Record Form shall be provided in digital format.			
5.1.5	Taking over letters from PUB (Drainage), Nparks (Turfig) and NEA (Cleaning), where applicable shall be provided in digital format.			
5.1.6	GIS layers as per the LTA Data Hub Data Collection Specifications, in true coordinates on SVY 21 system, for all types of assets constructed/ redeveloped/ removed/ relocated as part of the project shall be provided.			
5.2	Spares and Warranty			
5.2.1	For any unique products/ special finishes, 5% spares of the total quantity shall be provided.			
5.2.2	All proposed materials (i.e. sealant, roof panels, high strength coating for cycling path, painting, protective coating, tiles) must be readily available in the local market with appropriate warranties and guarantees, where applicable. Full details of the proposed materials (i.e. supplier catalogues, warranties etc.) shall be provided in digital format.			
5.2.3	All warranty schedule of proposed materials shall comply with the latest LTA's Materials and Workmanship Specification for Architectural Works (i.e. 10 years period for sealants, 5 years period for paintwork, 10 years period for powder coating system, 10 years period for aluminium panelling system).			

Notes:

- All compliances shall be clearly reflected in the drawings. This Checklist shall be submitted with other relevant Checklists. This Checklist shall be submitted for every submission/re-submission.
- The QP shall state the reasons for all non-compliances in the 'Remarks' column of the Checklist.

Name of Qualified Person

Signature of Qualified Person

Date

Checklist 2:

E&M CHECKLIST FOR COVERED LINKWAY SHELTER/ BUS STOP SHELTER/ TAXI SHELTER/ PICK-UP SHELTER

Traffic, Street and Commuter Facilities Lighting (Maintenance Related)

Project: _____

(✓) Tick the appropriate column for all items

Standard Requirements		Yes	NA	Remarks
1.0	General			
1.1	Summary list of proposed items, with brand and model, to be used on site.			
1.2	Electrical and lightning protection system installations embedded in the slab of PUB drains complied with LTA's requirements (if applicable).			
1.3	Consult LTA's Traffic, Street and Commuter Facilities Lighting if the roof alignment of the shelter affects any existing Street Lights.			
2.0	Electrical Distribution			
2.1	Power supply source is standalone i.e. supply source does not come from building switch board or share with building system.			
2.2	The control switches/ MCB for the different facilities are independent (i.e. control switch for shelter only control the lightings within covered linkway).			
2.3	The OG-Box shall be located adjacent to the shelter and shall not in any way obstruct the view of motorists/road users.			
3.0	Lighting Design and Light Fittings			
3.1	The mounting details of the light fittings to the shelter beams/columns are included.			
3.2	The light throw of the light fittings is not affected by beams/columns (i.e. minimise the discrepancy between the simulated lux and completed site measured lux).			

Notes:

- All compliances shall be clearly reflected in the drawings. This Checklist shall be submitted with other relevant Checklists. This Checklist shall be submitted for every submission/re-submission.
- The QP shall state the reasons for all non-compliances in the 'Remarks' column of the Checklist.

Name of Qualified Person

Signature of Qualified Person

Date

Checklist 3:

M&E CHECKLIST FOR PEDESTRIAN UNDERPASS/PEDESTRIAN OVERHEAD BRIDGE/FACILITY BUILDING SERVING VEHICULAR UNDERPASS

Vertical Transport and Tunnel E&M (Maintenance Related)

Project: _____

(✓) Tick the appropriate column for all items

Standard Requirements		Yes	NA	Remarks
1.0	General			
1.1	O&M manuals, T&C reports and summary list of proposed equipment/mechanical system, with brand and model.			
1.2	As-built drawings, control diagrams, single line diagrams (SLDs) endorsed by relevant QP.			
1.3	Design calculations, technical specifications, catalogues, test reports submitted and reviewed by LTA Mechanical and Electrical Services (MES).			
1.4	Lockset may be required to change to LTA maintenance team selected lockset before handing over. Keys for each lock and panel to be provided.			
2.0	Electrical Distribution			
2.1	Permit-to-Operate (PTO) for each lift/escalator displayed at suitable location.			
3.0	Lighting Design and Light Fittings			
3.1	Explanation/diagram of pump operation sequencing on site.			
4.0	Fire Extinguisher			
4.1	Sticker with valid date and endorsement by authorised contractor.			
5.0	Commuter Facility Equipment Monitoring Services (CFEMS)			
5.1	T&C report for all relevant monitoring points (refer to clause 4.4.2) signed by Developer and CFEMS vendor.			

Notes:

- All compliances shall be clearly reflected in the drawings. This Checklist shall be submitted with other relevant Checklists. This Checklist shall be submitted for every submission/re-submission.
- The QP shall state the reasons for all non-compliances in the 'Remarks' column of the Checklist.

