

**Date: 1 February 2021**

## **CD SHELTER REQUIREMENTS FOR MRT STATIONS**

### **SECTION 1 – INTRODUCTION**

#### **1.1 Scope**

This document covers the CD shelter requirements to be provided for the Cross-Island Line and future Line underground MRT stations. They cover:

- a. Main Entrances (Section 2)
- b. Protective doors (Section 3)
- c. Bomb pits (Section 4)
- d. TV and FM provisions (Section 5)
- e. Dry toilet areas (Section 6)
- f. Other requirements (Section 7)

#### **1.2 Categories of MRT Stations equipped with CD shelter requirements**

The categories of MRT stations are defined in terms of the net shelter area (m<sup>2</sup>) which is the public area that is available for occupation by the people. The categories are tabled for easy reference as shown in Table 1.1.

Categories of Stations	Net Shelter Area (m <sup>2</sup> )	Maximum Shelter Capacity (persons)*
S10	1000 – 1100	1833
S11	1100 – 1200	2000
S12	1200 – 1300	2166
S13	1300 – 1400	2333
S14	1400 – 1500	2500
S15	1500 – 1600	2666
S16	1600 – 1700	2833

RESTRICTED

S17	1700 – 1800	3000
S18	1800 – 1900	3166
S19	1900 – 2000	3333
S20	2000 – 2100	3500
S21	2100 – 2200	3666
S22	2200 – 2300	3833
S23	2300 – 2400	4000
S24	2400 – 2500	4166
S25	2500 – 2600	4333
S26	2600 – 2700	4500
S27	2700 – 2800	4666
S28	2800 – 2900	4833
S29	2900 – 3000	5000
S30	3000 - 3100	5166
S31	3100 - 3200	5333
S32	3200 - 3300	5500
S33	3300 - 3400	5666
S34	3400 - 3500	5833
S35	3500 - 3600	6000
S36	3600 - 3700	6166
S37	3700 - 3800	6333
S38	3800 - 3900	6500
S39	3900 - 4000	6666
S40	4000 - 4100	6833
S41	4100 - 4200	7000

S42	4200 - 4300	7166
S43	4300 - 4400	7333
S44	4400 - 4500	7500

**Table 1.1** Categories of MRT Stations equipped with CD shelter requirements

\* Based on 0.6m<sup>2</sup> per person.

## SECTION 2 – MAIN ENTRANCES

### 2.1 Definition of strike-point

A strike-point is the impact and detonation point of an explosive projective during a National Emergency.

### 2.2 Planning for Entrances

In planning a CD shelter, the chances of explosive projectiles falling near the main entrances of the CD shelter have to be minimised. Projectiles may enter through openings above the main entrance accessways. The trajectory of the projectile through an opening above the main entrance accessways shall be taken as a line in any direction between the vertical (0 degrees) to 45 degrees that would result in the nearest strike-point location to the protective steel doors at the main entrances of the CD shelter.

### 2.3 Line of Sight

A direct line of sight from the strike-point to the protective steel doors at the main entrances is to be avoided. However, if line of sight cannot be avoided, then the standoff distance from the explosive projectile has to be **at least 5 metres** away.

## SECTION 3 – PROTECTIVE DOORS

### 3.1 Door Types

Protective steel doors are to be provided at the main entrances to a MRT station. There are basically two types of protective steel doors:

- a. Large swing doors
- b. Smaller side swing door (PT)

