

**PARTICULAR SPECIFICATION**  
**APPENDIX AE**  
**KEY SECURITY REQUIREMENTS FOR MRT STATIONS**

## **KEY SECURITY REQUIREMENTS FOR MRT STATIONS**

### **General**

All architectural design of the Station shall incorporate and be read with all the necessary security requirements in accordance with the IDC, Security Protection Plan (SPP)/Final Security Protection Plan (FSPP) and other relevant security requirements imposed by the Authority.

All stakeholders shall comply with all directions and security guidelines issued by the Authority as may be in force from time to time, including, without limitation, any laws, regulations or rules in respect of the Public Transport safety and security.

### **At Grade Level – Perimeter Line, Station Façade, Adjacent Areas / Unpaid Areas / Other Areas**

#### **Perimeter Line**

The façade of the MRT station shall have a well-defined physical perimeter line separating secure and non-secure areas to prevent vehicle(s) from approaching the MRT station façade/boundary.

The perimeter line shall be designed to assist in preventing possible threats by ensuring that they will not endanger vulnerable areas. This line can be achieved in many ways depending on the protection level required, and the layout of the MRT Station.

Access control measure shall be implemented to prevent entry of unauthorized vehicles into station premises. The access control points shall be pushed as far away as practically possible from the station box and shall come with crash-rated bollards/barriers. (i.e. PAS 68:2013 – Impact Test Specifications for Vehicle Security Barriers; and PAS 69:2013 – Guidance for the Selection, Installation and Use of Vehicle Security Barriers).

Entrances of the stations (interchange and non-interchange) shall be designed to impede and restrict vehicular access with appropriate Hostile Vehicle Mitigation (HVM) measures around the station to mitigate the risk of a Hostile Vehicle crashing/ramming into it. Alternatively, for non-interchange stations, raised steps/walls (barriers) of minimal height 700mm, which serves as either access into stations or flood protection measures, can be used to mitigate hostile vehicles in lieu of crash bollards. Where possible, the Contractor shall propose the expected HVM measures for each station in consultation with the Engineer, for the Authority's acceptance.

The design of the raised steps/walls shall take reference from Figure 1 and also be subjected, but not limited to the following considerations:

- a. Uniform risers of maximum 150mm
- b. Treads of minimum 300mm
- c. No open riser
- d. Minimum height of raised steps 700mm

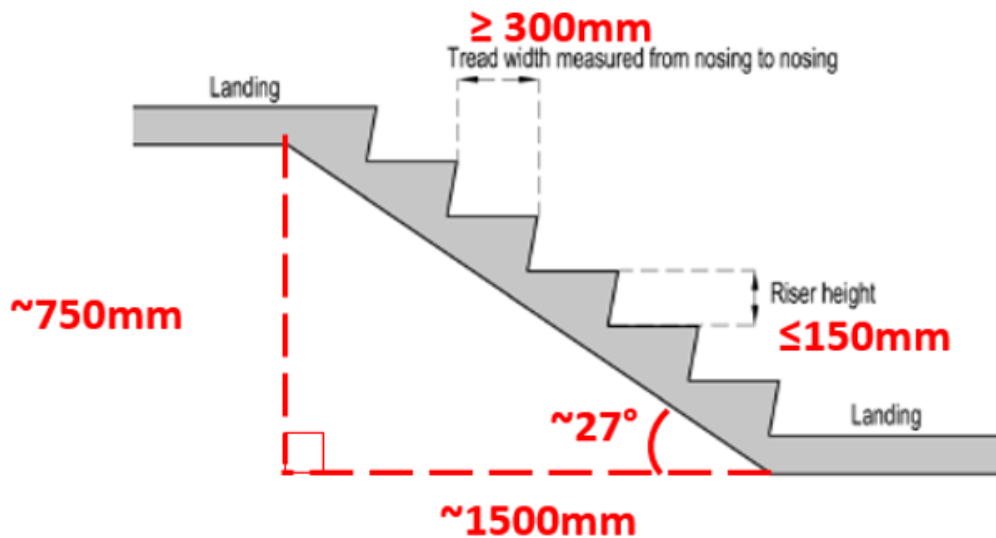


Figure 1: BCA requirement of Step width and height

The design of the HVM shall also be subjected, but not limited to the following considerations:

- HVM can be in the form of bollards, barriers, integrated landscape / streetscape features or level differences. It shall be noted that continuous HVM line may not necessarily be in the form of bollards and it may be a building façade, perimeter walls of a building where no vehicles are able to come close to the station boundary.
- All HVM shall be crash-rated, with test certification, according to PAS 68:2013 (or other equivalent, subject to acceptance by the Authority).
- Minimum crash-rating for any HVM shall be of a 7,500kg vehicle traveling at 48 km/h with an impact angle of 90 degrees and maximum penetration depth of 1m (i.e. PAS 68:2013 V/7,500(N3)/48/90:1).
- All gaps between HVM i.e. anti-crashed bollards shall not be more than 1200mm in width (clear distance) for traffic paralleling the barrier and shall not be more than 1000mm in width (clear distance) for traffic having a 90-degree approach to achieve a consistent HVM line, where possible.
- Contractor shall ensure all HVM to be implemented are feasible, designed with understanding of existing (and future) surroundings, meeting performance requirements and acceptable by the Authority.

### **Station Facade**

The station facade shall be of at least 3000mm in height with gaps/ openings of no more than 150mm measured from Finished Floor Level (FFL) and last point of hand/ footholds. Note: Gaps/ recessed areas of more than 30mm are considered as hand/ footholds.

There shall be no hand/ footholds (inclusive of adjacent surrounding and structures) within a 3000mm spherical distance from the station facade. Note: The 3000mm minimum height requirement shall be measured from the top of the hand/ footholds.

The cladding or any other form of covering used in the design of the station façade shall not allow items to be hidden (i) within the gaps between the framing of the structure and the said cladding; (ii) able to be pried open / forced apart for concealment of items within the resultant gaps created.

There shall be no horizontal protrusions of more than 30mm width within 3000mm of any openings of the station façade.

All entrances/ exits shall be secured during periods of non-use or silent hours. The gaps of the security shutter shall not be bigger than either 150mm in height (h) or width(w). Security shutter control panel shall be locked (with key) and installed at least 1200m away from the security shutter.

There shall not be any unnecessary access points or intrusion points (i.e. via Pedestrian Overhead Bridge) into station.

### **Adjacent Areas / Unpaid Areas / Other Areas**

Vent shafts – Air intake openings of vent shafts can be vulnerable to sabotage such as Chemical/Biological/Radiological (CBR) contamination and package bombs. Vent shafts shall be designed to be out of reach or other means to prevent easy access to mitigate CBR threats. The height of intake ventilation shaft openings (from FFL & last point of hand/ footholds to the base of ventilation shaft openings) shall be of minimum 5000mm.

The baseline requirements for intake ventilation shaft are provided below:

- a. The design shall minimize intrusion and any projectiles into Ventilation Shaft openings.
- b. The outer layer cladding (i.e. louvers, panels) shall be designed  $\leq$  150mm.
- c. The inner layer mesh of ventilation shaft openings shall not be more than 50mm x 50mm.
- d. The ventilation shaft (intake & exhaust) openings shall be built with forced entry resistant bars that can resist forced entry attempts for at least 5 minutes. (In accordance to SS-EN 1630:2011 / US Department of State 12-FAH-5 or equivalent).

As part of emergency response plans, the controls to the ventilation systems of stations should also be configured to prevent or mitigate the risk of contamination spreading in the event of a CBR contamination.

Skylight glazing and use of glass at station's facade – Apart from minimizing the use of glass throughout the premises where possible, consideration shall be given to forms of protection (such as blast resistant secondary glazing) to minimize the risk of secondary fragmentation. Care shall also be taken to ensure that various parts of the system, e.g. frames, anchorage and supporting wall, are designed appropriately. Glass facades shall be housed away from possible area of mass congregation such as main entrance or lower levels, where there could be direct impact from possible threats.

The baseline requirements for skylight are provided below:

- a. The placement of the skylight should be non-public accessible. The design of the building façade should take in consideration and eliminate potential handholds/ footholds that could gain access to the skylight.
- b. Designed with Tempered and laminated glass.
- c. Able to withstand human load.
- d. Frame of Skylight should be able to hold the glass for at least 72 hours if the skylight is damaged. in accordance to SS341: 2001(2012) +C1:2018).
- e. CCTV coverage required.

On top of the above baseline requirements, a catcher system for the skylight glazing is required for interchange stations if the location of the skylight is accessible to public.

The bicycle parking bays/areas shall be subjected, but not limited to the following considerations:

- a. Bicycle bay shall not be sited in areas of mass congregation or main thoroughfare such as station entrances/ exits.
- b. Bicycle bay shall only have only one designated ingress/ egress with CCTV coverage.
- c. The entire parking bicycle bay/area shall be monitored by CCTV cameras with sufficient lighting.
- d. The bicycle parking bays/areas shall not be sited within the footprint/ underneath above-ground MRT stations.

Bicycle parking bays/areas shall be designed such that they are sited more than 5000mm away from:

- a. Critical assets.
- b. Any glass facades.
- c. Entrances/exits of the MRT station.
- d. Main thoroughfares and areas of mass congregation.
- e. Columns/pillars of structures.

