

# ***Part 2: Particular Design and Performance Specifications***

**PARTICULAR DESIGN AND PERFORMANCE SPECIFICATIONS FOR  
EMERALD AND MASINAG STATIONS**

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## **1.0 GENERAL DESIGN REQUIREMENTS**

### **1.1 Introduction**

The proposed LRT Line 2 Extension Project was planned to expand the railway structures to the eastward section along Marcos Highway from Santolan, the last existing station of LRT Line 2 in Pasig City to Masinag in Antipolo City. The proposed project will include the construction of the viaduct structure with a length of 3.934 kilometers to Masinag junction; and the design and build of two (2) stations, tentatively referenced as Emerald and Masinag Stations.

The project was conceptualized to augment the ridership and traffic demand in the eastern portion of LRT Line 2 route, hence, improving the domestic transportation current capacity of the existing railway and to provide a more convenient access to commuters to Metro–Manila and vice versa. With this objective, the Government of the Philippines (GOP) has approved the budget to fund the implementation and utilize the world class expertise of local contractors in the successful development program of upgrading the transport services.

The procurement exercise and subsequent award of the contract for the execution of the project works shall be carried out using the Design–Build approach consistent with the prescriptions and applicable provisions of the GPPB procurement rules and guidelines. Under this approach, the Contractor, normally referred to under a Design–Build approach as the Engineering, Procurement and Construction or EPC Contractor, who will solely be responsible for the preparation of the detailed architectural and engineering design plans and specifications, the construction, installation and eventual completion of all the required contract works.

In order to guarantee that the project is implemented in an efficient and economical manner and in accordance with the applicable rules, guidelines and procedures, the LRT Line 2 Civil Works Consultant has prepared the Conceptual Design of the two (2) stations, the Performance Specifications and Parameters Report to serve as guidelines to prospective Bidders in the preparation of their respective Bids/Design Proposals.

Prospective Bidders are expected to prepare their own designs but shall consider and treat the relevant contents of this report and the Conceptual Design as the prescribed minimum requirements.

This document presents the design standards, codes, criteria and parameters for the works comprising the LRT 2 East (Masinag) Extension Project’s Emerald and Masinag stations.

The purpose of this Performance Specifications and Parameters is to:

- Establish the minimum requirements that the Contractor must conform to in the design and construction of the works comprising the project, and
- Create certainty for both the Department of Transportation and Communications (DOTC) and the Contractor in the standards of performance expected of the Contractor.

The bidder should design, propose and conduct contract duties in accordance with this report as guidelines, but in case any necessary details for its task performance are not

explicitly covered but necessary, the bidder must present and incorporate such details during the construction phase.

## 1.2 Units

Unless otherwise indicated in the Design Specifications, all units shall be in millimeters. The g factor between SI and MKS units shall be taken as 9.8.)

## 1.3 Survey and Setting Out

The coordinates and elevations for the design process, the reports, drawings and other documents shall be based on the common origin adopted by the LRTA from the Philippine Transverse Mercator Grid coordinate system and the Mean Sea Level datum established by the Bureau of Coast and Geodetic Survey (BCGS) respectively.)

## 1.4 Design Requirements

The bidders should prepare the detailed design in accordance with the approved concept design, performance specifications and parameters prescribed herein. However, it is possible to propose materials with equal or higher quality than the given minimum required standards.

In addition, regarding particulars needed to operate and manage the stations, the bidders should include those items which are necessary to complete the work but were not included or missed out in the conceptual drawings and in this PDPS. The bidders are responsible for design and construction of the omitted parts.

### 1.4.1 Standards and Codes

This section enumerates the relevant international and local standards and codes that served as the basis of the conceptual design and will likewise govern the development of the detailed design for the stations.

- a) All structures shall be designed for the appropriate loading and shall comply with the structure gauge adopted for the East (Masinag) Extension Project. The Design Specifications shall apply to all structures adjacent to, above or below the East (Masinag) Extension Project tracks.
- b) The design life for all structures shall be 100 year. Elements design life that may be replaced during the life of the structures may be designed for a lesser period.
- c) The permanent and temporary structures shall be designed in accordance with the clearance requirements.
- d) All design and construction of facilities shall comply with the environmental regulations and requirements of the Contract.)

Unless otherwise specified in the Design Specifications, the structures and facilities shall be designed in accordance with international standards and all applicable portions of the following standards and codes

#### **International Codes:**

- AMCA Air Movement and Control Association

- ACI 318 Building Code Requirements for Structural Concrete
- AISC Manual for Steel Construction
- AWS American Welding Society Structural Welding Code
- ARI Air-conditioning and Refrigeration Institute
- ASHRAE American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc.
- SMACNA Sheet Metal and Air-conditioning Contractors National Association, Inc.
- IEC International Electrotechnical Commission
- ANSI American National Standards Institute
- ASTM American Society for Testing and Materials
- ASME American Society of Mechanical Engineer
- NFPA National Fire Protection Association
- NFPA 10 Standard for Portable Fire Extinguishers
- NFPA 13 Standard for the Installation of Sprinkler Systems
- NFPA 14 Standard for the Installation of Standpipe, Private H Hydrants and Hose Systems
- NFPA 17 Standard for Dry Chemical Extinguishing system
- NFPA 20 Standard for the Installation of Centrifugal Fire Pumps
- NFPA 22 Standard for Water Tanks for Private Fire Protection
- NFPA 24 Standard for the Installation of Private Fire Service Mains and their Appurtenances
- NFPA 70 National Electrical Code
- NFPA 72 National Fire Alarm Code
- NFPA 130 Standard for Fixed Guideway Transit and Passenger . Rail Systems
- UL Underwriter's Laboratories, Inc.
- UBC Uniform Building Code
- ISO International Standards Organization
- (International Conference of Building Officials, Uniform Building Code (UBC))
- (U.S. Naval Facilities Engineering Command, Design Manual (DM-7))
- (SEAOC, "Recommended Lateral Force Requirements and Tentative Commentary")

#### **Local Codes**

- DENR Department of Environment and Natural Resources, Environmental Management Bureau DAO 2003-30
- DOLE Department of Labor and Employment DO 13
- DPWH Standard Specifications for Public Works and Highways, Vol. II, Highways, 2012 Edition

	DO 098, 2014 Construction Safety and Health Program
➤ PEC	Philippine Electrical Code 2009, Vol. I & II
➤ RA 9485	Philippine Society of Mechanical Engineers Code
➤ NPCP	National Plumbing Code of the Philippines, 2012
➤ RA 9514	The Fire Code of the Philippines, 2008
➤ RA 6541	National Building Code of the Philippines
➤ NSCP	National Structural Code of the Philippines, Volume I. (Buildings, Towers and other Vertical Structures, Fourth Edition, 2009)
➤ BP 344	The Law to Enhance Mobility of Disabled Persons
➤ PD 856	Code on Sanitation of the Philippines, 1976

#### 1.4.2 Priority of Standards and Codes

- a) The edition of each standard used shall be current (i.e., Base Date of Tender). Later editions that become available during the course of the Contract may be used upon receipt of a written statement of “No Objection” from the Engineer.
- b) The Philippine National Standards (PNS), shall be used to the maximum extent possible for specifying materials and testing methods as well as construction specifications and requirements.
- c) Design shall be made either by service load (allowable stress) or strength design (load factor) methods. The Contractor shall select one of these applicable methods and shall strictly adhere to said method for each element of the structure.
- d) In the event of conflicting requirements between the provisions of this PDPS and other standards and codes of practice, the provisions of PDPS shall have precedence. For other requirements which have not been included in the Design Specification, the order of code adoption shall follow the sequence of: Local Codes, and other International standards.

### 1.5 Materials Requirements

This Section relates to the properties of materials that are relevant to the design process.

All materials shall conform to the applicable specifications and codes in Sub-Clause 1.4.2.1 of this PDPS.

#### 1.5.1 Reinforced Concrete

##### a) Concrete

Unless otherwise indicated in plans or in the specifications, the minimum 28-day cylinder compressive strength of concrete shall be as follows:

- i. Ground slab on fill  $f_c' = 21 \text{ N/mm}^2$
- ii. Foundations, foundation beams,  
Bored piles  $f_c' = 30 \text{ N/mm}^2$

- iii. Columns, beams, girders, shear walls  
and suspended slabs  $f_c' = 30 \text{ N/mm}^2$
- iv. Prestressed Concrete Piles,  
Prestressed Concrete  $f_c' = 40 \text{ N/mm}^2$

b) Reinforcing Steel

Type	Grade	Yield Strength ( $f_y$ )	Remarks
Deformed & Plain Bar	40	280 $\text{N/mm}^2$	Spiral only
Deformed Bars	60	410 $\text{N/mm}^2$	Main Bars
Welded Wire Fabric mat	40	280 $\text{N/mm}^2$	Slabs

The steel bars (re-bars) for concrete reinforcement shall be in accordance with PNS or ASTM standards, and in addition:

- i. Bars of diameter 16mm or greater shall conform to ASTM 615, Grade 60
  - ii. Bars of diameter 16mm or lesser shall conform to ASTM 415, Grade 40
  - iii. Weld connected bars shall conform to ASTM A706 or PNS 49
  - iv. The maximum yield stress of Grade 415 bars shall not exceed 1.25 times the nominal yield stress. The ration of ultimate tensile stress to yield stress shall not be less than 1.25 times.
- c) Minimum concrete protective cover for reinforcement in cast-in-place structures shall be as follows:
- i. Concrete placed against earth 75 mm
  - ii. Formed surfaces exposed to weather or earth 50 mm
  - iii. Surfaces not exposed to weather or in contact  
with earth; except slabs, walls and joists 40 mm
  - iv. as (c) for slabs, walls and joists 20 mm

Concrete cover is from concrete face to outer face of stirrups/ties/secondary re-bars.

1.5.2 Structural Steelwork and Metal Decking

- a) All structural steelwork shall be to ASTM A572 Grade 50, S355JO, STKR490 or approved equivalent, unless noted in the drawings.
- b) Structural sections and shapes should conform to ASTM A6, EN 100025, or JIS equivalents and structural hollow sections should conform to ASTM A500, EN 10219, or JIS G 3466.
  - 1. Girder ASTM A242  $f_y = 344.737 \text{ MPa}$
  - 2. Other Structural Steel  
Members ASTM A36  $f_y = 248.211 \text{ MPa}$
- c) All steel sections on the drawings are identified as metric shapes.



- d) Connection details shown are indicative only.
- e) The Contractor shall design the connections for reactions and forces derived from conventional and three dimensional analysis reporting with indication on member/joint data sheets.
- f) Bolts, Nuts and Washers to be high strength A325M, minimum 2–No.16 Ø per connection unless specified otherwise on design drawings. For primary connections Tension Control Bolts (or mechanisms to control the bolt tension) shall be used.
- g) Welding shall conform to AWS. D1.5. Minimum weld size to be 5mm fillet weld leg length.
- h) Fabrication and erection of structural steelwork shall be in accordance with the AISC Code of Practice for Steel Building and Bridges.
- i) Steel metal deck shall be cold rolled  $F_y = 275 \text{ N/mm}^2$  with galvanized zinc coating minimum  $380\text{g/mm}^2$  minimum sheet thickness 1.0mm with 50mm trough suitable for up to 200mm slab un–propped pouring of slab.
- j) Steel stud connectors shall conform to AWS D1.1, when used in conjunction with steel metal deck they shall be through deck welded with suitable tools and welding consumables.
- k) All base plates and anchor bolt setting shall use Non–shrink Epoxy Grout e.g. Sikadur–42HE or approved equivalent.
- l) All steel work and underside of exposed metal decking shall be surface treated and painted in accordance with the specifications for special protective paint system.
- m) The corrosion protection system shall be designed in accordance with the best current international practice. The minimum design life to first maintenance shall be 12 years for other station building and structures not supporting the station building and tracks.

## **1.6 Special Design Consideration**

### **1.6.1 Protection of Adjacent Structures**

- a) The design shall ensure that the existing structures and utilities are protected against structural damage due to the construction works.
- b) The Contractor shall establish limiting values of movement (horizontal and vertical) and distortion on each building, structure and utility within the influence zone of the work.
- c) To protect the adjacent structures during construction, instrumentation shall be installed at least for the following items:
  - i) Monitoring of ground water level.
  - ii) Monitoring of settlement of adjacent structures and surrounding areas.
  - iii) Monitoring of lateral movement of excavation support, and

- iv) Monitoring of strut loads for braced excavation.
- d) The extent of the monitoring program shall depend on the size and type of facilities. Monitoring shall be initiated as early as possible in advance of construction.

#### 1.6.2 Design of Joints of Structures

Joints between concourse floor slab and guideway supporting piers shall be minimum 150mm to permit movement in both horizontal and vertical directions. Space for movement and water proofing shall be provided at all joints between the adjacent structures. Joints between main structures and the ancillary structures shall be capable of accommodating, in addition to the estimated differential settlement, a 25mm settlement of the ancillary structure, which could be caused by future contiguous structure.

#### 1.6.3 Protection for Existing Facilities Adjacent to the “New Stations”

The design and construction of protection for public and private facilities adjacent to the “New Stations” Project, shall be in accordance with Philippine Electrical Code, Part II, NECP, National and Local building Codes, the DENR, the MMDA, National Historical Society, etc.

### 1.7 Vehicular and Pedestrian Traffic Management

#### 1.7.1 General

In the course of construction of the Project, every effort shall be made to minimize the interruption of ground traffic adjacent to and/or over the construction site. All construction activities affecting ground transport shall be planned and scheduled in cooperation with the relevant authorities. All temporary structures for the support and maintenance of ground traffic adjacent to and/or over the construction site shall be designed and constructed in accordance with prevailing codes, standards and regulations.

Particular solutions to the traffic problems at a given location shall take the following consideration:

#### 1.7.2 Pedestrian Accessibility to Adjacent Buildings

Pedestrian accessibility to adjacent buildings at the sides of the construction area which are not accessible from other streets shall be maintained at all times. The minimum width of the access road shall be 1.2 meters.

#### 1.7.3 Sidewalks

Sidewalk arcades along the construction site shall be maintained at all times.

#### 1.7.4 Crosswalks

Crosswalks within the construction area shall be a minimum width of 2.0m and shall be separated from the adjacent traffic lanes.

#### 1.7.5 Bus Stops

The bus route should be maintained as much as possible, but they may have a temporary detour to comply with the construction requirements.

### 1.7.6 Detours

Where portions of streets are closed due to construction activity, suitable detours shall be provided.

### 1.7.7 Temporary Decking and Surface Restoration

The placing of traffic decking shall be done in stages to minimize interruptions of traffic. Similarly, backfilling for surface restoration shall be done in stages without affecting the traffic. In critical traffic areas, work shall be performed during nighttime working hours to the extent possible, and traffic flow restrictions shall be minimized during daytime working hours. Actual working hours shall be proposed by the Contractor and approved by the Engineer and the local authority.

### 1.7.8 Traffic Lanes

Generally vehicular traffic lanes which accommodate buses, trucks, taxis, cars, and motorcycles shall be 3.5m ~ 3.75m wide. The minimum width of lanes shall be in accordance with the requirements of the relevant authorities.

## 1.8 Railway Traffic Management

During the construction of stations, interruption of and interference with both passenger and railway traffic shall be kept to a minimum. Wherever possible, the design and the sequencing of the construction activities shall allow uninterrupted railway operations.

## 1.9 Durability Assurance

### 1.9.1 Design Considerations

The design shall address the durability of all elements of the structures. The design process shall incorporate an assessment of potential deterioration of materials in the exposure to environments (e.g. weather, ground water etc.) throughout its service life, including but not limited to:

- a) Durability of concrete
- b) Corrosion of metals
- c) Long term performance of sealant, waterproofing, coating and other forms of protection.
- d) Serviceability of embedded pipe work, services, etc., and
- e) Maintenance of architectural finishes which includes replacement of damaged materials.

### 1.9.2 Critical Elements

Particular attention shall be given to deterioration of elements, which cannot be easily accessed for maintenance or repair during its service life. In the case of these critical elements, the design shall be premised on the element (including all its component) to remain durable throughout its service life without maintenance. Measures shall be incorporated in the design of such elements to address the durability protection as required. Where normal methods of inspection are impossible, provision for monitoring material performance by instrumentation shall be implemented where practicable.

### 1.9.3 Durability Assessment

Based on the durability objectives of the Project, performance criteria for materials shall be developed from the following assessment:

- the micro–environment to which the element is exposed,
- potential deterioration mechanisms in this micro–environment,  
the likely material life,
- the feasibility and cost of in–situ monitoring, maintenance and/or repair, and
- the significance of deterioration.

## 2.0 BUILDING STRUCTURAL DESIGN REQUIREMENTS

### 2.1 General

Special restrictions may be imposed on the design of stations due to;

- The interfacing with Line 2, East (Masinag) Extension Line, Recto–Santolan line stations, roads, private and commercial development and facilities.
- Construction in conjunction with Joint Development facilities,
- Construction in urban areas with road and utility networks, and
- The need to continue operating existing facilities during the construction of the new stations

### 2.2 Standards and Codes of Practice

Building structural design shall be carried out in accordance with the Design Standards and Codes of Practice listed in Clause 1.4.2.1 of this PDPS document.

### 2.3 Loads

#### 2.3.1 Dead Load and Superimposed Dead Load

Dead load and superimposed dead load shall include but not be limited to the following:

- Dead weight of all structural members and architectural finishes,
- Dead weight of pedestrian walkway and other related structures,
- Dead weight of all surcharge loads, and
- Dead weight of all equipment and appurtenances,

#### a) LOADS

The loads and forces defined in this Subsection shall apply to all structures or parts of structures. For wind load, temperature effects, shrinkage, creep and other loads not specified herein, refer to National Structural Code of the Philippines (NSCP) or the National Building Code of the Philippines (NBC).

#### i. Dead Loads

Dead Load is the vertical load due to the weight of the entire structure and shall include permanently installed elements such as walls, partitions, floors, roofs, earthworks, conduits and other fixed service equipment.

When computing the dead load the following unit weights shall be used:

Steel	76.9 kN/m <sup>3</sup>
Cast Iron	70.6 kN/m <sup>3</sup>
Aluminum /Alloys	27.4 kN/m <sup>3</sup>
Timber (untreated)	7.8 kN/m <sup>3</sup>
Plain Concrete	23.5 kN/m <sup>3</sup>
Reinforced Concrete	24.5 kN/m <sup>3</sup>
Running Rail (including fastenings)	1.5 kN/m/track

Sleepers (prestressed concrete)	23.5 kN/m <sup>3</sup>
Ballast	17.6 kN/m <sup>3</sup>
Sub-Ballast	19.6 kN/m <sup>3</sup>
Cables	0.98 kN/m <sup>3</sup>
Absorption material of slab track	15.7 kN/m <sup>3</sup>
Slab base and trough of slab track	21.6 kN/m <sup>3</sup>

ii. Design live loads, unless noted otherwise

Live Load is moving load excluding wind load, stream flow, hydraulic pressure, earth pressure and seismic force. Floor and roof live loads for buildings shall be in accordance with UBC Code or Local codes, whichever produces greater stress, with following exceptions:

a) Roof	1.0 kN/m <sup>2</sup>
b) Platform	4.8 kN/m <sup>2</sup>
c) Concourse (partitions)	4.8 kN/m <sup>2</sup> + 1.0 kN/m <sup>2</sup>
d) Balustrade Infill Panels	3.0 kN/m <sup>2</sup> horiz, 1.5 kN/m <sup>2</sup>
e) Stair/Escalator	4.8 kN/m <sup>2</sup> ,1.3 kN/m <sup>2</sup> (center of treads)
f) Walkways	3.6 kN/m <sup>2</sup>

iii. Service loads for miscellaneous equipment

a) Roof	0.25 kN/m <sup>2</sup>
b) Platforms/Track Deck	0.5 kN/m <sup>2</sup>
c) Concourse	0.25 kN/m <sup>2</sup>

iv. Seismic Load, unless noted otherwise

a) Ground acceleration	A = 0.6g for Emerald Station
b) Ground acceleration	A = 0.5g for Masinag Station
c) Site coefficient	S=1.0 (based on NSCP provisions for soil profile type 1)

v. Train Load

The track supporting structures shall be designed to carry the actual Line 2 Train loads. This load shall be placed at the most critical position to generate maximum stress for the part of the structure considered.

A fatigue damage assessment shall be carried out for all structural elements which are subjected to fluctuations of stress. For structures carrying multiple

tracks, the fatigue loading shall be applied to a maximum of two tracks in the most unfavorable positions. The fatigue damage shall be assessed over the required structural life of 100 years.

- b) Contractor shall be responsible for finalizing and coordinating the design and details for elevator and escalator structural supports and fixing to suit his supplier's design criteria.
- c) Contractor for design and build shall be responsible for finalizing and coordinating the concept design and the detailed design to suit this design criteria.
- d) Pre-stressed Concrete
  - 1. The design of pre-stressed concrete shall be supplemented by the relevant provisions of ACI Standard "Building Code Requirements for Reinforced Concrete (ACI 318)".
  - 2. The minimum 28-day cylinder strength of concrete ( $f'_c$ ) for pre-stressed concrete structures shall be 35 MPa, maximum size of aggregate 20mm and the minimum compressive strength of pre-stressed concrete at release shall be  $f'_{ci} = 31$  MPa (4500 psi).
  - 3. The minimum compressive cylinder strength of concrete at the time of initial pre-stress ( $f'_{ci}$ ) shall be not less than 80% of the designed 28-day strength, nor less than 27.4 MPa.
  - 4. The maximum tensile stresses for concrete in flexure shall be as given in **Table 2.1**.

**Table 2.1 Maximum Tensile Stresses for Concrete in Flexure – Unit: Mpa**

Condition	Precast and Cast In-Situ Non-Segmental	Cast In-Situ Segmental	Precast Segments with Continuous Reinforcement at Joint	Precast Segments with No Reinforcement at Joint
Construction Load	$0.25\sqrt{f'_{ci}}$ Tension	$0.25\sqrt{f'_{ci}}$ Tension	$0.25\sqrt{f'_{ci}}$ Tension	0
Service Load	0	0	0	10 (1.00N/mm <sup>2</sup> ) Compression
Type B Earthquake	$0.25\sqrt{f'_{ci}}$ Tension	0	0	0

- 5. Pre-stressing steel shall conform to:
  - i) Seven Wire Strands – ASTM A416 Low Relaxation Strand of 12.7mm diameter with minimum ultimate strength of 1862 MPa (270,000 psi)
  - ii) Non-prestressed bars ASTM A615,  $f_y = 275.790$  MPa
- 6. Anchorages shall have strength not less than the ultimate tensile load of the pre-stressing steel to be used, and no harmful deformations shall occur

under this load. The ultimate tensile load of the pre-stressing steel shall be the ultimate tensile strength specified in ASTM multiplied by the sectional area and numbers of the wires, strands or bars.

7. Lightweight aggregate shall not be used in any main stress-carrying members.
8. Concrete stresses shall be designed for the loads as stated in the Clause 5 of this section and Load combination given in Section II Clause 3.11 of this report.
9. Concrete stresses shall be investigated for the following loading conditions:
  - Initial pre-stress dead load,
  - shipping,
  - erection,
  - time dependent pre-stress losses,
  - live load and impact,
  - differential settlement,
  - thermal load and repetitive dynamic loads,
  - camber deflection and concrete length changes shall be investigated for both short and long term effects.
10. Concrete stresses shall also be investigated for stress concentrations due to the pre-stressing force including angular changes of the pre-stressing tendons.
11. Pre-stressing steel shall be inside the concrete and bonded. Where provision has to be made for future additional tendons the future tendons may be external.

### 2.3.2 Live Load

#### a) Parking Areas (if any)

Minimum vehicular loads in parking areas shall be calculated according to the AASHTO. Bus loads shall be uniform live load of 10 kPa, unless specific conditions require an increased load.

#### b) Pedestrian Areas

Stations platform, stations hall, pedestrian ramps, mezzanines, commercial areas, office areas, sidewalks and other pedestrian areas shall be designed for a uniform load of 5 kPa, unless specific conditions require an increased load.

The mezzanine floors shall be designed for additional loading of the substations, transformers and other accessories to be housed in the concourse level.

For station platform one additional concentrated of 19.6KN shall be placed in the most critical position. The concentrated load shall be assumed to be applied to a square area of 1.00m x 1.00m.



Stairways shall be designed for a uniform load of 5 kPa or a concentrated load of 1.5 kN at the center of stair tread, whichever is more critical.

c) Other Areas

1. Storage Spaces and Machinery Rooms

Electrical equipment rooms, pump rooms, service room, control rooms, computer rooms, ticket center, storage spaces and machinery rooms shall be designed for a uniform load of 12.5 kPa. These design loads shall be increased if storage or equipment specifications indicate.

2. Escalators and Passenger Conveyors

Structures supporting escalators or passenger conveyors shall be designed for the maximum reactions (including live load) from the equipment units considered. This information shall be obtained through the equipment manufacturers.

3. Railings

Railings along station platforms and mezzanines shall be designed for a horizontal live load of 0.75 kN/m and vertical live load of 0.75kN/m at their top. Railings in machinery rooms and working areas shall be designed for a force of 1kN applied in any direction at any point.

4. Gratings

Ventilation shaft gratings in streets or in sidewalks shall be designed to carry 1.25 times of the HS20-44 loading. Gratings protected from vehicular traffic shall be designed for a uniform live load of 5.0kPa.

5. Curbs

Curbs shall be designed to resist a lateral force of not less than 0.5kN/m applied at the top of the curb or at a point 0.25m above the ground. Where sidewalk, curb and traffic railing form an integral system, the traffic railing loads shall apply in accordance with AASHTO Standard Specification for Highways and Bridges.