### 3.2 Large Swing Door

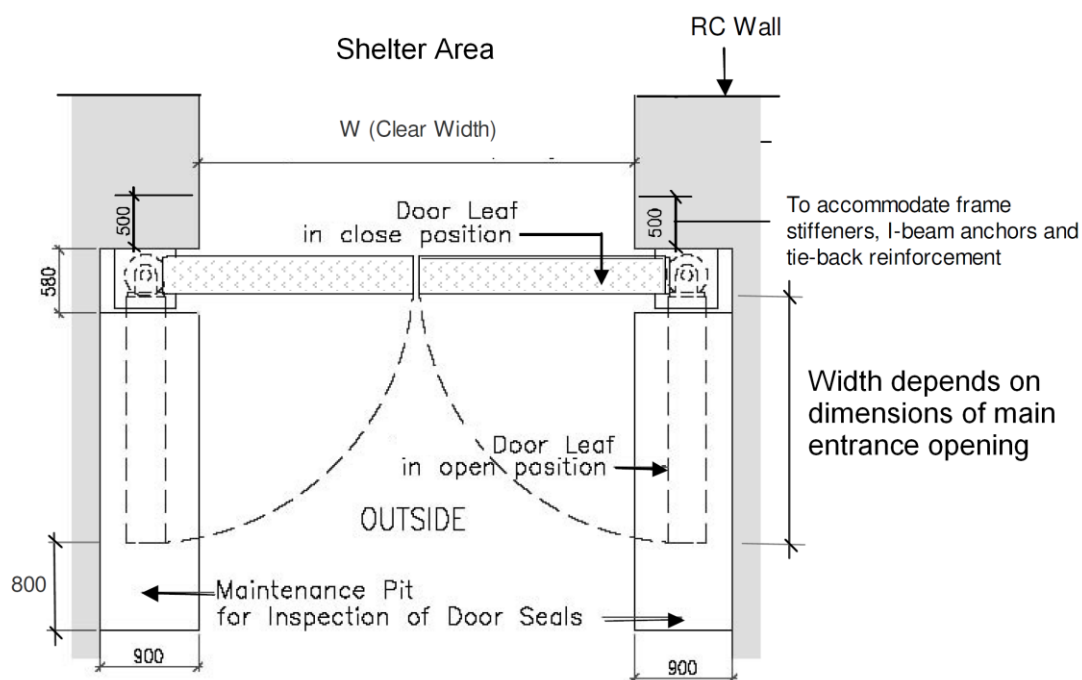
Two large steel swing doors (or double leafed swing doors) are to be installed at the main entrance of the MRT station to close and seal off the large opening. They are to be designed to protect against blast and fragmentation.

#### 3.2.1 Operational Requirements

The operation of the large steel swing doors must be from the protected side of the station. The doors may be concealed behind light architectural panels while in its opened position. These architectural panels are to be of the easily removal type when the doors need to be closed. All architectural fixtures and details concealing the doors are subject to Authority's approval. The doors are to be operated manually and shall be designed and equipped with manual devices or lever blocks to aid its operation.

#### 3.2.2 General Design Requirements

Minimum dimensions of layout and wall space for large steel swing doors are given as follows:



**Figure 3.1: Typical layout plan for large steel swing door**

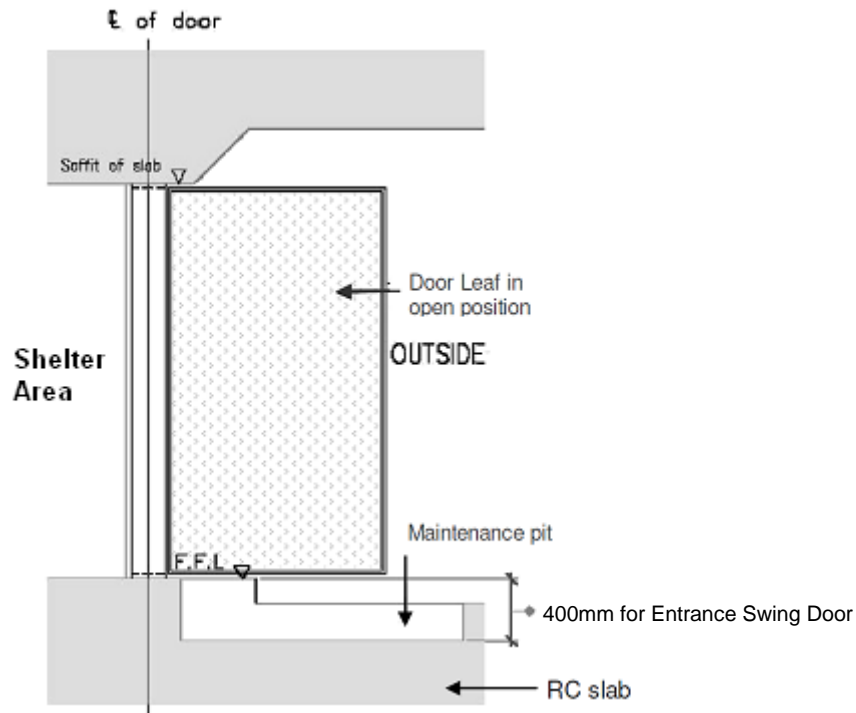


Figure 3.2 Sectional elevation view for large steel swing door with maintenance pit