Designated loading/unloading bays and parking lots shall be built away from the critical rooms and entrances/exits to the station and with access control measures. This will help provide better security management and checks on deliveries, and lower the risk to the public.

Fire engine/maintenance access way, the consultant shall propose the necessary access control measures to restrict and prevent unauthorized access or parking.

Letter box shall not be located at the following area:

- a. Areas where people are likely to congregate.
- b. Facing general commuter traffic.
- c. Near glass panels.
- d. Near plant rooms/ gas pipelines, critical facilities.
- e. Near columns / pillars of structures.
- f. Underground area.

The area where the letter box is located must be well-lit and sheltered from rain. The letter box adheres to the requirements in Clause 1.3.7 of this document.

Vision panels shall not be installed at the ground level doorways. If vision panels are installed, a security laminated wired glass or equivalent shall be used. Note to seek Fire Safety Shelter Department (FSSD) permission if there is no vision panel.

There shall be access control (i.e. Access Management System & ironmongery) for rooms deemed to be critical and important.

Security shutter shall adhere to these following requirements:

- a. Full shutters without gaps or shutter with perforation no bigger than 150mm in either height (h) or width (w) shall be provided to prevent intrusion into the station.
- b. Shutters control panel & top drum should place in the secure side to prevent break-in & tempering.
- c. Shutters control panel should be locked (with key) and installed at least 1200mm away from the shutter to prevent tampering.
- d. The provision of VSS coverage shall be accorded to align with the VSS standards.

## Concourse & Platform

Access gates shall be access controlled and gates designed to prevent easy break-in or climbing over. The gap measured between the FFL and base of the access gate shall be at a maximum of 150mm. The Contractor shall propose the necessary access control measures in consultation with the Engineer, for the Authority's acceptance to prevent unauthorized entry after operational hours.

Segregation between 24/7 publicly accessible link-ways/corridors and station premises – The overall height of the barrier between publicly accessible link-ways/corridors and station premises must be at least 3000mm with no footholds/ handholds (i.e. balustrades etc.) to prevent unauthorized entry after revenue hours.

Segregation of Paid and Unpaid areas within stations – Typical barriers/balustrades shall be provided to segregate between Paid and Unpaid areas. 100% video surveillance coverage shall be provided along the segregation.

To facilitate evacuation and emergency response in the event of emergencies, clear directional signage demarcating the evacuation and emergency routes shall be provided within the station and at the corridors integrated with any other buildings.

The layout of the stations shall take into account the following design considerations:

- a. There shall not be fare gates which allow commuters to bypass the Transit Security Officer (TSO) stationed at the concourse.
- b. An area of at least 9m<sup>2</sup> (3m x 3m) shall be allocated for the TSO to conduct security checks within the paid areas near the fare gates.
  - i. The area shall have dedicated CCTV coverage so as to allow for full surveillance and recording of the checking process by the TSOs with the entire image of counter-top where the check is taking place to occupy no less than 55%R.
- c. A clear area of at least 80m<sup>2</sup> shall be allocated for security screening within the unpaid area near the fare gates closest to the PSC.
  - i. There shall be provision of four 13A, 240V Power sockets for the screening devices within the clear area.
- d. Commuters should not be allowed to overlook the platform area from unpaid areas of the station unless there is 100% video surveillance coverage.



Recess Areas – Unsecured recess areas such as escalator and planter recesses at the concourse might potentially be exploited to conceal IEDs. These concealment areas shall be designed out of the facility, secured or sealed up, any other mitigation measures shall be proposed by the Contractors upon acceptance by the Authority.

Structures within the station – The same mitigating principle (refer to clause 1.3.6 above) applies to all gaps and blind spots of structures (e.g. ledges on advertising panels) in the station, which are vulnerable to exploitation by potential saboteurs for IED concealment. Machines or structures which are between the height of 1600mm and 3000mm as measured from FFL with horizontal ledge of  $\geq 50\text{mm}$ , to be topped with a surface angled at no less than a 30-degree slope to prevent items from being placed atop.

- a. Recessed panels and spaces within walls shall not have gaps which are more than 50mm.
- b. Any gaps between the structure / feature and other structure / feature shall be either less than 50mm or more than 1000mm. Gaps that are between 50mm and 1000mm shall be covered up securely or eliminated.
- c. The size of the openings (if any) should not exceed 50mm, measured across.
- d. There shall be no compartments in the machines/ structures.
- e. Machines shall be placed at least 2000mm away from Passenger Service Centre (PSC).

Planter Box – There shall be no planter box located at the paid area of the station.

For unpaid area (within station), the planter boxes shall be kept minimum. The planter box shall not be placed at the following areas:

- a. Near plant rooms/gas pipelines and critical facilities.
- b. Near critical column/pillar of buildings.
- c. Near Passenger Service Centre (PSC).
- d. Near CCTV camera (where it can be used as a form of foothold to adjust the angle of the camera).
- e. Near area of mass congregation.

For unpaid area (outside of station), i.e. station entrances, the planter boxes shall be placed such that it would not aid intrusion into the station, and shall not be placed at the following areas:

- a. Near plant rooms/gas pipelines and critical facilities.
- b. Near critical column/pillar of buildings.
- c. Near CCTV camera (where it can be used as a form of foothold to adjust the angle of the camera).
- d. Near area of mass congregation.

The planter boxes shall not allow one to scale or climb onto higher levels of the stations such as skylight, mezzanine levels or by pass Automated Fare Collection (AFC) gate into the paid areas.

The planter boxes must not allow for concealment of foreign items and the plants must be well-maintained with soil in the planter boxes filled to the brim so that item(s) placed would be conspicuous to passers-by/security officers/station staff. The planters should also be placed within video surveillance coverage, and placement of the planter should not cause blind spots to video surveillance coverage.

Location of critical rooms – Doors and walls of critical rooms (i.e. SER, CE/ISCS Room and other rooms identified by the Authority) shall be located Ym in all direction away from public accessible areas. Doors shall also be secured with both ironmongery and Access Management System (AMS) features.

- a. Some of these critical rooms shall be designed and reinforced to withstand an explosive force. If the public area is anywhere within Ym of the critical rooms in all direction, a blast analysis is required to check on the adequacy of the CER's walls/ ceiling slab/ floor slab/ doors against the design blast/ fragmentation load. Distance should be measured from the external face of the CER. More details will be shared upon tender award; and

b. SER & CE/ISCS Room

The contractor shall design the SER and CE/ISCS rooms as mentioned in the Architectural Design Criteria, and the Specifications for the wall (including roof and slab) and door design shall follow the architectural drawings. Structural Specifications will be shared upon tender award.

Both rooms shall be equipped with the following:

- Automatic Clean Gas Total Flooding System; and
- Anti-Shock Mounting for Video Surveillance System (VSS) equipment and racks to mitigate in-structure/ground shock generated from blast scenario.

In the event of blast occurring outside these critical rooms (i.e. SER, CE/ISCS Room) the following requirements must be achieved:

- All past video recordings stored in the recording facilities shall be preserved after the event; and
- Recording of video images shall continue for the surviving cameras which video transmission paths to CER are still available after the event.

Location and number of fare gates – Additional fare gates opposite the Passenger Service Centre (PSC) would require a higher level of TSO presence, especially peak hours, to cope with the multi-directional and extremely heavy flow of commuter traffic.

Considerations can be given to the design of fare gates so as pedestrian paths are channeled through a limited number of access points. This would allow focused attention by the TSO, as well as improve the ability to see and be seen by other users. However, design considerations have to achieve a balance between the security requirements and operational need of facilitating flow of commuters.

Public accessible receptacles - All Fire extinguisher boxes and Passenger Communication Boxes shall be locked with unique key and lock to prevent concealment of IEDs. See-through design and tamper-proof devices should also be considered (e.g. tampered-indicating devices). The fire extinguishers shall be wall mounted with gaps no greater than 50mm (gaps between the fire extinguisher cylinders to the wall).

Passenger Service Centre (PSC) - The exterior perimeter (glass panel) and door of the PSC shall be made of forced entry resistant materials capable of resisting 10 minutes (in accordance to SS-EN 1630:2011 / US Department of State 12-FAH-5 or equivalent) of forced entry attempts.

The PSC door shall be equipped with thumb-turn knob (or equivalent function) to deny access even when an authorized card is presented to the AMS to de-energize the Electro-Magnetic Lock (EML).

Seats shall be designed such that items cannot be placed or hidden away and be placed at a distance of no less than 1000mm from any vertical surfaces.

Link ways/ link bridges overlooking tracks shall be mitigated to prevent items from being thrown onto the tracks. There shall be physical barrier (i.e. glass façade) that is no lower than 3000mm in height from the FFL. *Note: If there are gaps/ openings on the physical barrier, the size of the gaps/ openings shall be less than 50mm by 50mm.*

There shall be no unsecured doors leading to station Back-of-House (BOH).

