Part 2. Employer's Requirements
Section VI – 2 Technical Requirements
VI – 2 – 1 General Specification

Civil Works and Maintenance Equipment for Depot

EMPLOYER'S REQUIREMENTS – GENERAL SPECIFICATIONS

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EMPLOYER'S REQUIREMENTS - GENERAL SPECIFICATION

1.0 General

1.1 Introduction

This General Specification covers the general aspects of Works and the requirement of Bids and Contracts, viz., submittal requirements of Design and Drawings, Management Plans, Project Planning and Progress Monitoring, Site Management, Drawings Standards, and Contractor's Obligations for Safety and Health, etc., for Manila Light Rail Transit Line 1 South (Cavite) Extension Project that involves Civil , Architectural and Electrical and Mechanical Works, including the supply of the necessary maintenance equipment and spare parts, testing and commissioning and training of operations and maintenance staff Package. This General Specifications shall be read in conjunction with the Instructions to Bidders including the Annexes (Part 1 of the Bidding Documents), Employer's Requirements General Specification, Technical Specification, and Tender Drawings (Part 2 of the Bidding Documents). General Conditions of Contract (GCC), Particular Conditions of Contract (PCC) and Schedule (Part 3 of the Bidding Documents), The abbreviations used in the Bidding Documents are given in Appendix A to this General Specifications.

1.1.1 Definition of the Location of the Site

Current LRT 1 operations cover approximately 20km of service line with a total of 20 stations from Roosevelt Avenue to Baclaran.

An integrated transport system is likewise envisaged with seamless transfers.

A unified ticketing system facilitating efficient movement between lines and more intermodal stations access between different lines and road-based transport services.

The LRT Line 1 South (Cavite) Extension Project involves the extension of LRT services of the existing 20-kilometer LRT Line 1 system southward from Baclaran through the cities of Parañaque and Las Piñas in Metro Manila, up to the municipality of Bacoor in the Province of Cavite.

The project to be carried out under JICA ODA loan Agreement which involves the procurement of 120 new rolling stock to comprise 30 trains, expansion of the existing depot in Pasay (Baclaran depot: which exclude track works, power supply, OCS, signaling and telecommunication works and some building works in depot), area is about 4.2 hectares to accommodate additional 13 train stabling tracks and provide light and heavy maintenance works that need to be added to the system with the expanded services. The new satellite depot in Zapote (which also exclude track works, power supply, OCS, signaling and telecommunication works and some building works in the depot), is about 4.3 hectares of land which include Entrance Access Road to the Depot to accommodate about another 18 trains stabling tracks and provide light maintenance works is also to be constructed.

1.1.2 Definition and Purpose of the Work

The Project is identified as a priority strategic transport investment for decongesting traffic and promoting growth of other urban centers outside Metro Manila. The government's current strategy is now to expand, integrate and increase the capacity of LRT services. An integrated transport system is likewise envisaged with seamless transfers, i.e., unified ticketing system facilitating efficient movement between lines and more intermodal stations access between different lines and road-based transport services. Moreover, the seamless interoperation of Lines 1 and 3 could be achieved within a few years.

These Projects will include: (1) the design and procurement of 120 new rolling stock forming 30 trains required for LRT Line 1; (2) depot development, which covers the construction of a new satellite depot in Zapote and the expansion of the current depot in Baclaran. These sub-

projects will interface with the works performed under EPC's Concessionaires Agreement projects.

1.1.3 Design and Technical Criteria

As the alignment in Manila is predominantly near the sea coast line and runs through relatively polluted air environment, which may present a mildly corrosive atmosphere all depot buildings, facilities and equipment shall be designed to operate satisfactorily under the above described conditions.

The Depot Expansion in Baclaran shall be designed to perform light and heavy maintenance and the Satellite Depot in Zapote shall be designed to perform light maintenance and both to accommodate the trains under this Contract and also the previous 3rd generations of trains.

The depot facilities and equipment shall be designed and tested to meet the RAMS requirements according the European Norm EN 50126 particularly to meet the safety requirements and maintenance requirements.

1.1.3.1 Design Changes

Deviation from the specified requirements and standards may be permissible only under very strict conditions as indicated below

a) That the deviation will achieve equivalent or superior level of safety and performance to the specified standards

b) That the deviation does not delay the procurement of the established manufacturing schedule. The Contractor shall be responsible for appropriate technical justification and to obtain the approval of relevant competent authorities.

1.1.3.2 Criteria for Design Personnel

All design work shall be conducted and controlled by adequate numbers of experienced personnel. The Contractor shall provide a well experienced and qualified design manager to perform the design works which is specified by Bid Document Part 1 Bidding Procedure Section-Ⅲ Evaluation and Qualification Criteria 1.1.1 Personnel.

1.2 Mobilization and Demobilization

1.2.1 Mobilization

Mobilization shall commence within 14 days after the date of issue of the "Notice to Proceed", or on the date of Commencement of Works, whichever is earlier. It shall consist of preparatory work and operations, mobilization of design team and design activities, including but not necessarily limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to the workplace for the establishment of offices, buildings and other facilities necessary to commence work on the project. Mobilization shall include providing prerequisite submittals prior to starting work, all plans and programs as stipulated in the Bidding Documents.

1.2.2 Demobilization

Demobilization will be considered as complete when all of the Contractor's equipment, materials, personnel, construction plant or any other resources belonging to the Contractor, that are not required for the Defects Notification Period, have been removed from the project site, and all the requirements of the Contract for issue of Taking Over Certificate of the Works have been satisfied. Demobilization shall include providing all the required submittals prior to close out of the work.

1.3 Submittals and Substitutions

In the Contract Documents, wherever possible, the minimum acceptable quality of workmanship and materials has been defined by reference to recognized industry and national standards, manufacturer's name and product, or description of the required attributes and performance.

To ensure that the specified products are furnished and installed in accordance with the design intent, procedures have been established for advanced submittal of design data and other requirements and for their review by the Engineer.

The Contractors shall make all submittals required by the Contract Documents, and revise and resubmit as necessary to establish compliance with the specified requirements. Individual requirements for submittals are described in pertinent Sections of this General Specification and in the Employer's Requirements – Technical Specifications.

Unless otherwise agreed by the Engineer, or specified elsewhere, the Contractor shall initially supply to the Engineer two copies of all drawings, specifications and other documents required to be submitted by the Contractor to obtain the approval of the Engineer. After approval the Contractor shall submit electronic copy and six (6) copies of the approved drawings, specifications and other documents for the use of the Engineer.

1.3.1 Co-ordination of Submittals

Prior to each submittal, the Contractor shall carefully review and co-ordinate all aspects of each item being submitted and verify that each item and the submittal conforms in all respects with the requirements of the Contract Documents. The affixing of the Contractor's signature to each submittal certifies that the review and co-ordination has been performed.

1.3.2 Certificates of Compliance

The Contractor shall certify that all materials used in the Work comply with all specified provisions thereof. Certification shall not be construed as relieving the Contractor from furnishing satisfactory materials if, after tests are performed on selected samples, the material is found not to meet the specified requirements.

a) The Contractor shall show on each certification the name and location of the Work, name and address of Contractor, quantity and date or dates of shipment or delivery to which the certificate applies, and name of the manufacturing or fabricating company. Certification shall be in the form of letter or company-standard forms containing all required data. Certificates shall be signed by an officer.

b) In addition to the above information, all laboratory test reports submitted with Certificates of Compliance shall show the date or dates of testing, the specified requirements for which testing was performed, and results of the test or tests.

c) The Contractor shall submit to the Engineer all Certificates of Compliance for products and materials as part of submittal procedure.

d) Any work performed by the Contractor prior to the approval of the Engineer, or before drawings and specifications are submitted and approved, shall be at the Contractor's risk.

1.3.3 Submittal Schedule

The Contractor shall compile a complete and comprehensive schedule of all submittals anticipated to be made during progress of the Work. This schedule shall include a list of each type of item for which Contractor's drawings, Shop Drawings, Certificates of Compliance, materials samples, guarantees, or other types of submittals that are required. Upon approval by the Engineer, the Contractor will be required to adhere to the schedule except when specifically otherwise permitted. The Contractor shall coordinate the schedule with all necessary sub-contractors and materials suppliers to ensure their understanding of the importance of adhering to the approved schedule and their ability to adhere to the agreed Contract schedule. The Contractor shall revise and update the schedule on a monthly basis as necessary to reflect the current conditions and sequences and shall submit the same to the Engineer for review and comment. The Contractor shall submit recovery schedule in case of delay

1.4 Standards and Codes

1.4.1 When a Standard or Code is referred to, it shall be assumed that the revision, current on the date of tender submission is applicable, unless otherwise stated.

Local laws and/or regulations and/or standards shall take precedence over any others in the event of conflict. Any conflict in requirements shall be brought to the attention of the Employer/Engineer for resolution.

The design of the works shall be in accordance with the Environmental Standards current at the time of installation/construction and the Contractor shall comply in all respect with the acts and regulations issued by the relevant authorities in respect to the protection of the environment.

1.4.2 Where no standard is identifiable, the Contractor shall make a proposal, which shall be subject to review by the Employer/Engineer.

1.5 Units

1.5.1 All drawings and design calculations submitted with the tender, or in accordance with the requirements of the Contract, shall use International System of Units (SI Units).

1.6 Warranty/Guaranty

1.6.1 The Contractor shall be responsible for the rectification of any defect or failure of equipment provided, due to defective design, material or workmanship. And provide warranty for the Defects Notification Period of 24 months from the date of issue of Taking-Over Certificate and additional time required, if any, by the Contractor for rectification of defects.

1.6.2 The warranty/guaranty period of special tools, test equipment, maintenance and unit exchanges spares shall be the full Defects Notification Period (**refer to Sub-Clause 1.6.4 of this General Specification**).

1.6.3 The repair and/or replacement of failed components and equipment and installation of repaired/replaced components/equipment shall be undertaken by the Contractor free of charge at Site. The Contractor shall bear custom duty, freight charges and all other expenses involved in the collection of defective components and equipment from the Site, and transportation to the manufacturer's works abroad and its return to Site after repairs. Further, should any design modification or rectification of defects or replacement of failed component or equipment be required to any component or equipment as a consequence of failure, the period of Defects Notification shall recommence from the date when the modified, rectified or replaced part is re-commissioned into service, and the modifications (including any further modifications required during the revised Defects Notification Period) shall be performed free of charge.

1.6.4 If there are any manufacturer's warranty/guaranty for any equipment, continuing beyond the period of Defects Notification Period, the same shall be passed on to the Employer and the Concessionaire and in such cases the warranty/guaranty period of such equipment shall be as provided by the manufacturer.

1.6.5 All replacement and repairs under the warranty/guaranty shall be carried out by the Contractor promptly and satisfactorily on notification of the defect by the Engineer.

1.7 Management Plans and Program

In order to ensure satisfactory execution of the contract, completion of works within specified targets, and also to ensure quality in design, manufacturing, construction, installation and implementation of the works, a series of Management Plans shall be developed. The following Plans shall be developed and submitted by the Contractor for Engineer's review, taking into account the outline plans submitted for some of them, along with the Bid.

a) Quality Assurance Management Plan (QMP);

b) Site Safety Management Plan (SSMP);

c) System Assurance Plan (SAP);

d) Environmental Management Plan (EMP);

e) Project Management Plan (PMP);

f) Site Management Plan (SMP);

g) Interface Management Plan (IMP);

h) Inspection, Test and Commissioning Plan (ITCP);

i) Project Implementation Program (Works Program); and

j) Design Submission Program.