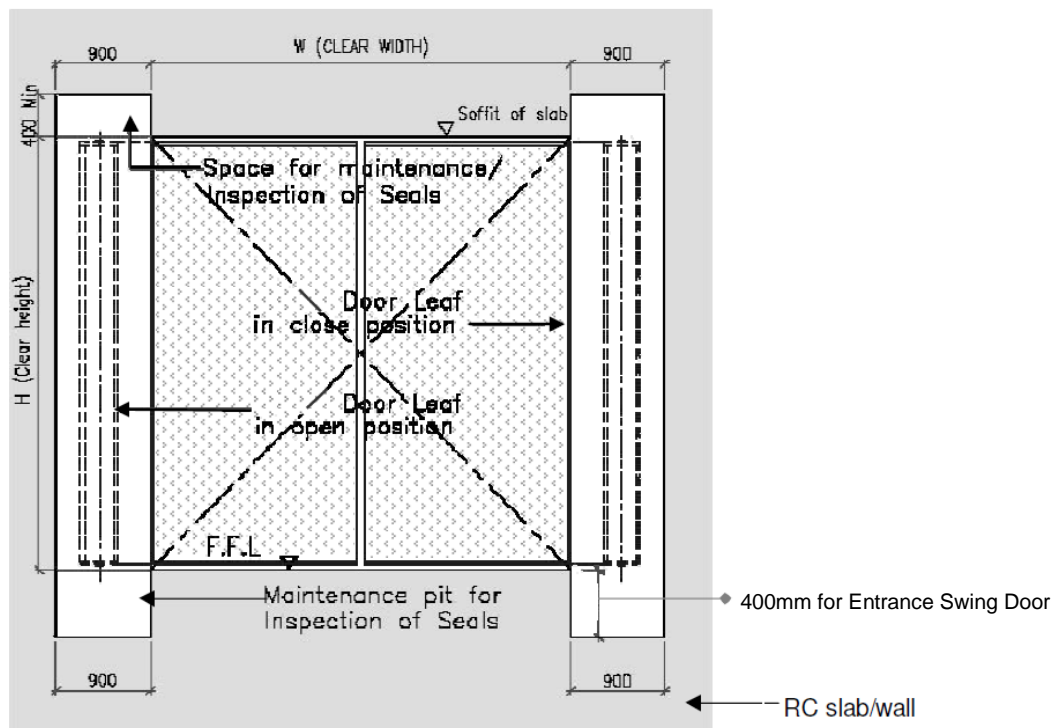


Figure 3.3 Elevation view for large steel swing door with maintenance pit

### 3.3 PT Door

A smaller side swing door (also known as the PT door in CD shelter terms) is to be installed beside or near a large swing door. PT doors have concrete in-fill door leaves. They are designed to protect against blast and fragmentation. PT doors shall be designed with dimensions as indicated in the Table 3.1.

Door Type	Clear Width (mm)	Clear Height (mm)
PT Door	1400	2100

Table 3.1 – PT Door Dimensions

PT doors are to be used as by-pass doors which provide entry and exit to and from the protected area when the large swing doors are closed. This by-pass door shall be located at the main entrance area next to a large swing protective steel door.