6. Access doors at street level (not applicable except for Pump House)

Access doors shall be designed for a uniform load of 17.5 kPa. The design of the station structure shall take into account all loadings resulting from the method and route to be taken for the installation, removal and replacement of the various items of plant and equipment.

2.3.3 Lateral Pressure

Lateral pressure on the structures shall include earth pressure, water pressure, lateral pressure, resulting from surcharges loads, seismic forces and wind effects.

a) Earth Pressure

Earth pressure on structures shall vary from active earth pressure to earth pressure at rest depending on soil displacement and to what extent movement is restrained. Coefficients of earth pressure shall be calculated based on Rankine's theory.

b) Design Earth Pressure

Design earth pressure shall be determined by considering deformation characteristics of structures and acceptable disturbances on adjacent areas due to structure displacement.

Cohesion shall be taken into account if justified by appropriate soil tests at the location of the structure. However, a minimum active earth pressure shall be used with  $K_a=0.2$  in all cases.

For areas where working space is available between the permanent structure wall and the temporary retaining wall, lateral loads on the structure wall shall be calculated according to the material used for backfilling.

c) Lateral Pressure Resulting from Surcharge

Lateral pressure resulting from vertical surcharge shall be calculated by multiplying vertical loads by the lateral load coefficient  $K$  as defined below.

Generally, the earth pressures are calculated as active earth pressure. If increased active earth pressure is considered while at-rest earth pressure is too conservative for the case, an average of the coefficients of active earth pressure and at-rest earth pressure may be used. For example, such earth pressure shall be used for designing counterfort retaining walls.

d) Water Pressure

The water pressure shall be based on the underground hydrostatic pressure.

### 2.3.4 Earthquake Load

Earthquake loads shall be considered for all structures. The National Structural Code of the Philippines (NSCP) Seismic Design Criteria and Commentary shall be followed.

a) Dynamic Analysis Method

The following buildings shall be analyzed and designed by the dynamic analysis methods.

1. Buildings with height equal to or greater than 50 meters.
2. Buildings having abrupt or unusual changes in mass, stiffness or geometry in the horizontal or vertical plane.

The design ground acceleration will be  $\frac{z^1}{1.35a_y F_u}$  and multimodal spectral superposition method is suggested. Normalized acceleration response spectra for different soil profile type are the same as those used in equivalent static analysis method.

b) Ductility Design

Ductility design shall be carried out in accordance with the National Structural Code of Philippines (NSCP) and Seismic Design Criteria and Commentary where appropriate.

2.3.5 Collision Load

a) Collision Load on Platforms

Platforms shall be designed to withstand a horizontal impact load of 1000 kN applied 1tn 90° to the TCL of the nearest track.

A 0.3m wide void shall be provided around columns that are within platform areas to prevent transfer or collision loads to the column.

2.3.6 Wind Load

Buildings shall be designed to resist wind loads in accordance with NSCP “Provisions Commentary and for Wind Load Cases”. The basic design wind speed shall be based on a 50 or higher (mean recurrence interval) fastest kilometer wind speeds, these higher values shall be the minimum basis wind speed.

a) Pressure coefficient and force coefficient

Pressure coefficients and force coefficients used in the determination of wind load on different buildings can be found from Table 2.5 to 2.17 and Figures 3.1, 3.2 of the Building Wind Loads Provisions in National Structure Codes of the Philippines.

b) Wind load on buildings

Design wind pressure for enclosed buildings usually shall be the product of velocity pressure, gust wind factor and pressure coefficient. Design wind force on unenclosed buildings shall be the product of velocity pressure, gust wind factor, force coefficient and projected area of buildings normal to wind direction. For detailed information, see Table 2 of the Building Wind Loads Provisions in National Structure Codes of the Philippines.

c) Wind load on components and cladding

Wind load on components and cladding are much higher than that on main wind-force resisting systems. Relevant provisions in the calculation of wind loads on components and cladding can be found from the Building wind Loads Provisions of National Structure Codes of the Philippines.

2.3.7 Effects of Temperature, Shrinkage and Creep

Effects of temperature gradient, shrinkage and creep shall be considered for structures above ground, refer to National Structural Code of the Philippines (NSCP).

### 2.3.8 Loadings on Temporary Retaining Structures

Loadings on temporary retaining structures shall include the lateral earth pressure due to adjacent ground cover, ground water pressure and surcharge resulting from railway trains, existing building, road traffic, etc.

### 2.3.9 Design Limits and Load Combinations

All steel structures shall be designed by using the working stress method while the ultimate strength method shall be used for design of the concrete structures.

#### a) Load Combinations for Steel Structures

Material allowable stress as per AISC requirements:

$$S \geq (DL + LL)$$

$$S \geq (DL + LL + WL)/1.33$$

$$S \geq (DL + LL + EQ)/1.33$$

$$S \geq (DL + LL + T + WL)/1.50$$

$$S \geq (DL + LL + T + EQ)/1.50$$

#### b) Load Combinations for Reinforced Concrete Structures

Material nominal strength as per ACI requirements:

$$U \geq 1.4 DL + 1.7 LL$$

$$U \geq 0.75 (1.4 DL + 1.7 + 1.87 EQ)$$

$$U \geq 0.75 (1.4 DL + 1.7 + 1.7 WL)$$

$$U \geq 0.9 DL + 1.43 EQ$$

$$U \geq 0.9 DL + 1.3 WL$$

$$U \geq 0.9 (DL + 1.3 WL)$$

$$U \geq 0.9 (DL + T)$$

For structures resisting earth pressure (E), the following load combinations shall also be considered:

DL = Dead Load

LL = Live Load

WL = Wind Load

EQ = Earthquake Load

T = Temperature Effects

F = Hydrostatic Pressure

E = Earth Pressure

## 2.4 Other Design Requirements

Corrosion control, as among other design requirements has been moved to Section II of this report.

### 2.4.1 Waterproofing

#### a) Performance Level Waterproofing

The performance level waterproofing shall be defined according to the following:

Performance Level	A	B
Leakage Rate	Not Allowed	Minor*
*No more than 5 ml per square meter of surface area per hour		

#### b) Methods of Waterproofing

The design and construction of the elevated structures shall incorporate the following features to achieve the different performance levels of waterproofing required.

- Performance Level A Waterproofing: For structures requiring Level A waterproofing special care shall be taken in the construction to ensure sound and dense concrete. Concrete containing a waterproofing admixture may be used. The exterior of the structure shall be protected by suitable materials to satisfy the requirement for waterproofness. Construction joints shall have a water stop and shall be sealed at the internal face.
- For structures requiring Level B waterproofing, extreme care shall be taken in the construction to ensure sound and dense concrete. All construction joints shall be as for Level A except that the sealant at all the internal faces of the construction joints shall only be required in roof and wall slabs.

#### c) Design Requirements

The following performance level of waterproofing shall be required for the structural members of station structures that are below ground:

Station Main Building	Performance Level
Roof slab	A
Bottom slab	B
External walls	A

Machinery rooms, such as train control rooms, auxiliary equipment space, and substations, switch gear, and similar rooms shall have the same degree of waterproofing as that for the main building.

## 2.4.2 Joints

Concrete sections shall be limited to proper length by providing construction joints. Except in diaphragm wall, the reinforcement within the construction joints shall be continuous. Construction joints in external walls and slabs shall have a waterstop. Diaphragm walls that are incorporated into the permanent works shall have a waterstop at all construction joints.

## 2.5 Design Method

### a) Design of Permanent Structures

The method used to analyze the elevated station structure shall take into account, but shall not be limited to, the following:

1. The method of construction, including temporary work.
2. The interference with the existing railways arising from the proposed construction method and procedure, and
3. The ground/structure interaction, including the effects of temporary works.

### b) Design of Temporary Structures

The method of construction shall take into account the following relevant parameter and procedures which shall be incorporated into the structural design.

1. The geology at the station site,
2. The hydrogeology and ground permeability at the station site,
3. The degree of settlement which would be expected. In this context, the location of the works in relation to the existing structures shall be considered,
4. The depth of foundation excavation required.
5. Any particular difficulty that a special plan might meet in respect of access clearances and working space.
6. The method of waterproofing for the completed structure, and
7. The requirements for maintaining vehicular and pedestrian traffic.

### 2.5.1 Flotation (Buoyancy)

Flotation shall be checked in accordance with the National Structural Code of the Philippines (NSCP). Footing (foundation) shall be checked for flotation using the minimum densities (unit weights). The maximum densities shall be used in all calculations relating to structural design of members. Dead load shall be calculated on the basis of unit weight less buoyancy forces. Dead load weight of "in situ" placed concrete structural elements shall be based on minimum and maximum densities of 23.52KN/m<sup>3</sup>.

## 2.5.2 Flooding

The buildings (e.g. substations, equipment buildings for signaling and communications, etc.) shall all be protected from flood. The design requirements against flooding for these building entrances shall consider the following criteria and select the maximum elevation for design.

- a) The historic maximum flood level plus 1.0m.
- b) The flood elevation of 100-year return period plus 1.0m.

## 2.6 Foundations

Shallow foundations may be used where there is a suitable bearing stratum near the surface, no highly compressible layers below, and calculated settlements are acceptable. Where the bearing stratum is underlain by weak and highly compressible materials, the use of deep foundations shall be recommended.

### 2.6.1 Shallow Foundations

This Subsection is applicable for the design of shallow foundations as follows; spread footings for isolated columns, combined footings for supporting the load from more than one structural unit, strip for walls, and mats or rafts beneath the entire building area.

#### a) Design of Shallow Foundations

Allowable soil bearing pressure for shallow foundations is limited for two considerations; the safety factor against ultimate soil bearing pressure shall be 2.0 or greater; and settlements under allowable soil bearing capacity shall not cause structural damage and shall not impair the serviceability and function of the given structure. The allowable bearing capacity shall be computed on the basis of the following minimum factor of safety requirements:

- For stations and other buildings associated with the operation of the Light Rail Vehicle (LRV) system, use a safety factor of 3.
- For temporary structures, use a safety factor of 2
- Increases in allowable soil bearing pressures by one-third of nominal bearing values are permitted for loading combinations including load from wind or earthquake.

The limiting settlements for buildings shall not exceed:

- Total settlement of 200mm
- Angular distortion of 1/250

Except where a detailed study to justify relaxation of these limits has been made and a written statement of "No Obligation" is given by the Engineer. Punching shear or local shear failures shall be checked for shallow foundations

on loose or relatively compressible soils. Allowable bearing Penetration Test (SPT) or Cone Penetration Test (CPT). These bearing pressures will be based on maximum foundation settlements but do not consider settlement effects due to the adjacent foundations. In the case of closely spaced foundations where the pressure beneath a footing is influenced by adjoining footings, a detailed settlement analysis must be made. Mat foundation shall be checked for flotation. Foundation design shall consider potentially detrimental substances in soils, such as sulfates with appropriate protection for reinforcement, concrete and metal piping.

Damproofing materials to resist water permeability to the concrete foundation structure shall be considered.

## 2.6.2 Bored Pile Foundation

These criteria cover the requirements for the design of permanent bored piles required for the LRT stations or other structures.

### a) Design of Bored Piles

Bored foundations shall be used when a shallow, spread, or mat foundation cannot be designed to carry the applied loads safely and economically. They shall also be used where scour, erosion or settlement may occur and the soil conditions permit their use even though the bearing capacity of the soil may be sufficient to make practical the use of shallow foundations.

#### **Piled Foundations:**

1. The design of piles shall be in accordance with ACI Criteria and applicable local codes. The design of piles shall also take into consideration the limits on total and differential settlements imposed by the supported structure.
2. The design of piles shall take into consideration the effect of negative skin friction which may result from construction dewatering, the construction of embankments, or from the pile installation method. The latest published relevant basin subsidence monitoring data shall also be evaluated with respect to its possible negative skin friction effects on piles. When negative skin friction is considered it shall be treated as an additional to the working load. If measures are proposed for reducing the effect of negative skin friction, tests should be specified to verify design assumptions.
3. Piles shall be designed to adequately resist the lateral loads transfer from the supported structure during earthquakes or from other lateral loads. No movement is allowed that will damage the structure when the lateral resistance of the soil surrounding piles is inadequate or when increased rigidity of the entire structure is required. Battered piles can be used in pile foundations. However it shall not have a farther out of plumb of more than one horizontal in six vertical. Where battered piles are to be used, consideration shall be given to the possibility of such battered piles encroaching on properties outside the right-of-way lines.



4. The design of piles shall make adequate allowance for group effects.
5. The minimum factor of safety to be adopted in the design of piles are as follows:
  - For loading combinations without earthquake or wind loads, use a safety factor of 3.
  - For loading combinations with earthquake or wind loads, use a safety factor of 2.
  - For loading combinations in case of negative skin friction force with earthquake or wind loads, use a safety factor of 1.2
6. Horizontal movement at the top of pile should be based on the specific requirements of the structure and shall be less than 1.0cm. In case of loading combinations with earthquake or wind loads, 1.5cm shall be the limit.
7. An adequate number of pile tests shall be specified. These shall include advance piles tested to ultimate load to verify design assumptions. The location and length of test piles shall be shown on the plans. Test piles shall be located so that, except unforeseen circumstances, they will cover all conditions of pile type, pile capacity and soil conditions which will be encountered.

### **3.0 STATION PLANNING AND ARCHITECTURAL DESIGN REQUIREMENTS**

#### **3.1 General**

This section covers the performance specifications and parameters to construct the stations for the LRT2 East (Masinag) Extension Project. Therefore, the bidder should prepare detailed design according to the design parameters and performance specifications as described herein. However, it is possible to propose materials with equal or higher quality than the given minimum required standard.

In addition, regarding particulars needed to operate and manage the stations, the bidder should include those that are necessary to complete the work but were not included in the drawings and in this report, and the contractor is responsible for design and construction of the omitted parts.

#### **3.2 Design Factors/General Design Requirements**

The design of the stations is governed and determined by the following factors:

- a) Operational requirements for using either the center island or side platforms
- b) Traffic, Road and Pedestrian requirements
- c) Utilities
- d) Structural Requirements
- e) Passenger forecasts and the resulting entrance location requirements
- f) Interfaces with proposed and potential future development projects
- g) Environmental Considerations
- h) Accessibility to construction site and disruption of traffic
- i) Flexibility in design to allow stations to respond to site specific requirements
- j) Future expansion
- k) Phasing of plant and machinery provisions

#### **3.3 Design Objectives**

##### **a. For the public in general**

- i. An attractive ridership image.
- ii. Urban Design Impact (including to its adjoining properties)
- iii. A distinctive corporate image
- iv. Provision of potential links to other transportation systems
- v. Provision of potential links to parking facilities
- vi. Provision of potential links to adjoining properties and footbridges.
- vii. Safeguards to pedestrians and adjoining properties from noise and air pollution
- viii. Traffic safety on the roads

- ix. No decrease in pedestrian utility at sidewalks
- x. Opportunity cost of the proposals

**b. For the Operator**

- i. Ease of use in different conditions; normal, peak, off peak, abnormal, emergency
- ii. Quality, as in a place of work
- iii. Ease of management and maintenance
- iv. Consequential effect on manning levels and responsibilities
- v. The potential for commercial revenue earning opportunities on user routes and the capability to link into commercial developments nearby.
- vi. Provision of a flexible concept of circulation to allow for provision of stairs along with the escalators, additional points of vertical access (including the sidewalk level) as well as links to adjoining properties, footbridges and extended elevated walkways.
- vii. The capability of increasing the number of ticket gates or direction of access should future needs dictate. The ability to change to a different type of ticketing system.
- viii. Provision of services to cope with international standards and capability of upgrading to allow for an increased level of comforts or amenity.
- ix. The provision of advertising space at concourse and platform levels and the capability of providing additional space for this purpose at roadside, above the road levels, on walkways and viaduct sides and on any other prime visual locations to generate additional revenue.
- x. Ability to construct a part of the station for initial operation that would easily extend the facilities for future expansion.
- xi. The provision of commercial space within the stations for public amenity and revenue.

**c. For the Passengers:**

- i. The effects of the design on passenger's attitude and behaviour.
- ii. The attractiveness of the facilities as measured by the following criteria:
  - a) Safety: Intrinsic safety of the proposals including protection from fire, mechanical, electrical accidents and "worst case" scenarios
  - b) Time: Perception of time, information, access time, waiting time, reliability and certainty.
  - c) Cost: Fare and value for money
  - d) Materials: The aesthetic value of the material; its sensitiveness to auditory and visual quality and its ecological effect ensuring cleanliness

and free of contaminants.

- e) Security: The risk of assaults and perceived threat to the safety of the riding public
- f) Amenity: Primary provisions as specified and secondary provisions to enhance comfort or increase utilities for the riding public during waiting time.
- g) Weather: Protection from rain and direct sunlight
- h) Comfort: Ease of use and movement
- i) Access: Access to persons with disabilities entering the premises of the station and to the platform

### **3.4 Design Criteria**

This section sets out the design criteria adapted for the planning and design of LRT Line 2 East Extension Stations to provide consistency in its layout, appearance, structural soundness and its identity with the prevailing system. It is also intended to have a consistency in the construction of the facility, passenger circulation, including its operations and maintenance procedures for the entire system.

The stations vary slightly in its complexity from the existing stations (along the route) with specific requirements identified through an interactive process in terms of the following: ridership forecasts; interchange requirements with other rail systems and public utility transport; spacing from station to station; alignment; utilities; roads and pedestrian requirements, interfaces with potential developments and environmental considerations.

#### **3.4.1 Basis for Criteria**

The main objective of the design is to attain the essential satisfactory quality of the station layout by providing adequate space for the movement of the end users from the ground level entrance up to platform areas and unto the train coaches.

Most important criteria considered in the design development of the station includes but not limited to the following:

- Sizing of Station Passenger Handling Facilities
- Emergency Evacuation
- Electrical & Mechanical Plant and Equipment space requirements
- Operational Accommodation
- Fire Safety & identification of area limits
- Stipulated Design Standards
- Passenger Circulation, comfort, ease of use, safety and security
- Signages
- Weather protection

- Modular approach to the design of all elements
- Buildability of the stations considering site constraints on either permanent or temporary situations.

### 3.4.2 Types and Station Identification

Two stations are being added to the system:

Name of Station	Type
a) Emerald Stations	Intermediate
b) Masinag Station	Terminal
1. Intermediate Station:	Serving only one line comprising two tracks
2. Terminal Stations:	Station placed at the end of a line.

## 3.5 Station Layout

### 3.5.1 General Requirements

#### a. Layout

The layout of stations is influenced by geological conditions, physical conditions (no support on the road within 5 lane), track geometry, operational requirements, predicted passenger flows and electrical and mechanical requirements.

West and East Valley Faults which are considered to potentially cause the largest impacts to the Metropolitan Manila area in case of earth movements are located within 2km from the Emerald Station. The geotechnical investigation report recommended the peak ground acceleration of 0.55g for the project site.

The existing five (5) lanes of Marcos Highway in both directions should be maintained for seamless traffic flow. For these reasons, the substructures of the stations will be located at the central reserve along the stretch of Marcos Highway. The concourse and platform levels is covered with curved rolled roof beams seated on the cantilever beams that are supported by single piers.

Considering the structural safety against lateral forces, superstructure of the station is structural steel to reduce the loads supported by the station and the viaduct is supported independently from the station structure. The separate side loading platform configuration is adopted for both intermediate and terminal stations to better spread out the loads.

#### b. Platform

The platform level shall have adequate room for waiting assembly for passengers in both normal operating conditions and several anticipated unfavorable conditions like overcrowding during system failure and heavy passenger queueing.

The dimensional design of the platform level at each station is determined by the minimum structural and spatial requirements, which allows for a concourse area to be located between street and platform levels.

Provision of safety walkway at the danger side of the platform track as protection in case the passenger/s accidentally falls from the train in the event the train's door accidentally opens at the danger side of the platform.

**c. Concourse**

The concourse consists of the automatic fare collection system that divides the concourse level into distinctive areas. The 'unpaid area' is where passengers gain access to the system, obtain travel information and purchase tickets. In passing through the ticket gates the passenger enters the 'paid area' which includes access to the platforms.

The arrangement of the concourse is assessed on station to station basis and is determined by site constraints and passenger accessibility requirements. However, it shall be planned in such a way that maximum surveillance can be achieved by the ticket hall supervisors over the ticket counters, Automatic Fare Collection (AFC) gates, stairs and escalators. Ticket counters and AFC gates shall be positioned such as to minimize cross flows of passengers thus, providing adequate circulation space.

Design considerations should allow sufficient room for queueing and flow of passengers at the top and bottom of stairs and escalators.

Sufficient space for queueing and passenger flow shall be allowed at the top and bottom of stairs and escalators. **Refer to Sub-Section 1.8.**

**d. Entrances**

Station entrances should be located at the most strategic locations with particular reference to passenger catchment points and limitations on the right-of-way allocated for the northeastern section line of the system.

**e. Offices**

Accommodation for offices, operation and maintenance areas, plant room spaces shall be located at the non-public areas at each station. The functions and sizes/dimensions (where applicable) are given in Attachment B.

The locations of auxiliary sub-station, pump houses and ground tank shall be at ground level and preferably in one of the areas within the vicinity of station site.

Similarly, air conditioning units shall be individually located in each room above the ground level.

**f. Equipment Rooms**

Equipment room shall be located in the same location as the existing LRT-2 stations. The size of accommodation to be provided should be bigger than the

existing LRT-2 stations to give room for easy accessibility during maintenance and replacement of equipment in case of malfunction.

The recommended sizes of space allocations as the minimum requirements for the specified equipment are as follows:

<b>Station</b>	<b>RSS</b>	<b>Substation</b>	<b>Signaling Room</b>	<b>Telecom Room</b>	<b>Electrical Room</b>
	Area (m <sup>2</sup> )	Area (m <sup>2</sup> )	Area (m <sup>2</sup> )	Area (m <sup>2</sup> )	Area (m <sup>2</sup> )
<b>Emerald</b>	N/A	55	40	23	48
<b>Masinag</b>	279	N/A	43	28	55

### 1. Recommendations

#### a) Installation of access floor in equipment room.

Equipment room of existing LRT-2 (power, signaling, telecommunications room) was designed as an overhead tray system, which has many constraints, like in rearranging or expanding the equipment. To deal with these problems, access to the floor recommended in the design is the use of cable route installation that will allow ease in future expansion, replacement and maintenance.

#### b) Common Grounding System

The purpose of the grounding system is to protect the equipment and prevent electric shocks from faulty current tripping that cause's power surge. Grounding system also protects metal structures and surfaces from electric corrosion. Specifically, grounding system for telecom room, signaling room, electrical room, and RSS sub-station room should be provided.

Provision of the common grounding system should be verified from the Electro-Mechanical Consultant as to its architectural component or structure of the system layout.

#### **g. Fire Emergency Exits**

Fire exits shall be located so as to provide access from the platform level to the street level. Safety shall be ensured in case of evacuation of passengers in the event of extreme emergency.

### 3.5.2 Queuing

#### a. Queuing Criteria: requirements are as follows:

Space shall be provided for queuing at all circulation and passenger service elements. The queuing area provides space for passengers to queue at various circulation elements, service areas and decision points without disrupting the movement of other passenger flow routes.

Queuing spaces shall be placed end to end; and shall not overlap. They shall be considered as part of the general space requirements for any given area, as indicated below:

b. Minimum Queuing Space

Location	Queuing Space
Card Readers, from face	2400mm
Customer Service Centre, from counter edge	2400mm
Escalators, from working points	5000mm
Fare Adjustment Office, from counter edge	2400mm
Lifts, from threshold	2400mm
Stairs, from working points	5000mm
Ticket Gates and Smart Card Gates, from face	8000mm

### 3.5.3 Balustrade Requirements

- a) Horizontal balustrading to the heads of stairs, escalators or open wells through floors, shall be constructed to a minimum height of 1.1m above finished floor level and designed in such a way as to withstand a crush load of 0.74KN per metre run. Materials shall be stable and robust. Any apertures within the balustrade shall preferably be enclosed with solid material; but consideration may be given to the inclusion of opaque or transparent materials as alternatives.
- b) The design concept and materials for balustrading the stair flights shall match with that on the open wells.

## 3.6 Passenger Handling

### 3.6.1 General

- a) Passenger handling requirements greatly influence the station design and operation of the railway. The design shall be based on a careful analysis of the requirements of the passengers and the operator.
- b) It is essential that the system is designed to provide maximum attraction to potential passengers and the following criteria shall be observed:
  1. Minimum distance of travel to and from the platform and in between platforms for transferring between lines
  2. Adequate capacity for passenger's ease of movement
  3. Convenience, good signage relating to circulation and orientation



4. Safety and security, including a high level of protection against accidents.

### 3.6.2 Operator's Requirements

The Employer as the operator of the system will require that the following has been taken into account.

1. Minimum capital cost to be incurred consistent to maximizing passenger attraction
2. Minimum operating costs are incurred consistent with maintaining efficiency and the safety of passengers.
3. Flexibility of operation including the ability to adapt to different traffic conditions, changes in fare collection methods and provision for the continuity of operation during any extended maintenance or repair period, etc.
4. Provision of good visibility of platforms, fare collection zones and other areas, thus aiding the supervision of operations and monitoring of efficiency and safety.
5. Provision of display of passenger information, advertising and commercial concessions.

### 3.6.3 Provision of Escalators and Stairs

The decision to provide an escalator or staircase for passenger movements shall be based upon forecasted passenger flow rates, vertical travel distance, structural limitations and the availability of space.

Assuming other criteria are met, stations shall be designed to accommodate all normal passenger movements between concourse and platform by escalators. Staircases and escalators shall be provided.