The plans and documents shall be coordinated with each other and shall collectively define, describe and encompass the Contractor's proposed methods, procedures, processes, organization, and sequencing of activities to meet the requirements of the Technical Specifications in respect of the subjects listed.

1.7.1 Quality Assurance Management Plan (QMP)

The Bidder shall submit as part of their Bid, an Outline Quality Assurance Management Plan.

Within 28 days (4 weeks) of the date of Commencement, the Contractor shall submit their detailed Quality Assurance Management Plan as per the requirements of **Clause 7.0** of this General Specification.

The Contractor shall develop the Quality Assurance Management Plan and Scheme and prepare a detailed QA/QC Plan document to fully describe their system; their system is to operate from contract award through design, construction, installation, manufacturing, testing, approval, warranty and maintenance. This program shall be structured in accordance with ISO 9001 or an equivalent quality system and shall ensure that the depot buildings, facilities and equipment are totally compliant with the specifications and be entirely suitable for use on the Line-1 system.

1.7.2 Site Safety Management Plan (SSMP)

The Bidder shall submit as part of their Bid, an Outline Site Safety Management Plan.

Within 42 days of the date of Commencement of Works, the Contractor shall submit a comprehensive Contract specific Site Safety Management Plan, elaborating the outline plans, submitted with their Bid. The Site Safety Management Plan shall include a Hazard Analysis Plan, Fire Control Program, Evacuation Procedure, Details of PPE, Chain of Reporting and all pertinent details to ensure hazards are rapidly identified and actions are taken to minimize risk to workers, equipment and materials, together with detailing methods of reporting and continuous improvements (**Refer to Clause 4.0 of this General Specification**).

1.7.3 System Assurance Plan (SAP)

The Bidder shall submit as part of their Bid, an Outline System Assurance Plan.

Within 42 days of the date of Commencement of Works, the Contractor shall submit a comprehensive System Assurance Plan. The plans shall include preliminary Hazard Log, and Reliability and Maintainability Plan (**Refer Clause 8.0 of this General Specification**).

The Contractor shall carry out the System Assurance activity based on the European Standard EN 50126. The Contractor shall submit his proposed System Assurance Plan (SAP) and Program certified by the Contractor's internal department or third party independent engineer from design and manufacturing section. The System Assurance Plan shall be specifically developed for this Contract. The System Assurance Plan shall address Reliability, Availability Maintainability, and Safety of the depot facilities and equipment. This shall ensure a high degree of reliability and minimize down time.

The System Assurance plan shall also include a Configuration Management Tracing System. This system shall be in place throughout the contract to assure that all deliverable items of Equipment shall be of the same configuration. All changes to equipment and configuration

change control process shall include the phases of configuration Identification, control of changes and configuration verification. (**Refer to Clause 8.0 of this General Specification**).

1.7. 4 Environmental Management Plan (EMP)

The Bidder shall submit as part of their Bid, the outline Environmental Management Plan consistent with the EMP identified in the EIS document and Supplemental EIS in consideration of the World Bank Environmental and Social Policy.

Within 45 days of the date of Commencement, the Contractor shall submit a detailed and comprehensive Environmental Management Plan which include Environment (Air, water and land) part and Social (People) part separately.

1.7. 5 Not Used

1.7. 6 Project Management Plan (PMP)

The Project Management Plan shall provide a clear overview of the Contractor's organization, the management system and methods to be used for completion of the works. The organization resources for the design, procurement, manufacture, installation, testing and commissioning, and setting to work, shall be clearly defined.

In accordance with the ITB, the Bidder shall submit an outline Project Management Plan as part of the Bid which shall provide the following information:

a) A diagram showing the organizational structure for the management of the Contract, with locations, names and position titles of staff and their line and staff relationship. The diagram shall include associate organizations and subcontractors and show clearly the individuals and lines of responsibility linking the various groups. It shall also identify the persons designated as contacts with the Employer's Representative.

b) The names, qualifications, positions and current resumes of key executive, supervisory and engineering staff to be employed full-time for the works, separately for principals and subcontractors.

c) A narrative describing the sequence, nature and inter-relationship of the main Contract activities including timing for exchange of information.

d) Procedure for documentation control.

e) The Bidder shall nominate a suitably qualified and experienced English speaking person (preferably an engineer) from their staff to be Project Manager. The nominee shall be subject to acceptance of the Engineer who shall have the right to demand their replacement at any time after the work commences, should the Engineer consider this to be in the best interest of the Project.

f) The Bidder shall submit their proposal for his Co-ordination Control Team and include the name and qualifications of the Team Leader of Interface Coordination. In addition, the Bidder shall also nominate a senior engineer to coordinate activities of the design offices and manufacturing works. The Engineer shall be responsible to the Project Manager for all works executed and ensuring that effective coordination is maintained with the various manufacturing units of the Contractor, Subcontractors and Suppliers and that contract delivery schedules are met.

g) The Project Manager for the Depot Works shall stay continuously on site in Manila and devote himself full-time to the Project, commencing not later than 15 calendar days from the date of Commencement and shall continue up to the end of Defects Notification Period.

The Contractor will submit the detailed Project Management Plan based on the outline Project Management Plan submitted with the Bid within 15 days of the date of Commencement. The Engineer will review the Contractor's Project Management Plan and shall have the right to

require the Contractor to make amendments as deemed necessary by the Engineer. The Contractor shall submit the detailed revised plan within 10 days of the review by the Engineer.

1.7. 7 Project Implementation Program (Works Program)

The Bidder shall submit as part of their Bid, the outline Project Implementation Program along with the Bid, as required in the Instructions to Bidders.

The Contractor shall submit within 28 days of the date of Commencement of Works, the detailed Project Implementation Program (Works Program)

The Contractor's detailed Project Implementation Program (Works Program) shall indicate how intends to organize and carry out the Works and achieve stages and complete the whole of the Works by the appropriate Key Dates. The Works Program shall be prepared in terms of weeks from the Date of Commencement of Works.

1.7.8 Design Submission Program

The Contractor shall submit within 28 days of the date of Commencement of Works, the detailed Design Submission Program which shall cover the Design phase and include a schedule identifying, describing, cross-referencing and explaining the Design Packages and submissions which he intends to submit. The Design Submission Program should take due account of the design coordination interface periods with other Designated Contractors and Subcontractors and be consistent with the Works Program. As of Design Submission Detail please refer **Clause 9.5.4** of this General Specification.

1.7.9 Site Management Plan (SMP)

The Contractor shall submit within 28 days of the date of Commencement of the Works a detailed and comprehensive Site Management Plan.

1.7. 10 Interface Management Plan (IMP)

The Contractor shall identify all interfaces with the Concessionaire (LRMC), third parties, Subcontractors and the designated Contractor for other packages. He shall submit the Interface Management Plan as per the requirement of **Sub-Clause 2.3** of this General Specifications, within 45 days of the date of Commencement of Works. He shall be responsible for liaising with the interface partners.

1.7.11 Inspection, Testing and Commissioning Plan (ITCP)

The Contractor shall submit within 70 days of the date of Commencement of Works an Inspection, Testing and Commissioning Plan to undertake testing and commissioning Works for the review of the Engineer. The inspection plan shall identify, inspection hold points, where work can only proceed after inspection without objection by the Engineer or upon issuance of waiver of inspection by the Engineer.

1.7.12 Interface and Liaison with LRMC

The Contractor shall submit within 60 days of the Commencement date of Works a "Proposed LRMC Coordination Procedure" to LRMC and Employer for their review and approval. If the submitted procedure is not acceptable, the parties shall meet to discuss same until an agreed procedure is established, at which time the agreed procedure will become the "Approved LRMC Coordination Procedure"

1.7. 13 Submittal Requirements of the Management Plans

The submittal requirements and the dates by which they are to be submitted for the review of Engineer of various Management Plans are summarized in the table below.

Table 1.7.13 Summary of Management Plan and Programs

No.	Description	Reference	Days from the Date of Commencement for submission
1	Quality Assurance Management Plan	GS 1.7.1 and 7.2	28 days
2	System Assurance Plan	GS 1.7.3 and 8.2	42 days
3	Site Safety Management Plan	GS 1.7.2	42 days
4	Environmental Management Plan	GS 1.7.4 and 3.3	45 days
5	Project Management Plan	GS 1.7.6	15 days
6	Project Implementation Program (Works Program)	GS 1.7.7 and 10.0	28 days
7	Design Submission Program	GS 1.7.8	28 days
8	Site Management Plan	GS 1.7.9	28 days
9	Interface Management Plan	GS 1.7.10 and 2.3	45 days
10	Inspection, Testing and Commissioning Plan	GS 1.7.11 and 12.0	70 days
11	Proposed LRMC Coordination Procedure	GS 1.7.12 and Appendix D	60 days

2.0 The Coordination and Integration of Electrical and Mechanical Equipment

2.1 General

2.1.1 The Contractor shall fully co-ordinate the special requirements for all items of electrical and mechanical equipment and shall ensure that these requirements are fully accommodated within the structural and architectural design.

2.1.2 The Contractor shall ensure that all systems and subsystems are both physically and functionally compatible with each other, and with those systems and subsystems utilized on the existing system, and will work together to meet the requirements of the Technical Specifications.

2.2 Documentation Requirements

2.2.1 In order to ensure the requirements of **Sub-Clause 2.1** of this General Specification, information shall be presented via two formats:

a) The Interface Management Plan.

b) Drawings as detailed in **Sub-Clause 9.5.3** of this General Specification.

2.3 Interface Management Plan (IMP)

2.3.1 The Contractor shall prepare and submit to the Engineer for review his Interface Management Plan within 45 days following Commencement Date.

2.3.2 The Interface Management Plan shall establish the methods and procedures used by the Contractor for controlling and ensuring compatibility of physical, functional and environmental interfaces of Contractor supplied equipment with the Employer's and/or Concessionaire's systems or equipment and other facilities under construction and/or under the control of the Employer and/or Concessionaire.

2.3.3 The Interface Management Plan shall also establish the requirements, methods and procedures to ensure formal, accountable channels of communication for the exchange of technical information.

2.3.4 Such methodology shall include both initial definition and formal change information when a change on one side of the interface will require a corresponding change to the other.

2.3.5 After the review of Interface Management Plan with no objections by Engineer, the Contractor shall execute the Works in accordance with the plan.

3.0 Environmental Conditions and Environmental Management Plan (EMP)

3.1 General

3.1.1 The design of equipment shall take account of the climatic conditions and operating conditions as specified in this General Specifications and the Technical Specifications as appropriate.

3.1.2 All equipment shall be designed to perform in a satisfactory manner in the environment in which it is installed and to withstand the effects of high winds, temperature, humidity, vibration, noise, air, and water pollution.

3.2 Environmental Conditions

3.2.1 The general environmental conditions in the Manila area are as follows:

The performance specification shall take into consideration the following environmental factors

a) Rainfall;

b) Temperature range;

c) Wind speeds and Direction;

d) Topography;

e) Geophysical conditions;

f) Isokeraunic levels (lightning strikes); and

g) Atmospheric pollution.