End Return Doors (ERD) (**if Applicable**) – For at grade station with half-height platform screen doors and non-enclosed BOH corridors on platform level, ERD shall be designed to prevent intrusion in to the BOH areas. The design of ERD shall also fulfils the following requirements:

- a. The platform-facing side of the ERD panel shall be at least 3000mm tall from FFL, an abutting panel of the same height (with width of at least 1200mm) should also be erected in parallel with the platform screen doors.
- b. Any opening or glass panels on the ERD or panel shall be 1200mm away from any door handle, mechanical locks or electronic access control exit devices, within the BOH areas.
- c. The design of the door handle shall not act as a form of hand / foot hold for aiding perpetrator(s) to intrude into the BOH. *Note: Gaps/ recessed areas of more than 30mm are considered as hand/ footholds*

A room of no less than 9m<sup>2</sup> (3m x 3m) shall be provided within the station boundaries for police operations. Contractors are to check with the Authority on the applicability as well as location of the room during the planning phase;

- a. The room shall be located within a secured location and outside of public view and access;
- b. The room shall be outfitted, but not limited, with the following:
  - i. Air-conditioner system;
  - ii. General CCTV coverage inside room with view of entrance & handcuff railing;
  - iii. Two 13 Amp power points;
  - iv. General Room lightings;

- v. Sprinkler system for fire suppression;
- vi. Public Announcement System; and
- vii. Handcuff Railing (Arrest Bar stainless steel / iron) – around 1m length of 30-50mm diameter mounted on wall at 0.9m height;

### **Access Control for MRT Stations**

The means of controlling and restricting access for the station shall be designed such that only authorized personnel are able to gain access into designated areas during normal operations while maintaining ease of egress during times of emergencies such as, but not limited to, fire evacuations, or any emergencies.

Designated loading/unloading bays and parking lots shall be built away from the critical rooms and entrances/exits to the station and with access control measures. This will help provide better security management and checks on deliveries and lower the risk to the public

There shall be access control measures proposed to the Authority for fire engine / maintenance access way to restrict and prevent unauthorized access or parking.

There shall be interface between the AMS and VSS such that intrusion into Critical / Important rooms will trigger an alarm and activate the corresponding display of the image of the relevant camera(s) automatically on the designated VSS viewing facility monitor.

The AMS shall support two factor authentication for access control. Such two-factor authentication may be achieved through a combination of physical tokens such as, but not limited to, presentation of a contactless smart card, Personal Identification Number (PIN) and / or Biometrics, subjected to the approval of the Authority.

The following scenarios depict the typical configurations in MRT stations. In the event that the design of the station does not fall within any of the following six scenarios, the Contractors are to promptly highlight the matter for approval by the Authority.

- a. Configuration 1: Doorway from Publicly Accessible areas to Exit Staircases
  - i. Card Reader (CR) on the Publicly Accessible face with Electro-magnetic Lock (EML), Door Contact (DC), Push Button (PB) and Emergency Break-Glass (EBG) on the Secured face of the doorway.
- b. Configuration 2: Doorway from Buffer Areas via End Return Doors (ERD)
  - i. CR on the Publicly Accessible face with EML, DC, PB and EBG on the Secured face of the doorway.
- c. Configuration 3: Doorway from Non-Publicly Accessible Areas
  - i. CR on both faces of the doorway with EML, DC and EBG on the Secured face of the doorway.

- d. Configuration 4: Doorway from Exit Staircase to Dead-end Corridor
  - i. CR on the staircase face of the doorway with EML, DC, PB and EBG on the face of the Dead-end corridor.
- e. Configuration 5: Doorway in front of lifts within Non-Publicly Accessible levels
  - i. No AMS provisions required as only authorized staff with authorized lift keyswitch will be able to access this level of the station.
- f. Configuration 6: Doorway from Exit staircases to Buffer areas
  - i. CR on face of Buffer areas with EML, DC, PB and EBG on the Exit staircase face of doorway.

The above-mentioned clauses are summarized in Table 1 below. Details can also be found within the Authority's Design Criteria and Performance Specifications (DCPS). In the event of discrepancies between standards found within this chapter and the DCPS, the standards found within the latter shall prevail with said discrepancies promptly highlighted to the Authority. Variations not covered within this guide as well as proposals for deviations shall be submitted to the Authority for acceptance.

<b>Configuration Details</b>	<b>Card Reader (CR) Location</b>
Doorway from Publicly Accessible areas to Exit Staircases	Publicly Accessible Areas
Doorway from Buffer Areas via End Return Doors (ERD)	Both faces of doorway
Doorway from Non-Publicly Accessible Areas	Both faces of doorway
Doorway from Exit Staircase to Dead-end Corridor	Exit Staircase
Doorway in front of lifts within Non-Publicly Accessible levels	No AMS required
Doorway from Exit staircases to Buffer areas	Both faces of doorway

Table 1: Summary of Card Reader (CR) locations within MRT stations

## **General Recommendations & Requirements**

Crime Prevention Through Environmental Design (CPTED) – CPTED principles and concepts shall be considered, such as brightening up the platform level through natural lighting and keeping the platform free of any obstructions/recesses which could be exploited for concealment of IED. Care shall also be taken to avoid creating spaces that will concentrate or “throttle” the force from a blast, such as alleyways, overhangs, or other enclosed spaces.

Any Alterations & Additions (A&A) works that affects the security of the existing Public Transport (PT) facilities shall follow the requirements stated in Annex A –Requirements for Alterations & Additions (A&A).

Landscaping around the station shall follow the requirements stated in Annex B – Landscaping and Security Requirements for Public Transport Infrastructures

Surveillance coverage – Video surveillance coverage in accordance to latest MHA VSS Standards shall be provided. Refer to Annex C – ‘Requirements for VSS Field of View (FOV) Endorsement’.

- a. In addition to the latest MHA VSS Standards, there shall be general coverage of the external access area of the AHU rooms shall be no less than 20%R.

**REQUIREMENTS FOR ALTERATIONS & ADDITIONS (A&A)**

The following depicts the processes required for Alterations & Additions (A&A) works that affects the security of the existing Public Transport (PT) facilities.

**1 Video Surveillance System (VSS) Related Works**

- 1.1 Any new structures or hoarding shall not obstruct or otherwise render ineffective, the coverage and maintenance of existing VSS cameras. This is inclusive of any new landscaping and structures, within 50m radius of MRT station entrances.
- 1.2 New additions of structures / fixtures such as lifts, escalators, staircases, entrances, signage, etc, shall comply with the requirements stated in the latest VSS Standards for MRT Stations i.e. rotakin percentage required.
- 1.3 There shall be no down-time for the existing cameras, unless approved.
- 1.4 If the existing VSS cameras are obstructed, qualified CCTV specialist will need to be engaged to adjust/relocate/add cameras to compensate the missing coverage. VSS coverage's compensation plan shall be devised and approved by LTA PTS prior to actual works on site.
- 1.5 The Contractor shall engage CCTV specialists to perform all VSS related works including updating of relevant documentation.
- 1.6 The engaged CCTV specialists shall be required to clear security screening before accessing the VSS coverage plan.
- 1.7 If access into Comms Equipment Room is required; a separate application for security screening is required.
- 1.8 CCTV specialist shall update any as-built drawings and present these to LTA PTS for the proposed VSS coverage plan in view of the changes made by this A&A works. All coverage plans shall be approved by LTA PTS prior to the commencement of work.
- 1.9 Upon completion of A&A works, the updated as-built VSS coverage plan shall include both the new / relocated cameras with inclusion of the existing VSS cameras. A copy shall be deposited into the record office
- 1.10 The new / relocated cameras' Field of vision (FOV) images shall be submitted together with the coverage plan for final endorsement by LTA PTS.
- 1.11 For any A&A works which affects more than 20% of the existing cameras, the affected areas shall comply with the coverage requirements stipulated in VSS standard for MRT Station (May 2018).



## **2 Unauthorised Access into the Public Transport (PT) facilities**

- 2.1 Proposed Structures shall maintain a minimum of 3m clear spherical distance from the following:
  - a) Edge of rail viaduct (refer to Figure 1);
  - b) Viaduct column;
  - c) Perimeter fencing;
  - d) Any gaps (more than 150mm) on the façade of the PT facilities that allows access into the premise.
- 2.2 Proposed structures, that overlook PT facilities, shall have mitigation measures in place (e.g. protection screens) to prevent unauthorized access and items being thrown into the PT facilities.
- 2.3 Proposed Structures shall not aid intrusion into the PT facilities by creating a hand hold / foot hold that allows intruders to circumvent the existing physical measures put in place.
- 2.4 Any potential gaps on the PT facilities' facade must be smaller than 150mm to prevent any intrusion.
- 2.5 In the event that the existing security shutter is to be removed, the Contractor is to provide mitigation measures to secure the station during and after the A&A works.
- 2.6 For installation of new security shutter, the following requirements shall be adhered:
  - a) Full shutters without gaps or shutter with perforation no bigger than 150mm in either height (h) or width (w) shall be provided to prevent intrusion into the station;
  - b) Shutters control panel & top drum should place in the secure side to prevent break-in & tempering;
  - c) Shutters control panel should be locked (with key) and installed at least 1200mm away from the shutter to prevent tampering;
  - d) The provision of VSS coverage shall be accorded to align with the VSS standards.