Provisions are also made in the electrical supply, together with consideration given to the inclusion for the laying out of cables and conduits.

This include provisions of escalator pits, electrical conduit, lifting hooks, knock-out panels, and adequate space for machine rooms in the initial construction.

Stairs fed by escalators shall be sufficiently wide as to provide a capacity at least equal to that of the escalator.

The numbers of escalators and sizes of the staircases were determined by checking the capacity against the AM and PM Peak flow rates for both normal and emergency conditions.

### 3.6.4 Passenger Movement in Stations

In order to transfer passengers efficiently from the street level to the trains and vice versa, station planning was based on established principles of pedestrian flow and arrangement to minimize unnecessary walking distances and cross flows between incoming and outgoing passengers.

- a. A typical flow pattern for a passenger using the system is as follows. Upon arrival at one of the entrances the passenger will proceed to the concourse

unpaid area where he can consult travel information on display and buy a ticket. The passenger will then enter the paid area by passing with a valid ticket through an automatic ticket gate and proceed to the platform where he will board the first train travelling to his destination. A journey from the platform to the entrance will be in reverse with the exception that when a passenger's ticket is invalid for the journey, it will have to be exchanged for a valid ticket and an excess fare paid before leaving the paid area.

- b. Detailed ridership forecasts were derived from a computer model which described the station flow rates in the peak hour. From these forecasts AM and PM Peak Fifteen (15) Minute Peak Demand are derived at each station for the Design Years 2016 and 2035.
- c. The layout shall be able to accommodate the worst case scenario at each station.
- d. Each station was individually assessed and a view taken to ensure ultimate passenger handling capacity is available and that there is the ability to install the minimum and most economic facilities at the first instance.
- e. Passenger handling facilities comprise the stairs, escalators and ticket gates required to process the peak traffic from street to platform and vice versa (these facilities must also enable evacuation of the station under emergency conditions, within a set safe time limit). The number of entrances from the street, and the requirements for ticket issuing machines, are also included.
- f. The capacity of each facility was based on a percentage of the Maximum Practical Capacity (MPC) depending on location and usage. Generally the Maximum Practical Capacity is provided for a uni-directional flow of passengers. The factors that were used for other situations are:
  - i. Bi-Directional flow – 80% of the MPC,
  - ii. Entrance/Concourse movements – 60% of the MPC to allow for the uncertainty involved in being able to predict development of the area around a station which may change passenger usage of entrances over a period of time,
  - iii. Concourse / Platform movements – 80% of the MPC
  - iv. Emergency Evacuation capacities – 90% of the MPC

### 3.6.5 Maximum Practical Capacities

The following figures represent the maximum practical capacities that are used in conjunction with the relevant design factors to determine the practical design capacities.

<b>Circulation</b>	<b>Capacity</b>
Walkway (Uni-directional)	88 passengers/meter/minute
Walkway (Bi-directional)	70 passengers/meter/minute

<b>Circulation</b>	<b>Capacity</b>
Stairs Up	63 passengers/meter/minute
Stairs Down	70 passengers/meter/minute
Stairs Bi-Directional	53 passengers/meter/minute
Escalator (0.75 m/sec)	150 passengers/minute

### 3.6.6 Passenger Handling Capacities

These are expressed in tabular form based on 3.5 above:

	MPC	Entrances to Concourse 60% MPC	Concourse to Platform 80% MPC	Escape 90% MPC
Walkway (Uni-directional)	88	52	70	79
Walkway (Bi-directional)	70	42	56	N/A
Stairs and Ramps Steeper Than 1:25 (per 1000mm width)				
Uni-Directional				
Up	63	37	50	57
Down	70	42	56	63
Bi-Directional				
Up	50	30	40	N/A
Down	56	33	44	N/A
Escalators (0.75 m/s)	150	90	120	135
AFC Ticket Gates	35	N/A	28	N/A
AFC (Disabled)	7	N/A	5	N/A
AFC (Free Wheel)	N/A	N/A	N/A	37
Swing Gates (for staff and emergency) 1200mm wide	105	63	84	94

### 3.6.7 Passenger Flows

- a) To facilitate passenger handling, separation between incoming & outgoing passengers at entrances will be by a central barrier and/or by escalators up and stairs down arrangements.
- b) Similarly concourses are divided in such a way that entrance to the paid area

is to one side of the passenger handling facilities and the exit to the other, thus reducing cross circulation to a minimum. The differing proportions of arriving and departing passengers in the morning and evening peaks may be catered for by reversing the direction of certain escalators and ticket gates, whilst still maintaining the integrity of the basic passenger flow.

- c) Passenger flow was designed, where convenient, to be on the left. Cross flows and changes in direction was minimised. Obstructions, such as columns and barriers, are located away from the main passenger flow. Access points between concourse and platform are evenly distributed along the platform, to minimize the walking distances for outgoing passengers and to facilitate an even distribution of passengers waiting on the platform and boarding the train.
- d) Public spaces are planned to provide open spaces allowing surveillance by station staff either visually. Narrow passageways, dead ends and visual obstructions shall be avoided.

### 3.6.8 Emergency Evacuation

- a) The requirement is to evacuate people from a station platform to another location, initially the next level below and then on to street level without hindrance.
  - 1. The principles followed are:
    - a) The total evacuation time for the movement of all passengers from platform level to the landing at the next level shall not exceed 4.5 minutes.
    - b) The total number of passengers to be evacuated is the equivalent to a full train load of passengers plus the maximum number of waiting passengers on the platform. For the emergency evacuation a full 4-car train load of about a thousand passengers shall be assumed. Trains may operate with different headways or frequencies up to 2035. Operational criteria need to be checked and determined for design years and calculations made for optimum capacity
    - c) The number of passengers waiting on a platform to be evacuated shall be taken to be the design headway for each of the design years multiplied by the fifteen minute peak demand passenger forecast.
    - d) The capacity of escalators, stairs and AFC gates in emergency evacuation conditions shall be taken as 90% of the Maximum Practical Capacities.
    - e) Escalators running against the escape flow are assumed to be stopped and are used as 1000mm wide staircases
    - f) The escalator running in the direction of escape at each level shall be deemed to be out of order and shall not be included in the escape

calculations.

- g) The maximum distance to an exit route on the platform shall be 50 metres.
- h) The time required to walk from the furthest point on a platform to the escalator or stair landing must be considered. Walking speed is 1 meter/second.
- i) A check shall be made to ensure that sufficient capacity exists at the level to which passengers are evacuated as being a place of ultimate safety so that people can move freely away from stairs and escalators as they arrive.
- j) The escape route capacity including stairs, escalators and passageways shall not be constricted along the exit route at any point.
- k) The emergency occurs in one direction of travel only
- l) All levels of the Station Areas and Escape routes out of the station are considered Places of Safe Passage capable of providing and maintaining safe conditions for evacuation from a fire at another level.
- m) There shall be no escape from a Station Area through any area not under the direct control of LRTA. Escape via Integrated Entrances from possible adjacent developments is not an acceptable escape route.

b) Calculation Method

Maximum Total evacuation time = 4.5 minutes

$$\text{Total Time (Minutes)} = \frac{\text{Train Load of Passengers} + \text{Waiting Passengers}}{\text{Available Capacity}}$$

$$\text{Available Capacity} = [(E(\text{move}) - 1) \times E(\text{ec})] + [E(\text{stop}) \times S(\text{ec})] + [Ws \times S(\text{ec})]$$

Where:

- E(move) = Number of escalators moving in the direction of escape
- E(Stop) = Number of escalators moving against the direction of escape that are stopped and used as 1000mm wide staircases
- Ws = Total width of staircases available for escape
- E(ec) = One minute Escape capacity of an escalator
- S(ec) = One minute Escape capacity per metre width of staircase

3.6.9 Concourse Barrier Gateways

- a) Gates shall be provided at the barriers enclosing the Paid area. At least one gate is installed at the end of each major array of Ticket gates. A minimum clear opening of 900mm is provided and the gate opens in the outward direction from the Paid area. These gates are to be opened in the event of an

emergency and be included in the escape capacity calculations.

- b) The total number of barrier gates required in the concourse will depend on the requirements for Emergency escape.

### **3.7 Platform Design Standards**

#### **3.7.1 General**

- a) Length

For the purposes of an initial design, the E.E. Platforms shall be 100 meters long (between the face of Head-wall and Tail-wall units). This allows for the length of an 4-car train and a stopping tolerance for the E.E. Platforms.

- b) Width

The nominal platform width measured from the platform edge to any continuous (longer than 2000mm) fixed structure shall be a minimum of 4000 mm. The minimum distance from the platform edge to any isolated obstruction, e.g. columns, shall be 3500mm (an isolated obstruction shall not be longer than 2000mm). This clearance shall be maintained for safety reasons, irrespective of passenger loading. No provision for installation of Screen Doors or barriers along the edge of station platform will be required. Towards the end of the platform, clear of any main circulation areas, platforms may taper, but in no case shall they taper to a width of less than 2500mm. Platform widths greater than the minimum may be required at stations with large passenger flows. The platform edge shall have a safety margin of 600mm wide with a non-slip surface and a yellow warning strip of 100mm wide of contrasting texture. The platform ends shall be provided with a 1200mm wide security gate and be installed with a Pressure Mat Alarm System.

- c) Features

A 1600mm wide stair shall be provided at each end of the platform leading to the track bed. Each Platform shall have a Head-wall Unit and a Tail-wall Unit located adjacent to the ends of the train. They are for the use of train drivers, train and station staff, and shall contain designated installations and equipment. For planning purposes, the size of the recess is 1200mm wide by 850mm deep.

The platform nosing shall be level with the cells of the design train doors of the rolling stock under normal conditions and for design purposes this shall be taken as 1080mm above rail level.

Platforms shall be laid to a fall of 1:100 from the platform edge for a distance of 4000mm towards the back of the platform.

A 2000mm wide continuous membrane shall be installed under the floor finishes as a platform edge electric insulation.

Markings on the platform to assist and control the flow of passengers

boarding and alighting the trains shall be provided.

A tactile floor strip shall be incorporated within the platform area for the blind and partially sighted.

### 3.7.2 Basis of Calculations: Station Capacity Assessment Guide

A platform functioning as a waiting area for trains is divided into functional zones, and each zone has width requirements:

- **Waiting Zone**—should be sufficiently sized to accommodate all waiting passengers at a maximum average peak minute density of  $0.65\text{m}^2$  per person per carriage block of the platform

$$\text{Waiting Zone Block Width} = \frac{\text{Block Loading} \times 0.65\text{m}^2/\text{pax} (\text{m})}{\text{Block Length}}$$

- **Circulation Zone**—provides the space behind or in front of the waiting zone for passengers to move to and from the platform without being encumbered by waiting passengers or those boarding or alighting train services

$$\text{Circulation Zone Width} = \frac{\text{Peak Minute Flow} (\text{m})}{40}$$

40

Minimum width of circulation zone is 1.0m, allowing space for two flows to pass, single line.

Typically, passengers/pedestrians will keep about 150mm distance from walls and columns indoor environment.

- **Activity Zone**—includes variety of space including but not limited to: seats for waiting passengers, retail units, ticket machines, timetables, and advertising space. A minimum of 0.30m should be incorporated for this zone to reflect the fact that some customers choose to wait leaning against the wall at the back of the platform.

Terminal Station Center Island Platform: some may not have the requirement for a waiting zone as passengers wait at the concourse before being directed to board. The platform width is driven by the maximum volumes of flow along them.

$$\text{Platform Width} = \frac{\text{Peak Minute Flow} + \text{Friction Effect} (\text{m})}{40}$$

40

- **Peak Minute Flow:** maximum two way flow passing along the busiest section of the platform, which includes the people passing along it but not using it to board or alight train services.

In the absence of any data, it should be estimated as 50% of the maximum load of the arriving train plus, plus 20% of the maximum load of departing train. A friction effect of 0.50m should be added to each platform edge to reflect the door opening may represent obstacle to flow and passengers tend to avoid walking too close to the platform edge.

### 3.7.3 Platforms General Principles

Element	General Principle
Platform Length	4 car train length plus allowance for inaccurate stopping of 5m
Single Side (speed less than 165 km/h)	Not less than 2.50m wide
Center Island (speed less Than 165km/h)	Not less than 4.00m wide
Columns/Obstructions	Should be at least 2.0m clear of platform edge
Headroom	At least 2.5m to structures and platform signs for width of at least 2.0m from the platform edge over the entire length. At least 2.3m for distances greater than 2.0m from the platform edge

#### 1. Factors to Consider When Establishing the Length of Platforms

The platform length is 93.2m plus 3.4m x 2 (margins at both ends) = 100m. This length is based on 4 car trains operating on the system. For access/egress on the platform, the length could be increased to 125m

#### 2. Factors to Consider When Establishing the Width of Center and Side Loading Platforms:

- A tactile warning zone 600mm–915mm wide is to be provided at the platform edge.
- A desirable minimum 2500mm of clear space should be provided between the edge of the platform and obstructions such as equipment, stairs, escalators, railings, and structural columns. The absolute minimum clearance is 1700 mm.
- For center loading configuration shelters, equipment and amenities are to be placed in the center portion of the platform.
- For side loading configurations shelters, equipment and amenities are to be placed adjacent to the back wall.

#### 3. Abnormal Conditions

Element	Perturbation	Evacuation	Construction	Special Events
Passageway (1way)	65 pax/m/min	80 pax/m/min	65 pax/m/min	65 pax/m/min
Passageway (2way)	50 pax/m/min	N.A.	50 pax/m/min	50 pax/m/min



Element	Perturbation	Evacuation	Construction	Special Events
Stairway (1way)	43 pax/m/min	56 pax/m/min	43 pax/m/min	43 pax/m/min
Stairway ( 2way)	35 pax/m/min	N.A.	35 pax/m/min	35 pax/m/min
Escalator	110 people	120 people	110 people	110 people
Concourse Accumulation Area	0.45m <sup>2</sup> /pax	N.A.	0.80m <sup>2</sup> /pax	0.80m <sup>2</sup> /pax
Platform Waiting Area	0.28m <sup>2</sup> /pax	N.A.	0.45m <sup>2</sup> /pax	0.45m <sup>2</sup> /pax
Platform Circulation Route	65 pax/m/min	80 pax/m/min	50 pax/m/min	50 pax/m/min
Ticket Gates	25 pax/gate	50 pax/gate	25 pax/gate	25 pax/gate

Service Perturbation: a significant delay to the service leading to increased waiting in the station environment (platform or concourse).

Where train service is 7 to 11 trains per hour, the busiest 15 minute period should be used.

In case of 15–30 minute delay with probable recovery, physical control measures are:

- No obvious movement of people other than in area 3 meters from building walls
- Potential opening of gates due to barrier line congestion (with loss of revenue)
- Removal of retain seating area
- Stop/reverse escalators to slow number of passengers coming into concourse level

#### 3.7.4 Other Information

Platform widths shall be determined to cater for the greater of the following scenarios:

a) Normal Service

The Platform width shall be determined by multiplying the peak minute flow by 0.65 sq. m/person and 5 minute head-way, then dividing by the platform length.

b) Delayed Service

The Platform width shall be determined by the peak minute flow, allowing for two missed head ways or passengers accumulated during 3 train Intervals, at 0.2 sq. m/per person, including alighting passengers from a crush loaded train.

For an island platform, the area between the boundaries of the two platform faces can be included in the calculation.

Space occupied by stairs, escalators, structure, seating, platform supervisor's accommodation etc., is not to be included as part of the platform area.

Normal operating conditions require a reservoir of space for passengers waiting for a train. An average area of 0.5 square meter per passenger is considered desirable under these circumstances. The required platform width for the design peak condition is calculated as follows:

For platforms without Platform Screen Doors

$$\text{Required platform width} = \frac{0.6 + (F \times SI \times 0.65)}{PL}$$

PL

where: F = the peak one minute flow of boarding passengers entering onto a single platform (i.e. wishing to travel in a given direction)

SI = service interval (minutes)

PL = Platform Length

This formula is based upon the assumption that a 600mm wide zone adjacent to the platform edge will remain unoccupied when there is no train at the platform.

### 3.7.5 Minimum Widths

The minimum acceptable platform width shall also be checked for emergency conditions against the following design criteria:

- a) A delay in service of 2 missed headways amounting to minutes is assumed in one direction in the peak hour. Therefore 3 headways of accumulated passengers are gathered on the platform.
- b) A full train load of passengers is required to disembark onto the same platform as the accumulated boarding passengers
- c) An average of 0.2 square meter per passenger is acceptable under such emergency conditions
- d) The train will not move from the platform until passengers have begun clearing the platform and hence the 600mm unoccupied zone adjacent to the platform edge for platforms without Platform Screen Doors need not be allowed for.

$$\text{Thus the Required Platform Width} = \frac{[(3SI \times F) + TL] 0.2}{PL}$$

Where: SI = Service Interval (minutes)

F = the peak one minute flow of boarding passengers

entering onto a single platform (i.e. wishing to travel in a given direction)

PL = Platform Length

TL = Train Load of Passengers

### 3.7.5 Other Features

- a) The track alignment through a station shall preferably be straight and level. However, consideration may be given to using horizontal curvature where required. Each location shall be judged individually.
- b) An under-platform refuge shall be provided below the cantilevered portion of the platform for the full length of the platform. The minimum horizontal width from the side of a train to any obstruction shall be 600mm and the full height from the track slab to the underside of the platform shall be available.
- c) Manhole access shall be provided into any under-platform cable or duct compartment
- d) Drains shall be provided in all voids under platforms, where applicable.
- e) A Platform Supervisor's Booth shall be provided on each platform. The box shall have glazed windows all around and the two boxes on an island platform may be combined where appropriate. The size shall be 10 sq. m for side platforms and 15 sq. m for island platforms.
- f) A Train Operator's toilet shall be provided at terminal station platforms and at others as may be designated by the Engineer. The toilet shall include WC, basin, mirror, soap dispenser, paper towel dispenser and waste paper bin unit.
- g) Space for fire hydrants, fire hose reels, communications equipment, paging equipment, lineside advertising panels, and commercial communications facilities, shall be provided as required for
- h) Fire Services, operational and commercial requirements.
- i. Passenger access points shall be arranged to encourage the distribution and collection of passengers evenly along the whole of the platform length. If required, access points may be offset from station to station to provide an even loading of passengers in the trains.

### 3.7.6 Clearances

- a) 100mm minimum depth shall be allowed for the provision of any screed and finishes on the platform. The structural clearances above the platform finished floor level shall generally be determined by clearances above the running rail for kinematic envelope. The minimum ceiling height above finished floor level shall be 3000mm and a 2500mm clearance shall be maintained to any obstruction (signs, etc.). For design purposes the platform edge shall be taken as being 1080mm above the rail level (assuming no cant over the length of the platform) and 1700 mm from the centre line of the track

for straight track stations. Adjustments for horizontal clearance will be required for curved track. The final dimensions should be checked against the existing rolling stock and its kinematic envelope.

- b) Adequate weather protection shall be provided for all elevated structures, and electrical facilities, in particular.

### 3.7.7 Seating

- a) A minimum of four banks of three seats shall be provided along the length of each platform away from the main passenger circulation areas. In the case of an island platform, consideration shall be given to locate some of the seats in the central area.
- b) The length of each bank of seats shall not exceed 2000mm and the top shall be fixed at a height of 400mm from the finished floor.
- c) Where possible, the seats shall be cantilevered from a back wall to facilitate floor cleaning. The projection from the wall shall not exceed 500mm.

## 3.8 Concourse Design Standards

### 3.8.1 General

The concourse shall be split into two distinct areas; the ticket hall or unpaid area where passengers digest travel information, and purchase tickets before proceeding into a paid area from which access is made to the platform level.

### 3.8.2 Concourse Size

- a. The size of the concourse is dependent on the passenger handling arrangement, the entrance locations and the space requirements for offices and electrical and mechanical plant at individual stations. The layout of the concourse is mainly determined by the location of station entrances and the siting of the access points to the platform. General standards are:
  - i. Where more than one concourse area is planned then the paid areas are connected to allow both station staff access to both areas and the passenger an alternative means of exit.
  - ii. Public facilities in the concourse shall be located clear of the main passenger flow routes.
- b. The size of the concourse which shall be needed to accommodate the design passenger flows shall vary with the number of ticket halls, paid areas, and the way in which the primary concourse elements are arranged. This depends in turn on escalator and staircase requirements and the location of the entrances.

### 3.8.3 Access and Space

- a) Within the concourse area the station ticket hall shall provide adequate space for passenger circulation and direct flow lines between ticket counters and AFC gates. Space shall be allowed for passengers' decision making and the provision of public facilities and ticket counters.

- b) The paid area shall give direct and clearly defined access to the platforms via escalators, lifts and stairs. Any public facilities in the paid area shall be located away from the direct route to the escalators and stairs.
- c) A lift for passenger use, particularly the disabled and for first aid and minor casualties shall be provided between platform and concourse. A similar facility shall be provided between concourse and street level in association with at least one principal entrance.
- d) All stations must have at least one staircase extending from the concourse to the platform level. This staircase must be located within the paid area in order that it may be used when an escalator is out of service and during emergencies.

#### 3.8.4 Vending and Telephones

- a) Space within the concourse area shall be made for free standing Automatic Teller Machines (ATMs ), vending machines, payment express terminals, photo booths, TV booths, free standing and/or wall mounted advertising panels.
- b) Space shall be provided for commercial kiosk facilities within the unpaid area which, during a period at the opening of the system, can be utilized as temporary ticket offices until such time as stored value tickets have become an accepted concept and the number of ticketing counters provided can cope with the predicted demand. The location of the kiosks/temporary ticket offices shall therefore take into account their initial and intended future use.

#### 3.8.5 Clearances

In all areas a minimum ceiling height of 3000mm shall be adopted with a minimum height of 2500mm to the underside of local obstructions such as signage. Electrical and Mechanical installations and service routes shall be contained above the minimum 3000mm ceiling height, and allowances for these services shall be taken into account.

Minimum finished floor level to Structural Ceiling	4500mm
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This is made up of:

Allowance for cables, ducts etc.	1000mm
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Allowance for suspended ceiling, fans and light fittings	200mm
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Finished Floor to underside of suspended ceiling	3000mm
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A floor finishes zone of 200mm shall be provided. The floor finish shall contain all necessary floor cable trunking for the provision of Ticket machines and ticket gates associated with the Automatic Fare Collection system.

#### 3.8.6 Security

Means of securing and closing the station at concourse level needs to be provided either at the station entrances themselves or at the concourse in the area of the

ticket gates. Crowd control means will be provided at entrances but provision may need to be made to allow entrances and concourse unpaid areas to be used for public access outside normal railway operational hours.

### 3.8.7 Acoustics

Due consideration shall be given to the acoustic environment of both the platform and concourse public areas with particular reference to the design and performance of the public address system.

## 3.9 Entrances

### 3.9.1 General

Station entrances provide the link between the station concourse and the surrounding streets, and their locations must reflect the separate constraints of both. They may also cater for inter modal interchange which may include bus transfer, taxi, motorised rickshaws, motorcycle and bicycle transfer, kiss and ride and park and ride facilities. Covered integrated links with such facilities may be considered if the predicted passengers warrant.

### 3.9.2 Access Requirements

- a) The position of entrances shall be determined by the juxtaposition of buildings, location of roadways, footpath width, space availability and flow directions of passenger traffic.
- b) Required entrances are to be within the right of way under the control of the LRT Line 2.
- c) Entrances at Street Level shall be easily identifiable.
- d) The widths of entrances shall take into account predicted passenger flows and available space. Entrances to stations shall have adequate capacity to satisfy predicted passenger flows and emergency evacuation requirements.
- e) Entrances to stations via developments (Integrated Entrances) are considered additional facilities and are not to be included in the assessment of minimum passenger handling or Emergency Escape facilities
- f) Each entrance shall contain a closure device for closure of the station during non-operational hours and be used as a means of crowd control.

### 3.9.3 Flood Control

- a) All entrances extending to street level must be protected against flooding. This protection shall be by the provision of a minimum of 3 steps up to a landing (+450mm minimum).
- b) The stairwell on all pavement entrances shall be surrounded by a solid concrete balustrade 1200mm high. The height of the balustrade must be checked against maximum flood conditions that could arise.

#### 3.9.4 Materials Considerations

- a) The selection of materials shall not radically depart from those used within stations and shall be robust, hard wearing and maintenance free.
- b) Floor finishes are to be laid to adequate falls in order to allow for the occurrence of any seepage, rainwater (from foot traffic), washing water, etc. Drainage provisions, including sumps and pumping facilities shall be included.

#### 3.9.5 Integrated Entrances

- a) An integrated entrance is an entrance incorporated within a development and may not be under the direct control of the LRTA. It shall not form part of the required exit route for station, concourse or the development, and shall not be included in capacity calculations.
  - i. Fire Precautions

All provisions with respect to the fire safety of the station and the development shall be agreed with the Fire Services who may require specific safety requirements at particular locations. However, as a minimum the following provisions shall be incorporated into the design.
  - b) A positive break in the form of a fully ventilated open well shall be provided between station exit routes and integrated entrances. The open well shall give access directly to open air and be enclosed by imperforate four-hour FRP walls during its passage through the development. It shall be ventilated by natural means and with exhaust fans, if natural ventilation means are not available. The cross sectional area of the well shall not be less than half that of the station entrance passageway. The effective cross-sectional area of the discharge point of the well shall not be less than that of the well.
  - c) The four-hour fire separation lobby shall not be used for any other purpose. Four hours separation by means of walls, floors and smoke/heat operated shutters shall be maintained between the railway and the development. The fire shutters shall have audible and visual alarms and the signals shall be relayed back to the Station Control Room.