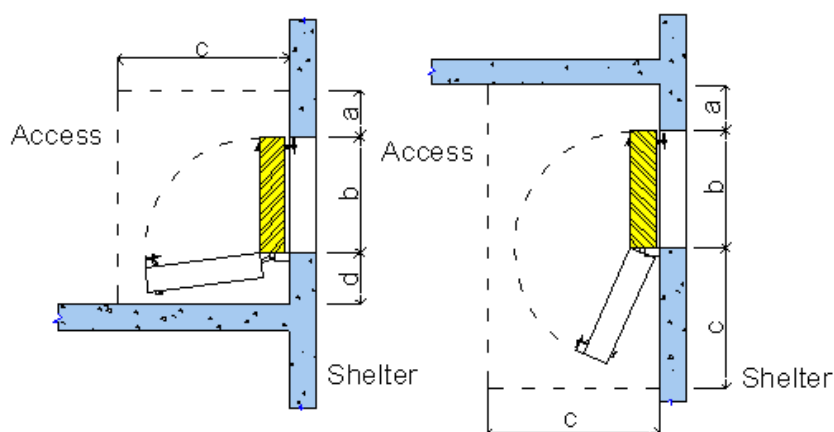
#### 3.3.1 Operational Requirements

PT doors must be provided with locking device. The doors must be able to be opened or closed by one man. In addition, PT doors shall be equipped with a manual prying or rescue device to force them open should they be jammed or blocked due to weapon effects.

#### 3.3.2 General Design Requirements

During the planning of the MRT station's layout, the designer is to ensure that the PT door swings in the correct direction. The full opening clearance must also be available with opened doors.

All PT doors must be installed such that they swing outwards away from the protected area. In order to accommodate the door leaf and to maintain a clear access way, side space must be adequately provided. In plan view, the following minimum dimensions must be observed:



Door Type	a (mm)	b (mm)	c (mm)	d (mm)
PT Door	200	1400	1955/1900	575/550

Table 3.2 Minimum Dimensions

### 3.4 Penetrations through walls supporting protective doors

#### 3.4.1 General Design Requirements

All walls at the MRT station's entrance area which directly abuts the main shelter area shall be of full height reinforced concrete and shall not contain air duct penetrations. This includes the walls supporting the protective doors. Air duct penetrations may, however, pass through buffer zones such as service corridors, bypass locks, and plant rooms before they enter the main shelter area, subject to the review and approval of the Authorities.

Penetrations of pipes and cable trunkings, cable trays, conduits, etc. through these entrance area walls are not preferred. If such penetrations through these entrance area walls cannot be avoided, the following requirements shall be complied:

- For penetrations of water filled pipes through these entrance area walls, there shall be isolation valves at the wall just before and after each of the penetrations.
- For penetrations of dry riser pipes through these entrance area walls, there shall be a removable short pipe section complete with quick coupling end caps just before and after the penetration at the wall.
- For penetrations of electrical cable trunkings, cable trays, conduits, etc. through these entrance area walls, it shall be by multi-cable transits (MCTs) cast onto the wall.

Floor openings (e.g. floor traps, floor wastes, waster sumps and inspection chambers (IC), etc.) shall not be located directly in front of the station entrances but in the buffer zones. The final location of these floor traps, floor wastes, waste sumps, ICs, etc., shall be subject to the review and approval of the Authorities.

### **3.5 Ventilation Duct Hinged-End Doors**

Ventilation duct hinged-end doors shall be provided at all ventilation supply and exhaust duct openings at the ventilation shafts/ plenums. The ventilation duct hinged-end doors shall be air-tight to prevent direct infiltration of contaminated air through the duct openings into the main shelter area and back-of-house.

#### **3.5.1 Operation Requirements**

The ventilation duct hinged-end doors are to be of hinged type with provision of exposed hand operated camlocks for ease of closing and locking purposes during CD mode. Also, when in the open position, a locking mechanism shall be provided to permanently hold the duct hinged end door from accidental closing. To provide air-tightness, an adhesive bonded neoprene gasket (or approved equivalent) between the hinged-end door and the duct frame shall be provided. The gasket shall be secured on the frame of the duct. Portable 'A-framed' ladders shall be provided to access duct hinged-end doors that are located at height less than 4m Above Finished Floor Level (AFFL). In the event that the ventilation duct hinged end doors are located above 4m AFFL, permanent stainless steel or aluminium cat ladders shall be provided for purpose of accessibility. The stainless steel/ aluminium cat ladder shall be located next to the ventilation duct hinged-end door so that a person is able to reach and close them easily.