Name of Qualified Person

Signature of Qualified Person

Date

CHAPTER 5 – SECURITY REQUIREMENTS

NOT AVAILABLE

CHAPTER 6 – SAFETY GUIDELINES

Table of Contents

6.1	Preamble	2
6.1.1	General	2
6.2	Construction Safety	2
6.2.1	General	2
6.3	Operation & Maintenance Safety.....	2
6.3.1	General	2
6.3.2	Working at Height	2
6.3.3	Layout	3
6.3.4	Access	3
6.3.5	Bus Operation	3
6.3.6	Handrails and Railings	3
6.3.7	Slipping and Tripping Hazards	3
6.3.8	Visual Contrast.....	3
6.4	Public Safety	4
6.4.1	General	4
6.4.2	Layout	4
6.4.3	Sight Visibility	4
6.4.4	Access	4
6.4.5	Handrails and Railings	5
6.4.6	Slipping and Tripping Hazards	6
6.4.7	Avoidance of Obstructions	6
6.4.8	Visual Contrast.....	6

6.1 **Preamble**

6.1.1 General

- 6.1.1.1 The Workplace Safety and Health Act, relevant subsidiary legislations, approved Code of Practices, Guidelines and published Singapore Standards shall be adhered to.
- 6.1.1.2 Design for Safety must be taken into consideration in reference with the latest prevailing Workplace Safety and Health (Design for Safety) Regulations and the Workplace Safety and Health Guidelines (Design for Safety).
- 6.1.1.3 The designer shall with due diligence make reference to the latest prevailing revisions of the legislations and regulations mentioned in the legal register of IDC Volume C Annex F. The designer shall ensure that the designs cater for the adherence of these requirements in construction, operations & maintenance as well as for public safety.

6.2 **Construction Safety**

6.2.1 General

- 6.2.1.1 Commuter infrastructure facilities shall be designed to ensure that it can be constructed in a safe manner. Design considerations must include safety for the workforce and public in compliance with LTA's Particular Specification (PS) Appendix B Safety, Health and Environment.

6.3 **Operation & Maintenance Safety**

6.3.1 General

- 6.3.1.1 Commuter infrastructure facilities shall be designed to ensure the facility can be safely operated, maintained and replaced, in consideration of both the operators and the public using the facilities.
- 6.3.2 Working at Height
 - 6.3.2.1 For high-void areas, mounting lights within safe reach shall be considered. Provision of safe access shall be considered in cases where light mounting at high levels cannot be avoided.
 - 6.3.2.2 The removal of roof panels shall be designed to such that it could be handled by one worker with platform ladder/mobile elevating work platform.
 - 6.3.2.3 Safety measures shall be taken to prevent removable components from falling during maintenance, removal and reattachment, such as the use of securing safety chains.

- 6.3.2.4 In overhead areas where vibration is expected, the use of screw/bolts with self-loosening prevention systems shall be considered.
- 6.3.3 Layout
 - 6.3.3.1 Position of street furniture such as overground (OG) boxes, lamp posts, traffic sign posts, etc, shall be appropriately located such that it can be safely operated and maintained.
- 6.3.4 Access
 - 6.3.4.1 All roofs and linkways shall be designed to allow maintenance access.
 - 6.3.4.2 Safe and proper access shall be provided for all parts of the infrastructure that requires frequent inspection and maintenance.
 - 6.3.4.3 Consider providing alternative access to ground level so that maintenance work on escalators/ lifts can be done with minimal disruption to commuters.
- 6.3.5 Bus Operation
 - 6.3.5.1 For bus stop that requires temporary relocation due to works, it shall be located at a site that is safe for bus operations (which is approved by LTA) and structurally safe for use.
- 6.3.6 Handrails and Railings
 - 6.3.6.1 The designer shall comply with the guidelines in 6.4.5 Handrails and Railings for Public Safety.
- 6.3.7 Slipping and Tripping Hazards
 - 6.3.7.1 All ground floor and flat surfaces exposed directly or indirectly to weather shall be designed with falls and gradient to prevent water ponding that can cause slip and fall.
 - 6.3.7.2 Avoid uneven surfaces due to tiles, aeration slabs and/or blocks that can cause tripping hazard.
- 6.3.8 Visual Contrast
 - 6.3.8.1 Labelling, coding, caution and warning displays shall be visible to increase maintenance efficiency and keep personnel out of danger.
 - 6.3.8.2 Wherever there is an unexpected change in level, designs shall include visual contrasting feature such as yellow paintwork.
 - 6.3.8.3 In addition, the designer shall also comply with the guidelines in 6.4.8 Visual Contrast for Public Safety.

6.4 **Public Safety**

6.4.1 General

- 6.4.1.1 Commuter infrastructure facilities shall also be designed to ensure a safe environment for the public using the facilities.

6.4.2 Layout

- 6.4.2.1 Position of street furniture such as overground (OG) boxes, lamp posts, traffic sign posts, etc, shall be appropriately located and do not impede movement of pedestrians, cyclists and PMD/ PAB/ PMA users.