#### 3.9.6 Entrances in Developments

- a. Entrance structures within a development must be designed in such a way that the use of the entrances is not adversely affected by any future redevelopment of the building structure.
- b. Entrances must be separated from the development by four-hour FRP structure up to the discharge point of the entrance onto the footpath.
- c. Flood protection, as required for all standard station entrances is to be provided.
- d. Any incidental water, as itemized in Clause 6.3, shall be similarly catered for.

#### 3.9.7 Development Entrances under the control of LRTA

- a) Where a horizontal or vertical entrance to an Integrated Commercial Area is

provided and this is under the direct control of the LRT Station Management, it may be used as part of an escape route in the event of a fire. The Integrated Commercial Area will need to be designated as a Place of Safe Passage and will therefore come under stringent Fire Precautions and the design will be agreed on an individual basis.

### **3.10 Escalator, Stair and Lift Design Standards**

#### **3.10.1 Street and Concourse Requirements**

- a) Stairs shall be provided for both upward and downwards movement. The rise of the stairs shall preferably be limited to 3500mm. Site conditions may cause an increase in this dimension.
- b) For the benefit of the disabled, all stations must contain at least one entrance where access can be obtained without the use of an escalator. If possible two entrances (one at each end of the station) shall contain stairs. Additional consideration to ensure unaided accessibility by the disabled is defined in the section relating to the Design for the Handicapped.

- i. Use of Escalators

Where there is a rise in the lower portion of less than 3200mm, an escalator shall not normally be provided. Thus, where the total rise from street level to concourse is less than 6700mm, escalators shall normally only be provided where they can be arranged to ascend directly from street level. If the total height difference from street level to concourse is greater than 10000 mm a down escalator shall also be provided in the lower portion.

For greater rise heights, the entrances shall be divided into two portions. The upper portion shall consist of stairs for both up and down movement, the lower portion shall consist of an escalator for upward movement and a staircase for downward movement.

Where entrances contain down escalators, in addition to up escalators, an auxiliary stair shall be provided if possible.

When down stairs parallel up escalators, their width shall not be less than 2000mm except that the width of an auxiliary stair may be reduced to 1800mm.

A staircase taking traffic from an escalator must be of sufficient width to provide capacity at least equal to the escalator, e.g. the incoming stair in the upper portion of an entrance taking traffic from an up escalator shall be not less than 2400mm wide.

Where escalator(s) are provided in the lower portion, the landing between the upper and lower portions shall not be less than 8500mm free length from the escalator working points. If the entrance is angled there shall be not less than 5000mm straight from the working point, but if there is a choice of direction not less than 8500 mm.



ii. Other Requirements

Where the width of the staircase is 4500mm or more a center handrail shall be provided on the stairs (but not the landings)

Where down staircases are parallel to escalators, the first riser shall preferably be positioned one tread width from the lower EWP towards the upper EWP, but the total rise may dictate otherwise.

Entrance/ exit stair or escalator shall have enlarged roof or rain canopy at street level (or open air) to give a greater passenger waiting area.

3.10.2 Concourse/Platform Requirements

- a) Where possible, the escalators shall be evenly distributed along the whole length of the station so as to avoid a concentration of passengers at a particular area. An escalator working point shall preferably be not less than 12000mm from any obstruction across the direct path of passengers, and in no circumstances less than 11000mm. Where escalators are arranged in banks, the clear distance from the escalator working point shall be increased by at least 1000mm for each additional escalator. Traffic flow across the path of passengers is deemed as an obstruction.

i. Safety

The combined capacity of stairs and escalators must be capable of satisfying the emergency evacuation requirements or normal passenger handling requirements, whichever are the greater.

The distance from escalator working points to ticket gates shall be not less than 12000mm.

A smoke containment bulkhead, extending 3000mm from the finished floor level to the structural soffit, must be provided at the foot of all stairs and escalators serving the platform level.

ii. Dimensions

In paid areas escalators shall be used where the height difference is greater than 2500mm.

All stations must have at least one designated staircase, minimum 1800mm wide, from the lowest to the highest levels.

The minimum distance between working points of escalators working in opposing directions is 25000mm.

iii. Other Requirements

Where a staircase is parallel to an escalator the first riser shall preferably be positioned one tread width from the lower EWP towards the upper EWP, but the total rise may dictate otherwise.

Where possible, passengers shall not have to travel from one passenger level to the next by more than one escalator.

No access shall be allowed from public stairways to plant-room areas.

### 3.10.3 Lifts for the Disabled

- a) Lifts shall be provided for the ambulant disabled to gain access from the street level to the concourse and then to the platform levels. The lift shall not by-pass the paid area gate-line, therefore, it will be necessary to have more than one lift. Ramps shall be provided where a change in level is not negotiable by lift.
  - i. The lifts serving the street level shall be weatherproof and flood protected with fire rated separation from any adjacent development areas.
  - ii. These lifts shall be available for use by the Disabled and by any other passenger.

### 3.10.4 Escalators

- a) All escalators shall be of the heavy-duty reversible type with a design maximum practical capacity of 150 persons per minute based on a service speed of 0.75 m/sec.

- i. Criteria

The following requirements are given for planning purposes:

Inclination	30 degrees
Step speed	0.75 m/s
Step width (min)	1000 mm
Number of flat steps at upper landing	5 (min)
Number of flat steps at lower landing	4 (min)

- ii. Headroom above escalator step

The following minimum dimensions shall be provided:

Minimum vertical clearance from	
step nosing line to soffit of structure	2750mm
Clear headroom from step nosing	
line to finished ceiling	2500mm (2300mm min)

- iii. Side Clearances of the well-way structure

Single and parallel escalators

Vertical Rise	Distance from escalator center line to:	
	Center Line of Adjacent Escalator (mm)	Face of Wall (mm)

Below 10000 mm	2200	1350
From 10000 mm to 15000 mm	24003	1650
From 15000 mm to 20000 mm	2600	1650
Above 20000 mm	2700	1850

#### Criss-crossed Escalators

Vertical Rise	Distance from escalator center line to	
	Center Line of Adjacent Escalator (mm)	Face of Wall (mm)
Both Escalators with rise below 10000 mm	2900	1350
One Escalator with rise below 10000 mm and the other with rise above 10000 mm	3200	Rise > 10000 mm: 1650 Rise < 10000 mm: 1350
Both Escalators with rise above 10000 mm	3500	1650
Both Escalators with rise above 20000 mm	3900	1850

The Side Clearance Standards shall be used for design purposes. In circumstances where it is not possible to achieve this standard and/or where some variation to the above standards in specific local areas would facilitate the design, reduced clearances may be accepted by agreement.

The Side Clearances Standards apply for the entire length of the well-way.

For any other special arrangements not covered in the above tables, the well-way design shall be referred to the LRT for further details.

#### iv. Side Clearance on Passenger Side

Minimum distance from the escalator center line to the inner surface (finished dimension) of the surrounding parapet wall or any fixed obstacles	1000mm
Clear height over the above distance	2300mm(min)
Parapet wall height surrounding concourse/	

platform escalators at upper landing 1165mm (min)

Where the escalator passes through a floor and the horizontal distance from the centre line of the nearer handrail to the ceiling or slab soffit is less than 550mm the intersection must form a straight vertical surface of not less than 450mm in height to avoid any wedging hazards.

v. Headroom in Machinery Spaces

Installation with Drive Motor below Escalator truss: Headroom at the upper machinery space, defined as the vertical distance from finished floor level at the escalator landing to the upper surface of the machine room floor slab, shall be a minimum of 3500mm

Installations with Drive Motor behind Escalator Truss: Headroom at the upper machinery space, defined as the vertical distance from the soffit of the slab incorporating the escalator landing to the upper surface of the machine room floor slab, shall be a minimum of 2300 mm

Headroom in the Lower Machinery Room Spaces: The clear height from the upper surface of the base slab of the lower machinery space to the soffit of the structure slab incorporating the lower escalator landing shall be a minimum of 2100mm. Minimum clearance under down stand beams to be 1800mm

vi. Size of Machinery Spaces

Upper Machinery Space:

- For installations with drive motor below escalator truss: The distance from the Escalator Working Point (EWP) to the inner surface of the end wall shall be a minimum of 6000mm.
- For installations with drive motor behind escalator truss: The distance from the EWP to the inner surface of the end wall shall be a minimum of 8500mm.

Lower Machinery Space:

The distance from the EWP to the inner surface of the end wall shall be a minimum of 6000mm. If possible it is desirable to increase this dimension to 6500mm.

vii. Slab Below Escalator Truss

An inclined slab shall be constructed below the escalator truss to provide necessary fire separation. Steps shall be formed on the upper surface of this slab along the sides of the truss. The perpendicular clearance between the underside of the truss and the nose line of the steps shall be 850mm minimum. However, in restricted circumstances a minimum of 500mm shall be permissible.

viii. Lifting Facilities over the Escalator Well-way for Installation

Cast-in sockets shall be provided at suitable locations for the installation of escalators. This will be required for the initial installation of the escalators during the construction of the station and for the future installation of escalators at previously determined locations.

ix. Escalator End and Intermediate Supports

The end supports shall be designed to the information given by the escalator manufacturer. Escalator truss trimming angles and bearing plates will be supplied by the escalator manufacturer.

Intermediate supports shall be provided where the vertical rise exceeds 5000mm.

x. Alternative Machinery Housing

The above clauses related to machinery housing may not be applicable in certain public areas due to a requirement to achieve a particular desired architectural feature. In such cases, the sizes of the machine chambers and escalator pits shall be to LRT approval and to an approved manufacturer's specification.

xi. Other Related Works

Suitable railing or other appropriate means shall be provided around the gaps between escalators or between the escalator and adjacent walls to avoid the danger of falling.

Suitable sealant shall be applied at the junction of the escalator decking and finished walls, and to skirting panels at the finished floor.

A drainage outlet or sump shall be provided in all escalator pits for the removal of water.

A flood landing of minimum 450mm height for all escalators terminating at street level shall be provided to protect against localised flooding.

### 3.10.5 Stairs

a) These standards refer to all stairways used by the public including auxiliary staircases. All staircases shall comply with local regulations

i. General Requirements

All treads, nosings and intermediate landings shall have non slip surfaces.

All stairs shall be provided with handrails on both sides. Where the width exceeds 2400mm a central handrail shall be installed. A central handrail may also be considered elsewhere where crowd control and passenger flows dictate. The handrail shall extend a minimum of 600mm beyond the bottom riser and 300mm beyond the top riser.

ii. Design Parameters

Continuous flights of stairs for use by the public shall have the following

design parameters:

Risers per flight	3 No (minimum) 14 No (preferred maximum) 16 No (absolute maximum)
Height of riser (subject to pitch)	150 mm (absolute minimum) 160 mm (preferred maximum) 170 mm (absolute maximum)
length of tread (subject to pitch)	280 mm (absolute minimum) 300 mm (preferred) 340 mm (absolute maximum)
Intermediate landing width	1500 mm (absolute minimum) 2000 mm (preferred)
Stair width Unidirectional Bi-directional	2000 mm (desirable) 1800 mm (absolute minimum) 2400 mm (absolute minimum)
Length of intermediate Landings	Lesser of 2000 mm or width of stairs with absolute minimum of 1800 mm.
Length of Flood Landing	2500 mm
Vertical Clearance	2700 mm (min.) measured from the finished step level (on line of nosings) to underside of suspended ceiling 2350 mm (min.) measured from finished step level to underside of signs.
Height of Balustrade	1165 mm
Handrail	850 mm high, 50 mm diameter 45 mm clearance between handrail and inside balustrade or wall finish.
Falls at entrance stairs	Flood landings are to fall 1:100 towards the street with side channels. Intermediate landings are to fall towards the concourse.

Staircases fed by an escalator shall be made sufficiently wide to provide capacity at least equal to that of the escalator.

The width of a staircase shall be measured from the finished surfaces of the inside faces of the balustrades or staircase walls. The only projection permissible will be the handrail.

No open risers shall be allowed.

### 3.10.6 Lifts

The following design parameters are listed to facilitate initial station planning only. All dimensions must be adjusted to suit the sizes of equipment and maintenance requirements

#### a) Lift for the Disabled / Casualty

Width Depth Height	Internal car dimensions	1500mm 2500mm 2300mm
Width Height	Minimum car and landing opening	1300mm clear (2 panels opening) 2100mm clear
Width Depth	Lift well approx. size	2450mm or 2100mm 3200mm or 2450mm
Hydraulic & Traction Lift	Headroom in lift well from top landing	4400mm minimum
Up or down	Speed (fully loaded)	From 0.6 to 1.0 m/s depending on the depth of the station box.
Lift Speed 0.6 m/sec 1.0 m/sec		Pit Depth 1500mm 1900mm
Dimensional requirements for a glazed lift may differ from the above. The Lift designer/manufacturer shall be consulted for requirements related to a glazed lift shaft and lift car.		
Handrails of 45mm to 50mm outside diameter suitable for use by the disabled shall be provided at the rear and sides of the car. They shall be mounted 850 mm above the car floor and extend to within 150mm of the corners		
Landing and car control buttons shall be fixed within 900mm to 1200mm above the landing or car floor. The distance from the front wall shall be at least 400 mm. Suitable tactile indications, identifying the level shall be placed adjacent to the control buttons.		

A 2-way communication panel shall be installed adjacent to the lift landings as call points to enable the rapid and unambiguous identification of those levels with disabled persons requiring evacuation.

b) Lift Type

All lifts shall preferably be of the traction type, hydraulic lifts shall be used where the machine room cannot be located directly above the lift shaft.

The disabled lifts shall also comply with relevant statutory design requirements on access for the disabled.

c) Emergency Doors

When the distance between consecutive landing doorsills exceeds 11000mm, intermediate lift shaft emergency doors shall be provided, so that the distance between sills is not more than 11000mm. The emergency doors shall preferably be identical to normal lift landing doors with the same clear height and width. Otherwise, it shall have a minimum clear height of 1800 mm and a minimum clear width of 500mm.

d) Ventilation of Shaft

A ventilation opening shall be provided at the top of the lift shaft. This opening shall have a minimum net free area of 0.15 sq. m or 1% of the horizontal cross sectional area of the lift shaft, whichever is the larger. The opening shall vent to the open air directly or via ducting or the lift machine / pulley room.

e) Inspection Trap

For hydraulic lifts only, an inspection trap shall be provided for maintenance access to the over-speed governor installed inside the lift shaft. This trap shall have a clear opening size of 750mm x 750mm and shall be located in the wall near the top of the lift shaft. Permanent means for access to this trap from outside the lift shaft shall be provided.

### **3.11 Design for the Handicapped**

#### **3.11.1 General**

In 1998, The Central Public Works Department of the Ministry of Urban Affairs and Employment, India published a document titled "Guidelines and Space Standards for Barrier Free Built Environment for Disabled and Elderly Persons." The principles outlined in this document shall be incorporated into the design of the stations. This document sets out background information, advisory information and mandatory standards for the overall guidance of designers relevant to various disciplines.

The whole of the document shall be applied as appropriate to the design of the stations and associated areas. Of particular interest is Chapter 16 devoted to Railway Stations which is quoted as follows:



### 3.11.2 Approach to Station

The approach should not have a difference in level. If a level difference is unavoidable, install a ramp or a ramp plus staircase.

(The ramp should comply with the guidelines for “Ramps” and the stair should comply with those for “Steps and Stairs”)

### 3.11.3 Paved Surfaces

#### a) Platform Entrances and Exits

- The station entrance/exit should not have a difference in level. If a level difference is unavoidable, install a ramp or a ramp plus staircase.
- (the ramp should comply with the guidelines for “Ramps” and the stair should comply with those for “Steps and Stairs”)
- It is desirable that space be marked out near the entrance/exit for vehicles carrying wheelchair users.

(For other details about parking lots, see “Parking Space”)

#### b) Reservation or Information Counters Reservation or information counters should have unobstructed approaches for wheelchair users. Counter heights should not be in excess of 850mm.

#### c) Concourse

- The width of the concourse should be at least 1800mm
- The concourse should not have a difference in level. If a level difference is unavoidable, install a ramp or a ramp plus staircase.(The ramp should comply with the guidelines for “Ramps” and the stair should comply with those for “Steps and Stairs”)
- The floor surface of a concourse should be made of non-slip material. At places, where the difference in level such as stairs, it is desirable that the appearance of the surface material be changed using colour contrast.
- Ensure that columns, signboards, and other fixtures do not protrude from wall surfaces (See “Protruding Objects” ref. Page No.33)
- Install guiding blocks on the concourse for persons with impaired vision (see “Guiding Blocks” Ref. Page No. 46).

#### d) Stairs

- For details, see the guidelines for “Steps and Stairs”

### 3.11.4 Lifts (Elevators)

Supply and Install a lift (elevator) as a means to enable passengers with disabilities to move between floors. For the lift (elevator), install two guiding blocks for persons with impaired vision 300mm away from the call button. For other details, see “Lifts”

### 3.11.5 PWD Toilet

Install a toilet and washstand suitable for use by wheelchair users and other passengers.

### 3.11.6 Ticket Gates

- a) At least one of the ticket gates should be wide enough to allow wheelchair users to pass through easily.
- b) One of the ticket gates should have a continuous line of guiding blocks for persons with impaired vision.
- c) For other details, see “Guiding Blocks”

### 3.11.7 Platforms

- a. The platform should have one row of dotted guiding blocks for persons with impaired vision, 800mm or more from the edge.
- b. The paved surface of the platform must be made with a non-slip material
- c. Stairs, kiosks and dustbins on the platform must not hinder the clear passage of persons with impaired vision and wheelchair users.
- d. A bench should be installed on the platform, having guiding block around it.

### 3.11.8 Railway and Metro Corridor Passenger Vehicles

- a) Doors
  - Car doors should be wide enough for wheelchair users [minimum 900mm]
  - The gap between car doors and the platform should be reduced to an absolute minimum.
- b) Aisles
  - Aisles should be wide enough for the passage of wheelchair users.
- c) Wheelchair Space
  - A space for a wheelchair should be made available at the side of the door.  
The space should be indicated inside and outside the car by using the universally recognised symbol for wheelchair accessibility.
  - Install a ring-strap or other appropriate safety grip for wheelchair users to hold onto.

### 3.11.9 Information

- a) The information board should be made easily readable by using sufficiently large text size, distinct contrast and illumination.
- b) It is desirable that in addition to a printed version of train schedule, table of fares and other travel information also be in Braille.
- c) For hearing impaired persons an electronic sign board of appropriate size and height should be displayed on each platform at conspicuous location for all announcements made by the railways.

### 3.11.10 Information Signs and Announcements

- a) Install a map of train routes
- b) Announce and provide in each car a visual display of the names of stations and route.

### 3.12 Corridor and Ramp Design Standards

#### 3.12.1 Corridors

The width of corridors or passageways in public areas shall be determined by capacity requirements subject to the minimum dimensions given below:

- minimum for unidirectional movement 1800mm
- minimum for bi-directional movement 2000mm
- minimum for staff only movement 1200mm

#### 3.12.2 Ramps

Ramps shall only be used for small changes in level or for use by wheelchairs and the following gradients shall apply:

- preferred maximum gradient 1:20
- absolute maximum gradient 1:12

Ramps shall be a minimum width of 1200mm for uni-directional movement and 1500mm for bi-directional movement. Rest platforms should be considered for long ramps (exceeding 10m) provided for wheelchair users. Rest platforms should provide a level area 1800mm long at intervals of approximately 10m.

### 3.13 Passenger Amenities

#### 3.13.1 General

A number of amenities shall be provided for the use of passengers within the station. Where these involve stationary passengers then the facilities shall be located clear of the main passenger flows.

#### 3.13.2 Advertising

- a) Advertising will be an important source of revenue for the LRT but the extent of the demand for advertising will depend on market forces. Potential sites for advertising within a station shall be located so as not to conflict with the principal requirement of the provision of signage to direct passengers, especially in an emergency.
- b) There are various advertising media that shall be used both within and outside the station which include:
  - i. 3-Dimensional Advertising
    - 3D Media - large models of products or company logos

- |   |   |
|---|---|
| Display Cabinets  | - for company products  |
| ii. 2-Dimensional Electronic Advertising                                      |   |
| Light Emitting Diode  | - Newscaster, information services  |
| Neon sign   | - Company logo / product information  |
| iii. Audio Advertising  |   |
| Radio style advertising, pre-recorded and played over station/train intercom. |   |
| iv. Mechanical Advertising  |   |
| Collapsible Billboards  |   |
| Retractable Screen  |   |
| Flip-sides  | - Billboard with 3 times space, rotates when required to reveal different adverts |
| Q – Board   | - Successor to the flipside giving space for many more advertisements             |
| v. Moving Image   |   |
| TV Monitors   | - used in either single units or in blocks of screens                             |
| Holograms   | - Lasers  |
| vi. Truematation  | - 2-Dimensional   |
| vii. Directly applied   | - advertisements directly painted onto surfaces                                   |
| Superlites  | - back-lit advertisements   |
| Projection  | - still image directly projected onto screens or walls                            |
| Billboards/Posters  | - conventional media  |

### 3.13.3 Design Criteria

A combination of many of the above means of advertising may be adopted at stations. Whatever media is used it must be integrated into the station design and not be treated as an add on element at a later date. All wiring and fixings must be concealed. Provision shall be made for cast in conduit and fixings for advertising media at identified sites whether or not the media is installed at the opening of the railway. Attention shall be paid to ensuring maintenance access to these zones.

### 3.13.4 Commercial Areas within the Stations

Areas for commercial use shall be located at stations. During period upon the opening of the railway system some of these areas will need to be used as temporary ticketing offices for the sale of single and multi-journey tickets.

### **3.14 Signage and Graphic**

#### **3.14.1 General**

This particular Design and Performance Specification (PDPS) deals with the requirements for the provision of a Signage and graphics System and associated components relating to the “identification signs”, “directional signs”, “information signs” and “regulatory signs” within the stations and their surrounding environs which forms part of the scope of works of the Contractor. This Specification also define and visualize materials and workmanship requirements for bidding and construction purposes.

- a) Passenger information signs located at stations will be many and varied ranging from station entrance signs to train indicator panels and information panels.
- b) Signs are to be provided in a dual language format
- c) All signage hardware shall be of a consistent range of materials and size/proportions.
- d) Location of clock and public information system to be clearly identified

#### **3.14.2 Scope of Work**

- a) The Scope of Works shall cover the preparation of the design and supply of a complete Signage and Graphics System for the LRT Line 2 East (Masinag) Extension Project, if any, and disposing them as directed by the Engineer.
- b) The document sets down the criteria and means by which the Bidder shall fulfil his obligations. Performance criteria, where specified, shall be considered as minimum requirements for which the Bidder’s proposals shall be based.
- c) The signs shall be installed at conspicuous places at the stations for safety and directional guidance of the end users (see Signage location on Tender Drawings). The Bidder shall carefully study and consider all necessary details for providing a signage system of high standard and uniform quality.

#### **3.14.3 Interface**

##### **3.14.3.1 Coordination**

The Contractor shall coordinate and interface with Employer and/or Engineer to obtain information on the Signage and Graphics.

##### **3.14.3.2 Other Trades**

The Bidder/Contractor shall:

- a. Fully acquaint himself with the Works being carried out by Other Contractors, if any, before and throughout the design and installation of the Signage and Graphics and coordinate as necessary with others.
- b. Take particular care to comprehensively advise the Subcontractor/Agency responsible for the provision of electrical equipment, what equipment will be required to service the Signage. This will include all

necessary incidentals to the switching on and off of different signage or parts of signage as specified.

#### 3.14.3.3 Supplemental Information

- a. The Contractor shall provide the name of the sub-contractor/supplier and products which he intends to use to carry out this Works.
- b. The Contractor shall submit all relevant information and calculations sufficient to demonstrate compliance to this PDPS and for submission to the Relevant Authorities.

#### 3.14.3.4 Prototypes

- a) The Prototype installations to be provided by the Contractor shall have the minimum features, facilities and capabilities specified in this PDPS.
- b) Prototypes shall be constructed to demonstrate the appearance and operation of complete signage installations and in this respect the trial installation is required to reflect, as far as possible, the conditions and support arrangements present in a station. The prototype shall incorporate all fixings, seals, finishes, attachments, details and appurtenances to fully reflect the 'as-installed' Site condition.
- c) The prototype installations proposed by the Contractor shall demonstrate to the Engineer's satisfaction, the requirements or the following, which shall be tested.
  - i. The graphic and architectural appearance,
  - ii. The fixing principle,
  - iii. The electrical installation, and
  - iv. The illumination as specified.

### 3.14.4 Performance Requirements

#### 3.14.4.1 Life Expectancy and Maintenance

- a. The design of the equipment shall be such that replacement of parts (except lamps) shall not become necessary under normal wear and tear for a period of five (5) years from the date of completion of the work. The design life of the Signage and Graphics as a whole shall be for a period of at least 20 years. The performance criteria shall be satisfied during the full design life.

#### 3.14.4.2 Environmental Criteria

- a. The Contractor shall ensure that the Signage and Graphics System shall be fully capable of resisting the atmospheric conditions likely to occur at the installed locations.
- b. Then Contractor shall ensure that the Signage and Graphics shall withstand, without, distress or progressive deformation, the following extremes of ambient air temperatures and humidity. No condensation shall take place either on the internal surfaces or within the interstitial construction thickness of the Signage and Graphics under the following temperature and humidity conditions:

Ambient Temperature : Min +15°C –Max. +40°C

Relative Humidity : Min 60% -Max. 100%

- c. The Contractor shall design the Signage and Graphics System such that no deleterious effect shall result from direct exposure to sunlight.