## **SECTION 4 – BOMB PIT**

### **4.1 Air Shafts with Bomb Pits**

Bomb pits in air shafts are to contain / reduce the effects of blast and fragments of conventional explosions from reaching the public areas of the MRT station. The bomb pit is to be sited at the bottom of an air shaft.

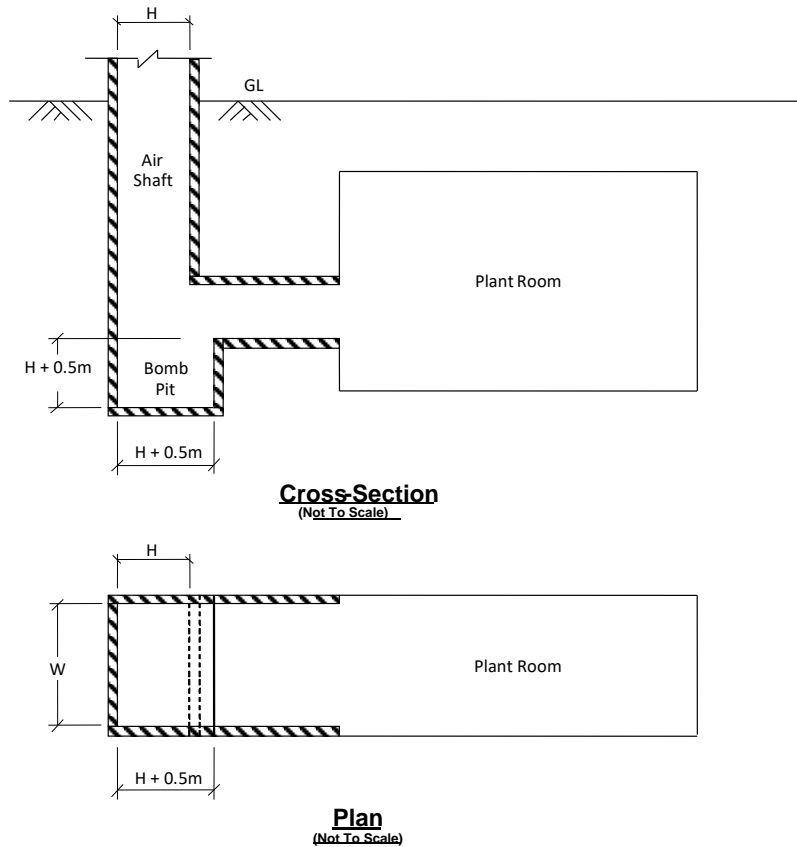
### **4.2 General Considerations**

The following are to be noted for the design of an air shaft with bomb pit for a MRT station:

- a. Actual values for the dimensions of the air shaft (shaft's internal dimensions of length (L) and width (W)) are the initial planning parameters which are to be determined by the Ventilation Engineer in accordance to the Authorities' ventilation requirements.



- b. The arrangement and design of the air shaft and bomb pit at the bottom of the air shaft is subject to the approval of the Authorities. The minimum dimensions of the bomb pit are shown in Figure 4.1.



**Fig 4.1 Typical air shaft with bomb pit**

## SECTION 5 – TV AND FM PROVISIONS

### 5.1 Introduction

A console to accommodate the control panel and input/output terminals for Television and Radio Distribution System shall be provided in the shelter command centre located in the Station Master Room (SMR). The components of this system shall conform to the requirements, standards and codes of practices of the local telecommunications authority.