Any other adverse conditions that may be applicable to the area under consideration

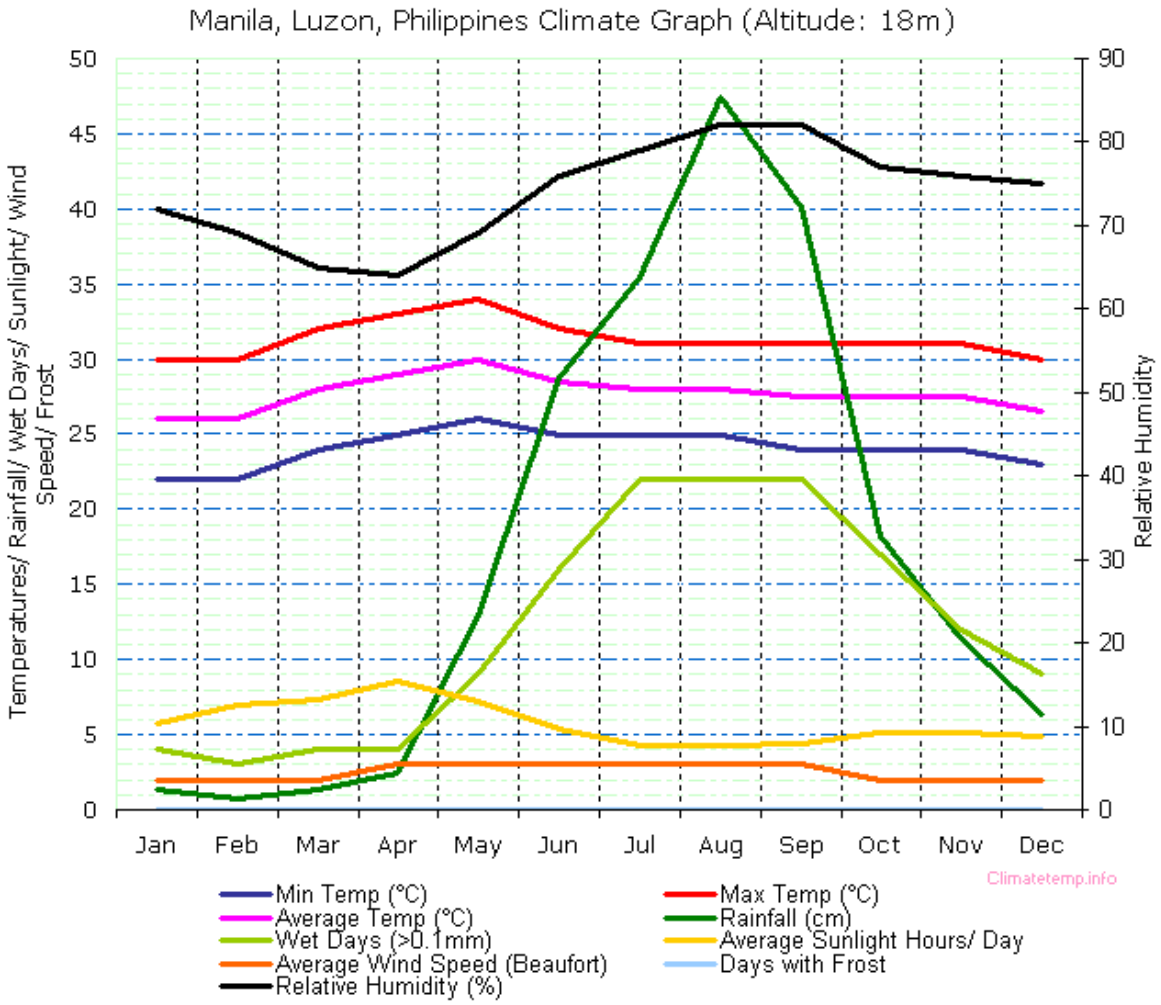
a) Rainfall

During the period from 1981 – 2010, PAGASA stations in the vicinity of the project area in NAIA (MIA) Pasay City and Port Area Manila recorded an annual rainfall amount of 1,767.8 millimeter (mm), and 2,103.6 mm with a total of 101 and 139 rainy days, respectively.

Increase in rainfall is normally observed during the southwest monsoon season (June, July and August) until the transition month of September, October and November in most areas of Luzon. PAGASA's climate projections in the Philippines showed varied trends in magnitude and direction of the rainfall strongly indicating increase in the effects of southwest and northeast monsoons.

Based on the Report of PAGASA on Climate Change in the Philippines in February 2011, the projected seasonal rainfall change will generally show a reduction in rainfall in most parts of the country during the summer season (March, April, May), but will also show as increase in rainfall during the southwest monsoon season (June, July, August) until the transition season (September, October, November) in most areas of Luzon and Visayas. Simply, this means that the usual wet seasons are expected to become wetter and the dry seasons, drier all over the country. In addition extreme rainfall events (heavy daily rainfall) will continue to become more frequent. Extreme rainfall is projected to increase in Luzon and Visayas only, in 2020 and 2050. The climate change scenarios for Metro Manila as stated in PAGASA 2020 and 2050 as well as the hazard map index of Metro Manila should also be considered.

Figure 3.2.1



Meteorological Data of the Philippines (Metro Manila) / Source Wikipedia

b) Temperature

The average normal annual temperature recorded at above mentioned PAGASA stations were 27.8°C, and 28.4°C, in NAIA (MIA) Pasay City, and Port Area Manila, respectively.

Based on climate trends from PAGASA using observed data during the period 1951 – 2010, there has been an increase in annual mean temperature by 0.648 °C or an average of 0.0108 °C per year-increase. The warmest months are observed in April, May and June and the coldest months during December, January and February, with the temperature ranges of 28-30°C and 25-27°C.

c) Wind Speed and Direction

PAGASA weather stations as mentioned above recorded prevalent wind direction for the period 1981-2010, as shown in Table 3.2.1. The average annual wind speed for NAIA (MIA), and Pasay City and Port Area, Manila are both 3.0 meters per second (mps).

Table 3.2.1 Prevalent Wind Directions		
	PAGASA Weather Stations	
Month	NAIA, Pasay City	Port Area, Manila
January to April	E	N, E, and SW
May to September	W	SW
October to December	E	SW and N
Annual	E	SW
Source: PAGASA		

d) Humidity

The monthly relative humidity from PAGASA typically ranges from 66% to 84% over the course of the year. The average values for relative humidity were 76%, 74% and 78%, recorded at NAIA (MIA) Pasay City, Port Area Manila and Science Garden Quezon City, respectively.

e) Air Quality

Monitoring data show particulate matter (PM) levels in Metro Manila that have exceeded the Air Quality Guideline Values set by the Philippine Government. Measures have been made to address the air quality problem in Metro Manila, but more needs to be done. Most of the particulate matter collected from different sites around Metro Manila was attributed to traffic sources. Black Carbon is a major component of particulate matter samples collected in Metro Manila.

These figures are merely indicative, and detailed values should be obtained from the Philippine Meteorological Services.

3.2.2 The Contractor's attention is drawn to the fact that because of solar load, track bed temperatures will reach 55 °C and temperatures inside closed boxes will reach 70° C. Because Manila is near the bay of the South China Sea, the air has a mildly corrosive atmosphere.

3.2.3 Manila having a dry climate for a considerable period of the year, the air frequently has high relative humidity aggravated by air pollutants (dust, etc.)

3.3 Environmental Management Plan

Based on the Outline Environmental Plan the Contractor shall submit a detailed Environmental Management and Monitoring Action Plan (EMMAP) illustrating the intended means of compliance with the Employer's Requirements including noise standards for the cars. This shall conform to **Sub-Clause 4.18** of Part 3 Conditions of Contract and Contract Forms Section VII General Conditions, and the Environmental Compliance Certificate (ECC) issued by the Department of Environment, Natural Resources Environmental Management Bureau (DENR-EMB) in June 2013, and Environmental Impact Statement (EIS) submitted by LRTA to DENR-EMB dated May 19th, 2012. A CD copy of ECC, EIS and amended ECC are included in **Bidding Documents Part 2 Employer's Requirements Section VI-4, Supplemental Information** for reference. It shall also ensure compliance to applicable environmental statutes such as:

a) Presidential Decree 1586, "The Philippine Environmental Impact Assessment System"
b) Republic Act 8749, "The Philippine Clean Air Act of 1999"
c) Republic Act 9275, "The Philippine Clean Water Act of 2004"
d) Republic Act 6969, "Toxic Substances and Hazardous Waste Control Act of 1990"
e) Republic Act 9003, "Ecological Solid Waste Management Act of 2000"
f) Republic Act 9729 "Climate Change Act of 2009"

The EMMAP shall state clearly the Contractor's environmental objectives in detail and demonstrate the proposed method of achieving the environmental objectives with regard to the requirement of the Contract. EMMAP also include Assessment of Environmental and social

Risks and Impacts, Labor and Working conditions, Resource Efficiency and Pollution Prevention and Community Health, Safety and security etc. which are mentioned in IFC Performance Standard (World Bank Environmental and Social Policy).

An amendment to the ECC was issued by DENR on September 19, 2016 which include the Baclaran Expansion Depot facilities and components.

4.0 Health and Safety

4.1 Introduction

4.1.1 The Employer places particular emphasis on high standards of health and safety and the purpose of this section is to provide information on the requirements that will apply to the Contractor.

4.1.2 In addition to the risks and hazards normally associated with construction works, the railway environment is particularly hostile with the risk of serious injury from electrocution or being struck by moving trains. Because of these hazards, the Employer has developed strict rules and operating procedures and associated training requirements with which all persons working on or about the LRT Line and the track must comply in the interests of their own safety and the safety of others. Particular requirements for work on or adjacent to the LRT Line are outlined in **Sub-Clause 4.6** and **Sub-Clause 4.7** of this General Specification.

4.1.3 The Contractor shall point out in a timely manner to the Engineer the risks associated with both the basic assumptions of the project and the technical requirements innate in the construction.

4.1.4 The Contractor shall have to take into consideration when planning the Technical Project the general principles governing labor hazard prevention adapted to fit technical projects and in particular:

a) Elimination of risks;

b) Addressing risks at their source;

c) Evaluation of risks that are unavoidable and propose preventive measures;

d) Description of the working method and of any required equipment, wherever this is deemed to be necessary due to high risk during construction, maintenance or repair of the project;

e) Replacement of hazardous materials for less hazardous ones;

f) Priority in decision-making concerning group protection in relation to the individual protection measures;

g) Adjustment to technical developments;

h) Architectural techniques and/or organizational options in order to get the various works or work phases organized when they are performed simultaneously or successively;

i) Projection of the performance duration of those varied works or work phases; and

j) The planning of an administration system meant to prevent labor hazards where the various roles and duties of the project administration staff are to be mentioned, as well as the special institutions for the prevention of professional hazard (Safety Engineer, Safety and Health at Work Coordinator, Labor Doctor, Committee for the Safety and Health of People at Work) provided by law. Also incorporated therein must be made of the basic safety and health procedures at work (e.g. report of labor accidents, emergencies, use of explosives, deletion of personnel, medical checkups) as well as instructions for safe work, where necessary (e.g. use of means of individual protection, work at considerable height).

4.2 Health and Safety File

4.2.1 The Contractor shall appoint a Safety Engineer, also shall act as Officer of Safety and Health Issues, who assumes the responsibility to prepare the Safety and Health Plan and the Safety and Health File at the design stage.

4.2.2 The Safety and Health File will contain only the basic segments of the project, as well as instructions and useful information in relation to health and safety issues which, possibly, may have to be taken into consideration during the subsequent phases of the design as well as during the project's life, such as maintenance work, conversion work, cleaning, etc. For example, the instructions and details referred to above concern the safe performance of the various maintenance works, the prevention of hazards arising from the presence of the public utility networks (water supply, power supply, gas and steam supply, etc.) the fire protection, etc.