### 3 Creation of Hiding Spaces

- 3.1 Erected hoardings shall not create hiding spaces thus a sloping roof (minimally 30 degrees) shall be installed on top of the hoarding enclosure or full height to ceiling.
- 3.2 The proposed work and the logistics provided at the work area shall not create blind spots and/or hiding places that could be exploited.

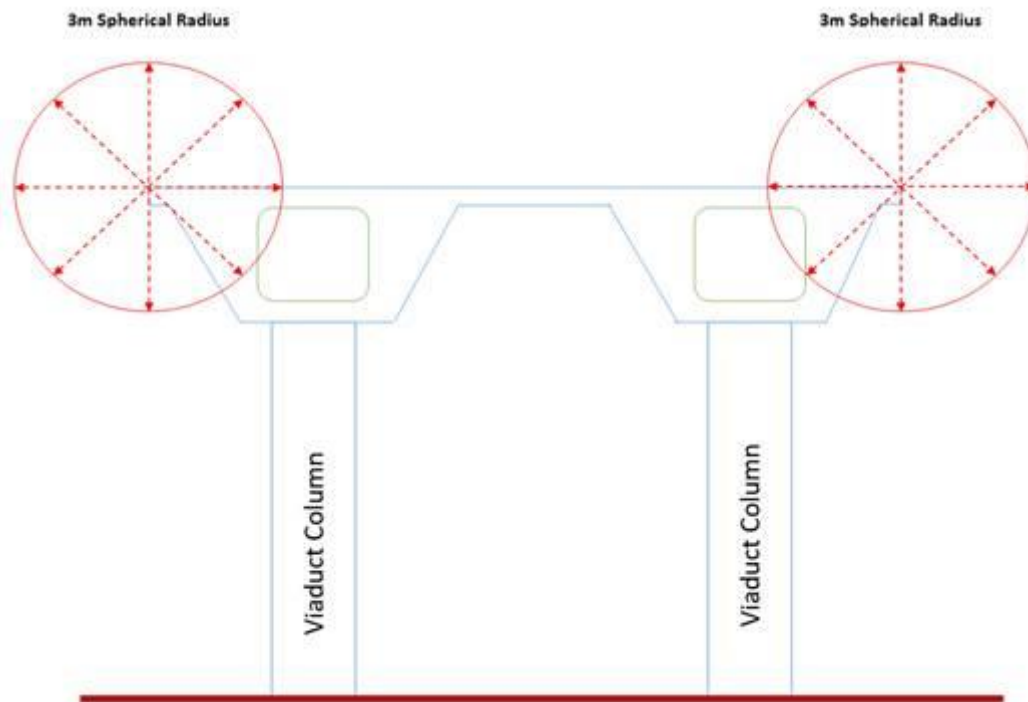


Figure 1: 3m clear spherical distance from edge of rail viaduct

## **LANDSCAPING AND SECURITY REQUIREMENTS FOR PUBLIC TRANSPORT INFRASTRUCTURES**

### **1 Background**

- 1.1 Tree planting and landscaping around public infrastructures are key in enhancing the living environment in built-up areas, and providing green respite to the public in our City in a Garden.
- 1.2 Security concerns have made the integration of building architecture and landscaping increasingly critical. Strengthening security measures through environmental design involves a coordinated effort in planning, landscaping, architecture design and law enforcement. This guideline sets out the agencies' requirements and agreed solutions which can be adopted to address these requirements.

### **2 Objectives**

- 2.1 The objectives of the guideline are as follows:
  - i. To update on landscaping and security requirements for MRT entrances and auxiliary structures.
  - ii. To provide design strategies
  - iii. Administrative workflow

### **3 Landscaping and Security Requirements for Various Infrastructures**

#### **3.1 MRT Entrances and Auxiliary Structures**

- a. Landscaping Requirements
  - i. Standard roadside verge shall be provided for both tree planting (2m) and service verges (3m). Please refer to the Standard Design of Road Elements extract in Figure 1. The tree planting verges are to be free of encumbrances so that tree planting will not be stymied. The service verges are to be free from any planting so it will not affect illumination of street lighting as well as creating blockages for signages.

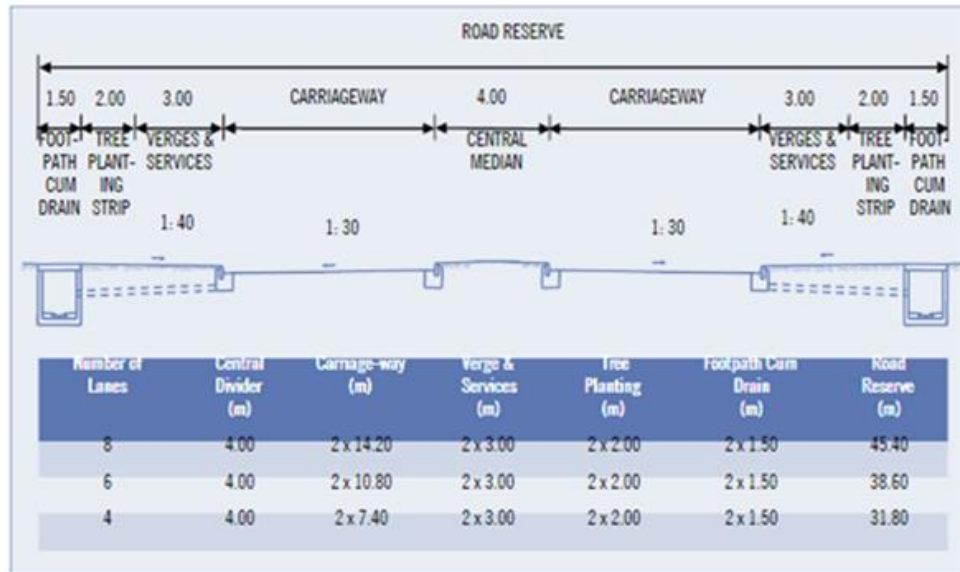


Figure 2: Road Reserve Criteria based on Standard Design of Road Elements

- ii. Standard roadside table width shall be safeguarded. The width is to include covered linkways and cycling paths of the MRT station entrance to prevent encroachment into the roadside verge. Vertical trellises plantings are to be implemented on all covered linkways where possible in order to soften the hardscape of the increasing numbers of roadside structures. The trellises structure shall be located at covered linkway columns.
  - iii. Recommended 2m wide planting verge around MRT entrances and auxiliary structures for lush thematic landscaping around station vicinity.
  - iv. Green roof provision may be incorporated within MRT building façade and auxiliary structures where possible to soften the hardscape. The overall design shall also cater for maintenance accessibility, loading capacity and the necessary structural components of a green roof and vertical greenery.
- b. Security Requirements
- i. Minimum 95% CCTV coverage of areas outside the street level entrances/exits to a radius of 50m from main station entrance (stipulated in MHA VSS standards).
  - ii. No obstruction to CCTV coverage to allow MHA and SPF to trace the facial and movement path of persons and vehicles.
  - iii. Design must not allow for concealment of Improvised Explosive Devices (IEDs)
  - iv. Landscaping/structures shall not provide any handhold/fothold to aid intrusion into the stations.
  - v. For greening of MRT viaduct column, it shall adhere to the following requirements:

- Greening shall not allow items to be hidden behind plants or any structures erected for the plants. It shall be porous for ease of detection.
  - No handhold/footholds created for intruders to scale on the MRT viaduct
  - Any structures erected on the MRT viaduct columns shall meet all other requirements imposed by LTA. This includes lighting protection, maintenance of the viaduct etc.
- vi. Landscaping/structures shall not be higher than the underside of the MRT viaduct rims (maximum height of plants/structure must be at least 3m spherical away from the bottom of the viaduct). Please refer to Figure 2.