**3.14.4.3 Features of Signage**

- a. Illumination requirements:

Performance	Description	Unit	Requirement
Uniformity	Ratio of min. to max. illumination	Ratio	Max. 1 to 3
Brightness	Average brightness of white foreground	Candle/sm.	Min. 500
Brightness	Average brightness of white background	Candle/sm.	Min. 20
Brightness	Average brightness of hidden message	Candle/sm.	Min. 150 – Not to be exceeded by another illuminated color. To be 0 when 'hidden'
Brightness	Relative output expressed as percentage of light emitted with reference tube and ballast	%	Min. 95
Specular reflectance	Reflector output	%	Min. 23
Reflector	Total reflectance	%	Min. 88
Reflector	Diffuse reflectance	%	Min. 78

- b. Signage and Graphics panel

Unless specified or approved otherwise, shall be as indicated in Tender Drawings.

- c. Illumination

Lamps shall be of low energy fluorescent lamps, fitted into the signage to facilitate access to the lamp chamber for replacing the lamps or maintenance to the ballast and lamp starters. It shall not be necessary to remove the sign graphic panel of the Sign to access the lamps. The illumination shall be flicker free.

- d. Moveable parts and mechanisms

The Contractor shall;

- i. Ensure all mechanisms are failsafe.

- ii. Provide safety restraints such that all movable assemblies are built-in to prevent accidental dislodgement and subsequent collapse during maintenance.
- iii. Design all movable parts and mechanisms to be maintenance-free wherever possible, or be located at positions where maintenance to these parts can be reached without dismantling the Signage and Graphics support or structure.
- iv. Ensure all Signage and Graphics allow access to internal electrical components without providing access to the general public.
- v. Provide all information/Bulletin panels to incorporate locks to removable frames and panels to prevent access by unauthorized persons.

#### *3.14.4.4 Vibration Criteria*

All Signage and Graphics elements and supporting structures shall be sufficiently rigid to avoid generation of noise by panel excitation as a result of vehicular or air movement.

#### *3.14.4.5 Fire Safety*

- a. The materials used in the Signage and Graphics elements shall conform to the following criteria:
  - i. They shall not introduce a significant fire load into the station;
  - ii. They shall have flame spread rating equal to zero (0); and
  - iii. They shall be constructed of non-combustible materials does not propagate smoke and heat emission thus producing toxic gasses.
- b. All the major supporting structures of the Signage and Graphics elements shall be of non-combustible construction.
- c. Any of the surface finish applied to the Signage and Graphic elements shall achieve a Class 1 rating. Any of the surface finishes shall also have a low smoke emission when tested to British Standard (BS) 6853:1999 – Code of Practice for fire precautions in the design and construction of railway passenger carrying trains.
- d. Where single cables are required to be installed they shall comply with requirements of BS 4066:2000 or equivalent Method of test on a single vertical insulated wire or cable. All cables used shall be of the retardant or fire resistant, low smoke and halogen free type. All cables used shall be housed in metal conduit/ducting.

#### *3.14.4.6 Abrasion Resistance*

The Signage shall also resist abrasion from cleaning methods and maintenance systems without any noticeable change in surface appearance.



#### 3.14.4.7 Safety

Passenger and LRTA/Operation personnel safety shall be a prime consideration in the design of the Signage and Graphics. In the event of an electrical fault it should be possible for authorized person to isolate the Signage by disconnecting the local electrical supply, to allow rectification of the faulty element without obstructing the normal station operation. A circuit breaker (CB) must be incorporated between the internal wiring of each Signage and the incoming supply "Live" cable.

#### 3.14.4.8 Tolerances

- a. All dimensions shall be checked, confirming all dimensions critical to the works. Site measurements shall be undertaken allowing sufficient time for corrective action to be undertaken to the works, to ensure an accurate fire protection within agreed tolerances.
- b. Work shall be carried out within the approved tolerances.
- c. All controlling, dimensions, especially at the interface with surrounding building elements and structure, shall be observed.

### 3.14.5 Materials

#### 3.14.5.1 Compliance with Standards and Local Ordinances

- a. All materials and components to be used, shall comply with the requirements of this Specification.
- b. Where no alternative standards are stated in this specification, all details, for which standards have been issued by the Philippine Government shall be in accordance with such standards.

#### 3.14.5.2 Materials

All materials incorporated in the works shall be new and of first class commercial quality, free from imperfections, and selected for long life and minimum maintenance under the conditions specified.

##### a. Stainless Steel

Unless otherwise specified, steel shall be austenitic, non-magnetic, using either grade American Iron and Steel Institute (AISI) 304 (Stainless) and American Society for Testing and Materials (ASTM) A167 (Specification for stainless and heat-resisting steel plate, sheet and strip) for plate, sheet and strip and also ASTM A276 (Specification for Bar stock for mechanical and allied purposes) where relevant.

Stainless steel fasteners, bolts screws nuts and other fixings shall be either grade A2 or A4 (ISO 3506 1981), Specification for corrosion-resistant stainless steel fasteners

##### b. Aluminum and Aluminum Alloys

Unless specified otherwise, aluminum sheeting shall be a minimum of 3mm thick and satisfy the requirements of BS EN 485: Parts 1-4 (Part 1, 1988 – Technical

Conditions for Inspection and Delivery; Part 2, 1995 – Mechanical Properties; Part 3, 1988 – Tolerances on Shape and Dimensions for Cold–Rolled Products), BS EN515: 1988 – Aluminum and Aluminum Alloys. Wrought Products. Temper designations) and BS EN 573: Part 1-4 (Part 1, 1988–Numerical Designation System; Part 2, 1995 – Chemical Symbol Based Designation System; Part 3, 1995 – Chemical Composition; Part 4, 1995 – Forms of Products),or its equivalent in ASTM.

c. Screws and Pivots

The use of iron and steel for screws, springs and pivot shall be avoided wherever possible. Steel screws when used shall be plated with zinc, chromium or, when tolerance limitations preclude plating, shall be of corrosion – resistant steel.

d. Bolts, Studs, Nuts and Washers

All bolts studs and nuts shall conform to the standard and to metric dimensions and shall generally be of bright steel. Those subject to vibration, high temperature or pressure shall be of high tensile material.

Bolts, studs, nuts and washers shall be made of free machining quality stainless steel when:

- Subject to frequent adjustment or removal, such as adjusting bolts, removable screws or bolts, and adjustable bearings.
- Used for any application subject to corrosion.

Bolts, studs and nuts shall be suitably machined.

Nuts, bolts, tab–bolts, set pins and any other item subject to vibration shall be secured with reviewed locked devices.

e. Adhesives

Adhesives shall be specially selected to ensure use of types which are impervious to moisture, resistant to molds, fungi and other forms of attack of deterioration.

f. Acrylic

i. Acrylic shall be light transmissible type with Flexural performance to ASTM D790 (Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics).

ii. Acrylic sheet shall be resistant to Ultra-violet exposure and to conditions of the local environment.

g. Reflective Foil

Reflective foils shall be self–adhesive aluminum silver color suitable to conditions of the local environment.

h. Vinyl Laminate

Vinyl laminate shall be 0.05mm thick high bond self-adhesive vinyl sheet. The Vinyl laminate shall be used either as a cut out sign or a stick-on sign with silk-screened artwork.

i. Vinyl Sign

Vinyl signs shall be 1.5mm thick with silk-screened artwork; to be fixed onto substrate by means of high band (3M) double sided tape.

j. Diffuser

The diffuser shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration or loss of light transmittance and shall not become brittle with age or exposure to ultra-violet light and sunlight.

k. Self-adhesive Vinyl Film

All film shall be cast vinyl with a permanent acrylic adhesive backing and shall be applied on various background surfaces. All texts or images shall be computer cut as per typographics or graphics described in the Drawings.

### 3.14.6 Electrical Works

#### 3.14.6.1 General

Electrical works shall be carried out in compliance with Philippine Electrical Code (PEC) and the Philippine National Building Code (PNBC) regulations and codes that are in force at the time of contract. Illuminated Signs shall be considered as special luminaires and shall comply with the requirements of PNBC (Luminaires). Internal wiring shall be color coded and clipped within the Signage at maximum distance of 200mm center. Grommets shall be used where wiring passes through holes. Under no circumstances shall wiring be permitted to rest or rub on raw metal edges. A fixed terminal block shall be provided within each Signage panel. Each terminal shall be of sufficient size for three 2.5mm<sup>2</sup> cables. Where required, each lamp or group of lamps shall be wired out to independent terminals for separate remote switching.

All non-current carrying metal parts of luminaires shall be connected electrically, continuous and bonded to the earth terminal. Hinged, moveable or removable parts shall be provided with a permanent connection to the earth terminal.

#### 3.14.6.2 Lighting

- a. The Contractor shall provide signage complete with the specific lamps. The laminated Signage shall be factory wired and ready for installation upon delivery to the site.

Tubular fluorescent lamps of 230VAC 50/60 Hz (Tubular fluorescent lamps for general lighting service) shall comply with BS1853-1; 1995. Linear fluorescent shall have bi-pin caps and silicon coated glass envelopes, or shall have similarity treated so that a deposit of moisture on the lamp will not prevent the arc from striking under start-up conditions. All fluorescent lamp ways shall be fitted with an integral fuse and shall be suitably rated to protect against a faulty condition.

Linear fluorescent lamps shall have the following characteristics:

Voltage	:	230V
Efficacy	:	96 Lm/W minimum
Average rated life at 50% lamp mortality	:	12,000 hours
Color temperature	:	6,400K
Color rendering index	:	Ra 80+

Compact fluorescent lamps shall have the following characteristics:

Voltage	:	230V
Efficacy	:	69 Lm/W minimum
Average rated life at 50% lamp mortality	:	10,000 hours
Color temperature (K)	:	6,400K
Color rendering index	:	Ra 82

b. Lenses and Diffusers

All lenses or other light diffusing elements shall be movable, but positively held so that hinging or other normal motion will not cause them to drop out.

c. Lamp Holders

Linear fluorescent lamp holder shall be bi-pin and rated for use with required lamps and shall comply with BS 5101-4: 1980 (Specification for lamp caps and holders together with gauges for the control of interchangeability and safety). Compact fluorescent lamp holders shall be of four-pin.

Socket bridges, wiring channels and ballast covers shall be die formed of not less than 0.9mm thick cold rolled steel.

d. Control Gear

All control gear selected shall be of proven quality, matched to the particular lamps under control.

e. Ballasts

Ballast for discharge lamps shall be suitable for use on an electrical supply of 230V AC, 60Hz and shall be perceptibly noise free in operation.

Ballasts for fluorescent lamps shall be of the semi-flow loss type, of the vacuum impregnated type, suitable for operation on a 230 Volt, 60Hz supply, and all be perceptibly quiet in operation.

The relative light output: (percentage of light emitted with reference tube and ballast) shall not be less than 95%.

Power factor correction capacitors for use in tubular fluorescent and other discharge lamp circuits must be of greater than 0.90. General and safety requirements shall be provided to all luminaires to ensure that each luminaire has a maximum power factor not less than 0.9 lagging.

f. Earth Leakage Currents

Earth leakage currents from Signage and Graphics shall be within the limits specified in Section 10.3 BS (Luminaires).

3.14.6.3 *Finishes and Colors*

All finishes shall be applied in the factory and shall be stable, fade resistant, and affected by the effects of ultra-violet or natural daylight and sunlight.

Painted surfaces shall be finished with synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 180°C minimum, catalytically polymerized after application as appropriate. White finishes shall have a minimum of 85% reflectance. Aluminum and aluminum trims shall be finished with an anodized coating of not less than 50g/m<sup>2</sup> of a color and surface finish. Baked enamel surfaces shall have the finish applied smoothly. The finish shall not be less than 0.2mm thick of non-yellowing, white, Baked enamel with a reflectance of not less than 85%.

3.14.6.4 *Quality Assurance*

Materials, equipment and appurtenances provided in the manufacture of lamp and associated components supplied under this Specification shall conform to the ISO 9001 or equivalent quality assurance standard.

**3.15 First Aid Facilities**

First Aid and the treatment of minor injuries will be initially catered for at the First Aid Room.

**3.16 Bins**

- a) Refuse bins shall be located throughout the station and approaches for disposal of small items of rubbish. The size of the bins shall be restricted to minimize the fire risk. The bins shall be emptied periodically and rubbish transferred to the bin store prior to removal by the public authorities.
- b) Ash Trays/Bins shall be located adjacent to the litter bins in the unpaid area of the concourse only

### **3.17 Access for Maintenance**

#### **3.17.1 General**

- a) All areas of the station shall be accessible for inspection and maintenance.
- b) Door and access panel sizes shall be of sufficient width and height for the installation/removal of the equipment within the room or rooms served. Manhole access shall have a minimum clear opening of 750mm x 750mm.
- c) Room layouts shall make provision for withdrawal space and circulation space around equipment where appropriate.

#### **3.17.2 Vertical Access**

- a) Vertical access for maintenance staff shall utilize zone of the following:
  - 1.2m minimum width of standard stair
  - 1.0m wide 60<sup>0</sup> maximum pitch metal staircase with handrails with a maximum rise of 3.0m
  - 0.5m minimum width of ladder access with hoops provided from a height of 2.0m for all rises above 3.0m
  - 0.5m width of step irons. Step irons shall only be used where the rise is less than 3.0m.

### **3.18 Provisions for Fare Collection**

The Contractor shall provide raceways, and shall interface with the AFC for the provision of space for the location of AFC Equipment.

### **3.19 Building Materials and Finishes**

The finalization of the station facilities' design will entail the selection of materials and their finishes. In order to complete this exercise, relevant Criteria are to be considered.

An indicative selection of finishes is indicated and included as **Annex A** for reference purposes only.

## **4.0 STATION SERVICES**

### **4.1 General**

- a. This section describes the design and performance requirements for the installation of stations services included in 2. Stations. These requirements are considered as the minimum to be achieved by the Contractor; the Contractor is responsible in undertake further advancement of the design, supply, installation, testing and commissioning of the building services for the approval of the Engineer.
- b. This Specifications shall be read in conjunction with the Employer's Requirements – PDPS, Employer's Requirements – General Specifications, Conditions of Contract, Instructions to Bidders, Tender Drawings and other documents forming part of the Contract.

### **4.2 Scope of Work**

The Station Services included in this Contract Package are as follows:

- a. Water Supply System,
- b. Drainage, Sanitary and Sewerage Works
  - i. Storm Water Drainage
  - ii. Foul Water (Sewage) Drainage
- c. Lighting and Electrical Power
- d. Other station services such as Fire Protection, Signage and Graphics System, Elevators and Lifts, and Facilities for the Handicapped, have been treated and discussed separately in the Sections 3 and Section 5. Other services that are dependent with other subsystems, e.g. Lightning Protection, Stray Current Control, Grounding and Corrosion Protection, etc., are discussed in Section 6 – Interface Works.

### **4.3 Standards**

Each of the above mentioned installations shall be designed and constructed in accordance with the provisions and technical instructions described in the present and following sections and to the corresponding standards mentioned below. These standard and codes shall be deemed to have formed part of the Contract.

1. IEC Standards for indoor and outdoor electrical installations,
2. National Plumbing Code of the Philippines,
3. Code on Sanitation of the Philippines,
4. Fire Code of the Philippines, and
5. NFPA 130.

#### **4.4 Water Supply System – Design**

- Water distribution Pipe work,
- Service valves within the stations,
- Valves for sanitary fixtures and faucets, and
- Sanitary fixtures.

##### **4.4.1 Scope of Work**

The Contractor's scope on water supply system works shall include:

- a. Obtaining connection from Manila Water Supply System on behalf of the Employer,
- b. Undertaking one borehole well in each station (if underground water is available) in the location of the station for domestic water and firefighting system,
- c. Distribution of water through a network of pipes throughout the station, wherever required, including connection and supply of water to all wash basins, toilets, firefighting sprinkler system and providing one drinking water taps in the office areas,
- d. Providing all fittings, including water taps of suitable material (stainless steel is preferable).

##### **4.4.2 Design Requirements**

The Contractor shall perform all design functions necessary for the development of systems, sub-systems and components.

##### **4.4.3 Standards, Codes and Regulations**

The design of the works shall be governed by all applicable latest edition of local codes, regulations, standards and requirements issued by all the local statutory authorities and agencies.

##### **4.4.4 Quality Assurance**

All materials such as pipes, fittings, jointing materials, components and appliances shall be of the type, size, brand, material, quality and workmanship approved by the ENV/PUB and PSB. Manufacturers of all these products shall have manufacture of similar products specified for a period of at least 5 years.

#### **4.5 Drainage, Sanitary and Sewerage Works**

##### **4.5.1 Scope of Work**

The works covered under these specifications shall include the design of all Drainage, Sanitary and Sewerage Works. The works shall include:

- a. Storm Water Drainage
  - i. Drainage of run-off water that enters the station entrances, openings, and open areas during rain, wherever allowed,



- ii. Drainage of storm water from roof gutters and roof decks,
  - iii. Drainage of storm water entering accesses and air intake/ exhausts,
  - iv. Drainage of water from firefighting,
  - v. Drainage of condensate water from the ventilation and air conditioning equipment,
  - vi. Drainage of escalator pits,
  - vii. Drainage of elevator wells (to include an in-line oil interceptor where hydraulic lift is used), and
  - viii. Connecting all the drainage outlets to the national storm water drainage or sewer drainage system.
- b. Foul Water Drainage
- i. Drainage of sewage water from sanitary rooms,
  - ii. Drainage of all rooms equipped with foul water supply,
  - iii. Drainage of water used for floor washing,
  - iv. Drainage of water from stall concessionaires, wherever allowed, and
  - v. Connecting the drainage water outlets to the national sewer system.
- c. Sanitary Works
- i. Provision of all sanitary fittings including water closets, wash basins of approved size and brand,
  - ii. All fittings and fixtures required for sanitary works of suitable material as per National Codes,
  - iii. All required plumbing works as per the National Standards and Codes, and
  - iv. Providing mirrors and fittings inside the toilets/restrooms of a good standard.
- d. Sewerage Works
- i. Taking all permission from the building authorities for the sewerage works,
  - ii. Provision of a system for collection of sewerage from the toilets/restrooms and taking to the common pipe system for disposal,
  - iii. All pipe works to take the sewerage to the national sewer system and connection to national sewers including obtaining permission for connection, and
  - iv. All required pipe works, fittings and fixtures, plumbing works, etc., as per National Standards and Codes.

#### 4.5.2 Design Requirements

The Contractor shall perform all design functions necessary for the development of systems, sub-systems and components.

#### 4.5.3 Standards, Codes and Regulations

The design of the works shall be governed by all applicable latest editions of local codes, regulations, standards and requirements issued by all the local statutory authorities and agencies.

## **4.6 Station Lighting and Electrical Power**

### **4.6.1 Scope of Work**

The Contractor shall take full responsibility for the detailed design necessary for the proper performance of Station Power and Lighting Works.

- a. All works and materials for complete Station Power and Lighting Works including all electrical equipment and devices to complete the work including panelboards, lighting luminaires, wiring devices, cables and conduits/wireways, and all accessories and fittings, hangers/supports, etc., which are necessary for the project,
- b. Provision of General and Emergency Lighting,
- c. Provision of receptacles (convenience outlets) for small power loads,
- d. Provision of power supply to air conditioning and ventilation outlets (or enclosed circuit breaker),
- e. Provision of power supply to fire pump and jockey pump,
- f. Provision of power supply to water and sump pumps, as required,
- g. Provision of distribution lines for commercial stalls (wiring, conduit, protection device) per area,
- h. Wall switches,
- i. Electrical outlets included for ventilation fans and air conditioners, and
- j. Electrical wiring, conduits and accessories for lighting, power outlets including illuminated signage.

Air conditioners shall also be provided including switches, outlets and support brackets, and openings to fix air conditioners.

### **4.6.2 Lighting**

The design for lighting by the Contractor shall define the architectural lighting concept which shall be integrated with and enhance the overall architectural design intent. This shall extend to all public areas accessible and visible to the public within the transport facility. The architectural lighting concept shall contribute to the design objectives of clarity in the passenger route and support the identification of key transport facility functions such as Service Counters, Ticket Machines, ticket gates, vertical circulation elements, platforms, and entrance/exit routes. The 'lift' environment shall ensure an atmosphere of safety. Glare and dazzle shall be avoided by determining the relative position and angle of lighting sources to the public and the reflectivity of finishes. Lighting levels shall be defined in a Station Room Datasheets or Architectural Checklists. Each light shall contribute to attaining

the required light level. Switching any of the individual lights off means that the light level is no longer achieved.

a. General Lighting

General Lighting shall cover the following:

- i. Public Areas
    - a. Escalators and stairs/landing
    - b. Emergency exits
    - c. Passenger Handling Area
    - d. Mezzanine Floor in full
    - e. Platforms
    - f. Hallway
    - g. Toilets
    - h. Lift (Elevators)
    - i. Outdoor areas in the vicinity of station entrances
  - ii. Staff Areas
    - a. Ticket booths
    - b. Passenger Assistance booth
  - iii. Technical Areas
    - a. Electrical rooms
    - b. Signaling Local Control Room
    - c. Battery room
    - d. Equipment room
    - e. Substations
- b. Emergency Lighting
- i. Emergency lighting shall provide a lower illumination than the general lighting, and shall be used in cases of power cut-off. Battery pack, built-in into these luminaries should be sufficient to provide 3 hours continuous operation.
  - ii. The emergency lighting shall cover the following:
    - a. Passenger platforms
    - b. Passenger Handling Area/Concourse,
    - c. Stairs,
    - d. Staff and Technical Areas, and
    - e. Any other area where emergency lighting can be applied.
- c. Safety/Security Lighting

- i. The safety lighting refers to exit/escape signs and shall serve the public, staff and technical areas of the stations. Battery pack, built-in into these luminaries is sufficient to provide 3 hours continuous operation.
  - ii. The security lighting refers to luminaries at strategic locations which are turned on at night and is used mainly to provide illumination to the roving guard-on-duty.
- d. Lighting Design and Performance Requirements
- i. The lighting design shall determine in detail the functional, technical and operational features to meet the lighting level requirements and suit the needs of maintenance and operation of the lighting facilities.
  - ii. The Contractor shall submit lighting level simulations using computerized lighting software for Engineer's approval, the subsequent lighting system design shall indicate number, location, and selection of light fixtures based on the approved lighting simulations.
  - iii. The simulations for interior lighting shall be based on the installation of fluorescent light fixtures ceiling mounted damp proof (IP 65). The reflection factors shall be selected in each case in accordance with the architectural finishes in the area as for example:
    - a. Ceiling : 0.40,
    - b. Walls : 0.30;
    - c. Floor : 0.10
  - iv. The level of lighting reference for the calculations shall vary according to the requirements of different areas. It shall be the floor of the public areas, 0.85m from the floor (table level) for offices and staff rooms and 1 m from the floor (working level) for technical rooms and other working areas.
  - v. The lighting of workspaces shall ensure good visibility of the visual objects. The requirements to be met by the lighting systems are based on the following criteria:
    - a. Lighting level;
    - b. Luminance distribution;
    - c. Limitation of glare;
    - d. Direction of light and shadow;
  - vi. The lighting system can only satisfy the specified requirements if all the above criteria have been taken into account. Depending on the type and level of difficulty of the visual task or of the type of the room to be lit, priority may be given to one or other of these criteria.
  - vii. All lighting fixtures installed in stations and recesses shall be of the recent technology on "low power consumption – economy" electronic ballast type.

- viii. Any failure of one single luminaire should not cause the failure of a complete lighting system or circuit, therefore the phase sequence shall be designed to fulfill the requirement of optimized load balancing.
- ix. The wiring circuits for normal lighting and emergency lighting shall be separately grouped/labeled or installed in separate conduits/wireway. The normal and emergency wiring circuit in the platform level can be installed linearly in one (1) wireway.
- x. Lighting fixtures for platforms/stairs shall have IP65 protection and IEC certified, Unbreakable polycarbonate compliance with ASTM D 256, unbreakable clear polycarbonate diffuser, waterproof, shock resistant, UV stabilized to prevent yellowing, smooth exterior surface and with internal prismatic reading for efficient luminance, stainless clips.
- xi. All materials to be used for the lighting project shall be brand new. The Engineer may require the contractor to demonstrate/compare different lighting lamps system for power consumption economy.