4.2.3 It is pointed out that the Safety and Health Plan and Safety and Health File constitute part of the Works and shall be submitted to the Engineer for approval. It shall be updated as the works proceed and shall be available for viewing.

4.3 General Health and Safety Requirements

4.3.1 Legislation and Regulations

The Contractor shall be subject to penal and civil laws for all injuries of their personnel, as well as personnel of the Employer and Third Parties, even when the Contractor has implemented the specifications approved by the Employer. The Contractor shall perform all Works in a healthy and safe manner and in accordance with Philippine Laws, Presidential Decrees, Police and Other Regulations and directions of the Employer. If no relevant Philippine Laws, Presidential Decrees, Police and Other Regulations exist, then the relevant standards and codes of practice and current best practice of acknowledged international Codes shall apply. The Contractor shall also comply at all times with any other mandatory requirements, local safety, security, and other regulations in force and to which the Works are subject, including any requirements specified by the fire brigade.

4.3.2 Contractor's Obligations

a) The Contractor shall ensure the safety of all operations in connection with the Contract and shall take all necessary action to ensure the safety of all persons who may be in, on or adjacent to the Site, including the Employer's staff and their agents, Designated Contractors and Utility Companies.

b) The Contractor shall take all necessary precautionary measures in order to prohibit the entrance of the public to the Job site.

c) The Contractor shall provide and maintain, throughout the Contract duration, all protection measures necessary for the protection and safety of all persons.

d) The Contractor shall comply immediately with all instructions from the Employer in respect of the safety of the Works.

e) The Contractor shall ensure that all personnel on the Site are properly trained and supervised to ensure their safety and the safety of others while on Site.

f) The Employer may require the immediate removal from Site of any person who, in the opinion of the Employer, fails properly to observe the provisions of the relevant legislation, regulations and rules as appropriate, and such other statutory regulations that from time to time may be in force. Such a person shall not under any circumstance return to the Site without the Employer's approval.

g) The Contractor shall ensure that proper and adequate health and safety provisions, including those set out in this Contract, are included in subcontracts placed by the Contractor.

h) The consumption by Contractor's personnel of alcoholic drinks or partaking of any drug or other substance that might impair proper performance of their duties on the Site is strictly forbidden.

i) The Contractor shall establish a policy, procedures, and standards for providing a workplace that is free from harassment, intimidation, and threats. This includes, but is not limited to threats of violence, physical challenges to fight, stalking, attempted assault, or assaulting by or against employees, customer employees, vendors, visitors, and members of the public.

j) The Contractor should have a policy of "zero tolerance" regarding violence in the workplace and takes reasonable steps to prevent or address any acts or threats of this nature.

4.4 Site Safety Plan

4.4.1 Site Safety Management Plan (SSMP)

Within six (6) weeks from Commencement Date, the Contractor shall submit a Site Safety Management Plan in English. This plan shall include the approach and structure that the detailed plan will take and, in particular, will address the following items:

a) The Contractor's Health and Safety Policy Statement.

b) The Contractor's organization and arrangements for health and safety. Particular reference shall be made to the Site arrangements and procedures for ensuring compliance with health and safety legislation, regulations, codes of practice and, where relevant, National Standards and other International standards.

c) Nomination of Safety Officer reporting to Project Manager who will have an overview of all Site safety matters. The responsibilities, qualifications, training and experience of those nominated should be specified. The name of the Safety Officer shall be made known to the Engineer.

d) The name, address, educational qualification, work experience and health condition of each personnel deployed for SHE jobs shall be submitted to the Employer for the purpose for comments and approval well before the start of the work. Only on approval by the Employer these personnel are authorized to work. In case any of the SHE personnel leaves the Contractor the same shall be intimated to the Employer. The Contractor shall recruit new personnel and fill the vacancy.

e) A schedule of safety procedures to be used on the Project, including those related to the maintenance and safe operation of Contractor's Equipment.

f) The Contractor's procedures for reporting and investigating accidents, dangerous occurrences or occupational illness.

g) The Contractor's policy and procedures for identifying and eliminating Site hazards. Reference shall also be made to mitigating measures which include procedures for the identification of the need for, and the provision of, personal protective equipment (PPE), permits systems, safety rules and safety training.

h) The Contractor's emergency plan referred to in **Sub-Clause 4.5.1e** of this General Specification.

The Contractor shall prepare an Emergency Response Plan for all work sites as a part of the Contractor SHE Plan. The plan shall integrate the emergency response plans of the Contractor and all other subcontractors. The Emergency Response Plan shall detail the Contractor's procedures, including detailed communications arrangements, for dealing with all emergencies that could affect the Site. This include where applicable, injury, sickness, evacuation, fire, chemical spillage, severe weather and rescue.

i) Proposals for ensuring a mutual understanding between the Contractor and the Employer with regard to the elimination or mitigation of hazards on Site.

j) Methods of integrating Contractor and the Employer's safe working practices and procedures and, where relevant, those of Designated Contractors, other Contractors and Utility Companies.

An outline program for safety tours and detailed safety inspections to identify any variation in construction activities and operations, machineries, plant and equipment and processes against the Safety Plan and its supplementary procedures and programs.

k) The Contractor's disciplinary procedures with respect to safety related matters.

l) The Contractor's procedures for assessing the suitability of subcontractors with respect to health and safety.

m) The Contractor's procedures for ensuring that his personnel are medically fit for the tasks they are carrying out. The procedures shall take into account working hours and environment.

n) The Contractors safety organizational chart.

o) Within twelve (12) weeks from Commencement Date, the Contractor shall provide the Engineer with the finalized Site Safety Management Plan for his approval, taking account of any directions or requirements from the Employer on the Site Safety Management Plan submitted. Where specific requirements cannot be complied with, the reasons should be stated and any alternative arrangements specified. The finalized plan shall also detail the measures that will be implemented to eliminate or mitigate against the hazards pointed out and specified by the Engineer during the review of the plan submitted.

p) The Contractor shall carry out monthly reviews of the measures contained within the Site Safety Management Plan to demonstrate that the required levels of Safety are being achieved and maintained.

q) The Contractor shall submit a full report to the Employer and the Engineer at monthly intervals, of each such review.

r) The Engineer will review the Site Safety Management Plan from time to time and will advise the Contractor of any matter with which the Engineer is not satisfied, and the Contractor shall take such steps as are necessary to satisfy the Engineer.

s) The Engineer will carry out such safety studies or audits as considered necessary. The Contractor shall make available, specialist personnel as the Engineer may consider necessary for the performance of such safety studies or audits.

4.5 Site Safety Requirements

4.5.1 Site Organization and Arrangements for Safety

a) Safety Supervisors

Prior to commencing of the actual Works, the Contractor shall appoint Site Safety Supervisors (who should be separate from line construction management) for each working shift as may be necessary to provide adequate supervision, and shall supply to the Engineer the names and details of qualifications, experience and training of the persons so appointed. Before starting work, and at such other times as may be required by the Engineer, the Contractor's Safety Officer and Safety Supervisors shall meet the Engineer's safety representative to discuss and agree the safety measures to be implemented on Site. At all times when work is being carried out on the Site, the Contractor's Safety Officer or a nominated deputy shall be available on the Site to take immediate action on all safety matters.

b) Site Safety Committee

i. The Contractor's Safety Officer or his designated representative shall attend meetings of a Site Safety Committee chaired by the Employer or Engineer, which shall meet at no less than monthly intervals. The Site Safety Committee will also include representatives of major subcontractors, Designated Contractors, Utility Companies, other authorities (Fire Brigade, Police, etc.) and other specialists as the Employer may decide.

ii. The Contractor shall act without delay upon decisions or recommendations as made from time to time by the Site Safety Committee with regard to general or particular matters of health and safety.

iii. Arrangements will be made by the Employer or Engineer for the local Fire Brigade to visit the Site periodically and the Contractor shall make available to the Fire Brigade and the Engineer/Employer, and any other authority that may so require it, any information that they may reasonably require.

c) Site Inspections

i. The Contractor's Safety Officer shall carry out detailed inspections of the Site at a frequency agreed with the Engineer. The Contractor shall also be required to carry out safety tours and other inspections with the Engineer or his representative at a frequency required by the Engineer.

ii. The Contractor shall be responsible for ensuring that all health and safety related inspections are properly recorded and described in an approved inspection book, and that this book is signed by the inspecting person immediately on completion of the inspection.

iii. Reports of statutory examinations and inspections shall be entered in the prescribed inspection books, copies of all certificates should be available for inspection by the Engineer. Statutory notices shall be displayed as required.

iv. The Contractor’s Site staff shall possess appropriate documentation including where applicable their photo identity cards, entry permits, visitors pass, Track Safety Certificates and medical certificates. The Engineer will carry out periodic inspections of the documentation

d) Notification of Accidents

i. In the event of any recordable accident or dangerous occurrence arising at the Site during the execution of the Works, the Contractor shall comply with the legal requirements for reporting of injuries, diseases and dangerous occurrences.

ii. In addition to any statutory reporting, the Contractor shall report to the Employer and the Engineer, within 48 hours, any accident or dangerous occurrence involving his personnel or other parties, that occurs on the Site.

e) Emergency Procedures

i. The Contractor shall submit for approval by the Engineer and include in the Site Safety Management Plan detailed proposals for any reasonably foreseeable emergency, stating the procedures to be adopted for each emergency. The Contractor's Emergency Plan shall detail the duties and responsibilities of personnel on Site and in particular shall identify a senior Site official with responsibility for liaising with the emergency services. The Emergency Plan shall also include the names and telephone numbers of the Contractor's staff who would be available to organize or assist with emergency action in the event of an incident occurring on the Site outside the Contractor's normal working hours. Approved copies of the Emergency Plan and procedures shall be produced by the Contractor and distributed and displayed at each

place of work together with any other documents, posters or notices which the Employer may direct or are required by law.

ii. Arrangements shall be made for emergency medical treatment and evacuation of the victim in the event of an accident or dangerous incident occurring, the chain of command and the responsible persons of the Contractor with their telephone numbers and addresses for quick communication shall be adequately publicized and conspicuously displayed in the workplace

iii. Contractors shall require to tie-up with the hospitals and fire stations located in the neighborhood for attending to the casualties promptly and emergency vehicle kept on standby duty during the working hours for the purpose.

iv. Contractor shall conduct an onsite emergency mock drill once in every month for all their workers and their subcontractor's workers.

Before starting work on the Site, the Contractor shall ensure that all of their personnel are:

v. Informed of the location of the nearest external telephone and the procedure for calling the Fire Brigade and other emergency services.

vi. Informed of and understand fully the evacuation procedures from the Work sites.

f) Safety Communication

The Contractor shall take every effort to communicate the Safety, Occupational health and Environment management measures through posters campaigns / billboards / banners / glow signs being displayed around the work site as part of the effort to rise safety awareness amongst to the work force. Posters should be in Tagalog and English and other suitable language deemed appropriate. Posters / billboards / banners/ glow signs should be changed at least once in a month to maintain the impact.

g) Traffic Management

i. The Contractors shall adopt procedures to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen at construction sites.

ii. The Contractor shall employ proper precautions. Wherever operations undertaken are likely to interfere with public traffic, specific traffic management plans shall be drawn up and implemented by the Contractor in consultation with the approval of local police authorities and/or the concerned metropolitan / civil authorities as the case may be.

iii. The Contractor shall ensure the cleanliness of roads and footpaths by deploying proper manpower for the same. The Contractor shall ensure proper sweeping, cleaning washing of roads and footpaths throughout the entire duration of the contract including disposal of excess materials arising from the cleaning operations.

iv. The contractors shall ensure that all construction equipment leaving the site should be cleaned and roadworthy.