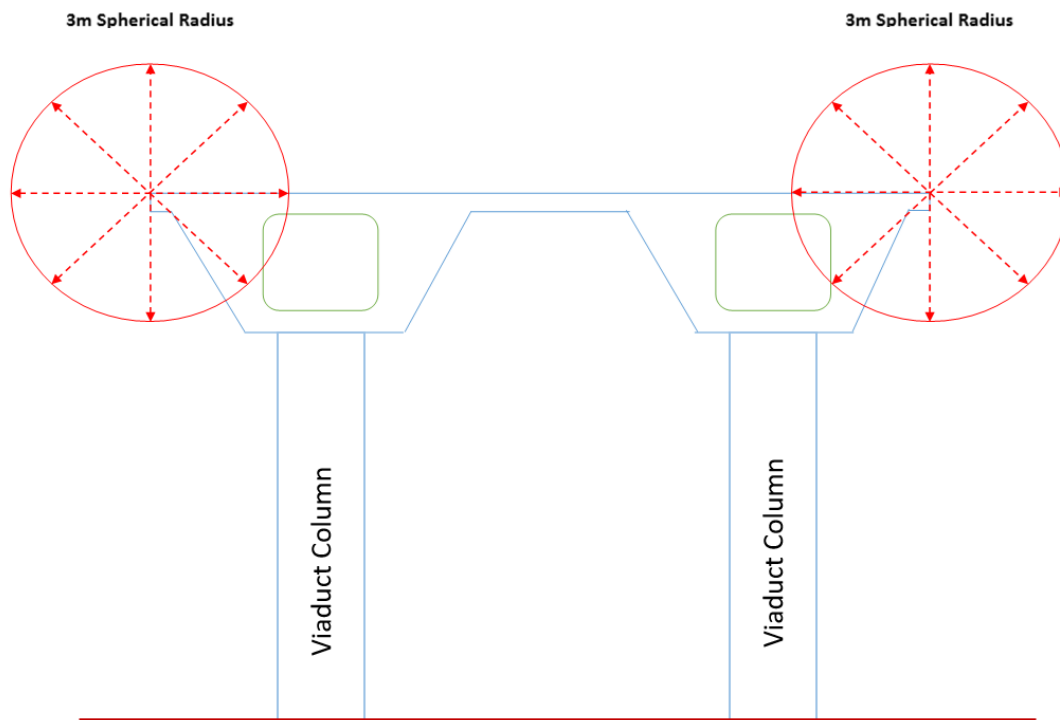


Figure 3: 3m Spherical Distance Clear of Viaduct Rims

### 3.2 Ventilation Shafts and Cooling Towers

- a. Greenery Requirements
- i. Standard roadside verge shall be provided for both tree planting and service verges. The tree planting verges are to be free of encumbrances so that tree planting will not be stymied.
  - ii. Recommended 2m wide planting verge around the structures for landscaping to screen off the harsh structures.

- iii. Green roof provision may be incorporated with the structure, where possible to soften the hardscape.
- b. Security Requirements
  - i. There shall be general coverage of ventilation shafts where the air intake for station and tunnels is located. Coverage requirements shall follow the requirements stated in the MHA VSS standards for MRT stations.
  - ii. For existing ventilation shaft(s) which the lowest point of the air intake openings/louvers is measured (from the ground) at a height of less than 5m, the VSS coverage shall cover the ground level and the air intake openings/louvers of these shaft(s).
  - iii. For ventilation shaft(s) which the lowest point of the air intake openings/louvers is measured (from the ground) at a height of 5m or more, the VSS coverage shall (minimally) cover the ground level of these shaft(s).

## 4 Design Strategies

4.1 A good design of urban environments could lessen or prevent incidence of crime while creating attractive and active urban environments that foster a unique sense of place.

### a. MRT Entrances

#### i. CCTV Surveillances

- LTA is to provide sufficient surveillance cameras within the MRT maintenance boundary to have more than 95% CCTV coverage within a radius of 50m around MRT stations. In addition, LTA will be mounting cameras on infrastructures maintained by LTA beyond the MRT maintenance boundary to overcome blind spots within road reserves (e.g. near footpath and road kerb) for future rail development (Figure 3).
- With the implementation of walk to ride scheme around MRT entrances, surveillance camera also utilises the columns of adjacent covered link way to enhance coverage

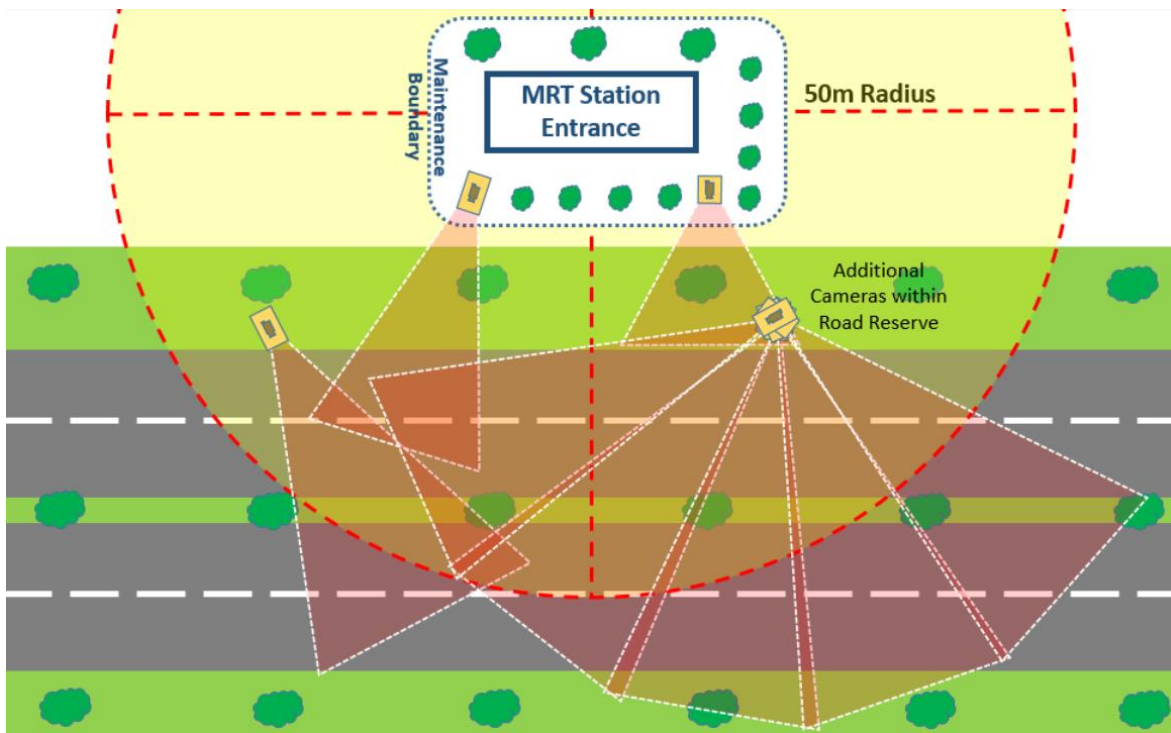


Figure 4: Additional Cameras installed beyond maintenance boundary to provide sufficient coverage.

#### ii. Landscaping design

- NParks will also work with LTA to maximise opportunities for surveillance coverage around station entrances. There are two general approaches for landscaping (i) beyond the Road Reserve and (ii) within Road Reserve for MRT entrance.

- The generic planting guideline for the internal landscaping of the 2m planting provision around the MRT entrance (beyond road reserve) is as follows<sup>1</sup>:
  - 3m (lowest branch) clear span of trunks
  - 1m girth/300mm trunk diameter (fully grown)
  - Shrubs height maximum of 1000mm
  - Trees spaced 6m apart (center to center)
  - Trellis/creepers should not obstruct camera views or aid intrusion

Note that the above is also valid for planting around vent shafts.

- NParks will be given freedom to design and implement a lush roadside landscape for the planting provision in the road reserves (within 50m radius of the MRT entrance). The roadside trees will be planted within tree planting verge to minimize line of sight obstruction and allow for mounting of cameras within the service verge. The generic planting parameter considerations are as follows:
  - Up to 3m girth /1m trunk diameter/ (fully grown)
  - Shrubs height maximum 1000mm
  - Big trees spaced 6m to 8m apart (center to center)
  - Small trees spaced 3m apart (center to center) in between the big trees

Note that if there are existing road infrastructures (e.g. lamp posts), this consideration shall not contradict the NParks guidelines<sup>2</sup>. Please refer to Figure 4 below.

- For areas which requires specific landscaping design and planting palette, NParks will work closely with LTA to mitigate any CCTV obstruction.

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<sup>1</sup> Reference to planting parameters, please refer to 'Greenery Provision for Roadside'.

<sup>2</sup> Reference to planting parameters, please refer to 'Guidelines on Greenery Provision and Tree Conservation for Developments'.