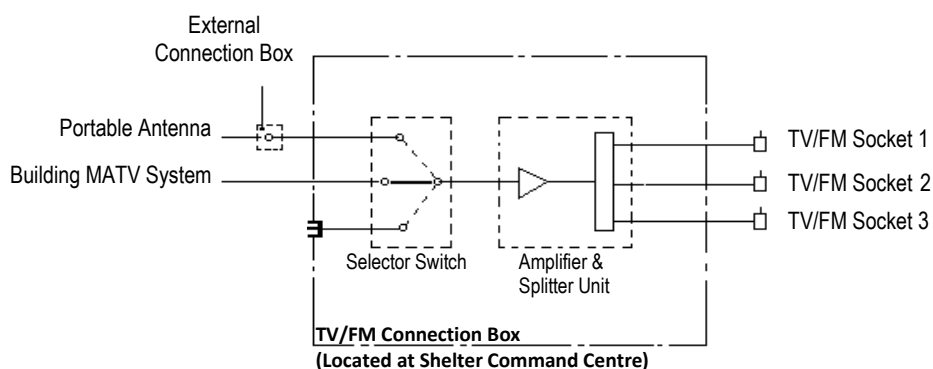
### 5.2 TV/ FM Socket Outlets

TV/FM sockets outlets shall be provided according to Table 5.1 and Figure 5.1. The connection to the central digital antenna system shall be permanently provided. An external connection box of the metal-clad type compliant to IP54 shall also be provided for a portable and removable antenna system. A selector switch shall be installed at the shelter command centre to facilitate the switch-over connection to either the building central

digital antenna system or portable antenna system, all shall be enclosed in a metal-clad box to IP54. All TV/FM socket outlets shall be of the metal-clad and double-barrel type. A 13A metal-clad switched socket outlet shall be provided next to every TV/FM socket outlet for easy connection to any television or radio appliance.

CD Rooms/Areas	Remarks
Public Area	1no. of TV/FM point per 500 m <sup>2</sup> (min. 3 at each station level)
Station Master Rm	1no. of TV/FM point & System Console complete with portable antenna selector panel

**Table 5.1:** TV/FM Point Schedule



**Figure 5.1:** Typical TV/FM connections

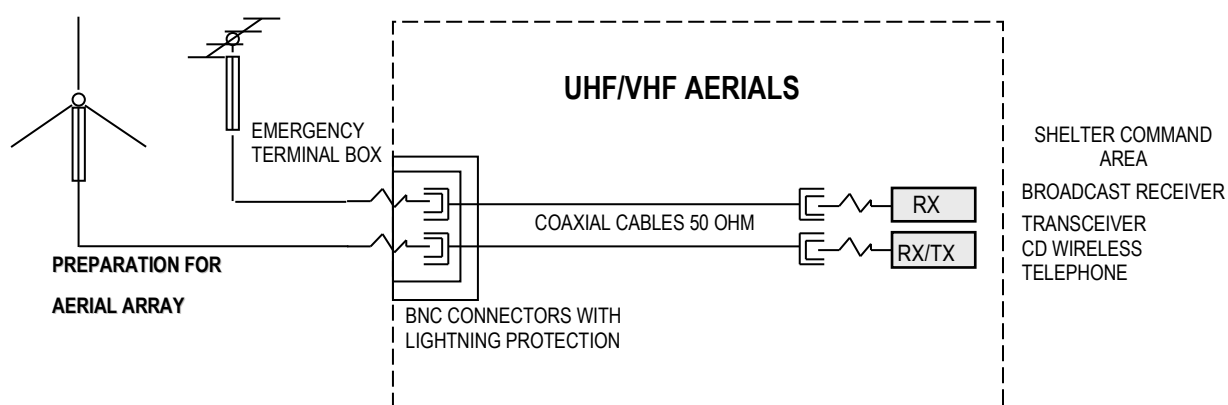
### 5.3 External Antenna Connections

The same external metal-clad connection box shall be used to provide the connections to an external antenna for the following purposes:

- Reception of radio and television broadcasts
- Reception and sending of CD operational messages via wireless transceiver.

The connections shall be of the coaxial type (50 ohms with BNC plug).

The antenna connections shall be equipped with over-voltage protection devices. Refer to Figure 5.2.



**Figure 5.2: Typical external antenna connections**

## SECTION 6 – DRY TOILET AREAS

### 6.1 Dry Toilet Area

The dry toilet area comprises removable dry toilet buckets, lightweight partitions, wash-basins and hoses. The only permanent installations required for each dry toilet area (Fig 6.1) are 2 water supply outlets, 2 floor traps and an exhaust system.

### 6.2 Dry Toilet Requirements

The minimum number of dry toilet units required for each category of MRT station is shown in Table 6.1. The dry toilet units shall be proportionately distributed at the Concourse and Platform levels, subject to the review and approval of the Authorities.