The parts of the lighting system should be easily reachable with a regular ladder for maintenance reasons and easy to be maintained. General accessibility and replacement of lamps without tools shall be possible.

e. Lighting Levels

- i. The rated luminance assigned to a particular type of room, location or activity is based on the difficulty of the visual task and assumes that the effect of this luminance on the visual performance shall not be adversely influenced by such factors as direct glare, reflected glare and contrast reduction/shadow.
- ii. The main concern with regards to civil work interfaces is the ceiling structure and surface condition of the areas to be illuminated for existing areas. The following Table G-1 specifies the required lighting levels:

Table G-1 Required Lighting Levels

Room No.	Station Area		Illumination Level in Lux (average)	Position of Measurement
1.0	<b>Public Areas</b>			
1.1	Exit to streets including external part of staircases + escalators	normal	150	Floor
1.2	Escalators and stairs (indoor part)	normal	250	Floor
1.3	Top and bottom landing of escalators and stairs	normal	250	Floor
1.4	Emergency Exits	normal	250	Floor

Room No.	Station Area		Illumination Level in Lux (average)	Position of Measurement
1.5	Concourse-general (mezzanine)	normal	150	Floor
1.6	Platforms	normal	150	Floor
1.7	Accesses to platforms	normal	150	Floor
1.8	Corridors - Exits from platforms	normal	150	Floor
1.9	Lifts (Elevators)	normal	150	Floor
2.0	<b>Staff Areas</b>			
2.1	Ticket Booth	normal	400	Floor
2.2	Passenger Assistance Booth	normal	400	0.85 from floor
3.0	<b>Technical Areas</b>			
3.1	Signaling Local Control Room	Normal	400	Floor
3.2	Battery Room	normal	150	Floor
3.3	Electrical Room	normal	150	Floor
3.4	Substation	normal	15	Floor

f. Station Lighting Design Requirements

- i. Station public areas lighting shall be achieved mostly but not limited to fluorescent luminaires depending on the limitation of using fluorescent luminaires as the situation requires. The lighting color shall be daylight.
- ii. High Bay luminaires using High Intensity Discharge lamps shall be used for high ceiling areas.
- iii. Luminaires shall be positioned so that they do not obscure signs or train indicators. Especially for corridors, staircases, and entrances/exits, the luminaires shall be positioned so that passengers do not cause shadows to obscure staircase landings or corridor junctions/turns.
- iv. Outdoor lighting for station entrances shall be mounted on stations' columns/walls or roof slab and shall provide illumination to the station entrances, to illuminated signs and to adjacent walkways. As described above it shall be controlled by photoelectric switches.
- v. The lighting design in coordination with other system shall also coordinate with Telecom , Signaling, and Safety groups with regards to alignment with PA speakers, clocks, CCTV cameras, signal lights, safety signs, station names, and platform mirrors. The lighting fixtures/wireway for stations public areas shall be of the linear type, in coordination with the architectural

elements, unless otherwise specified. These lighting fixtures shall have the following characteristics:

- a. Serving as cable raceways for lighting cables and other future cables, in accordance with the aesthetic requirements for non-existence of visible cabling in public areas,
  - b. The wireway/raceway shall be hot dip galvanized and the installation design of all fixtures shall be that it can withstand the wind velocity caused by typhoons, and
  - c. It shall be ensured that proper cable operation and life expectancy are not adversely affected by temperature effects from the lighting and the cabling itself.
- vi. The external lighting design of the ticket booths on the stations shall follow the concept design of the newly constructed booths or as approved by the Engineer.
- vii. For stations with limited platform space due to the presence of the electrical room and relay room and when a linear type fluorescent luminaires installation design is not possible, other types of lighting fixtures suitable to the required condition can be used upon the approval of the Engineer.
- g. Switches and Control
- i. Lighting switches for public area lighting shall be installed in locations accessible to the station staff. The switches shall be in an enclosure with key made of materials suitable to protect the switches from physical and environmental damages. All other station areas (offices, staff and technical rooms) as well as other technical rooms in shafts, recesses, etc. shall have local wall mounted switches.
  - ii. Switches of light box shall be 10A, 220V, quiet-matic type with stainless cover.
  - iii. Switching of lighting fixtures at the platform level shall be alternate or staggered.

#### 4.6.3 Requirements for Materials and Fittings for Power Supply System

All equipment and materials supplied as part of the Station Power and Lighting Works shall comply with the requirements of this section. These requirements shall be taken to be generally applicable in accordance with good practice, and they shall not relieve the Contractor from ensuring that all materials and equipment incorporated in the Works are suitable for their intended purposes and environments.

##### a. Wiring Devices and Equipment

###### i. Snap Switches

Switches shall be heavy duty, rated 10A, 240V AC quite-type. All exposed materials subject to corrosion shall be stainless steel i.e. cover plates, mounting screws, etc.

ii. Receptacles

Provide heavy-duty, grounding type duplex receptacles. Ratings shall be 15A, 2P, 3W, 240V. Bodies shall be of ivory thermosetting plastic supported on a metal mounting strap. Wiring terminals shall be of the screw type. Connect grounding pole to the mounting strap. All exposed materials subject to corrosion shall be stainless steel i.e. cover plates, mounting screws, etc.

iii. Weatherproof Receptacles

Provide in a cast aluminum box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. The cap(s) shall be provided with a spring-hinged flap.

iv. Air-Conditioning Unit Outlets

Rating shall be 30A, 2P, 3W, 240V grounding type. All exposed materials subject to corrosion shall be stainless steel i.e. cover plates, mounting screws, etc.

v. Disconnect Switches NEMA KS1

Switches serving as motor-disconnect means shall be horsepower rated and heavy duty type. NEMA 4X if installed outdoors.

vi. Enclosed Circuit Breaker

UL 489. Individual molded case circuit breaker shall be thermal magnetic type. Voltage, continuous current rating, number of poles, interrupting capacity shall be suited to application. Nema 4X if installed outdoors.

vii. High Efficiency Single-Phase Motors

Single-phase fractional-horsepower alternating-current motors shall be high efficiency types corresponding to the applications listed in NEMA MG 11.

viii. High Efficiency Polyphase Motors

Polyphase motors shall be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10.

ix. Motor Controllers

All controllers shall have thermal overload protection in each phase. Magnetic-type motor controllers shall have under voltage protection when used with momentary-contact pushbutton stations or switches and shall have under voltage release when used with maintained-contact pushbutton stations or switches. When used with a pressure, float, or similar automatic-type or maintained-contact switch, the controller shall have a hand-off-automatic selector switch. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the "hand" position. All safety control



devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices, shall be connected in the motor control circuit in both the "hand" and the "automatic" positions. Control circuit connections to any hand-off-automatic selector switch or to more than one automatic regulatory control device shall be made in accordance with an indicated, or a manufacturer's approved, wiring diagram. The selector switch shall have means for locking in any position. For each motor not in sight of the controller, the controller disconnecting means shall be capable of being locked in the open position or a manually operated, non-fused switch which will disconnect the motor from the source of supply shall be placed within sight of the motor location. Overload protective devices shall give adequate protection to the motor windings, be of the thermal inverse-time-limit type, and include a manual-reset type pushbutton on the outside of the motor controller case. The cover of a combination motor controller and manual switch or circuit breaker shall be interlocked with the operating handle of the switch or circuit breaker so that the cover cannot be opened unless the handle of the switch or circuit breaker is in the off position.

x. Panelboards

Panelboards for use as service disconnecting means shall be circuit breaker equipped. Panelboards shall be made from steel sheet not less than 2.0 mm in thickness. Design shall be such that any individual breaker can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as a means of obtaining clearances as required by UL. Where "space only" is indicated, make provisions for the future installation of a breaker sized as indicated. All panelboard locks included in the project shall be keyed alike. Directories shall be typed to indicate load served by each circuit and mounted in a holder behind transparent protective covering.

xi. Panelboard Buses

Provide UL listed bus current ratings as indicated. Support bus bars on bases independent of the circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide an isolated neutral bus in each panel for connection of circuit neutral conductors. Provide a separate ground bus marked with a green and yellow stripes along its front and bonded to the steel cabinet for connecting grounding conductors.

xii. Circuit Breakers

UL 489, bolt-on, thermal magnetic-type having a minimum short circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker shall be mounted. Breaker terminals shall be UL listed as suitable for type of conductor provided.

xiii. Multi-pole Breakers

Provide common-trip type with a single toggle/operating handle. Breaker design shall be such that an overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

xiv. Transformers

General purpose, dry-type, self-cooled, ventilated or unventilated. Provide transformers in NEMA 2 enclosure. Transformer shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 115 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformer of 115 degrees C temperature rise shall be capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating. Transformers shall be quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

b. Wiring Methods

- i. All apparatus shall have adequate provision for the entry and termination of all associated power and auxiliary cables and, where necessary, the Contractor shall provide for this purpose a suitable terminal box mounted directly upon and immediately adjacent to each item involving such interconnection.
- ii. All wires between the terminals of two items of equipment shall be given unique wire numbers according to an approved system. A wire number shall not change solely by virtue of passing through.
- iii. Identification markers shall be fitted to all wires and multicore cables tails within enclosures in accordance with the diagram for the apparatus concerned. Cable and core markers shall be of insulating material, colored according to the Contractor's system, with a glossy finish to prevent adhesion of dirt. They shall be legible and durably marked and shall not be affected by oil or moisture. Numbers shall not be duplicated unless the corresponding wires are directly in series or parallel.
- iv. Rigid Steel Conduits (RSC) or Galvanized Cable Tray shall be used for all feeder runs and risers and in general all raceway for power and lighting, as the case may be.
- v. Cable tray shall be ladder type (with or without cover depending on the approval of the Engineer). Trays shall be constructed steel that has been zinc-coated after fabrication. Trays shall be heavy duty type and shall include splice and end plates, dropouts, and miscellaneous hardware. Edges, fittings, and hardware shall be finished free from burrs and sharp edges. Fittings shall have not less than load-carrying ability of straight tray

sections and shall have manufacturer's minimum standard radius. Radius of bends shall be 305 mm.

- vi. Flexible metal conduit shall be used for connection from ceiling to lighting fixtures and where RSC is impractical under such conditions where equipment is prone to vibration or thermal expansion. Flexible metal conduits shall be liquid tight, with a flexible steel core and extruded liquid tight neoprene jacket overall.
- vii. Conductors are copper unless otherwise specified. Insulated conductor manufactured more than 6 months before delivery to the job site shall not be used. Material specifications, i.e., brand, size, insulation type, voltage, etc., shall be clearly printed at the insulation.
- viii. 600 Volt Wires and Cables: Provide wires with THW designation. Only wires with "W" in the type designation shall be used in wet or damp locations. Conductor sizes indicated by square millimeter ( $\text{mm}^2$ ) for copper conductors.
- ix. Conductors: Conductors  $5.5 \text{ mm}^2$  and smaller shall be solid, and those  $8 \text{ mm}^2$  and larger shall be stranded.
- x. Minimum Conductor Sizes: Minimum size for branch circuits shall be  $3.5 \text{ mm}^2$ . For Class 1 remote-control and signal circuits, it shall be  $2.0 \text{ mm}^2$ ; and for Class 2 low-energy remote-control and signal circuits,  $2.0 \text{ mm}^2$ .
- xi. Color Coding: Provide color coding
  - a. For all service, feeder, branch, control, and signaling circuit conductors.
  - b. For grounding conductor, color shall be green with yellow stripes. For neutral, color shall be white, except where neutrals of more than one system are installed in same raceway or box, the other neutral shall be white with a colored (not green) stripes.
  - c. Junction Boxes and Pull Boxes (With Volume Greater than 100 cu. inches): hot-dip, zinc coated steel sheet, gauge # 14.
- xii. Splices and Termination Components
  - a. Connectors for wires  $5.5 \text{ mm}^2$  and smaller shall be insulated pressure-type (twist-on-splicing connector). Provide solderless terminal lugs on stranded conductors. ii. Underground Conduit (Other Than Service Entrance): Rigid Steel conduit with coal tar coatings.
  - b. Conduit in Floor Slabs: Rigid steel conduit.
- xiii. Conduit Installation
  - a. Unless indicated otherwise, conceal conduit within finished walls, ceilings, and floors. Keep conduit at least 150 mm away from parallel runs of hot pipes.

- b. Where conduits cross a seismic joint, approved flexible conduit shall be used. It shall be provided with adequate seals to satisfactorily plug the conduits on the warm side of the wall to prevent condensation within the conduit.
  - c. Where conduits rise through floor slabs, the curved portion of bends shall not be visible above the finish slab.
  - d. Support conduit/wireway by wall brackets, hangers, or ceiling trapeze.
  - e. Make changes in direction of runs with symmetrical bends or cast-metal fittings
  - f. Conduit bends shall not contain more than two 90° bends or the equivalent. Provide pull or junction boxes where necessary to comply with these requirements.
  - g. Conduit Installed in Concrete Floor Slabs shall be located so as not to adversely affect the structural, strength of the slabs.
  - h. Sealing of Cable Holes through Floors and Walls – After completion of cabling, all penetrations through floors and walls shall be sealed employing fire-resisting materials
  - i. Fasten conduits to sheet metal boxes and cabinets with two locknuts where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least a single locknut and bushing.
  - k. Flexible connections of short length of a maximum of 1.8 meters shall be provided for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Liquid-tight flexible conduit shall be used in wet locations. A separate ground conductor shall be provided across flexible connections.
- xv. Boxes, Outlets, and Supports:
- a. Provide boxes in the wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be of the cast-metal hub type when located in normally wet locations, when surface mounted on outside of exterior surfaces, when installed exposed up to 2 meters above interior floors and walkways. Boxes in other locations shall be sheet steel (minimum gauge #16 hot-dip, zinc coated), except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic sheathed cable conduit system. Each box shall have the volume required by the Code for the number of conductors enclosed in the box.

- b. Threaded studs driven in by powder charge and provided with lock washers and nuts or nail-type nylon anchors may be used in lieu of wood screws, expansion shield or machine screws
  - c. Boxes for use with raceway systems shall not be less than 38 mm deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting-fixture outlets shall be not less than 100 mm width, except that 100 mm by 50 mm boxes may be used where only one raceway enters the outlet.
  - d. Pull Boxes shall be hot-dip, zinc coated steel sheet minimum gauge # 16, except where cast-metal boxes are required in locations specified above. Furnish boxes with stainless steel screw-fastened covers. Where several feeders pass through a common pull box, tag the feeders to indicate clearly the electrical characteristics, circuit number, and panel designation. All exposed materials subject to corrosion shall be stainless steel, i.e., cover plates, mounting screws, bolts and nuts, etc.
- xvi. Extension rings may be used only on existing boxes in concealed conduit systems where wall is furred out for new finish.
- xvii. Mounting Heights
- Mount panelboards, circuit breakers, and disconnecting switches such that the height of the operating handle at its highest position will not exceed 2 meters from the floor. Mount lighting switches 1.4 meters above finished floor, receptacles 300 mm above finished floor, and other devices as indicated. Measure mounting heights of wiring devices and outlets to the center of device or outlet.
- xviii. Conductor Identification
- Provide conductor identification within each enclosure where a tap, splice, or termination is made. For conductors 14 mm<sup>2</sup> and smaller, color-coding shall be by factory-applied color-impregnated insulation. For conductors 22 mm<sup>2</sup> and larger, color-coding shall be by plastic-coated self-sticking markers, colored nylon cable ties and plates, or heat-shrink type sleeves. Identify control circuit terminations.
- xix. Splices
- Make splices in accessible locations. Make splices in conductors 5.5 mm<sup>2</sup> and smaller with an insulated pressure type connector. Make splices in conductors 8 mm<sup>2</sup> and larger with a solderless connector and cover with an insulation material equivalent to the conductor insulation.
- xx. Covers and Device Plates
- Install with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices.
- xxi. Grounding and Bonding

Ground all exposed non-current-carrying metallic part of electrical equipment, metallic raceway systems, grounding conductor in nonmetallic raceways, and neutral conductor of wiring systems.

xxii. Grounding Conductor

Provide an insulated, green with yellow stripes equipment grounding conductor in all feeder and branch circuits. This conductor shall be separated from the electrical system neutral conductor.

## 5.0 FIRE PROTECTION SYSTEM

### 5.1 DESIGN REQUIREMENTS

#### 5.1.1 General

- a. The design of a station shall include the following:
  - Fire prevention measures
  - Fire control measures
  - Fire detection systems
  - Means of escape
  - Access for firemen
  - Means of firefighting
- b. All aspects of fire prevention and control will require close liaison between the Contractor and the firefighting authority and final proposals shall be subject to the approval of the relevant authorities.

#### 5.1.2 Scope of Work

The new Emerald and Masinag Stations shall have Fire Detection and Alarm System, FDAS and Fire Protection System and Equipment.

The Fire Detection and Alarm System shall consist of Fire Alarm Control Panel (FACP), Bells/horns, Smoke Detectors, Heat Detectors, and Manual Pull Stations.

The Fire Protection System shall consist of:

- a. Wet-Type Fire Protection System which includes wet pipes and hose reel (WPH), wet pipe and automatic sprinklers (WPS), and water supply system (complete with piping, water tanks, pumps, and pump controllers).
- b. Portable Fire Extinguishers using dry chemicals, CO<sup>2</sup>, and clean agent, totaling not less than eighty (80) in quantity.

In Emerald and Masinag Stations, portable fire extinguishers shall be provided as required in locations indicated or as directed by the Engineer.

#### 5.1.3 Fire Prevention

- a. Fire prevention measures shall be designed and implemented to minimize the risk of outbreak of fire by appropriate choice, location and installation of materials and equipment.
- b. In station planning terms, potential sources of fire can be reduced by:
  - The use of non-combustible or smoke retardant materials where possible
  - Provision of layouts which permit ease of maintenance for equipment and cleaning of the station
  - Provision of special storage spaces for combustible materials such as paint

and oil

- Prohibition of gas based cooking facilities in the staff areas.
- Prohibition of smoking
- Provision of cigarette and litter bins
- General good housekeeping
- Staff training and procedures

#### 5.1.4 Fire Control

- a. Control of the spread of fire and smoke shall be by achieved by compartmentalization of fire risk areas, smoke extraction and smoke containment.
- b. Compartmentalization is aimed at limiting the extent of a fire. A compartment consists of a portion of the station or other structure which is separated from adjoining portions by walls, floors and/or doors. Any opening must be capable of being sealed in the event of a fire, e.g. duct openings sealed with fire dampers. Fire resistance periods (FRPS) shall be selected for spaces according to their degree of fire load and the degree of protection required for life safety, security of the system and the preservation of adjoining areas.
- c. Openings, including ducts and passages between LRT property and any adjoining structure which allows free access into the LRT property shall be protected by fire doors, fire shutters, fire dampers, etc., as appropriate.

#### 5.1.5 Fire Detection

- a. The fire alarm and detection system for each station shall comprise automatic smoke/heat detectors, and break glass units interconnected with the local fire alarm panel. The panel shall be located in the Station Control Room/Ticket Office together with a mimic panel indicating fire status on a zone by zone basis.
- b. Upon receipt of a fire signal, the fire alarm panel shall operate audible and visual alarms within the staff areas only. The warning for the public shall be implemented by staff via the public address system.
- c. The automatic fire detectors of the smoke and heat sensitive type shall be installed in the staff offices, traction substation, electrical rooms, and lift machine rooms.

#### 5.1.6 Means of Escape

- a. Design for evacuation of passengers from stations is described elsewhere. Standards quoted here apply to the non-public areas of offices and plant-rooms. Non-public areas of stations are accessible only to LRT Staff and usually only in small numbers. These areas shall be compartmented and fully covered by the fire detection and alarm system.
- b. As with the public areas of a station, escape from all non-public areas shall be



possible to a place of safety. For staff-only areas a place of safety shall be an area outside the compartmented area of the fire. Staff will be trained in fire-fighting procedures and may not require total escape from the station in a contained fire situation.

- c. The travel distance from any point in non-public areas to an area of relative safety shall depend upon whether alternative means of escape are available. Where only one direction of escape is available travel distances shall be less than 20m. Where escape is possible in more than one direction the travel distance shall be less than 40m. Escape routes from plant areas may include manhole or ladder access.

#### 5.1.7 Access for Firemen

- a. Access for firemen shall be provided by:
  - A designated route from an Access Point to the Station Control Room
  - A designated route from an Access point to all levels of the station
  - In some station designs, these protected routes may be the same for part of their lengths
  - The Access Points shall be at street level in the open air, close to a designated space for off-road parking for two firemen's vehicles.
- b. Additional stairways may be identified for the use of fire fighters, where access from the Firemen's Access Stairway to certain parts of the building is obstructed by tracks, or in other ways. This stair shall serve all principal levels, shall be pressurized, and shall be fitted with sprinkler system and a fire-fighting hydrant. The locations of these stairs will be determined on a case by case basis. Wherever possible, access will be from street level.

#### 5.1.8 Fire Hydrant and Hose Reel System

- a. All works shall be performed in accordance with all applicable municipal codes and laws and regulations issued by Government Agencies or Authorities. The latest standards, codes and regulations published shall be used.
- b. The proposed fire protection system shall comprise the following:
  - Fire hydrant and hose reel system for the public areas.
  - Portable fire extinguishers for the electrical rooms, pump rooms, staff offices and public areas.
- c. A fire hydrant and hose reel system shall be provided at each station to protect plant, occupants and public areas as a first means of fighting the fire whilst awaiting the arrival of the local fire authority.
  - i. Water Supply
    - Firefighting water supply shall be fed from a storage tank and duplicated pump set.

- The water tank shall be sized for a minimum of 30 minute storage capacity.
- Fire department connection to a stand pipe shall also be provided at ground floor level as a secondary source of water supply.
- A wet stand pipe system shall supply water to the fire hose cabinets located at accessible locations within the station public areas.

ii. Fire Hose Cabinet

The fire hose cabinet shall be equipped with a 40mm diameter, 30m long flexible hose with nozzle, a 65mm diameter angle valve with coupling and a 4.5 kg capacity multi-purpose portable dry chemical fire extinguisher.

iii. Water Pressure

A diesel engine driven horizontal spindle fire pump and motor driven jockey pump, complete with accessories shall be housed in a pump room located adjacent to the water tank. The jockey pump will keep the system flooded and pressurised at all times.

5.1.9 Fire-Resisting Construction

The main structural elements shall be designed to have a Fire Resistance Period (FRP) not less than that specified below.

<b>Fire Resistance Period (hours)</b>		
<b>Structural Elements</b>	<b>Underground structures, and other structures incorporating development above</b>	<b>Surface and overhead structures, without development above</b>
Roof Structure	-	0 *
Stations	4	2
Substations	4	2
Cable tunnels	4	2
Ventilation Buildings	4	2
Ancillary Buildings	4	2
Staircases	4	2

\* where it can be shown that the structural elements supporting the roof can survive the design fire without undue risk of collapse.

5.1.10 Compartmentalization of Station Areas

a. Lifts

Lifts between floors in public areas may consist of glass cars with glazed doors and glass lift shafts. Such shafts shall be protected by concealed smoke reservoir bulkheads in suspended ceilings. Where lifts pass through floors that

are not protected by smoke extraction they shall be separated from that floor by a minimum of one-hour FRP separation.

Non-glazed lifts in staff areas may have glazed doors for security purposes but shall be separated from the surrounding floor by a smoke lobby with one hour FRP walls and doors.

b. Offices and Plant Rooms

Station Control Room glazing shall be protected by a two hour FRP fire shutter. All offices and plant rooms shall be separated from the public circulation spaces by two hour FRP separation. Each plant room shall be a separate compartment. In plant rooms roller shutters may be used, in addition to fire-rated personnel pass doors. Such shutters shall normally be closed and be fire rated to the same FRP as the wall in which they are contained. The Fire Resistance Periods to be used for sub-compartmentalization shall be not less than specified below. Offices and staff areas shall be separated from the public spaces, but shall not be subject to sub-compartmentalization.

5.1.11 Separation from Property Developments

The structural elements supporting, and the compartment walls and floors separating a station from a Property Development Area shall have four-hour Fire Resistance Period. Where necessary this separation may be achieved by fire shutters. If a shutter comes down over the front of a shop or otherwise blocks an Escape Route, an alternative means of escape shall be provided.

5.1.12 Fire Resistant Period for Sub-Compartmentalization

In the accompanying Table

Note: 1. The FRP requirements in the Table are for general application only. With Individual FRP requirements considered on a case by case basis.

2. \* Fire separation where adjoining staircases shall be 4 hours FRP

<b>Fire Resistance Period (hours)</b>		
<b>Compartments</b>	Underground structures, and other structures incorporating development above	Surface and overhead structures, without development above
Substations	4*	2*
Station Substations (including transformer rooms)	2*	2*
Ventilation Plant rooms	2	1
Electrical Equipment Rooms (excluding transformer rooms)	2	1
Escalator machine Rooms	2	1

<b>Fire Resistance Period (hours)</b>		
<b>Compartments</b>	Underground structures, and other structures incorporating development above	Surface and overhead structures, without development above
Signalling Equipment Rooms	2	1
Battery Rooms	2*	2*
Rectifier Transformer Room	2*	2*
Rectifier transformer bay (Outdoor)	N/A	N/A
Control Rooms (including Computer rooms)	2	2
Telecommunication Rooms	2	1
Ventilation Shafts	2	-
Under-platform Cable ducts	2	1
Exhaust Ducts	1	1
Protected Staircases	4	2
Store Rooms	2	1
Refuse Rooms	2	1
Station Facilities, Offices, and other Rooms in Staff Areas	1	1
Pump Rooms	4	2
Standby Diesel generator Rooms	4	2
Fuel Storage tank Rooms	4	2
All other Areas	1	1

#### 5.1.13 Fire Detection and Alarm System

The FDAS Contractor shall take full responsibility for Fire Detection and Alarm System including detailed design of the works. The work shall include the following materials to complete Fire Detection and Alarm System such as Fire Alarm Control Panel, Bells/Horns, Smoke Detectors, Heat Detectors, Manual Pull Stations, Cables and conduits/wireways, and all accessories and fittings, hangers/supports, etc.

The following are the scope of works to complete the Fire Detection and Alarm System including the Fire Alarm Control Panel:

1. Provision of power supply to Fire Protection System, wherever required,

2. All other items incidental for the proper completion of the installation works,
3. Coordination with other trades that interfaces with their works,

Fire detection and alarm system for all electrical and equipment rooms including traction substations shall not be a part of this Contract but in Fire Protection System and Equipment.

#### 5.1.14 Fire Protection System and Equipment

The Fire Protection System and Equipment Contractor shall take full responsibility for Fire Protection System and Equipment including detailed design.

All works for complete Fire Protection System and Equipment including wet pipe and hose reel (WPH) wet pipe and automatic sprinkler (WPS) and water tanks, pumps and pump controllers are all fire extinguishers and all accessories and fittings, hangers/supports, etc. which are necessary to complete the project. Any room/area not covered in Fire Protection System works shall be covered by the Wet Type System and shall be provided in the Fire Detection and Alarm System contractor.