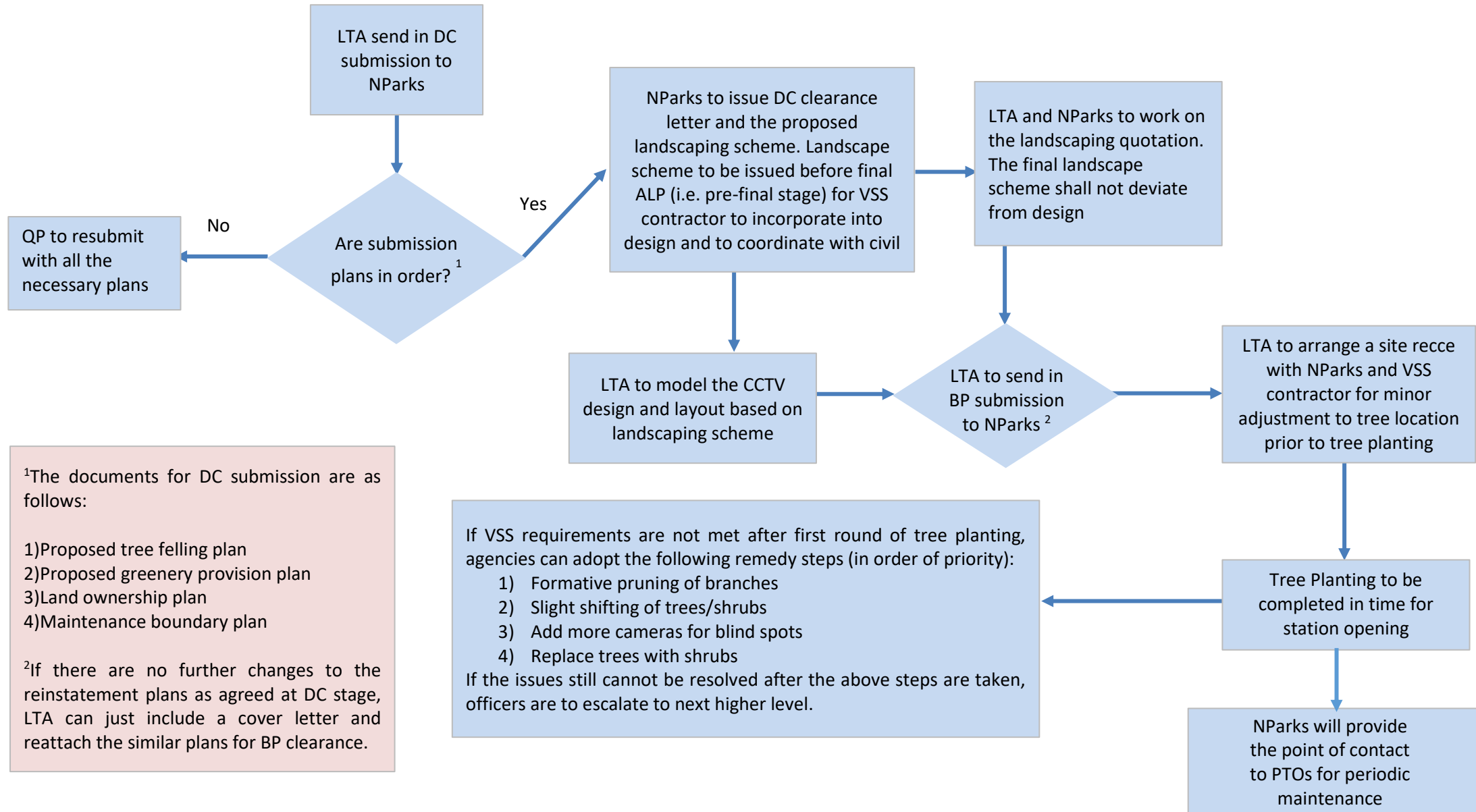
Item	Proposed Roadside Elements	Refer to the Subsequent Illustration	Minimum Clearance Required from the Edge of Proposed Roadside Element to the Centre of Proposed Tree/Palm		
			Palm	Small to Medium Tree	Large tree
1	Splay corner of: - Entrance culvert - Bin centre access - Substation access - MDF room access - Fire engine access	CI 1	1.0m	1.5m	2.5m
2	Scupper pipe/drain	CI 2	1.0m	1.5m	2.5m
3	Lamp post	CI 3	3.0m	3.0m	3.0m
4	OG box TAS manhole Sewer line and manhole Electrical post Fire hydrant SCV box Lighting control box Traffic control box Traffic light Lightning pits	CI 4	2.0m	2.0m	2.5m
5	Crossings (e.g. pushcart ramp for bin centre)	CI 5	1.5m	1.5m	1.5m

Figure 4: Position of Roadside Element<sup>2</sup>

## **5 Reference**

- 5.1 Requirements contained herein may not include conditions / requirements imposed by relevant Government and Statutory Authorities / Agencies. The following guides/ standards, not limited to the following, shall be used for reference:
- i. Guidelines on Greenery Provision and Tree conservation for developments (2019)
  - ii. Video Surveillance System Standards for Mass Rapid Transit (MRT) Stations (May 2018)

## 6 Administrative Workflow



**REQUIREMENTS FOR VSS FIELD OF VIEW (FOV) ENDORSEMENT**

The following stipulates the processes required for Video Surveillance System (VSS) endorsement works that meet the security requirements for Public Transport (PT) facilities.

**1 General Requirements**

- 1.1 The coverage design shall comply with the coverage requirements stipulated with relevant Standards; Code of Practice; Design Criteria and Performance Specification and any other requirements imposed by the Authority.
- 1.2 The Contractor shall submit detailed drawings showing the coverage of each camera. The coverage design of each camera shall be subject to the acceptance of the Authority.
- 1.3 The Contractor is expected to attend relevant meetings and/or present its findings as required by the Authority, furnish documentation and information pertaining to the solutions proposed.
- 1.4 The Contractor shall ensure that the coverage design incorporates the latest architecture drawing.
- 1.5 The Contractor shall demonstrate the ability to calculate the overall coverage area for each level to ensure compliance. Calculations shall take in consideration of potential blindspots affected by landscaping, signages and structural elements (eg. beams, columns, building).
- 1.6 All calculations and drawings comprising the submission shall be substantially complete and checked. The Authority reserved the rights to reject any inaccurate submissions.
- 1.7 Should the Authority not accept any of the submissions prepared by the Contractor, the Contractor shall make the necessary revisions, undertake further analyses or provide additional information as required. These additions and/or amendments shall then be consolidated and incorporated into a fresh submission that shall be prepared and re-submitted for acceptance.
- 1.8 All revisions made on drawings for revisions shall be highlighted in bright colors, preferably red against, and clouded for clear identification of amendments / changes.
- 1.9 In the event where the coverage requirements fail to meet the requirements due to site conditions, the Contractor shall check with, and obtain consequent responses in writing to the Authority for acceptance.

- 1.10 The Contractor shall highlight any deviation(s) which is non-compliant with the endorsed coverage design in the forms of writing for the Authority's acceptance. Failing which, any such deviations shall be resolved to the satisfaction and clearance of the Authority with costs incurred in the resolution being borne by the Contractor.
- 1.11 The Contractor shall provide consolidated final documentation for the Works in both binded hardcopy and CD softcopy format of minimum 3 sets each. The documentation shall minimally consist of:
  - a. VSS Checklist
  - b. Calculations
  - c. Final Coverage Design
  - d. As-Built Coverage Design
  - e. CCTV images

## **2 Process Requirements**

- 2.1 The Coverage Review Process shall include the submission of the following:
  - a. VSS Checklist
  - b. Coverage Calculations
  - c. Final Coverage Design
  - d. As-Built Coverage Design
  - e. CCTV images
- 2.2 The documents/drawings shall be submitted sequentially in the order above, and only after the acceptance of the previous documents/drawings by the Authority.

### 3 Deliverables and Milestone Requirements

<b>Deliverables</b>	<b>Milestone</b>
VSS Checklist and Coverage Calculations Report	To be submitted before engaging PTS for Pre-Final Coverage endorsement.
Final Coverage Design	To be finalized and submitted before construction.
As-Built Coverage Design	To be finalized and submitted 2 weeks before Temporary Occupation Permit (TOP).
CCTV images	To be finalized and submitted 2 weeks before Temporary Occupation Permit (TOP).

### 4 Submission Requirements

<b>Deliverables</b>	<b>Requirements</b>
VSS Checklist and Coverage Calculations Report	<p>3 hardcopies in colour.</p> <p>At least A4 in size.</p> <p>All documents to be submitted in softcopy format stored in CD or DVD rom.</p>
Final Coverage Design	<p>3 Softcopies in Colour.</p> <p>All documents to be submitted in softcopy format stored in CD or DVD rom.</p>
As-Built Coverage Design	<p>3 hardcopies in colour.</p> <p>At least A0 in size.</p> <p>All documents to be submitted in softcopy format stored in CD or DVD rom.</p>
CCTV images	<p>3 hardcopies in colour.</p> <p>At least A4 in size.</p> <p>All documents to be submitted in softcopy format stored in CD or DVD rom.</p>

## 5 VSS Checklist & Coverage Calculations Report

- 5.1 The Contractor shall prepare and submit the 1st cut coverage design to LTA Project team for review. During the initial review with LTA Project team, the Contractor will go through the coverage design and update the VSS checklist accordingly to ensure compliance. Any comments shall be captured inside the remarks columns and submitted within three working days from the date of review.
- 5.2 Once all the comments are addressed, the contractor shall prepare the Coverage calculations. The Contractor shall demonstrate the ability to provide accurate measurement by leveraging on proven computer simulation programme(s) or other engineering tools/software.
- 5.3 The Coverage Calculations Report shall clearly state the Total Gross area, Total Blockages, Total Net Area, Total Blindspot and Total Area of Coverage. The Coverage Calculations Report are tabulated based on per level and the definition of the terms used are defined as follows:

Description	Definition	Calculations
<b>Total Gross area</b>	Total Area of interest for public area (e.g. platform, concourse, street levels) including columns, signage, trees etc.	Tabulated by computer simulation programme(s) or other engineering tools/software.
<b>Total Blockages</b>	Total Area occupied by blockages (e.g. Columns, signage, trees etc.)	Tabulated by computer simulation programme(s) or other engineering tools/software.
<b>Total Net Area</b>	Total Net Area.	Total Gross Area – Total Blockages
<b>Total Blindspot</b>	Area that cannot be covered by CCTV.	Tabulated by computer simulation programme(s) or other engineering tools/software.
<b>Total Area of Coverage</b>	Total Area of Coverage.	Total Net Area – Total Blindspot

- 5.4 Sample illustration of the Coverage Calculation Report and VSS Checklist are shown in Figure 1 & Figure 2. Both documents will be shared with the awarded Contractor.