4.5.2 Personal Protection

a) Personal Protective Equipment (PPE)

The Contractor shall undertake a survey and needs analysis of PPE requirements for the Works and for the conditions on Site and shall provide all appropriate PPE for their personnel.

i. The PPEs and safety appliances provided by the Contractor shall be of the standard. If materials conforming to standards are not available, the Contractor as approved by the Employer shall procure PPE and safety appliances.

ii. The Contractor shall agree with the Engineer the designation of "hard hat" areas on the Site and the Contractor shall provide approved safety helmets for their personnel.

iii. The Contractor shall provide and enforce the wearing of approved safety helmets and footwear and where necessary, eye goggles, ear protectors, safety harnesses and other personal protective equipment. The Contractor shall ensure that all persons on Site wear PPE at all times in areas where PPE is required.

iv. Wherever work is carried out on or near to the LRT facilities, particularly at carriage way, or adjacent to a public way, the Contractor shall ensure that personnel shall, at all times, wear high visibility fluorescent garments.

b) Permit to Work

i. Wherever there are potentially hazardous conditions, the Contractor shall consider whether operating a "Permit to Work" system would reduce the hazards.

ii. The Contractor shall secure necessary Work Permit where statutory requirements exist.

The Contractor shall develop a Work Permit system, which is a formal written system used to control certain types of work that are potentially hazardous. A work permit is a document, which specifies the work to be done, and the precautions to be taken. Work Permits form an essential part of safe systems of work for many construction activities. They allow work to start only after safe procedures have been defined and they provide a clear record that all foreseeable hazards have been considered. Permits to Work are usually required in high-risk areas as identified by the Risk Assessments.

4.5.3 Safety of Equipment and Plant

a) Contractor's Equipment, Tools, and Vehicles

i. The Contractor shall ensure that their own and their subcontractor's construction tools, plant and vehicles required for the execution of the Works are maintained in a safe condition and are used only by trained operators.

ii. Equipment shall be examined and checked by the Contractor prior to it being delivered to Site or placed into service to ensure that it is operating in a safe mode.

iii. The Contractor shall ensure that all equipment is maintained in a thoroughly serviceable condition and, where appropriate, the equipment shall be included in a preventive maintenance program or subjected to pre-use inspections. Maintenance records and programs shall be made available to the Engineer when required. Any item of plant or equipment considered by the Engineer to be unserviceable or unsafe, shall not be used and shall be removed from the Site without delay.

iv. Where appropriate, the Contractor shall provide the Engineer with the most recent statutory inspection certificates in respect of all plant and equipment subject to statutory inspections, together with recent maintenance records for all items of equipment and tools which are being used in connection with the Works.

v. Equipment driven by any form of combustion engine shall not be used below ground in confined areas or within the Employer’s premises, unless otherwise approved by the Employer. All mechanical equipment required within the Employer’s premises or below ground, or other confined area, unless otherwise agreed by the Employer, shall be powered by electricity or compressed air from an electrical compressor. Where Contractor's Equipment driven by combustion engine is permitted and used, then it shall be located where fumes will be effectively vented to atmosphere and will not cause a nuisance or be a hazard to health.

vi. The Contractor shall ensure that any noise-emitting equipment, which is required to be operated continuously or at night, shall be housed in a suitable acoustic enclosure. The requirements of **Sub-Clause 9.19** of this General Specification shall apply with respect to noise disturbance.

b) Contractor's Lifts and Hoists and Other Lifting Equipment

i. All hoisting facilities shall satisfy the relevant legislative requirements.

ii. The Contractor shall operate all cranes strictly in accordance with national standards for the safe use of cranes. All cranes, hoists and the like shall be fitted with overload warning devices.

iii. To enable the Engineer to approve the use of the crane, the Contractor shall provide the following information at least 12 days before it is intended to bring a crane to the Site:

1. Information concerning lifting capacity at various radii.
2. Wheel, track and outrigger loads under traveling and lifting conditions.
3. Details of crane positioning and load delivery route required for any lifting operation.
4. Current insurance and test certificates for the crane, including chains, slings and other associated equipment.
5. The dimensions and weights of the items to be lifted.
6. The positioning of crane outriggers and the tail swing of any counterweights.
7. The proximity of the crane and the working envelope, relative to the nearest operational running line or siding, if any.
8. The orientation of the crane jib relative to any structure, running line or siding and a risk assessment of the crane jib collapsing or the crane overturning.
9. The proximity of site services and public or the Employer's utilities, including buried pipelines, drains, cable ducts, or overhead power lines shall be established. Sub-surface voids, manholes, chambers or other buried structures shall also be identified.

iv. Competent operators and banks men shall be clearly identified and shall be in possession of current certificates of training and Personal Protective Equipment (PPE). The operators of shaft hoisting gear shall be in telephone communication with the top and bottom landings.

v. The safe working load shall be clearly and indelibly marked on all lifting equipment.

vi. The Contractor shall prepare and maintain an up-to-date register containing test certificates of all lifting and hoisting equipment used on the Works. The register shall be available on Site from the commencement of construction for inspection by the Engineer and other relevant authorities.

vii. The operation of cranes, including crane arcs, shall be confined within the Work site boundaries unless otherwise approved by the Local Authority and the Police and agreed with the Employer.

c) Contractor's Access Equipment

i. Work shall not be carried out from a ladder, if the type of work cannot be carried out safely. Ladders shall only be used for the purpose for which they are designed.

ii. The Contractor shall ensure that all scaffolds erected on the Site shall be erected in accordance with the relevant national regulations. The Contractor shall arrange for full information and details concerning the permitted use and loadings of scaffolds to be clearly displayed on the scaffolds. The Contractor shall not permit any person other than a qualified operative to alter, erect, dismantle or otherwise interfere with any scaffold on the Site. Any scaffold being altered or dismantled or otherwise not suitable for use shall have a notice erected warning that it must not be used.

iii. The Contractor shall ensure that only experienced persons are permitted to carry out work on staging erected in roof areas and that all necessary safety harnesses and anchorage points are provided and used.

iv. No scaffold, ladder, trestle, or staging shall be used unless:

1. It has been inspected during the preceding seven days.
2. It has been inspected after rough or severe weather, which may have affected stability and safety.
3. The details of each inspection have been recorded. Records are not required for scaffolds under 2 meters in height or for ladder or trestle scaffolds. All inspections shall be made by a competent person.

d) Temporary Lighting and Power Supplies

i. If so required under the Contract, the Contractor shall provide and maintain adequate lighting and power supplies for all parts of the Works.

ii. All electrical installations shall comply with the current regulations for Electrical Installations.

iii. The Contractor shall give to the Engineer a copy of all certificates prepared upon completion of electrical installations and prepared for the periodic checks as required in accordance with the current Regulations. Periodic check certificates shall also be supplied whenever substantial alteration is made to an installation. The Contractors shall appoint a certified person to be solely responsible for ensuring the safety of all temporary electric equipment on the Site.

iv. All temporary electrical, installations which are associated with work on the Employer's property shall be in conformance with the relevant local standards and to inspection by the Engineer.

4.5.4 Site Hazards

a) Cleanliness of the Site

i. The Site shall be maintained in a clean, tidy and safe condition. The Contractor shall ensure that flammable materials, e.g. paper, cardboard, oily rags, etc., do not accumulate. Spillage of hazardous liquids shall be mopped up immediately or absorbed in sand or other suitable material, which shall be disposed of by the Contractor in a manner appropriate to the spillage.

ii. The Contractor shall immediately remove and dispose any kind of refuse, inappropriate, loose or useless materials or sludge that have been disposed by same either voluntarily or involuntarily to any of the aforementioned areas. Household waste shall immediately be disposed to covered litter boxes or plastic bags to be collected by the Local Authorities. Burning of useless materials is strictly prohibited.

iii. All access shall be kept clean of obstructions at all times.

iv. Gas hoses for welding equipment shall be kept clear of footways. Electric cables shall be routed to avoid tripping hazards and the possibility of damage by vehicles. Where cables or hoses need to cross routes, they shall be suitably boarded over.

v. Pipe lengths or timber shall not be left lying about, especially pieces of wood with projecting nails or metal with sharp or jagged edges.

b) Control Against Insects and Rodents

i. The Contractor shall ensure that the conditions will not be favorable for the development of insects and rodents in the worksite area. The aforementioned is valid

for any areas or installations occupied by the Contractor outside the worksite boundaries, throughout their occupation.

ii. Whenever, the presence of insects or rodents is observed, the Contractor shall carry out disinfection/rodent eradication according to the Engineer's directions.

c) Work in Confined Spaces

i. The Contractor shall ensure that all work or entry into confined spaces is carried out in accordance with national legislation, which lays down specific requirements when work is carried out inside any chamber, tank, pit, pipe, flue or similar confined space.

ii. If dangerous fumes are likely to be present or the proportion of oxygen in the air is likely to be substantially reduced, the confined space shall have a manhole or other adequate means of egress. The manhole shall be of adequate size for a person using breathing apparatus.

No persons shall enter a confined space in these circumstances unless:

1. That they have been trained in the safety aspects of working in confined spaces and that they are in possession of a competency certificate for such work.
2. They are wearing suitable breathing apparatus and PPE.
3. They have been authorized to do so by a responsible person and they have a Confined Space Permit to Work.
4. Where practicable they are wearing a belt with a safety line and are carrying suitable air quality detectors.
5. Appropriate methods of illumination are available.
6. Means of immediate rescue is available.

Each person when entering the confined space must be warned when the safe period will expire.

The confined space shall not be certified as safe unless:

7. Effective steps have been taken to prevent the entry of dangerous fumes.
8. The space contains no sludge deposit or other material liable to give off dangerous fumes.
9. The space has been adequately ventilated, has a supply of air adequate for breathing and has been tested for dangerous fumes.
10. There is no risk of excessive amounts of water being present, or of sudden flooding occurring.
11. Where a confined space is certified as safe, the wearing of breathing apparatus is optional; however a Permit to Work shall still be required.

iii. Sufficient resuscitation apparatus, lighting, breathing oxygen, belts, ropes, and approved breathing apparatus shall be provided adjacent to the confined space, and this equipment shall be maintained and examined every month by a competent person and the results entered into a register provided for that purpose. The register shall be available for inspection by the Engineer at all times.

d) Protection Against Fire

i. The Contractor shall take strict precautions to protect the Works, the Employer's property and all personnel on the Site from damage or injury due to fire.

ii. The Contractor shall not burn any waste or other material on Site.

iii. The Contractor shall follow safe procedures for removing tanks and pipes, which may have contained flammable liquids. In particular, the Contractor shall take adequate precautions to prevent fire or explosion caused by gas or vapor.

iv. The Contractor shall keep all exits, signs and means of access clear of obstructions, particularly access to fire-fighting equipment and emergency stairs and doors.

v. Underground, the Contractor shall heat water using electric immersion heaters only and space heating shall be by electric convectors. All appliances shall be securely fixed.

vi. The Contractor shall comply with International and National fire safety standards with respect to all materials, which are to be incorporated in subsurface parts of the Permanent Works.

vii. The Contractor shall comply with International and National fire safety standards with respect to all Temporary Works in areas of interface with the existing LRT system.