1. Provision of power supply to Fire Protection System, wherever required,
2. Coordination with other trade of work/contractor,
3. Coordination with companies/offices including acquisition of permits related to the services,

The tables below are showing rooms and locations in the station where one of the system will be provided.

#### DRY TYPE SYSTEM

Concourse			Emerald		Masinag	
			FDAS	FPSE	FDAS	FPSE
	<b>Pump Room</b>		√	DC	√	DC
	<b>Public Area</b>					
		Paid	√	DC	√	DC
		Unpaid	√		√	
	<b>Technical Rooms</b>					
		Substation	√	CO <sup>2</sup>	√	CO <sup>2</sup>
		Electrical	√	CO <sup>2</sup>	√	CO <sup>2</sup>
		Telecom	√	CA	√	CA
		Signaling	√	CA	√	CA
	<b>Ticket Offices</b>					

		Ticket Vending Booth	√	DC	√	DC
		Passenger Assistance Booth	√	DC	√	DC
<b>Platform</b>						
	<b>Public Area</b>					
		Paid	√	DC	√	DC
		Unpaid				
	<b>Technical Rooms</b>					
		Transformer Room				
		Electrical				
		Telecom				
		Signaling				
	<b>Ticket Offices</b>					
		Ticket Vending Booth				
		Passenger Assistance Booth				

**Legend:**

**FDAS** – Fire Detection and Alarm System

**FE** – Fire Extinguisher, Portable

√ - with corresponding equipment

**DC** – Dry Chemical, Portable

**CO<sup>2</sup>** – Carbon Dioxide, Portable

**CA** – Clean Agent, Portable

**WET TYPE SYSTEM (PACKAGE B)**

	<b>Public Areas</b>	<b>Wet Type System</b>
1.	Station Entrance	Wet type + Hose reel
2.	Stairs/Escalators	Wet type + Sprinkler
3.	Concourse	Wet type + Hose reel
4.	Platforms	Wet type + Hose reel
5.	Public WC	Wet type + Hose reel

6.	Space for Kiosks or shops	Wet type + Hose reel
7.	Access to Platform Level	Wet type + Hose reel
<b>Staff Areas</b>		
1.	Staff WC	Wet type + Hose reel
2.	Passage for Staff Areas	Wet type + Hose reel
3.	Cleaners Room	Wet type + Hose reel
4.	Terminal Train Staff Area	Wet type + Hose reel
<b>Technical Areas</b>		
1.	Corridor for Technical Rooms	Wet type + Hose reel
2.	Escalators Truss Work	Wet type + Sprinkler
3.	Elevator	Wet type + Sprinkler

#### 5.1.15 Reference Standards

American Society for Testing and Materials (ASTM) Publications:

- a. 53–80 Pipe, Steel, Black and Hot–Dipped Zinc–Coated Welded and Seamless  
120–80 Pipe, Steel, Black and Hot–Dipped Zinc–Coated (Galvanized) Welded  
and Seamless for Ordinary Uses
- b. Factory Mutual System (FM) Publication: (1987) Approval Guide
- c. National Fire Protection Association (NFPA) Publication: 13–89 Sprinkler Systems  
70–87 National Electrical Code
- d. Underwriter’s Laboratories, Inc. (UL) Publications: 262–80 Gate Valves for Fire  
Protection Service

## 5.2 AUTOMATIC WET-PIPE FIRE EXTINGUISHING SYSTEM

### 5.2.1 General

The work includes the design new automatic wet-pipe fire extinguishing system and standpipe system to afford complete fire protection coverage for the Proposed LRT Line 2 Stations of East (Masinag) Extension Project. The sprinkler protection shall provide protection for the Mezzanine, PHA and Platform areas and standpipe system for the entire stations.

### 5.2.2 Products

#### 5.2.2.1 Sprinkler's Head

Heads shall have nominal 12.5mm (0.50 inch) orifice. Temperature rating of the sprinkler head shall be ordinary.

1. Pendent sprinkler shall be recessed, and with chrome plated finish. Escutcheon plate shall have a painted white finish.
2. Upright sprinkler shall have a natural brass finish.
3. Horizontal sidewall shall have a chrome plated finish. Escutcheon plate shall have painted white finish.

#### 5.2.2.2 Sprinkler Reserve Cabinet

Provide metal cabinet (painted) with extra sprinkler heads and sprinkler head wrench in the pump room. The number and types of extra sprinkler heads shall be as follows:

No. of Sprinklers	Extra Sprinklers
300 & less	24
300 to 1000	36

#### 5.2.2.3 Fire Hose Cabinet

1. Hose cabinet shall have full glass door recessed on wall and shall able to accommodate 38mm (1 ½ inch) hose rack unit with 30 meters (100 ft.) of hose and portable fire extinguisher. Door and frame shall be made of aluminum.
2. Angel Hose Valve shall be 38mm (1 ½") diameter and shall have rough brass finish.
3. Hose shall be 38mm (1 ½") diameter x 30 meters (100 feet) lined hose.
4. Nozzle shall be 38mm (1 ½") diameter, shall have adjustable fog, straight stream and shut-off features and shall have solid brass with satin finish and rubber bumper. Fire, Potter and Reliable are acceptable brands.
5. Fire extinguisher shall be 9.5 liters (2 ½ gallon) pressurized water with a UL rating of a 2A.

#### 5.2.2.4 Pipe Sizes 65mm (2 ½ inches) and Larger

1. Steel Pipe: ASTM A 53, Schedule 40, (Standard), black steel pipe.



2. Butt welding Fittings: ANSI B16.9 Class 150.
3. Flanges: ANSI B16.5, Class 150
  - a. Gaskets: AWWA C 111 cloth inserted red rubber gaskets
  - b. Bolts: ASTM A 193 Grade B8. Bolts shall be extended no less than two full threads beyond the nut with the bolts tightened to the required torque.
  - c. Nuts: ASTM A 194 Grade 8.
  - d. Washers: ASTM F 436. Provide flat circular washers under bolt heads and nuts.

#### 5.2.2.5 Piping Sizes: 50mm (2 inches) and Smaller

1. Steel Pipe: ASTM A 53, Weight Class STD (Standard), steel pipe with threaded end connections.
  - a. Threaded Fittings: ANSI B 16.3 Class 150
  - b. Unions: ANSI B 16.3 Class 150
2. Pipe Hangers and Support: Provide in accordance with NFPA 1350
3. Valves: NFPA 13, Provide valves of types approved for fire services. Gate valves shall be OS & Y type and shall open by counterclockwise rotation. Check valves shall have flanged clear opening swing check type with flanged inspection and access cover plate for sizes 100 mm (4 inches) and larger. Butterfly valves listed for fire protection services are acceptable substitute for OS and Y valve.

#### 5.2.2.6 Flow Switch

Vane type water flow detector shall be used with adjustable retard element to prevent false alarm signals caused by fluctuating water pressure. Retard element shall be adjustable from 0 to 70 seconds.

#### 5.2.2.7 Supervisory Switch

Valve position supervisory switch shall be designated to monitor OS & Y valve or butterfly valve as applicable.

#### 5.2.2.8 Pipe Sleeves

Provide where piping passes through walls, floors, roofs, and partitions.

#### 5.2.2.9 Escutcheon Plates

Provide one piece or split hinge type metal plates for piping passing through floors, walls and ceilings in exposed areas. Provide polish stainless steel or chromium-plated finish in copper alloy plates in finished spaces. Provide plain finish on plates in unfinished area.

#### 5.2.2.10 Fire Department Inlet Connections

Provide connections 1.00meter above finish grade, of the approved four-way type, concealed type with 65mm (2 ½ inches) National Standard female hose threads with plug and chain. Fire department connection shall have rough brass finish.

#### 5.2.2.11 Fire Extinguishers

Portable fire extinguisher classification and rating system shall be that of Underwriters Laboratories Inc. (UL). Extinguisher shall be UL listed. Number and location of fire extinguishers shall be in accordance with NFPA-10.

#### 5.2.2.12 Pressure Gages

Pressure gage shall have a dial not less than 89mm (3 ½ in.) in diameter and shall be provided with a gage valve. Unit of pressure shall be both in psi and kg/sq.cm.

#### 5.2.2.13 Alarm Check Valves

Provide variable pressure type alarm check valve complete with retarding chamber, alarm test valve, alarm shut-off valve, drain valve, pressure gages, water motor alarm, accessories and appurtenances necessary for the operation of system. Water motor alarm shall be weather proofed, to sound locally on the flow of water. Mount alarms on the outside of the outer walls of each building.

### 5.2.3 Design of Sprinkler System

The sprinkler system shall be hydraulically operated. Pipe schedule design will not be acceptable. Hydraulic calculations shall be submitted prior to acceptance of the proposed sprinkler layout. Design shall be in accordance with NFPA-13. Design area shall not be less than 2,000 square feet. Friction losses shall be calculated in accordance with Hazen-Williams formula with "C" value of 120 for steel pipe.

## 5.3 FIRE PUMPS

### 5.3.1 Reference Standards

- a. Factory Mutual System (FM) Publication:
  1. 1987 Approval Guide
- b. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Publications:
  1. SP-58-83 Pipe Hangers and Supports – Materials, Design and Manufacture
  2. SP-69-83 Pipe Hangers and Supports – Selection and Application
  3. SP-80-87 Bronze Gate, Globe, Angle and Check Valves
- c. National Fire Protection Association (NFPA) Publications:
  1. 20-87 Centrifugal Fire Pumps
  2. 24-84 Private Fire Service Mains
  3. 70-87 National Fire Electrical Code
- d. Underwriter Laboratories Inc. (UL) Publications:
  1. 1987 Fire Protection Equipment Directory

### 5.3.2 Fire Pump System

Provide fire pumps and associated equipment which shall be in accordance with NFPA 20 and NFPA 70, except as modified herein. Devices and equipment for fire protection service shall be UL listed or FM approved. In NFPA 20, the advisory provisions shall be considered to be mandatory, as though the word “shall” had been constituted for “should” wherever it appears; reference to the “authority having jurisdiction” shall interpreted to mean the Consultant. Section titled “Fire Protection General Requirements” applies to this section, with the additions and modifications specified herein.

### 5.3.2 Products

#### 5.3.2.1 Fire Pumps

Provide electric motor driven fire pumps if power supply to the pumps can be provided from two sources (Normal and Emergency). If the Emergency supply cannot accommodate the power requirement of the fire pump, Engine driven fire pumps shall be provided. Fire pumps shall be automatic start and shall be manual push-button start and stop. Each pump capacity at rated head shall not be less than that indicated. Each pump shall furnish not less than 150 percent of rated capacity at not less than 65 percent of total rated head. For installation with positive head, pumps shall be Horizontal Split Case type of pump with automatic air release, circulation relief valve, discharge pressure gauges, main relief valve, enclosed waste cone and automatic controller. For installation with pumps above the storage tank,

use Vertical Turbine Fire Pump. Fire pump accessories shall include flow meter. Provide concentric discharge increase if applicable.

#### 5.3.2.2 Alarm

Alarm signal shall be transmitted to the building fire alarm control panel upon the following conditions: electric motor controller has operated into a pump running condition, loss of electrical power to electrical power starter, low water level in the storage tank and phase reversal on line side of motor starter. Provide alarm silencing switch and red signal lamp, with signal lamp arranged to come on when switch is placed in the OFF position.

#### 5.3.2.3 Pressure Maintenance Pump (Jockey Pumps)

Provide pump with controller to maintain the system pressure. Provide pump of the electrically driven, multi stage turbine type or submersible type of jockey pumps (as applicable) with capacities as indicated. Pump shutoff pressure shall not exceed the design working pressure of the system.

#### 5.3.2.4 Pump Driver

Provide electrical motors, controllers, contractors, and disconnects as specified herein. Power supply to each motor and controller shall be as indicated. Engine driven fire pumps shall have listed or approved engine for fire pump service. Engine horsepower shall be adequate to drive the pump at all conditions of speed and load over the full range of the pump performance curve. Diesel engine shall be of the compression ignition type with electric starting device taking current from two battery units mounted not less than 12 inches above the floor. Engine cooling system shall be closed circuit type heat exchanger.

1. Motors: Motor horsepower shall be not less than pump horse power requirements at all points on the pump operating curve.
2. Controllers: Controllers shall be approved for fire pump service and arranged for automatic and manual push-button pump starting and manual push-button pump shutdown. Controller shall be completely terminally wired, ready or field connections, and mounted in a moisture resistant enclosure arrange so that controller current carrying parts will not be less than 305 mm (12 inches) above the floor. Controllers shall not be of the autotransformer or wye delta starting type.

#### 5.3.2.5 Flow Meter

Provide UL listed or FM approved or equal flow meter for fire pump installation with direct flow read-out device. Meter shall be made of the venture type meter suitable for water flow range of 250 to 750 gpm.

#### 5.3.2.6 Pressure Gages

Pressure gages shall have a dial not less than 89mm (3 ½ in) in diameter and shall be provided with a gage valve. The fire pump discharge gages shall have a pressure up to 300 psi. Unit of pressure shall be both in psi and kg/sq.cm.

### 5.3.2.7 Low Level Switch

Provide low-level switch in the fire storage tank. The low level switch shall actuate a trouble alarm in the building's fire alarm control panel once the water in the tank goes below 300mm from the bottom of the tank.

### 5.3.2.8 Above-Ground Water Piping Systems

Pipes: As specified in Section 15501 Fire Extinguishing System (Wet Pipe).

#### a) Pipe Hangers and Supports

MSS SP-58 and MSS SP-69 or its equivalent. Provide adjustable type. Finish of rods, nuts, bolts, washers, hangers, and supports shall be zinc plated after fabrication.

#### b) Valves

Provide valves of types listed or approved for fire protection service with flanged or treated end connections. Pressure ratings shall as specified in Fire Extinguishing System (Wet Pipe).

- i) Gate Valves: Provide outside screw and yoke type, which can be opened by counterclockwise rotation.
- ii) Check Valves: Provide flanged clear opening swing check type valve with flanged inspection and access cover plate for sizes 4 inches and larger.
- iii) Relief Valve: Provide each fire pump with and approved spring operated relief valve conforming to NFPA 20.

### 5.3.2.9 Additional Pipe Hangers and Supports

Provide additional hangers and supports for concentrated loads in piping between hangers and supports, such as for valves.

1. Vertical Piping: Support metal piping at each floor, but at not more than 3 meter intervals.
2. Horizontal Piping: Support piping as follows:

#### MAXIMUM SPACING (METER)

Nominal Steel Pipe Size (mm)	25 and Under	32	38	50	65	75	86	100	125	150
Spacing (m)	2	2.4	2.7	3.0	3.3	3.7	4.0	4.3	4.9	5.7

## **6.0 INTERFACE REQUIREMENTS**

### **6.1 General**

The Major interfaces between Civil Works (segregated into two areas; the viaduct and the stations) and the Electro–Mechanical Works (segregated in the following major disciplines: Track, Overhead Catenary System, Power Supply, Telecommunications, Signaling, Automatic Fare Collection and Station Equipment) have been identified and provided in this Particular Design and Performance Specification (PDPS).

The contractor for the stations is under obligation to ensure necessary, proper and effective interface and coordination relative thereto with respect to the viaduct and E&M works, shall be conducted during the Design and Implementation of the works.

For each of the items having been identified, the interfacing parties have been identified and allocated as "Provider" (the party having this provision in their scope of work) and "User" (the party who will use this provision. The Party being the "Leader" of each particular interface item has also been identified as the interfacing party to take the leadership to address at the satisfaction of both Interfacing Parties.

The interfacing requirements to be complied with by Interfacing Contractors shall include, but are not limited to, the provision to a common Interface Management Plan (IMO), the provision of a Detailed Interface Design (DID), the contribution to the Coordinated Program, the attendance to the Monthly Interface Meeting chaired by the Engineer and the obligation to coordinate their activities in a timely and controlled manner. However, the responsibility of collecting the interface information from the Specialty contractors of other Works solely depend upon the contractors and the Engineer/Employer shall not be held responsible for any of the lapses or delay in the project due to the same.

### **6.2 Major Interface Requirements**

In general, the interface listed hereunder shall be identified.

The civil works associated with the stations would provide suitable interface for the following subsystem and other components. The dimensions and other environmental requirements of the interface would be developed by the Contractor in consultation with the Engineer during the Final General Design.

The major interface requirements will be needed for;

- Rectifier Substation Room
- Telecommunications Room
- Signaling Room
- Electrical System Room
- Ticketing Equipment
- Local Control Room
- Miscellaneous Operations Room

- Fixing of OCS System
- Viaduct
- Track Elevation
- Brackets for the Speakers, Clocks, Microphones, CCTV cameras, radio mast lightning rod, signals, Count-down Display
- Primary Cable Containment
- Secondary Cable Containment
- Grounding/Earthing Connections
- Temporary Power Supply
- Escalators
- Lifts (Elevator)

### 6.3 Interface Between Viaduct and E & M Works (for References)

The general interface between Viaduct and Electro–Mechanical Works are listed below. These are not comprehensive and contractor should satisfy himself that all his requirements are included.

Interface	Comments
Provision of Combined Services Drawings (CSD)	<ul style="list-style-type: none"> <li>• During the Design Stage, the Viaduct Contractor shall provide the E&amp;M Contractor with their inputs in order to prepare the Combined Services Drawings.</li> </ul>
Provision of Structural Electrical and Mechanical Drawings (SEM)	<ul style="list-style-type: none"> <li>• During the Design Stage, the E&amp;M Contractor shall provide the Viaduct Contractor with their inputs in order to prepare the Structural, Electrical and Mechanical Drawings.</li> </ul>
Static Loads and Vertical Alignment	<ul style="list-style-type: none"> <li>• During the Design Stage, The E&amp;M Contractor shall provide, for their input in design calculation, the Viaduct Contractor with static and dynamic loads.</li> </ul>
Horizontal and Vertical Alignment	<ul style="list-style-type: none"> <li>• During the Design Stage, the Viaduct Contractor shall provide the E&amp;M Contractor, for their concurrence, with their proposed Horizontal and Vertical final alignment.</li> </ul>
Standard Viaduct and Non–Standard Viaduct	<ul style="list-style-type: none"> <li>• During the Design Stage, the Viaduct Contractor shall provide the E&amp;M Contractor, for their input in design process, with their general drawings for the Viaduct (Standard Portion and Non–Standard Portions such as, but not limited to, Connection at</li> </ul>

Interface	Comments
	Santolan Turn-Back Facilities(including span length).
Upper plinth/slab of Standard and Non-Standard Viaduct	<ul style="list-style-type: none"> <li>• A) Demarcation Line <ul style="list-style-type: none"> <li>✓ The scope of works of the Viaduct Contractor includes provision of dowel bars necessary for the construction of the concrete plinth by the E&amp;M Contractor for the Standard Viaduct and Non-Standard Portion (such as, but not limited to, Connection at Santolan Turn-Back Facilities);and</li> <li>✓ The scope of works of the E&amp;M Contractor includes the construction of the track and of the cable contained/detainment walkway.</li> </ul> </li> <li>• B) Design Stage <ul style="list-style-type: none"> <li>✓ During the design stage, the Viaduct Contractor shall provide the E&amp;M Contractor, for their concurrence, the detailed drawings showing the interface characteristics (roughness of concrete, final level, installation tolerances, rebar interface to bound cable containment, drainage conduits, etc.)</li> </ul> </li> <li>• C) Implementation stage <ul style="list-style-type: none"> <li>✓ During the implementation stage, the Viaduct Contractor and the E&amp;M Contractor will coordinate their site activities and access to the site.</li> </ul> </li> </ul>
Catenary Poles/Gantries Fixation	<ul style="list-style-type: none"> <li>• A) Demarcation Line <ul style="list-style-type: none"> <li>✓ The scope of works of the Viaduct Contractor includes the construction of the concrete catenary poles fixation at the end of each girder (both sides) together with the studs/nuts necessary to fix the footplate of the poles/gantries for the Standard Viaduct and Non-Standard Portions (such as, but not limited to Connection at Santolan Turn-Back Facilities ); and</li> <li>✓ The scope of works of the E&amp;M Contractor includes the construction of the poles and gantries necessary for the Overhead Catenary System.</li> </ul> </li> <li>• B) Design Stage</li> </ul>



Interface	Comments
	<ul style="list-style-type: none"> <li>✓ During the design stage, the E&amp;M Contractor shall provide the Viaduct Contractor for their concurrence with detailed drawings and data design requirements of the poles/gantries allowing the Viaduct Contractor to design the concrete catenary fixations.</li> <li>• C) Implementation Stage <ul style="list-style-type: none"> <li>✓ Prior to the construction of catenary poles/gantries fixation, the E&amp;M Contractor shall provide the Viaduct Contractor with the template of the base plate. During the implementation stage, the Viaduct Contractor and the E&amp;M will coordinate their site activities and access to the Site.</li> </ul> </li> </ul>
Earthing	<ul style="list-style-type: none"> <li>• A) Demarcation Line <ul style="list-style-type: none"> <li>✓ The scope of works of the Viaduct Contractor includes the provision of earthing along the Standard Viaduct and Non-Standard Portions (such as, but not limited to, Connection at Santolan Turn-Back Facilities ) together, for each location, the provision of an earth pit where the E&amp;M Contractor will connect their earthing cable/network; and</li> <li>✓ The scope of works of the E&amp;M includes the provision and cable containment from the earth pit to their connection onto the viaduct.</li> </ul> </li> <li>• B) Design Stage <ul style="list-style-type: none"> <li>✓ During the design stage, the E&amp;M Contractor shall provide the Viaduct Contractor, for their concurrence, with drawings and data/value for design requirements of the earthing system allowing the Viaduct Contractor to design their earthing grid/pit.</li> </ul> </li> <li>• C) Implementation Stage <ul style="list-style-type: none"> <li>✓ During the implementation stage, the Viaduct Contractor and the E&amp;M Contractor will coordinate their site activities and access to the Site.</li> </ul> </li> </ul>

#### 6.4 Interface Between Elevator/Escalator with E&M Works

1. Interface shall be done between the Stations Contractor's Elevator/Escalator supplier/subcontractor works and Telecom works for the provision of SCADA points for monitoring of on/off status of the elevators and escalators.
2. The **main earth copper bus bar** located at the Electrical room, Substation, Signaling room & Telecommunication room are to be installed by the electrical works of P2 Contractor. The copper bus bars are interconnected to the earth grids.
3. Electrical Works and E&M Works shall interface with each other to develop an **integrated conduit scheme** applicable to both contractors. The scheme shall have the approval of the Engineer.
4. AFC panels and feeders for TVB and PAB are by AFC contractor. Electrical Works will provide the tapping point for the feeders of AFC panels.
5. Telecom main panel and feeder are by Telecom subcontractor. Electrical Works to provide the tapping point for the feeder of Telecom main panel.
6. Signaling main panel and feeder are by Signaling contractor. Electrical Works will provide the **tapping point** for the feeder of signaling panels.
7. Provide signaling load requirements for the following:
  - a. Emerald (Robinson's Metro East)
  - b. Masinag (SM City Masinag)
8. Electrical Works shall provide three (3) **tapping points** to Signaling for 250VA, 230VAC, 1 phase loads.

Signaling will provide:

250VA, 230V, 2P+G heavy-duty weatherproof (duplex) outlets for maintenance use of Signaling Point Machines.

#### 6.5 Certain Specific Interface Requirements (to be provided in the Civil Works)

1. **Access Catladder** – Provide approved standardized catladders to under platform voids, vent shafts, hatches, cable towers, E&M equipment, etc.
2. **Platform End stairs** – Provide safe platform end stairs for use during emergency situation, i.e. adequate width, preferably 900mm, but not less than 600 mm, and bottom riser not more than 170mm.
3. **Floor Hatch Cover** – All floor hatch cover should be flushed with the floor and protected against damage by heavy E&M equipment movement.
4. **Maintenance Platform** – Provide adequate platform with railing/catladders for maintenance access to E&M equipment, louvers, valves, water tanks, switches, etc., at high level.

5. Platform End Walkways – E&M equipment mounted on the wall should not cause the platform end walkways to have inadequate width for emergency egress.
6. Escalators – The railing balustrade design should tie in with the escalators to prevent children from falling.  
Slope surface between two escalators need some means to defer people from sliding down.  
Provide deterrent triangles at beams/slabs that are near the escalators edge.  
The gap between the escalator handrail and adjacent handrail should be at least 80mm apart.
7. Channel Gratings – Provide gratings over channels/drains where access is needed.
8. Taps and Drain Pipes – All discharge points to water taps and aircon drain pipes shall be directly over or near floor traps.  
No water tap is allowed to be installed inside the distribution board room or in other rooms where there are electrical accessories. It should be located at least 2m away.
9. **Water Service Valve Chambers** – All water service incoming valve chambers are to be designed with drainage provision and meter reading facility.
10. **Movement Joints** – Ensure that there are no movement joints above plant rooms to eliminate risk of leakage of water into these rooms.
11. **Cover for Incoming Water Meter and Control Valve** – Ensure that cover is light enough for regular inspection and emergency usage and at the same time, secured enough to prevent the cover from pilferage.
12. The Station Contractor shall have interface with to have the fire pump and fire engine connected with 'SCADA' for "stop/Run" status Monitoring.

#### 6.6 Viaducts (to be provided in the Civil Works)

1. **Low Viaduct Parapet on Non-Walkway Side** – Provide additional railings on the low parapet wall where there is no third rail to act as deterrent for staff safety.
2. **Viaduct Near Station end Stairs** – 3m of hand railing to be provided on parapet leading to emergency access from track to end stairs.
3. **Bearing Pads** – Should be accessible for future maintenance and replacement.
4. **Drainage System for Viaduct** – The system should be designed for proper drainage.
5. **Walkways** – Should have no dead ends.
6. **Railings** – to be provided near station at places where detrained passenger is likely to makes use of for escape.