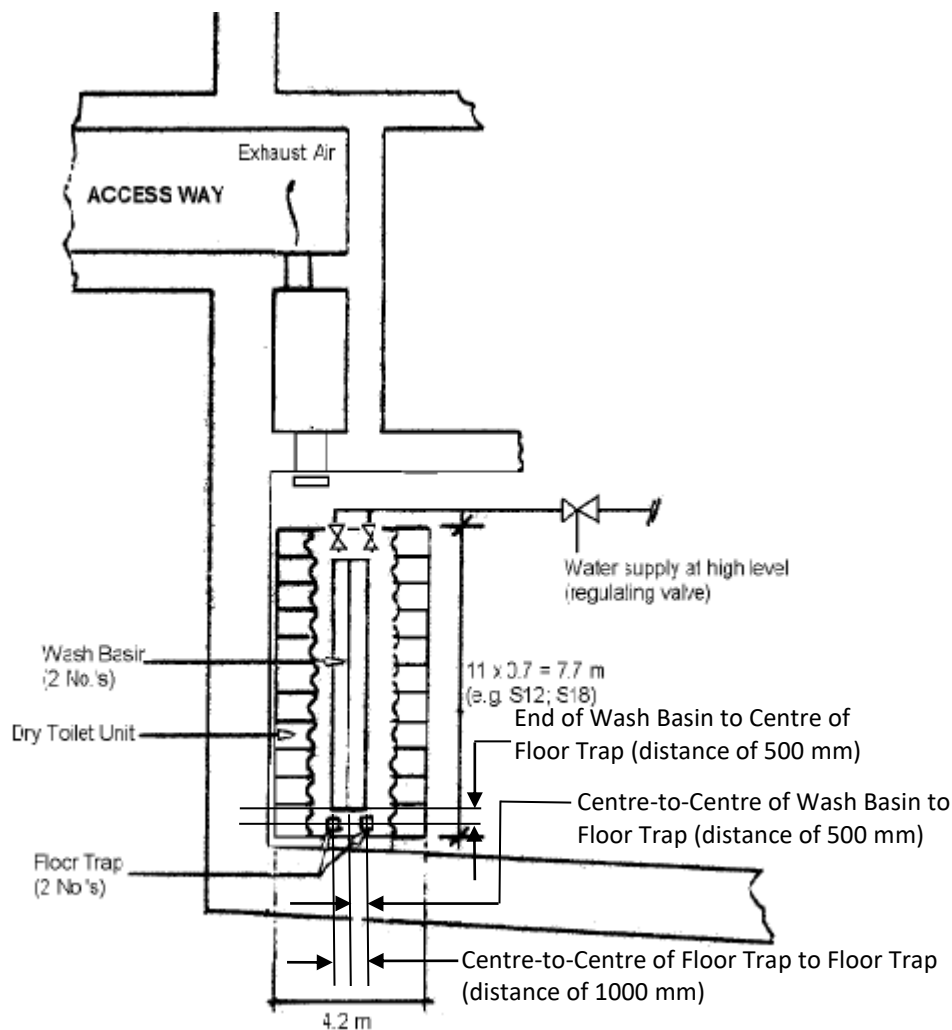
Station Categories	Net Shelter Area (m <sup>2</sup> )	Total No. of Dry Toilets	No. of Dry Toilet Areas
S10	1000 – 1100	24	2
S11	1100 – 1200	24	
S12	1200 – 1300	30	
S13	1300 – 1400	30	
S14	1400 – 1500	36	
S15	1500 – 1600	36	
S16	1600 – 1700	36	3
S17	1700 – 1800	42	

S18	1800 – 1900	42	
S19	1900 – 2000	42	
S20	2000 – 2100	48	
S21	2100 – 2200	48	
S22	2200 – 2300	48	
S23	2300 – 2400	54	
S24	2400 – 2500	54	
S25	2500 – 2600	60	4
S26	2600 – 2700	60	
S27	2700 – 2800	60	
S28	2800 – 2900	66	
S29	2900 – 3000	66	
S30	3000 - 3100	66	
S31	3100 - 3200	72	
S32	3200 - 3300	72	
S33	3300 - 3400	72	
S34	3400 - 3500	78	
S35	3500 - 3600	78	
S36	3600 - 3700	78	
S37	3700 - 3800	84	
S38	3800 - 3900	84	
S39	3900 - 4000	84	
S40	4000 - 4100	90	
S41	4100 - 4200	90	
S42	4200 - 4300	90	
S43	4300 – 4400	96	
S44	4400 - 4500	96	