4.5.5 Health Hazards

a) Hazardous Materials

i. The Contractor shall impose necessary controls and procedures for the safe handling of hazardous substances.

ii. Specific requirements related to the control of exposure to asbestos and lead are outlined in **Sub-Clauses 4.5.5b** and **4.5.5c**, below.

b) Asbestos

i. The Contractor shall not deliver any asbestos materials to the Site.

ii. The Contractor shall submit to the Engineer for his approval details of any friction materials containing asbestos, which are proposed to form part of the Works. Such materials or the equipment containing such materials shall be clearly labeled in accordance with the relevant regulations.

iii. The Contractor shall comply with International and National regulations for the control of asbestos. The Contractor shall immediately cease work, cordon off the area and inform the Employer and the Engineer if any asbestos is discovered during the course of the Works. Qualified personnel shall carry out asbestos surveys.

iv. Where any work will result in exposure to asbestos, the Contractor shall submit for approval by the Employer and the Engineer his proposals for carrying out the remedial measures that may be required to comply with **Sub-Clause 4.5.5b**.

v. The Contractor shall not commence any work on the LRT Line which necessitates contact with asbestos, until the area or installation has been visited by the Employer's Specialist for Asbestos Control and removal measures as instructed by the Engineer have been completed.

c) Lead

The Contractor shall ensure that any work involving the use of lead in any form will be planned and carried out in accordance with International and National regulations for the control of lead at work. The regulations apply to any work including any type of handling, moving, storing, processing or otherwise, that exposes any person to lead, including any work from which lead arises:

i. In the form of lead dust, fume or vapor in such a way that it could be inhaled.

ii. In any form which is liable to be ingested such as powder, dust, paint, or paste.

iii. In the form of lead compounds such as concentrated lead alkyl which could be absorbed through the skin.

d) Ionizing Radiation

The Contractor shall implement measures to control exposure and dosage due to all sources of ionizing radiation, if any, which may be subject to statutory controls.

e) Noise

The Contractor shall impose controls and conduct any assessments as required by statutory noise regulations. Copies of noise assessments shall be made available for inspection by the Employer and the Engineer. Further requirements with respect to disturbance from noise are set out in **Sub-Clause 9.19** of this General Specification.

f) Contaminated Water

i. The Contractor shall ensure that all personnel working in contact with drainage water are suitably safeguarded.

In particular the Contractor shall ensure that their personnel:

1. Are aware of the provisions related to men working in contact with sewage, etc. The Contractor at a point shall display this notice or a card or a suitable alternative as agreed by the Engineer, which is conspicuous to all personnel working in such conditions.
2. Are provided with and wear all necessary protective clothing and equipment. In addition to overalls and gloves this shall include a facemask (respirator) and goggles where splashing may occur.
3. Are advised of the nearest washing area and are provided with waterless hand cleanser and towels where clean running water is not available in the working area.
4. Only consume food in a designated rest room or clean area.
5. Cover all cuts, scratches or abrasions with waterproof plasters.
6. Enforce a No Smoking Policy.

ii. The Contractor shall take special precautions to protect all their personnel and others attending the Site from Leptospirosis Jaundice (Weils Disease). Recommended precautions are the wearing of protective clothing and the elimination of rat infestation.

4.5.6 Fire Protection

a) Minimizing Fire Hazards

i. Fire hazards include but are not limited to the following:

ii. Electrical switchgear.

iii. Electric and electronic equipment installed or being installed.

iv. Electrical cables and circuits.

v. Electric traction supplies and contact wire systems.

vi. Rail-Road vehicles and other self-propelled rolling stock

vii. Oil/fuel spillages.

viii. General combustible materials (wood, paper, etc.).

ix. The Contractor shall minimize the potential fire risks during installation. Consideration shall be given to the Site supervisory controls necessary to ensure a low risk of fire. The Contractor shall also:

1. Establish adequate means of "first aid" fire-fighting and provide suitable extinguishers, hoses and other appliances at selected locations.
2. Establish arrangements for calling the local Fire Brigade by telephone and other means such as radio.
3. Pay particular attention to the design of all electrical and mechanical systems and avoid overloading the electrical supply system and maintain equipment in good working order.
4. Ensure that all personnel are fully trained in the use of fire-fighting equipment and rescue procedures.
5. Adopt a 'Permit-to-Work' system for special operations, particularly those that carry a relatively high fire risk.
6. Promote general tidiness and cleanliness and ensure the removal of all flammable materials from tunnels or sub-surface workings when not required.
7. Identify all possible sources and categories of fire and the appropriate means of fire-fighting.
8. The Contractor shall strictly enforce a ban on smoking.

b) Control of Dangerous Work

The Contractor shall not carry out any flame cutting, welding, grinding, spark producing or similar hot work operation involving risk of fire without approval from the Engineer and the following shall apply:

i. If hot working is likely to be undertaken the Contractor shall advise the Engineer of the need for such hot work and agree with the Engineer all precautions to be implemented throughout the duration of the hot work.

ii. The Contractor shall not carry out hot work underground when it could reasonably be done on the surface.

iii. The use of thermic lance or any paraffin/gas blowpipe shall not be permitted.

iv. The Contractor shall limit as far as is reasonably practicable the emission of smoke or any noxious or pungent fumes and he shall protect all persons there from.

v. The Contractor shall provide a competent and trained fire watchman for the whole duration of any hot working. The fire watchman shall be trained in the use of various types of extinguishers and other fire-fighting equipment and he shall ensure that an adequate supply of appropriate firefighting materials and equipment is readily available whilst burning or welding works are underway. The fire watchman shall not be engaged on other duties and shall remain on fire duty for at least one hour after the completion of welding or burning work to ensure there is no possibility of the outbreak of fire.

vi. Only qualified welders or fitters tested in accordance with this Specification shall be permitted to burn or weld. They shall not be permitted to work alone but shall be accompanied by a competent fire watchman.

vii. Petrol-driven plant shall not be used in any underground workings.

4.6 LRTA Line 1 Rules and Regulations (Procedures)

The Contractor shall comply with all LRTA's Rules and Regulations and any subsequent revision thereof when working on or near the Operational LRT system.

4.7 Safety Requirements on or Adjacent to the LRT Line

4.7.1 Rule Book and Safety Procedures

a) When working on or adjacent to the LRT Line, the Contractor, unless otherwise agreed with the Employer/Concessionaire, shall work in accordance with the rules and regulations specified in LRTA Rule Book and the Concessionaire's Safety Procedures and in any subsequent revisions thereof. In case of conflict, the Concessionaire's Safety Procedures shall prevail.

b) Each member of the Contractor's Site staff shall know, understand and comply with the appropriate sections of the LRTA Rule Book and the Concessionaire's Safety Procedures at all times.

c) The Contractor shall comply with the requirements of the Employer's Engineering Instructions as may be notified by the Employer from time to time.

d) Within two weeks from Commencement Date, the Contractor will be provided with a copy of the LRTA Rule Book and the Concessionaire's Safety Procedures relevant at that time.

4.7.2 Notification of Accidents

In the event of any incident or dangerous occurrence on or about the LRT Line during the carrying out of the Works, the Contractor shall comply with statutory requirements for notification of accidents. A copy of the notification shall be given to the Employer, in order that the Employer may comply with statutory requirements as appropriate.

The Contractor shall maintain records of the activities of its personnel carrying out the Works. In the event of an incident affecting the operation of the LRT Line, the Contractor may be required to give evidence to an investigation team if the Contractor's work is involved.

4.7.3 Safety on the LRT Line

a) Person in Charge on Site

The Contractor shall appoint a responsible person as the Person in Charge on Site for any work carried out on the LRT Line. The Contractor shall ensure that the Person in Charge on Site has been trained and is clearly identifiable. The Contractor shall provide, for approval by the Engineer, the names and details of qualifications, experience and training of the persons so appointed. The appointed Person in Charge on site may also act as Safety Supervisor per **Sub-Clause 4.5.1a** of this General Specification for any particular shift.

b) Work in Traffic Hours on the LRT Line

Where the Contractor is required to work in Traffic Hours on the LRT Line the work shall not take place closer than 2 meters from the nearest track, the following safety precautions shall be observed:

i. The Contractor shall make all arrangements necessary for the safe and efficient protection of the trains and the public and shall provide and maintain all temporary structures, shields, fences, close boarded decks and protective screens to such sizes and of such types as may be approved by the Employer. The Contractor shall erect such protective arrangements during Engineering Hours occupation(s) of the Track.

ii. The Contractor shall ensure that their personnel and equipment do not encroach on or cross the Track.

iii. When work is being carried out at places where the Track is electrified, the Contractor shall issue to all personnel engaged on the work any instructions supplied by the Engineer/Employer regarding the danger to persons working in proximity to the overhead supply lines, cables, wires and electrical equipment and shall see that such personnel are made fully conversant with such instructions and that they are strictly

obeyed. The Contractor shall display warning posters of the potential hazards in prominent positions on the Site.

c) Work in the Track

All work, and the movement of men and materials, which is to be executed in any of the circumstances detailed below shall only be carried out during Engineering Hours and in full compliance with the rules set out in the LRTA Rule Book and the Concessionaire's Safety Procedures:

i. Any work within 2 meters horizontally and 4.2 meters vertically from the nearest running rail, with the exception of work on platforms.

ii. Any work involving the lifting or placing of objects in such a position and in such a manner that either the objects or the lifting equipment might be a danger to the LRT at any stage during the operation.

iii. Any work requiring access to be gained along or adjacent to the Track or restricted clearance areas.

iv. Any other work which, in the opinion of the Employer, could endanger the LRT.

d) Track Occupation during Engineering Hours

i. Occupation of the Track during Engineering Hours will be arranged by the Employer/ Concessionaire and normally be granted after the traction current has been switched off. All staff, equipment and materials shall be cleared off the Track not less than 20 minutes, or such other period as the Engineer/Employer may decide, before the traction current is switched on again.

ii. The Contractor shall not commence work without the Engineer's/ Employer's/ Concessionaire's Safety Officers being in attendance that enforce the "Site Safe Procedure".

iii. The duration of the period of occupation may be interrupted by the passage of an Engineering Vehicle and all work shall be suspended as and when directed by the Engineer/ Employer/ Concessionaire during the passage of the vehicle. Under no circumstances will cranes or mechanized plant be allowed to work after the approach of a vehicle has been signaled or warning given of the approach of a vehicle, until such vehicle has been passed clear of the Site.

iv. When work has ceased at the end of each shift all exposed uncompleted work shall be protected with a hoarding.

v. Panels of hoardings on platforms or adjacent to the Track which are removed during Engineering Hours shall be securely replaced to the Engineer's/ Employer's/ Concessionaire's satisfaction not less than thirty minutes, or such other period as the Engineer/ Employer/ Concessionaire may decide, before the start of Traffic Hours.

e) Engineer's/ Employer's/ Concessionaire's Safety Officer/s

The Contractor shall, before commencing any work on or adjacent to the Track, give adequate notice to the Engineer/Employer/ Concessionaire of his intention to work and arrange with the Employer for the attendance for the duration of the work of the Engineer's/ Employer's/ Concessionaire's Safety Officers.

4.7.4 Safety Training Requirements

a) Training Requirements

No member of the Contractor's personnel shall work on the LRT system and in particular on or adjacent to the Track without first having attended and passed the relevant safety training courses including those outlined in b), and c) below.

All personnel attending the safety training courses shall first undergo a medical appraisal, which shall satisfy the standards for such appraisals. All persons shall be declared medically fit as a pre-requirement to attending the training courses and working on the LRT Line.