6.4.3 Sight Visibility

- 6.4.3.1 Line of sight on oncoming buses shall be maintained throughout the entire bus stop shelter. Columns and green trellises of covered linkway shall not obstruct the line of sight of oncoming buses.
- 6.4.3.2 Planting restriction zone (e.g. vegetation of not more than 500mm high) to be specified in the Tree Affected Plan or Site Plan to ensure clear visibility over any proposed planting.
- 6.4.3.3 Position of development boundary walls, structural columns and street furniture (e.g. overground (OG) boxes, signs, signboards, etc.) shall not obstruct line of sight of both motorists and pedestrians, cyclists, and PMD/ PMA/ PAB users. Where routing of footpaths, cycling paths, shared paths and covered linkways is required, the design shall take into consideration of adjacent property perimeter to ensure unobstructed line of sight and smooth alignment.

6.4.4 Access

- 6.4.4.1 Steps are not permitted at the alighting and boarding area of the bus stop shelter and taxi/pick-up shelter, passageway of the Pedestrian Underpass, POB bridge deck and covered linkways. The periphery access to the facilities shall be barrier free.
- 6.4.4.2 Any level difference shall be mitigated by ramp. Please refer to the latest BCA's Code on Accessibility in the Built Environment.
- 6.4.4.3 Staircases shall not be placed in the same line after the landing from POB ramps to prevent wheelchair and PMA users from the risk of falling.

6.4.5 Handrails and Railings

- 6.4.5.1 Barriers shall be provided in accordance with the requirement of the current edition of the Standard for Building Control Regulations and Code on Accessibility in the Built Environment. 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 finished floor level or pitch line of a flight of stairs to the top of the highest continuous horizontal member.
- 6.4.5.2 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.
- 6.4.5.3 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.
- 6.4.5.4 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.
- 6.4.5.5 Refer to the Civil Design Criteria Chapter 3 for requirements relating to live loads at handrails and balustrades.
- 6.4.5.6 Handrails at ramps shall be continuous throughout the entire length (including any intermediate landings).
- 6.4.5.7 Handrails and grab bars on the accessible route shall contrast with the colour of its background to aid visibility.
- 6.4.5.8 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.
- 6.4.5.9 Handrails ends shall turn down or return to the wall or balustrade with no open end.
- 6.4.5.10 Railings with sufficient height shall be provided to prevent danger to pedestrians, cyclists and PMD/ PAB/ PMA users travelling along stretches with deep drop or steep slope.
- 6.4.5.11 Position of railings shall not obstruct and create safety hazard to pedestrians, cyclists and PMD/ PAB/ PMA users.

6.4.6 Slipping and Tripping Hazards

- 6.4.6.1 The choice of floor finishes shall comply with the current edition of Singapore Standard (SS) 485 'Slip Resistance Classification of Public Pedestrian Surface Materials'.
- 6.4.6.2 All floor finishes shall be certified to the minimum classification under SS 485 Annex E Table E.1.
- 6.4.6.3 Designs shall not incorporate protruding elements or gaps that contributes to tripping / entrapment hazards.
- 6.4.6.4 Where two floor materials meet, the floor shall be levelled across the junction to avoid any tripping hazard.
- 6.4.6.5 All steps shall be fitted with non-slip grooved colour contrasting nosing tiles between 50mm and 65mm in width.
- 6.4.6.6 Rubber nosing strip, and metal insert are not acceptable for staircase.
- 6.4.6.7 Adequate drainage and falls shall be provided to eliminate any possibility of water ponding on all flat surfaces.
- 6.4.6.8 Non-slip drain covers shall be installed levelled with footpaths, cycling paths, shared paths and covered linkways.

6.4.7 Avoidance of Obstructions

- 6.4.7.1 Position of supporting columns of covered linkway shall be designed to avoid any obstruction to footpaths, cycling paths, shared paths and covered linkways.

6.4.8 Visual Contrast

- 6.4.8.1 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.
- 6.4.8.2 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.
- 6.4.8.3 Floor surfaces shall contrast with the walls in tone and colour, otherwise the skirting must provide a clear distinction between the floor and wall.
- 6.4.8.4 Any elements used by the public shall contrast in colour or tone from their surroundings.

- 6.4.8.5 There shall be a permanent tonal contrast between treads and nosing for all steps.
- 6.4.8.6 Detectable warning surfaces shall be provided at the top, bottom and intermediate landings leading to another path of travel.
- 6.4.8.7 Detectable warning surfaces are not required at enclosed intermediate landings where handrails are continuous and do not lead to another path of travel. Colour contrast shall be provided instead.
- 6.4.8.8 For staircases, detectable warning surfaces shall extend across the full width of the stairs for a depth of 600mm, with a setback of 300mm from the stairs.
- 6.4.8.9 For ramps or slopes, detectable warning surfaces shall extend across the full width of the ramp or slope for a depth of 300mm or 600mm depending on how it ties in with any adjoining staircase, with a setback of 300mm from the edge of the ramp or slope.
- 6.4.8.10 Detectable warning surfaces shall consist of flooring material that is contrasting in colour with the surrounding floor material and of a different texture from the surrounding floor material. Tripping hazard and slip resistance shall be addressed in accordance with the minimum classification of floor finishes under SS 485 Annex E Table E.1.
- 6.4.8.11 Should the ramp or staircase forms 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.