Table 6.1 Dry Toilet Requirements

### 6.3 Arrangement of Dry Toilet Units

Figure 6.1 shows a typical arrangement of the dry toilet units, the wash basins, water supply taps and floor traps. The width of the arrangement is 4.2 m whereas the length varies between 4.2 m (12 units) and 6.3 m (18 units). However, the final layout of the dry toilet area shall be subjected to the approval of SCDF. The 2 nos. regulating valves (complete with water outlet points) shall be mounted on the wall or column at a height of 1.4 metres above the finished floor level, if the dry toilet area is located next to a wall or column.



**Figure 6.1 Typical Dry Toilet Area Layout**  
**(Actual layout to be approved by SCDF)**

#### 6.4 Sanitary System

The system comprises the following:

- a. Floor traps for dry toilets to drain waste water.
- b. Floor traps instead of floor drains shall be provided.
- c. Piping leading to the ejector tank.

#### 6.5 Provision of Exhaust at Dry Toilet Areas

An exhaust system is to be provided at the dry toilet areas. It shall be in operation when the shelter is in use. The exhaust system for permanent toilets located inside the shelter shall also continue operation when the shelter is in use.

All exhaust fans for all these toilets shall be located within the shelter.

## SECTION 7 – OTHER REQUIREMENTS

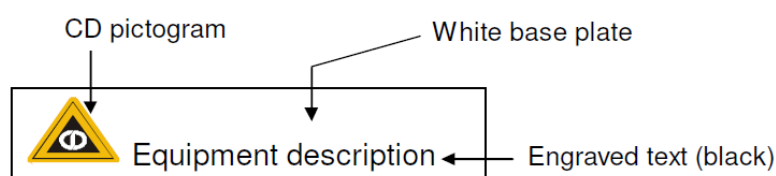
### 7.1 Painting of Protective Steel Doors

All protective steel doors shall arrive on site with a base coat of paint, and should be painted after their installation with the required number of finishing coats according to the specifications, to provide proper anti-corrosive protection.

### 7.2 Marking of Protective Steel Doors

The protective steel doors shall be marked as shown below.

The label shall come with CD logo. The text shall be black on white background. Exact description shall be proposed for approval.



### 7.3 CD Stickers

Stickers of photo-luminescent material incorporating the CD logo shall be provided for identifying the access panels of the entrance protective steel doors, dry toilet area's water supply outlet connections, and exhaust fans. The colour schemes & dimension for the CD sticker is illustrated in Figure 7.1.

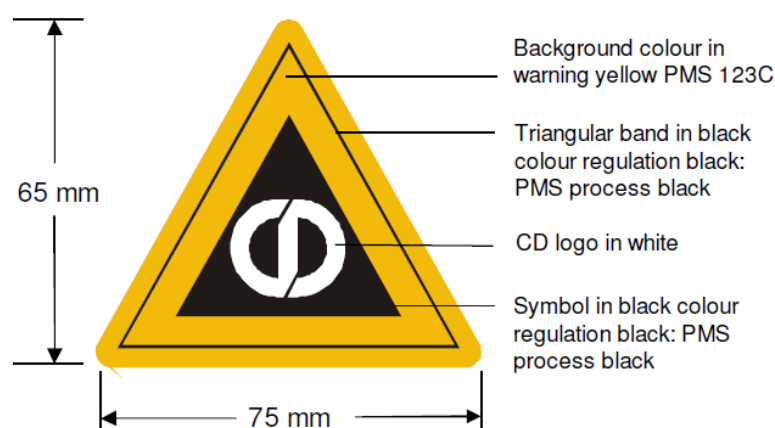


Figure 7.1 CD sticker incorporating CD logo