The Contractor shall organize quality Safety, Health and Environment training to engage Managers, supervisors and other personnel/workers in behavioral change and improve safety performance

The Contractor shall analyze the training requirements for all the employees and initiate a training program to demonstrate that all persons employed, including subcontractors, are suitably qualified, competent and fit.

A matrix and schedule of training requirements, covering general, task–specific and SHE-related training, showing the training frequency and interval between refresher courses.

The training courses shall be provided free of charge by the Engineer/Employer. All other expenditure incurred by the Contractor as a result of their personnel attending the courses or medical appraisal shall be borne by the Contractor.

b) Fire Fighting and Evacuation

The Contractor shall ensure that all personnel on Site are properly trained in the fire precautions to be observed in the course of the work, the use of fire-fighting equipment maintained on Site, the actions to be taken in case of fire and the fire evacuation procedures from sub-surface sections of the LRT Line and within station premises.

c) Training of Contractor's personnel for the System and the Track

All Contractor's personnel who will be or may be carrying out work or who may require access on or adjacent to the LRT Line or the Track, shall attend a course arranged by the Engineer/Employer before commencing any such work or obtaining any access. On successful completion of the course, the trained Contractor's personnel will be issued with certificates by the Employer, and these shall be carried at all times by the Contractor's personnel. Contractor's personnel attending the course shall wear suitable clothing including boots or shoes for walking along the Track and shall have in their possession a High Visibility Vest.

4.7.5 Use of Radios

The Contractor shall ensure that the use of personal radio sets or other similar electrical equipment (including personal stereo sets with headphones but excluding hearing aids) is forbidden in all areas of the LRT Line.

The Contractor shall seek approval for the use of radio transceivers on the Employer’s premises. A written request shall be submitted to the Engineer/Employer at least 14 days before the proposed use of the radio equipment and the request shall include information on output power and allocated frequency.

4.7.6 Personal Protective Equipment (PPE)

The Contractor shall ensure that high visibility clothing conforming to the requirements, is worn by all persons at all times when in work site, on or near the Track.

The minimum standard to satisfy the above requirement is the "High Visibility Vest" which may be purchased from an approved supplier.

4.7.7 Hot Working

The Contractor shall ensure that Hot Working is carried out in accordance with the following requirements in addition to those specified in **Sub-Clause 4.5.6b** of this General Specification.

Permits for hot working shall be applied for by the Contractor from the Engineer not less than 48 hours prior to the proposed commencement date of the operation.

The Contractor shall not undertake any hot work anywhere within the confines of the operating LRT zone during Traffic Hours, without the approval of the Engineer.

Where hot working is to be performed in any part of the Works which is connected to the LRT Line, the Engineer/ Employer/ Concessionaire may also supply a fire watchman in addition to the Contractor's responsibilities as set out in **Sub-Clause 4.5.6b** of this General Specification. If the attendance of the Engineer's/ Employer's fire watchman is considered necessary, work shall not commence until they are in attendance.

4.7.8 Safety of Equipment and Plant

a) LRT Line Equipment

All work shall be carried out in such a manner so as to ensure the safety of the LRT Line, to prevent damage to LRTA's/ Concessionaire's equipment and to require the absolute minimum of alteration to such equipment.

b) Screening of Lights

All lights or lasers provided by the Contractor shall be so placed as not to cause any confusion with or so as not to interfere with any signal lights on the LRT Line. If directed by the Engineer, the Contractor shall forthwith remove such lights and lasers and replace them in a position approved by the Engineer. Such approval shall not preclude the Engineer from giving further directions as to such replaced lights or lasers.

4.7.9 Fire Protection Requirements

a) The Contractor shall ensure that, on the Employer's operating premises, he maintains the integrity of the partition of rooms and areas throughout the duration of the Works. The Contractor shall agree with the Engineer/Employer the means of ensuring such integrity of the partition and maintenance of the fire protection systems installed on the Employer's premises. The Contractor shall not obstruct access to fire-fighting equipment, nor isolate fixed fire protection or detection equipment unless approved by the Engineer.

b) Materials Standards

All materials used on underground work shall be in compliance with **fire safety standards,** unless otherwise approved.

c) Fire Performance of Temporary Hoardings in Enclosed Areas

The fire performance criteria and approved painting systems for temporary hoardings in enclosed areas shall be to the approval of the Engineer.

d) Storage and Use of Gas Cylinders, Flammable and Volatile Materials

i. The Contractor shall not take or store anywhere on the LRT Line any cylinders of industrial or flammable gases, including Oxygen, and containers or flammable and volatile materials without the prior written permission of the Engineer/Employer.

ii. The Contractor shall make arrangements for any storage of flammable and volatile material, including Oxygen, to be strictly controlled during the period of the Works.

iii. Gas cylinders and flammable and volatile materials shall be stored only at ground level and in locations approved by the Engineer. The storage areas shall be in a position that will not cause an obstruction to passageways, and staff accommodation and not be near any source of ignition. Gas cylinders shall be stored in locked cages and be vertical and properly supported. Hoses and cylinder keys shall be removed from cylinders and kept away from the cylinders. Flammable and volatile materials shall be stored in locations separate from gas cylinders and in sealed metal containers with a maximum storage of all materials in one place of 0.025 m^3.

e) No Smoking Policy

The Contractor shall throughout the progress of the Works, strictly enforce the Employer's ban on smoking in the project site except on the designated smoking areas of the LRT System.

4.7.10 Hazardous Materials

In addition to the requirements of **Sub-Clauses 4.5.5** and **4.6** of this General Specification the Contractor shall comply with the Employer's Engineering Instructions with respect to the use, storage, licensing and inspection of storage facilities for hazardous materials. All hazardous materials should be accompanied with a Material Safety Data Sheet (MSDS).

4.7.11 Delivery and Handling of Materials

a) The delivery of materials, plant or equipment by the Contractor through public areas of the LRT Line shall be undertaken only during Engineering Hours.

b) The Contractor shall not place any material, plant or equipment within 2 meters from the nearest running rail unless approved by the Engineer/ Employer/ Concessionaire.

c) The Contractor shall submit to the Engineer, for approval, proposals for any lifting of heavy items, storing or transporting of materials, plant or equipment on or along LRT premises. The Contractor's proposals shall include information on floor loads. The Contractor shall provide at least two weeks' notice of their intention to carry out such work.

4.8 Occupational Health and Welfare

4.8.1 Physical Fitness for Workmen

The Contractor shall ensure that their employees / workmen subject themselves to such medical examination as required under the law or under the contract provision and keep a record of the same.

The Contractor shall not permit any employee / workmen to enter the work area under the influence of alcohol or any prohibited drugs.

4.8.2 Medical Facilities

4.8.2.1 Medical Examination

The Contractor shall arrange a medical examination of all their employees including their sub-contractor employees employed as drivers, operators of lifting appliances and transport equipment before employing, after illness or injury, if it appears that the illness or injury might have affected his fitness.

The Contractor shall maintain the confidential records of medical examination and only be made available to the Employer or to the physician authorized by the Employer when required.

No building or other construction worker is charged for the medical examination and the cost of such examination is to be borne by Contractor employing such worker.

The medical examination shall include:

a) Full medical and occupational history

b) Clinical examination with particular reference to:

General Physique;

i. Vision : Total visual performance using standard ophthalmology equipment such as a Titmus Vision Tester should be estimated and suitability for placement ascertained in accordance with the prescribed job standards.

ii. Hearing : Persons with normal hearing must be able to hear a forced whisper at twenty-four feet. Persons using hearing aids must be able to hear a warning shout under noisy working conditions.

iii. Breathing : Peak flow rate using standard peak flow meter and the average peak flow rate determined out of these readings of the test performed. The results recorded at pre-placement medical examination could be used as a standard for the same individual at the same altitude for reference during subsequent examination.

iv. Spine : Adequately flexible for the job concerned

v. Lower Limbs : Adequate leg and foot concerned

vi. General : Mental alertness and stability with good eye, hand and foot Coordination.

c) Any other tests which the examining doctor considers necessary

4.8.2.2 Ambulance and Infirmary Room

The Contractor shall ensure that an ambulance and infirmary room are provided at the construction site or an arrangement is made with a nearby hospital for providing such ambulance for transportation of serious cases of accidents or sickness of workers to hospital promptly and such an ambulance and room are maintained in good condition and is equipped with standard facilities.

4.8.2.3 First-Aid Boxes

The Contractor shall ensure that an appropriate numbers of First-aid box for workers is provided and maintained at the construction site.

4.8.2.4 HIV/ AIDS Prevention and Control

The Contractor shall adopt the Employer's Policy on "HIV / AIDS Prevention and Control for Workmen Engaged by Contractors".

The Employer will engage a professional agency for implementing the guidelines laid down in the policy and communicate to the Contractor.

The Contractor shall extend necessary support to the appointed agency by deputing the workmen to attend the awareness creation programs.

The Contractor shall also extend necessary organizational support to the appointed agency for the effective implementation of the Employers' workplace policy on HIV/AIDS for workers of the Contractors.

4.8.2.5 Prevention of Mosquito Breeding

Measures shall be taken to prevent mosquito breeding at site. The measures to be taken shall include:

a) Empty cans, oil drums, packing and other receptacles, which may retain water and shall be deposited at a central collection point and shall be removed from the site regularly.

b) There should not be accumulation of still water at any site, In case of still water, it should be covered by earth and levelled.

c) Contractor's equipment and other items on the site, which may retain water, shall be stored, covered or treated in such a manner that water could not be retained.

d) Water storage tanks shall be provided.

4.9 Noise

The Contractor shall consider noise as an environmental constraint in their design, planning and execution of the Works and provide demonstrable evidence of the same on Employer's request. The Contractor shall, at their own expense, take all appropriate measures to ensure that work carried out by the Contractor and by their sub-Contractors, whether on or off the Site, will not cause any unnecessary or excessive noise which may disturb the occupants of any nearby dwellings, schools, hospitals, or premises with similar sensitivity to noise.

Without prejudice to the generality of the foregoing, noise level reduction measures shall include the following:

a) The Contractor shall ensure that all powered mechanical equipment used in the Works shall be effectively sound-reduced using the most modern techniques available including but not limited to silencers and mufflers; and

b) The Contractor shall construct acoustic screens or enclosures around any parts of the Works from which excessive noise may be generated.

The Contractor shall ensure that noise generated by work performed by the Contractor and their sub-Contractors during daytime and night time shall not exceed the maximum permissible noise limits.

4.10 Welfare Measure for Workers

4.10.1 Latrine and Urinal Accommodation

The Contractor shall provide sufficient latrines and urinal accommodation at site.

Where women are employed, separate latrines and urinals accommodation shall be provided on the same scale as mentioned above.

4.10.2 Drinking Water

The Contractor shall make available in every worksite, effective arrangements to provide sufficient supply of potable drinking water with minimum quantity of 5 liters per workman per day. Quality of the drinking water shall conform to the requirements of national standards on Public Health.

While locating these drinking water facilities due care shall be taken so that these are easily accessible from the place of work for all workers at all location of work sites.

5.0 Design Safety

5.1 General

5.1.1 The safety of passengers and staff is of the greatest consideration, therefore considerable attention shall be afforded in setting out the parameters for the design of matters that can have an effect on safety and availability. This includes not only the performance of the trains, but also concerns such as maintenance of tolerable environmental conditions and standby operation under emergency conditions.

5.1.2 Hence, the Contractor shall bear in mind the safety requirements and ensure that the design and performance of their plant and equipment are compatible with the overall high safety standards of the Manila LRT Line 1.