#### 6.7 Elevated Walkway and Crossover Bridge (to be provided in the Civil Works)

1. Provide mesh wire screen 2.5m high (min) along both sides of pedestrian overpass.
2. Provide corrugated (rib type) corrugated metal roofing over the elevated walkway and cross-over bridge, preferably arch shape.

#### **6.8 Interface Requirements between Santolan–Emerald Station and Emerald–Masinag Station**

These requirements are detailed in the PDPS in different sections. Consolidated documents to be issued as Bid Bulletins

The Viaduct Contractor (under Package 1) shall undertake the cutting of trees, replanting of the required saplings for each tree cut as required by the MMDA and DENR, including obtaining permission for cutting of the trees. His work will be limited to trees on the side walk or locations affected by the works of the station except the tree along the viaduct alignment and affected by the viaduct. The Viaduct works shall include cutting of trees, etc., throughout the viaduct alignment, including the trees within the station area, if there's any.

## Annex A – STATION FINISHES

### A.0 General

The list shall apply to all areas as indicated in this specifications:

#### A.1 Floor

1.	Non-slip vitrified homogenous tiles, 300x300mm	Corridor in Admin Area, Concourse Paid & Unpaid Area, Platform
2.	Tactile, 300x300mm	For Disabled directional finder
3.	Homogenous Vinyl Tile, 300x300mm	For Admin Area
4.	Ceramic floor Tile, 200x200mm	For FT, MT, PWD, Janitor rm.
5.	Anti-static raised floor	For Telecommunication rm., Signaling rm.
6.	Floated, chemically resistant and hardened concrete floor finish	For Substation, Electrical Rm. Meralco meter rm., Battery rm.

#### A.2 Wall

1.	Ceramic Glazed Wall Tile	For FT, MT, PWD
2.	Cement Plaster (rendered for decoration)	Admin. Rooms
3.	Cement Plaster (rendered for decoration)	External Walls

#### A.3 Ceiling

1.	Type C, Aluminum Linear Ceiling System	Platform
2.	Type F, Aluminum Linear Ceiling System	Concourse and Bridges
3.	Type J, Aluminum Linear Ceiling System	Admin Rooms and Staircases
4.	Anti-Graffiti Paint on Architectural concrete	

#### A.4 Thermal and Moisture Control

1.	Skylight with aluminum frame with factory applied thermosetting PVDF	Main roofs, Eaves skylight
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	coating, non-combustible with NFDA 130 with 16mm polycarbonate	
2.	Aluminum Ventilation louver	Roof Monitor
3.	Single skin pre-formed pre-finished metal roofing	Bridge roof, access stair roof
4.	Curtain walling aluminum frame with factory applied thermosetting PVDF coating with 6mm polycarbonate monolithic	Stair and escalator
5.	Liquid applied waterproofing	Track deck
6.	Laminated safety glass	Elevator enclosure

#### A.5 Doors and Windows

1.	2HR fire rated Doors,	Signaling RM, Telecom, RM Electrical Substation
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#### A.6 Non-structural Metal Works

1.	Stainless steel carrier rail	Concourse Platform
2.	Stainless steel handrail	Staircase service stairs
3.	Dia.48.2 hot deep galvanized coating with special protective coating	Exit stairs
4.	Catwalk	Platform ceiling
5.	Ladder to catwalk	Platform

#### A.7 Special Metal Panel

1.	Metal fascia panel	Exterior wall
2.	Metal panel balustrade wall	Breast feeding Room

#### A.8 Special Construction

1.	Ticket booth	PAO
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**Annex B - MINIMUM STATION ACCOMMODATION**

**SUMMARY SCHEDULE**

<b>Room Schedule</b>	<b>Room Name</b>	<b>Size (Sq. m)</b>
U.01	Station Entrances & Passageways	as per drawing
U.02	Concourse Public Area	as per drawing
U.03	Station Control Area	10
U.04	Station Manager's Room	30
U.05	Ticket Office	as per drawing
U.06	Cash & Ticket Room	16
U.07	Passenger Assistance Office	Free Standing Unit : 4
U.08	First Aid Room	10
U.09	Security / Police Room	10
U.10	Storage Room	10
U.11	Janitor's Room (incorporating rest area & locker space for cleaners)	20
U.12	Garbage Room	5
U.13	Staff Dining Area	30
U.14	Staff Toilets	20
U.15	Staff Lockers	20
U.16	Public Toilets	30
U.17	Breastfeeding Room	12
U.18	Line Dispatcher's Booth	12
U.19	Signaling Room	TBD
U.20	Telecommunications Room	TBD
U.21	Station Auxiliary Substation	TBD
U.22	Train Operators' Room	20
U.23	Platform Public Area	as per drawing
U.24	Fire Tank & Pump Room	30
U.25	Water Tank & Pump Room	15
U.26	Traction Substation	TBD
U.27	Commercial Spaces and Kiosks	as per drawing

**Notes:**

**The above schedule is included in order to:-**

- Indicate the minimum requirements which shall be included but which is not limited to the spaces indicated.
- Illustrate the Generic content which shall be reassessed on an individual station specific basis so as to determine the final requirements.



### SCHEDULE OF SPECIFIC STATION ACCOMMODATION

Detailed information relating to specific station accommodation included is as follows:

- U.03. Station Control Area
- U.04. Station Manager's Room
- U.05. Ticket Office
- U.06. Cash and Ticket Room
- U.07. Ticket Hall Supervisor & Excess Fare Collection - (Passenger Assistance Office)
- U.08. First Aid Room
- U.09. Security/Police Room
- U.10. Storage Room
- U.11. Janitor's Room
- U.12. Garbage Room
- U.13. Staff Dining Area
- U.14. Staff Toilets
- U.15. Staff Lockers
- U.16. Public Toilets
- U.17. Breastfeeding Room
- U.18. Line Dispatcher's Booth
- U.19. Signaling Room
- U.20. Telecommunications Room
- U.21. Station Auxiliary Substation
- U.22. Train Operators' Room
- U.24. Fire Tank and Pump Room
- U.25. Water Tank and Pump Room
- U.26. Traction Substation
- U.27. Commercial Spaces and Kiosks

### SPECIFIC ROOM REQUIREMENTS

#### U.03 Station Control Room

Function                    The center for supervision of all passenger related activities on the station. Holds communication and emergency controls for station plant such as elevators, escalators, fire detection and suppression. Acts as an emergency control center for the station and liaison with outside parties,

	including Fire and Emergency Services
Location	At Concourse Level incorporated in the ticket booth. The room must be located so as to have a good overview of concourse activities and be accessible from the non-paid area.
Size	Approx. 10 sq. m.
Design	The floor of the office shall be elevated 200mm above the concourse floor level using a suspended floor system with cabling below. Internal control desk and panels to be carefully laid out so as to be functional, uncluttered and efficient. The room requires a large vision panel, constructed of fire rated glass or provided with a fire shutter for a non– fire rated vision window. Sufficient space will be required for the provision of cabinets, notice boards and other mounted equipment.
Signaling	Provision for a Local control panel.
Communications	Desk or counter with automatic and direct line telephones, electronic mail and CCTV monitors, radio, public address and passenger display facilities and associated panels. Station Master Clock
AFC	Concourse ticket gate control and indications (equipment monitoring and control) unit. Emergency release button. Station accounting system.
Escalators	Monitoring of Emergency Stop Buttons
ECS	Air conditioning: Provisions to be supplied via a split–type package unit with treated fresh air supply which will maintain the room at a slightly positive pressure.
Electric supply	Provision of Mains Distribution Board and lighting panel
Services	Lighting: average 300 lux at desk working level. Power: general purpose sockets: Fire protection: Station fire alarm panel, automatic smoke detection systems, plus portable fire extinguisher  Links to fire alarm panels of associated development areas that may impact on passenger access and egress.

#### **U.04. Station Manager’s Office**

Function	To provide office accommodation for the Station Manager. It also holds space for several staff and an area for entertaining guests.
Location	Adjacent to the Cash Room.
Size	Approx. 30 sq. m.
ECS	Air conditioning: Provisions to be supplied via a split–type package unit with treated fresh air supply which will maintain the room at a slightly positive pressure.
Services	Lighting: average 300 lux at desk working level. Power: general purpose sockets:

Fire protection: automatic smoke detection systems plus portable fire extinguishers.

#### **U.05. Ticket Office**

Function	To facilitate the sale of tickets
Location	Located inside the ticket booth at the unpaid concourse area. Care must be taken to ensure that queuing areas associated with this facility do not obstruct normal passenger flows between entrances and ticket gates.
Size	Depends on number of ticket office windows required
Design	The floor level shall be 200 mm above concourse level. Speech transfer facilities will be required in the windows and induction loops.
ECS	Air conditioning: Provisions to be supplied via a split-type package unit with treated fresh air supply, which will maintain the room at a slightly positive pressure.
Services	Lighting: average 300 lux at desk working level. Power : general purpose sockets: Fire protection: automatic smoke detection system, plus portable fire extinguishers.

#### **U.06. Cash and Ticket Room**

Function	To provide secure storage for cash, tickets, cash vaults, cash trolley, and accountancy and security documents. To provide a secure area for the hand over of value items between station staff and courier or delivery staff. To house local control equipment for the automatic fare collection equipment, equipment for counting cash. Will be used for auditing purposes and for storage of cash trolleys, trolley vault transporters, vaults and document drawers. A separate cash vault with access via a vault door is required to store cash vaults for a period of time when collection services are disrupted.
Location	Preferably at concourse level within the paid area for added security but could be elsewhere.
Size	16 sq. m. depending on the volume of traffic
Communications	Automatic telephone
AFC	Ticket encoder / sorter, ticket magazine rack, cash counting & bagging equipment.
ECS	Air conditioning: Provisions to be supplied via a split-type package unit with treated fresh air supply which will maintain the room at a slightly positive pressure
Services	Lighting: average 300 lux at desk height Power: general purpose socket outlets Fire protection: automatic smoke/heat detection systems plus portable Fire extinguishers.

Furnishings Secure cabinets, safe, shelving, desk & chair

#### **U.07. Ticket Hall Supervisor & Excess Fare Collection [Passenger Assistance Office]**

Function This office shall be located in the most suitable position for supervising the movement of passengers to the maximum extent feasible within the concourse and between the gates and platform level. AFC gates and Ticket Machines shall be supervised from this office and it will also be used for the collection of Excess Fares.

Location The office should be located adjacent to the barrier gates.

Size 4–6 sq. m.

Design The floor of the office should be elevated 200 mm above the concourse floor level. It should be constructed of non-combustible materials, with vision panels of non-reflective glass. Service counter with speak through unit will be required for the collection of excess fares.

ECS Air conditioning: Provisions to be supplied via a split-type package unit with treated fresh air supply, which will maintain the room at a slightly positive pressure (Dependent on the specific requirements).

Services Lighting: average 300 lux at desk working level.  
Power: general purpose sockets:  
Fire protection: automatic smoke detection system plus portable fire extinguishers.

#### **U.08. First Aid Room**

Function To provide a private area for rendering first aid to passengers or staff, to store first aid equipment and supplies.

Location Not significant

Size 10 sq. m.

Communications Automatic Telephone

ECS Air conditioning: Provisions to be supplied via a split-type package unit with treated fresh air supply, which will maintain the room at a slightly positive pressure.

Services Lighting: average 300 lux at table height  
Power: general purpose socket outlets  
Fire protection: automatic smoke detection system plus portable fire extinguishers.  
Plumbing: cold water, hot water, floor gully

Furnishings Storage cabinets, desk and chair, first aid table/bed, stretcher and stretcher case, wash basin, medical inspection lamp.

#### **U.09. Security/Police Room**

Function To provide office accommodation for the use of the security personnel

	and/or police.
Location	Preferably near to staff areas and toilets
Size	10 sq. m
Communications	Automatic Telephone
ECS	Air conditioning: Provisions to be supplied via a split-type package unit with treated fresh air supply, which will maintain the room at a slightly positive pressure.
Services	Lighting: average 200 lux at table height Power: general purpose socket outlets Fire protection: automatic smoke detection system and portable fire extinguishers.
Furnishings	Storage cabinets, desk and chairs

#### **U.10. Storage Room**

Function	To store materials, some of which may be flammable or toxic, mops, brooms, dusters and other cleaning tools. Space for powered cleaning machines should be provided. Mops, dusters etc. will need to be hung to dry.
Location	Not significant
Size	Approx. 10 sq. m.
Ventilation	Mechanical extract system
Services	Lighting: average 150 lux at floor level Plumbing: cold water, floor gully Fire Protection: automatic smoke/heat detection and sprinkler systems plus portable fire extinguishers
Furnishings	Shelving, metal storage bins for flammables, cleaners sink and hanging racks.

#### **U.11. Janitor's Room**

Function	For cleaner's general storage and cleaning equipment storage.
Location	Concourse unpaid area
Size	20 sq. m.
Services	Lighting: average 150 lux at floor level Plumbing: cold water, floor gully Fire Protection: automatic smoke/heat detection and sprinkler systems plus portable fire extinguishers Ventilation: grills at top and bottom for free air circulation.
Furnishings	Cleaner's sink, storage cabinets/shelves

## U.12. Garbage Storage

Function	To hold refuse collected in the station until it can be disposed of by public or contract disposal agents
Location	Adjacent to a street access or at street level preferably under the stairs.
Size	5 sq. m.
Services	Lighting: average 150 lux at floor level Plumbing: cold water, floor gully Fire Protection: automatic smoke/heat detection system plus portable fire extinguishers. Ventilation: grills at top and bottom for free air circulation.
Furnishings	Fireproof metal storage bins

## U.13. Staff Dining

Function	To provide a location where staff can relax on work breaks and eat food they obtain from outside.
Location	Near staff toilet and locker facilities within the staff/administrative zone.
Size	Dependent on number of station staff
Communications	Automatic Telephone
ECS	Air conditioning: Provisions to be supplied via a split-type package unit with treated fresh air supply, which will maintain the room at a slightly positive pressure.
Services	Lighting: 150 -250 lux Power: general purpose socket outlets Fire Protection: automatic smoke/heat detection plus portable fire extinguishers Plumbing: Well water, sink, floor gully
Appliances	Refrigerator, electric cooker and microwave oven for meals
Furnishings	Dining table, chairs, sink unit and pantry cabinets
Equipment	Chilled drinking water facilities are to be provided, with related servicing included portable fire extinguisher.

## U.14. Staff Toilets

Function	To provide toilet and washing facilities for station staff, maintenance staff and in emergency, train drivers. Separate toilet facilities for male and female employees. The operator may permit staff from commercial units' access to these facilities.
Location	Preferably at concourse level at one end of the concourse.
Size	To accommodate the required facilities.
Ventilation	Mechanical extract system which will maintain the room at a negative pressure

Services	Lighting:	average 150 - 200 lux at floor level
	Plumbing:	Hot and cold water, wash hand basins, showers, floor gully
Furnishings	Dependent on staffing numbers but a minimum of:	
	Male:	1 urinal, 2 WC cubicle, 1 washbasins, mirror, electric hand drier
	Female:	2 WC, 2 wash basin, mirror, 1 electric hand drier.

#### **U.15. Staff Lockers**

Function	To provide a location where staff can store personal items and issued items of documentation or equipment. Separate areas for use by male and female staff for changing and storage of personal belongings.	
Location	Near staff toilet facilities within the staff/administrative zone.	
Size	Dependent on number of station staff	
Communications	Automatic Telephone	
Ventilation	Mechanical extract system which will maintain the room at a negative pressure	
Services	Lighting:	150 -250 lux
	Power:	general purpose socket outlets
	Fire Protection:	automatic smoke/heat detection plus portable fire extinguishers
Furnishings	Full height lockers for assigned staff, stacked half-height lockers for roving staff. Benches, Coat hooks and Mirrors, clothes hanging/drying space.	

#### **U.16. Public Toilets**

Function	To provide toilet facilities for use by the public, including the provision for disabled facilities. To include diaper changing table in the female toilet.	
Location	Dependent upon station layout. A location within the unpaid area is preferred.	
Size	Dependent upon requirement	
Ventilation	Mechanical extract system which will maintain the room at a negative pressure	
Services	Lighting:	average 100 - 200 lux at floor level
	Plumbing:	Well water, wash hand basins, floor gully

#### **U.17. Breastfeeding Room**

Function	To provide facilities for use by lactating mothers, including the provision for milk extraction facilities.	
Location	Dependent upon station layout. A location within the unpaid area is preferred.	

Size	12 sq. m.
ECS	Air conditioning: Provisions to be supplied via a split-type package unit with treated fresh air supply, which will maintain the room at a slightly positive pressure.
Services	Lighting: average 200 lux at table level Plumbing: Well water, wash hand basins, floor gully
Furnishings	Upholstered chairs, tables

#### **U.18. Line Dispatcher's Booth**

Function:	Monitor and supervise platform management and dispatch of train.
Size:	12 sq. m.
Design:	It should be constructed of non-combustible materials, with vision panels of non-reflective glass.
Communications	PABX, Radio coverage, CCTV, Telephone with direct lines to Station Control Room, P/A, Signaling Indication
ECS	Air conditioning: Provisions to be supplied via a split type package unit with treated fresh air supply, which will maintain the room at a slightly positive pressure (Dependent upon site specific circumstances).
Services	Lighting: 200 lux Power: general purpose socket outlets Fire protection: automatic smoke/heat detection system and portable fire extinguishers.
Furnishings:	Working desk, filing cabinets, drawers, stretcher

#### **U.19. Signaling Room**

Function	To house signaling equipment
Location	End of platforms preferred well separated from rooms containing transformers.
Size	40 sq. m.  [As required depending on equipment requirements at specific locations].
Design	No window, glass block or light penetrable panel shall be allowed. Air outlets must not be installed above signaling equipment to avoid condensate from dripping onto the signaling equipment thereby affecting safety and system performance. The room shall be sealed against the ingress of dust. Service piping such as rainwater down pipes and SWC cables etc. should not be routed through the room and must not be located near, above or under water pump / fuel / pantry rooms.  All services shall be located above a certain height to be coordinated with the signaling contractor. A minimum clear height of 3.2 meters is required to a ceiling level; although a false ceiling will not be required.  Door-ways must provide a clear opening of at least 1.200 meters wide



and 2.100 meters high.

Communications	Automatic and maintenance telephones
ECS	Air-conditioning: Provisions to be supplied to maintain the room at the required temperature of $24 \pm 2^{\circ}$ C with a positive pressure via the use of 2 No. split-type package units – (one unit to act as a stand by facility to the other)
Services	Lighting : average 200 lux at floor level Power: general purpose socket outlets Fire Protection: automatic smoke detection and portable fire extinguishers.

## U.20. Telecommunications Room

Function	To house communications equipment
Location	Adjacent to or as near as possible to the station control room but well separated from station substation. Access to equipment by unobstructed path from station service corridor.
Size	20 sq. m.
Design	No window or glass block shall be allowed. Air outlets must not be installed above telecommunication equipment to avoid condensate from dripping onto the telecommunication equipment affecting system performance.  Floor, wall and ceiling materials and finishes coated or sealed to maintain a dust free environment. Service piping such as rainwater down pipes and SWC cables etc., should not be routed through the room. The room must not be located near, above or under water pump/fuel/pantry rooms.  All services shall be located above a certain height to be coordinated with the telecommunication contractor. A minimum clear height of 3.2 meters is required to ceiling level. Doorways must provide a clear opening of at least 1.2 meters wide and 2.1 meters high. False ceiling is not required.

Communications	Automatic and maintenance telephones
ECS	Air-conditioning: Provisions to be supplied to maintain the room at the required temperature of $24 \pm 2^{\circ}$ C with a positive pressure via the use of 2 No. split-type package units – (one unit to act as a stand by facility to the other)
Services	Lighting - Normal: 300 lux at floor level - Emergency: 100 lux Power - General purpose socket outlets with MCB distribution panels. Fire Protection automatic smoke detection and portable fire extinguishers.

### **U.21. Station Auxiliary Substation**

Function	To house equipment for stepping down the voltage.		
Location	Convenient for access to incoming and outgoing cables.		
Size	As required depending on equipment requirements at specific locations.		
Communications	Automatic power and maintenance telephones		
ECS	Ventilation:	Combined mechanical ventilation and smoke extract system	
Services	Lighting	-	average 200 lux at floor level
	Power	-	general purpose socket outlets
	Fire Protection:	automatic smoke detection and portable fire extinguishers	

### **U.22. Train Operator's Room**

Function	To provide accommodation for train crew to change clothing, store issued documents and equipment and personal effects.		
Location	At designated Stations. At platform level.		
Size	To be determined in relation to distribution of train crews between locations.		
ECS	Air conditioning: Provisions to be supplied via a split-type package unit with treated fresh air supply, which will maintain the room at a slightly positive pressure.		
Communications	Automatic Telephone		
Services	Lighting:	average 200 lux at desk height	
	Power:	general purpose socket outlets	
	Plumbing:	Hot and Cold water, sink, floor gully	
	Fire protection:	automatic smoke/heat detection plus portable fire extinguishers.	
Furnishings	Wardrobe lockers for the maximum number of staff, hanging space for clothing, chairs		

### **U.24-25. Fire Water Tank and Pump Room & Domestic Water Tank and Pump Room**

Function	Room or space to house pumps for firefighting purposes and to provide to the station's water supply needs. Provide access to the water tanks from the pump rooms.		
Location	Adjacent to the water tank at ground level which allows the pumps to operate with a positive suction pressure		
Size	As required depending on equipment requirements at specific locations.		
ECS	Ventilation:	mechanical exhaust system	
Services	Lighting	-	average 200 lux at floor level
	Power	-	general purpose socket outlets

Fire Protection: automatic smoke detection  
 Drainage - sump and mercury float level switch

**U.26. Traction Substation**

Function	<p>A Traction Substation comprises a number of spaces housing the following equipment:</p> <ul style="list-style-type: none"> <li>Rectifier Transformers</li> <li>Rectifiers</li> <li>DC Switchgear</li> <li>Inverter Transformer [at certain traction sub-stations]</li> <li>Inverter [at selected traction sub-stations]</li> <li>LV AC Distribution Panel</li> <li>110v DC Distribution Panel</li> <li>Track Earthing Panel</li> <li>DC Smoothing Reactor</li> <li>RTU for SCADA</li> <li>Control Equipment and Relay Panels</li> <li>Battery Room</li> <li>Switchgear</li> <li>Store Room - for vital Spares, Instruments, etc.</li> <li>Allocated Space for maintenance facilities- [i.e.: vertical hoists, Travelling hoists, etc...].</li> <li>Tracks for the movement of Rectifier Transformers</li> </ul>
Location	As indicated on drawings
Size	Dependent on the Supply Authority, particular equipment sizes, maintenance and access requirements
Communications	All spaces except rectifier Transformers - Automatic, power and maintenance telephones
ECS	<ul style="list-style-type: none"> <li>Rectifier Transformers - Mechanical Ventilation depending on degree of enclosure of the room</li> <li>Rectifiers - Ventilation: combined mechanical ventilation and smoke extract system</li> <li>DC Switchgear - Ventilation: combined mechanical ventilation and smoke extract system</li> <li>Control Equipment &amp; Relay Panels - Ventilation: mechanical extract system</li> <li>Battery Room - Ventilation: individual mechanical extract system</li> </ul>

	Switchgear	-	Ventilation: combined mechanical ventilation and smoke extract system
Services	Lighting		
	Rectifier Transformer Area-		average 200 lux at floor level
	Rectifiers	-	average 200 lux at floor level
	DC Switchgear	-	average 200 lux at floor level
	Control Equipment & Relay Panels		Average 300 lux at panel area
	Battery Room		average 100 lux at floor level
	Switchgear	-	average 200 lux at vertical surface 600 mm above floor level
	<b>Power</b>		
	Rectifier Transformers	-	general purpose socket outlets
	Rectifiers	-	general purpose socket outlets
	DC Switchgear	-	general purpose socket outlets
	Control Equipment and Relay Panels		general purpose socket outlets
	Battery Room		general purpose socket outlets
	Switchgear		general purpose socket outlets
	<b>Fire Protection</b>		
	Rectifier Transformers & Inverter Transformers	-	automatic smoke/heat detection system and portable fire extinguishers
	Rectifiers & Inverters	-	automatic smoke/heat detection system and portable fire extinguishers
	DC Switchgear and portable fire extinguishers	-	automatic smoke/heat detection system and portable fire extinguishers
	Control Equipment & Relay Panel and portable fire extinguishers	-	automatic smoke/heat detection system and portable fire extinguishers
	Battery Room	-	automatic smoke/heat detection system
	Switchgear and portable fire extinguishers.	-	automatic smoke/heat detection system and portable fire extinguishers
<b>N.B.</b>	A Cable Way / Gallery route for Duct banks shall be provided between Traction Sub-Stations and Station facilities.		

## **U.27. Commercial Outlets and Kiosks**

Function	Commercial outlets and kiosks shall only be provided in designated areas
Location	They shall be located within the unpaid area of the station complex in such a manner that there shall be no interference with passenger flow to or within the concourse areas. Their location shall be subject to approval from relevant authorities and they may be limited in size and the amount and type of goods for sale in that these may be a fire or safety risk affecting either the safety of passengers or operation of the railway.
Design	All finishes, floors, walls, ceilings, shop fronts and services shall be carried out by others, except that approval will be required to coordinate the visual appearance with railway requirements.
Size	As approved
Services	To be independent from the station system. Each concession shall be supplied with an endorsed fire service installation, power supply and telephone point.