Coverage Calculation Report									
Station Name:									
Checked by (Name of Contractor):									
<b>Calculation for Platform Level</b>									
Total Gross area								Remarks (if Any)	
Total Blockages									
Total Net Area									
Total Blindspot									
Total area of coverage									
<b>Calculation for Concourse Level</b>									
Total Gross area								Remarks (if Any)	
Total Blockages									
Total Net Area									
Total Blindspot									
Total area of coverage									
<b>Calculation for Street Level</b>									
Total Gross area								Remarks (if Any)	
Total Blockages									
Total Net Area									
Total Blindspot									
Total area of coverage									

Figure 5: Coverage Calculation Report

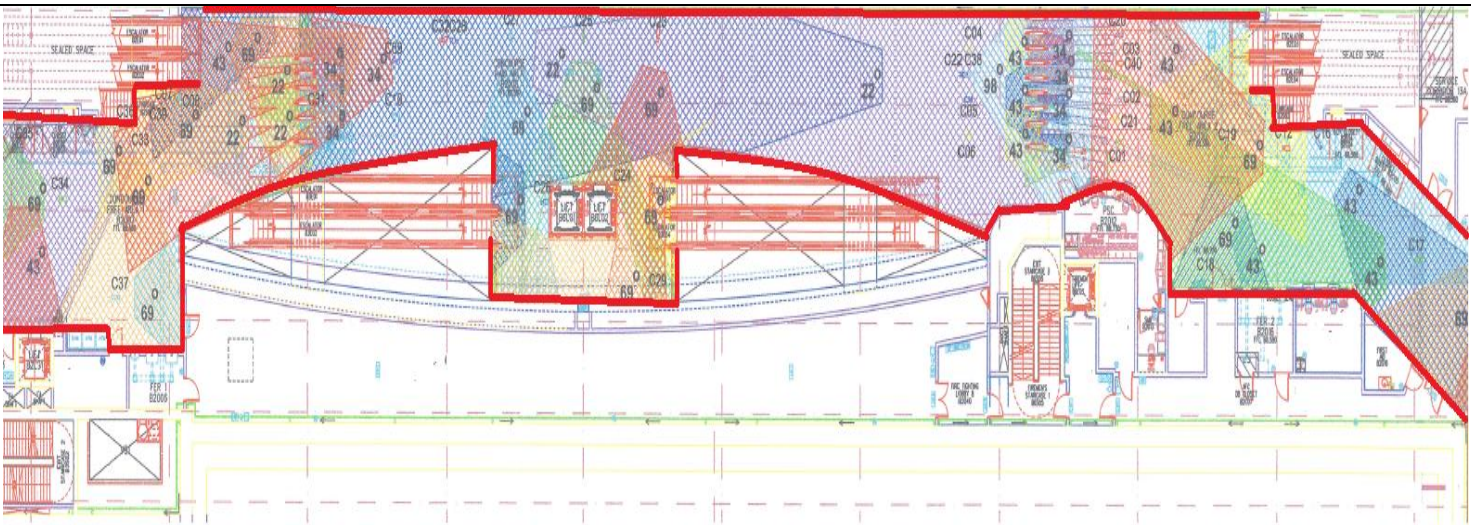
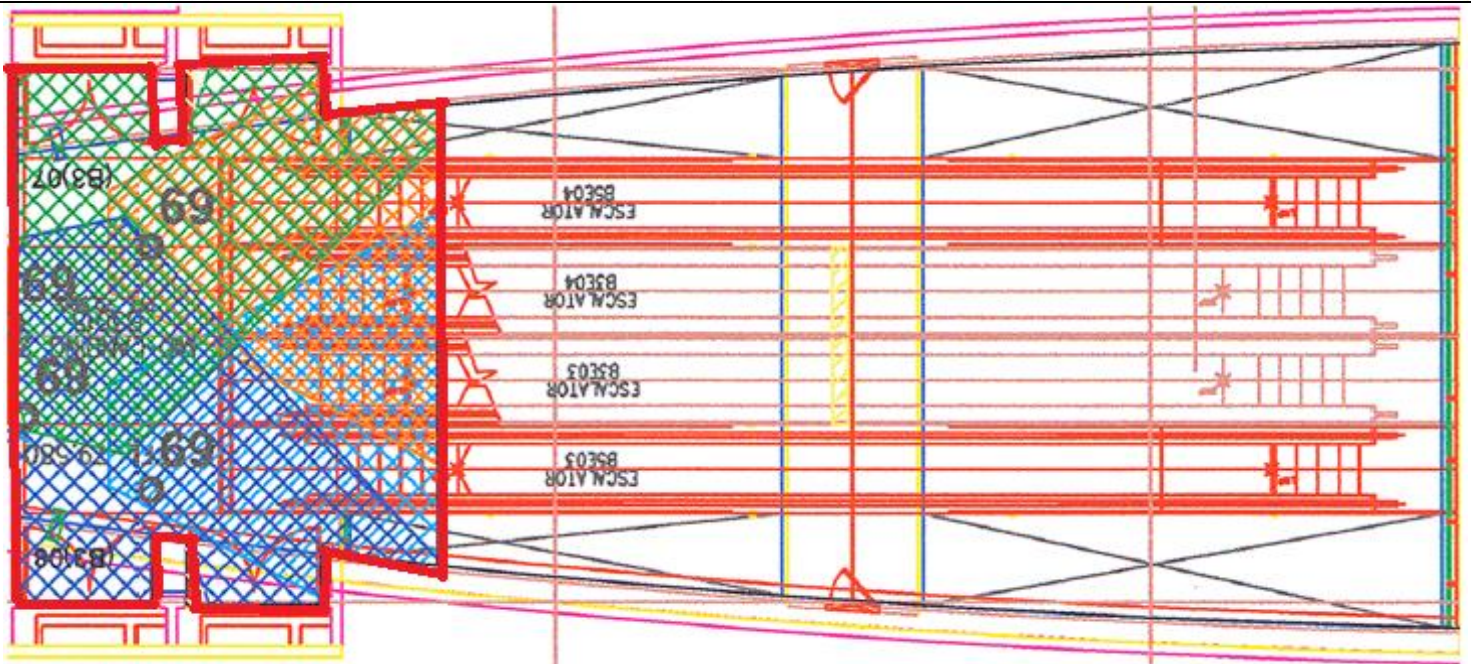


Station Name/ Lines:		Attendees:				Checked by (Name of Contractor):	
Date of Accessment: DD/MM/YYYY							
*Note:		*All 20%R & 55%R camera feeds must include a person(height around 1.6m) for Enhanced detection or recognition purpose.				Ok during endorsement, but need further confirmation (see remarks)	
		*Street view must covers 100% of Bicycle Bay.				Not ok (see remarks)	
		*Cameras View shall include Cam ID, Date and time.				Comments cleared	
		*Based on VSS STANDARD FOR MRT STATION (May 2018) Based on 1080P				N.A/ No information required	
		* To check for gaps behind stairs & escalators for platform level					
		*There shall be minimally one camera for two fare-gates at each side to cover Ingress and egress.					
Location	Define Area	Detect > 10%R (Y or N)	Observe > 10%R (Y or N)	Recognise > 20%R (Y or N)	Identify > 55%R (Y or N)	Remarks (Reviewed on DD/MM/YY)	Remarks (Reviewed on DD/MM/YY)
Platform Level	Platform Edge		N.A	N.A	N.A		
	Train Service Number		N.A	N.A	N.A		
	Train Entry End of Each Platform	N.A	N.A	N.A			
	Train Exit End of Each Platform	N.A	N.A	N.A			
	Bottom of Escalators/Stair		N.A	N.A	N.A		
	Stairs Leading to Platforms		N.A	N.A	N.A		
	Cross Passageways		N.A	N.A	N.A		
	Entrances to Emergency Exits		N.A	N.A	N.A		
	95% Coverage of Platform Public area		N.A	N.A	N.A		
	Frontal View of the lift doors for people entering plaform level	N.A		N.A	N.A		
	General Views of the associated lift lobby areas	N.A		N.A	N.A		
	(1) 22KV Switch Room 1	N.A	N.A		N.A		
	(2) Service TX Room 1	N.A	N.A		N.A		
	(3) LV Switch Room 1	N.A	N.A		N.A		
	(4) Traction Power Sub-station (TPSS)	N.A	N.A		N.A		
	(5) Traction TX Room	N.A	N.A		N.A		
	(6) SER	N.A	N.A		N.A		
	(7) Emergency Power Supply (EPS)						
LV Switch Room 2	N.A	N.A		N.A			
22KV Switch Room 2	N.A	N.A		N.A			
Service TX Room 2	N.A	N.A		N.A			

Figure 6: VSS Checklist

## 6 Final Coverage Design

- 6.1 Upon acceptance of the VSS Checklist and Coverage Calculation Report by the Authority, the Contractor shall submit both documents to LTA PTS for review. During the review with LTA PTS, the Contractor shall capture all comments in the VSS checklist and submit within three working days from the date of review. All the comments shall be cleared/addressed before proceeding to Final Coverage Design submission.
- 6.2 The Contractor shall ensure that the Coverage Design is accurate and easy to read. The layout of the Final Coverage Design shall take into account the following design considerations:

S/N	Description	Illustration
a	Clear representation of the Rotakin presented in the FOV legends	<p><b>FoV Legends</b></p> <p><b>Concourse Area - 95% coverage at 10%R:</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: cyan; border: 1px solid black;"></span> FoV no. 1</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: green; border: 1px solid black;"></span> FoV no. 2</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; border: 1px solid black;"></span> FoV no. 3</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: orange; border: 1px solid black;"></span> FoV no. 4</li> </ul> <p><b>Pedestrian Access &amp; Security Check - frontal view at 55%R:</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: cyan; border: 1px solid black;"></span> FoV no. 1</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: green; border: 1px solid black;"></span> FoV no. 2</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; border: 1px solid black;"></span> FoV no. 3</li> </ul> <p><b>Critical Room - frontal view of doors at 20%R:</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: cyan; border: 1px solid black;"></span> FoV no. 1</li> </ul> <p><b>Special Purpose Room - view of entrance &amp; handcuff at 10%R:</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: cyan; border: 1px solid black;"></span> FoV no. 1</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: green; border: 1px solid black;"></span> FoV no. 2</li> </ul>
b	Clear representation of the FOV by using different colors.	
c	FOV shall not see through structures/ columns/ signages/ landscaping/ walls/ escalators/staircases and any other objects.	



d	Simple & Short Camera ID	
e	Blindspot directly in front of the camera shall not be shaded.	



f	For softcopy submission, the coverage design shall be have the ability to toggle between the different layers according to the Rotakins	<div><div><div><div><div></div><div></div><div></div></div><div><div></div><div></div><div></div></div><div><div></div><div></div><div></div></div></div><div>Layers</div><div><div></div><div></div><div></div></div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></di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6.3 The Contractor shall ensure that the Field of View (FOV) and associated Rotakin are able to achieve the desire outcome during actual implementation. This can be achieved by using computer simulation programme(s) or other engineering tools/software which aids in design. Some illustrations as shown below:




Coverage	3 D Images
	
	

7 As Built Coverage Design

7.1 The design consideration is the same as mentioned in Clause 6.2 of Annex C. The Contractor shall highlight any deviation(s) which is non-compliant with the endorsed coverage design during construction stage in the forms of writing for the Authority’s acceptance. Failing which, any such deviations shall be resolved to the satisfaction and clearance of the Authority with costs incurred in the resolution being borne by the Contractor.

## 8 CCTV Images Requirements

- 8.1 The CCTV images shall be submitted using a human reference height of 1.64m to 1.7m. Sample illustration as shown:





Rotakin	Images	Description
10%R		The person shall be placed at the furthest edge of the FOV.
20%R		The Person shall be placed near the designated area.
55%R		The Person shall be placed near the designated area.



8.2 The CCTV images shall be submitted for endorsement using the following format:

- Day Live image
- Night Live Image (only applicable to street level)
- Day recorded images
- Night recorded images (only applicable to street level)

Sample image as shown:

Camera ID: C-10	
Live Image (Daytime)	Live Image (Night-time)
	
Recorded Image (Daytime)	Recorded Image (Night-time)
	
Title: Video Surveillance System Camera Images (As-Built)	
Rev: 0	Date: _____
Page: 11/43	

**REQUIREMENTS FOR PROTECTION AGAINST BLAST THREATS**

- 1** Introduction
- 1.1** The design parameters/ requirements stipulated in the reference design were adopted in the submissions to and obtaining approval from security authority. Any change(s) by the Contractor to the details or information provided will require the Contractor to engage a professional and qualified Security & Blast (S&B) Consultant to perform commensurate analysis, assessment, and derive at appropriate solutions to fully meet the required level of protection for the station, as per the original submitted/ approved design. Contractor is deemed to allow time and cost in this regard.
- 2** General Requirements
- 2.1** The Contractor shall ensure that all security requirements imposed by the Authority and/or other government agencies and stakeholders are addressed, with suitable protection and mitigation measures.
- 2.2** The Contractor shall ensure that the security measures and design of the MRT Station incorporates all the necessary security requirements in accordance with the Security Drawings, Specifications and other security requirements imposed by the Authority, government agencies and stakeholders. The Contractor shall also coordinate and ensure a viable holistic approach to the overall security requirement.
- 2.3** The Contractor shall seek approval from Authority (LTA) if modification is necessary. Any variations from the Contractor shall be endorsed by a Competent Person (CP) and submitted for acceptance by the Relevant Authority with costs arising from the submission borne by the Contractor.
- 2.4** Should the Contractor make any amendments to the design, the Contractor shall engage professional Security and Blast Consultant(s) who are qualified Competent Person (Security) and/or Competent Person (Blast) as per the requirements by the security authority.



### 3 Requirements for Non-Structural Components

3.1 Non-structural components typically comprise items such as external architectural cladding, glazing, louvres, and doors.

#### 3.2 Performance Specifications – Blast Doors

- The design of each door shall be demonstrated as adequate via testing or design calculations. All design calculations shall be prepared in accordance with UFC 3-340-02, (Reference A) by a qualified blast engineer. The design must consider the entire door systems, including the door, the frame, and the fixings. Where the design justification is presented via testing, the justification must also demonstrate that the fixing details into the building are equivalent to that used within test.
- The location of each blast rated door are shown on Figure 1. The requirements for each door are:
  - a. The SER Door (D1) shall comprise inward opening double door. The door shall be designed to achieve a Moderate Damage response for the following blast demand:
    - Peak Pressure 16kPa.
    - Peak Impulse 166kPa-ms.
- The Moderate Damage response criteria is taken in accordance with Table 4-8 of PDC-TR 06-08 (Reference B) as:
  - a. All door systems, including the door, frame and fixings, shall be designed to not exceed the peak rotation of 6 deg and a peak ductility of 10 under the design loading.
- The blast doors shall be fabricated from a steel frame clad with steel on the inner and outer faces. Non-structural outer finishes, e.g. wood veneers, are permitted as long as they are securely fixed to the door. No glazing or louvres are permitted in any of the doors.
- The doors shall have an automatic closer. The normal operation force required to open the door shall be 30N at the outside edge and shall not exceed 90N.
- In addition to the blast requirement, all doors shall also comply with all other operational requirements, e.g., architectural appearance, thermal, noise, operability, etc.

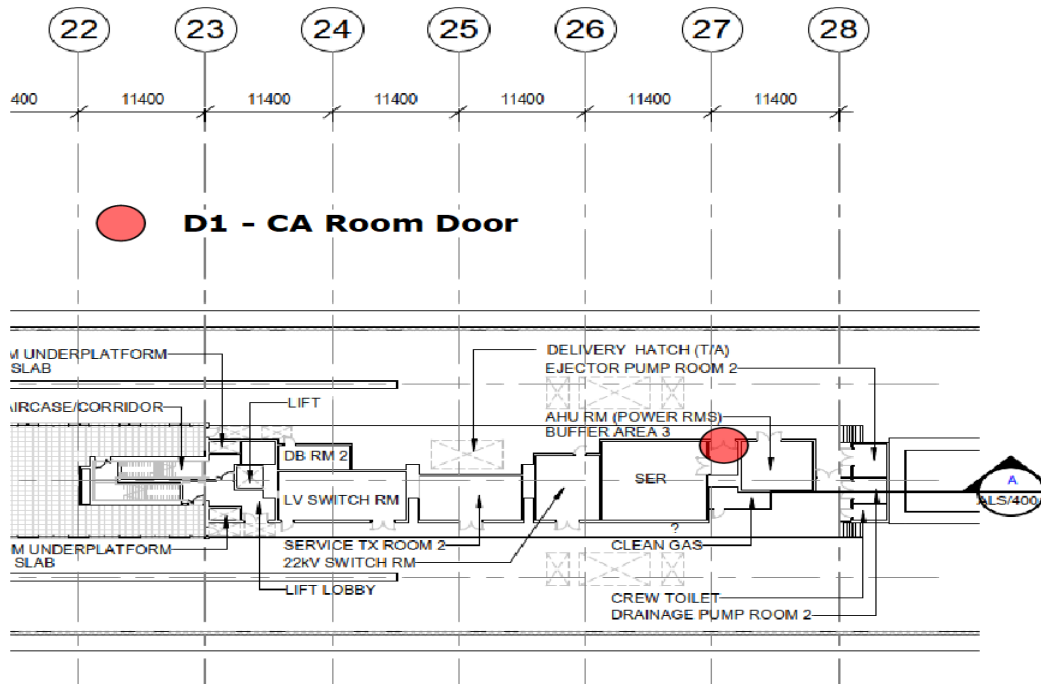


Figure 1 Blast Door Location Plan

Door ID	Location	Current Dimensions	Current Details	Proposed Upgrade
D1	Level B3 Platform SER	Standard single/double doors	Basis of design: Standard double door units.	Pressure: 16kPa Impulse: 166kPa-ms

Table 1 Door Details

**4**

**REFERENCES**

- A. UFC 3-340-02, "Structures to Resist the Effects of Accidental Explosions", September 2014.
- B. PDC-TR 06-08, "Single Degree of Freedom Structural Response Limits for Antiterrorism Design", January 2008.