5.1.3 For guidance, but without limiting the Contractor's responsibilities as to safety requirements, the principal aspects of the philosophy of design for the Manila LRT Line1 are given below:

a) Train movements shall be possible at all times, except for a complete and simultaneous failure of power supply at all feeding points;

b) The system shall be designed to prevent flooding during conditions of heavy rainfall or water supply system damage;

c) Hand-operated fire-fighting equipment shall be provided in electrical equipment rooms etc.; and

d) The design of buildings and the physical arrangement of equipment shall be such as to limit misuse of equipment by public and staff and to frustrate attempts of sabotage and vandalism.

5.1.4 The Contractor shall pay due attention to the need to safeguard the staff who will be required to operate and maintain the LRT Line. For guidance, but without limiting the Contractor's responsibilities as to safety requirements, the principle aspects to be considered and incorporated into the Works should include:

a) The provision of metallic guards to all moving parts such as gears, belt drives, chain drives, interlocking mechanisms and similar items;
b) Notices for exits, hazards and high voltages;
c) Provision for lubricating, greasing, adjusting and other maintenance facilities that can be reached without hazard; and
d) Identification of all equipment, pipes, cables, ducts and similar installations.

5.2 Materials

5.2.1 All apparatus, connections and cabling shall be designed and arranged to minimize the risk of fire and any damage, which might be caused in the event of fire. Wherever practicable, materials shall be used which do not support combustion and which do not give off smoke, corrosive or toxic fumes, when heated in accordance with the requirements of DIN 4102 (class A1, A2).

5.2.2 Where it is not possible to meet this requirement, materials shall be selected which provide the minimum practicable hazard, and care shall be taken to minimize the risk of the effects of any fire extending beyond the place of its initiation.

5.3 Fire Resistance Periods

5.3.1 Structures shall be designed so that the different areas are separated by a minimum Fire Resistance Period (FRP) in accordance with National Fire Code or NFPA 130. Electrical and Mechanical systems that pass through these structures shall include means to maintain the FRP of the structure.

5.3.2 The local codes mentioned in the said standard shall be considered as well as the relevant directives of the Fire Department.

6.0 Technical Requirements Common to All Equipment

6.1 Standards

6.1.1 Where no particular National or International Standard is specifically stated in the documents, the Works shall comply with the relevant standard, code, or recommendation of the following organizations:

a) The International Organization for Standardization (ISO);

b) The International Electro technical Commission (IEC);

c) International Telecommunication Union (ITU);

d) The European Committee for Standardization (CEN);

e) The European Committee for Electro technical Standardization (CENELEC);

f) International Union of Railways (UIC);

g) British Standards Institution (BSI);

h) National Fire Protection Association, USA (NFPA);

i) Japanese Industrial Standards (JIS);

j) German Standards Organization (DIN);

k) French National Railway (SNCF);

l) German National Railway (DB); and

m) European Telecommunications Standards Institute (ETSI).

6.1.2 The standards of the above organizations referred herein represent the minimum requirements that shall be met. The Contractor may adopt standards of the countries of source, but they shall confirm that such standards are equivalent to or better than those either referred to in the documents or listed above. The Contractor shall submit three copies of such standards for the Engineer's review, drawing attention to all differences. In the case that the Engineer does not approve such standards, the Contractor shall adopt those specified.

6.1.3 It shall be understood where reference is made within these documents to certain standard specifications, the reference shall be construed to mean the standards, with all subsequent amendments, changes or additions as thereafter adopted and published that are in effect at the date of invitation to tender.

It shall be the responsibility of the Contractor to ascertain that all relevant local laws, rules, standards, codes and regulations are strictly adhered to.

6.1.4 Unless otherwise approved by the Engineer, any reference in any standard to a recommendation shall be interpreted by the Contractor as a requirement of the Employer. Also, unless otherwise approved by the Engineer, whenever any such standard provides for alternatives, the most stringent alternative shall apply.

6.1.5 The Contractor shall provide one (1) copy of all relevant manufacturing and testing standards for items under his scope of supply.

6.2 Units

6.2.1 The International System of Units (SI Units) shall be used for measurement and design criteria for equipment, drawings and materials supplied and installed under this contract, unless approved otherwise in writing by the Engineer.

6.3 Suitability of Purpose

6.3.1 The E&M Works shall be so designed, constructed and installed to meet their particular use by the Employer. The design shall facilitate inspection, cleaning, lubrication, repairs and operation in which continuity of service is a major consideration.

6.3.2 All materials used shall be of the highest quality and of the class most suitable for operating under the conditions specified and shall withstand the variations of environmental conditions without distortion, deterioration or undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work for which it must perform. No welding, filling or plugging of defective parts will be permitted without the approval in writing of the Engineer.

6.3.3 The design shall incorporate every necessary feature to ensure the safety of all those concerned in the operation and maintenance of the Works.

6.3.4 As far as possible, the plant and equipment offered by the Contractor shall be the standard manufactured model with an appropriate documented history of reliable service and performance. All items of plant and equipment shall be new and shall not have been in service at any time prior to delivery, except as required for testing purposes.

6.3.5 Corresponding parts susceptible to renewal shall be interchangeable. When required by the Engineer, the Contractor shall demonstrate this feature.

6.3.6 All apparatus shall operate without undue vibration and with the least practicable amount of noise in accordance with the requirements of the Technical Specifications. The system shall meet the overall noise limitations of the applicable Philippine Codes.

6.3.7 Containers, boxes, kiosks, cubicles and similar enclosed compartments forming part of auxiliary equipment shall be adequately ventilated to restrict condensation and, where necessary, suitable integral anti-condensation heaters shall be provided. The use of drain holes may only be permitted subject to the approval in writing of the Engineer.

6.3.8 All outdoor apparatus shall be so designed as to avoid pockets in which water can collect.

6.3.9 The underside of all tanks and cylinders shall be ventilated in an approved manner to prevent corrosion.

6.3.10 Accessible means shall be provided for the easy lubrication where required of all bearings, mechanisms and moving parts. Grease lubricators shall be fitted with standard nipples.

6.3.11 All mechanism shall, when necessary, be constructed of stainless steel, brass or gunmetal to prevent jamming or sticking due to rust or corrosion.

6.3.12 All tapered pins used in any mechanism shall be of the split type.

6.3.13 All electrical connection and contact shall be of ample cross section and surface for carrying continuously the maximum design current without undue heating, and shall be secured by bolts or set screws of ample size, and fitted with locking devices of approved type and material.

6.3.14 Surfaces subject to rubbing or wearing shall be machine finished. Joints employing a gasket material shall be so constructed that the packing is maintained under sufficient compression in all parts, so that an efficient joint can be made without the use of jointing compound. Gasket material shall be of the minimum thickness necessary and of approved composition.

6.3.15 All apparatus shall be designed to obviate the risk of accidental short circuit due to animals, birds and vermin. Openings in ventilation enclosures shall be so constructed to prevent entry of vermin and insects.

6.3.16 All apparatus incorporating hinged doors shall be erected so that the doors can be opened to at least 90 degrees after adjacent equipment has been installed.

6.4 Manufacturer's Standards

6.4.1 Unless specified otherwise, all materials and equipment associated with the installation shall be handled and installed strictly in accordance with the manufacturer's recommendations and by workers who have undergone training by the manufacturer and have previous experience with the equipment and materials.

6.4.2 The Contractor shall ensure that their staff and subcontractors use special tools recommended by the manufacturers for the installation of their materials and equipment.

6.5 Right of Rejection

6.5.1 The Employer and the Engineer shall have the right to reject all material or work that is non-compliant, and require the replacement and rectification of the Works at the sole expense of the Contractor.

6.6 Design for Introduction to Service

6.6.1 All equipment shall be designed in such a manner that it can be installed, tested and commissioned under the Contract without adversely affecting the operation or safety of the operating railway. The equipment shall be designed so that, where appropriate, considering the operating procedures adopted by the Employer/ Concessionaire, it can be brought into operational use during Engineering Hours and if necessary during a single night. The Contractor shall base their design accordingly.

6.7 EMI/RFI

6.7.1 Electro-Magnetic Interference/Radio Frequency Interference (EMI/RFI) shall be held to a minimum commensurate with good design practices, and in no case shall signal levels be permitted which interfere with, or compromise, the operation of any of the Employer's systems.

6.7.2 Test data shall be submitted indicating compliance with the latest industry guidelines.

6.7.3 The Contractor shall demonstrate by test that electromagnetic interference levels do not exceed the current pertinent recommendations of the International Electro technical Commission. In addition, the Contractor shall demonstrate by test that their equipment does not interfere with any of the Employer's existing systems. Should testing prove that the Contractor's equipment interferes with any of the Employer's systems, as adjudged by the system supplier, the Contractor shall make all appropriate modifications to the equipment to bring it into compliance with this requirement.

6.7.4 The Contractor is required to submit for review and approval the EMI/RFI study report which shall be prepared in accordance with EN 50121-2.

6.8 Earthing and Bonding

6.8.1 The Contractor shall comply with the Engineer's "Earthing and Bonding" policy. See Bid Document Part 2 Employer's Requirements Section VI-2-2 Technical Specification D-1 Electrical Works 3.0 Earthing and Lightning Protection.

7.0 Quality Assurance

7.1 General

7.1.1 All work and materials required in the Contract shall be executed and controlled by a Quality Assurance Management Scheme in accordance with the requirements of ISO 9001 or equivalent and as approved by the Engineer. The Quality Assurance Scheme and systems shall be submitted in the English language.

7.1.2 Nothing in this **Sub-Clause 7.1.1** shall relieve the Contractor from their obligations under the Contract.

7.2 Quality Assurance Management Plan

7.2.1 Within four (4) weeks from Commencement Date, the Contractor shall submit a detailed Quality Assurance Management Plan to the Engineer for his review and comments. The Quality Assurance Management Plan shall indicate the approach and system structure that the detailed plan will take and shall include the following:

a) Project details including name, Contract Number;

b) A summary of the Project requirements including all proposed quality activities;

c) All Quality Assurance System details including proposed Reporting and Quality Control Procedures, proposed by the Contractor for his use in the execution of the Works;

d) A list of all the Codes of Practice, Standards and Specifications that the Contractor proposes to apply to his work. This shall include those that differ from or complement the requirements of the Contract or those specified in the Contract;

e) The Contractor's proposals for internal, subcontractor and contractor-under-subcontractor quality assurance audits, including a schedule;

f) A statement detailing the records that the Contractor proposes to keep, the time during which they will be prepared and the subsequent period and manner in which they will be indexed, prepared and stored; and

g) Inspection and test plans for every activity requiring inspection and testing. The plans shall identify the level of inspection and testing required and stipulate who is responsible for releasing an activity from a "Hold Point".

Within six (6) weeks from Commencement Date, the Contractor shall provide the Engineer with the final detailed Quality Assurance Management Plan taking into consideration any directions or requirements from the Engineer on the Quality Assurance Management Plan.

7.2.3 The detailed Quality Assurance Management Plan shall be updated as necessary from time to time to incorporate for continuous improvement, all changes to the Contractor's control procedures shall be submitted to the Engineer for approval.

7.3 Quality Organization

7.3.1 The Contractor shall submit a detailed organization chart. It shall identify the responsibilities, authority and interrelation of all personnel who manage, perform and verify items affecting quality system and the works. The organization chart shall be specific only to this Contract.

7.3.2 The chart shall identify the quality management representative who shall act as the Quality Co-coordinator(s) for the Contractor in all dealings with the Engineer.

7.4 Identification and Traceability

7.4.1 The Contractor shall produce and maintain procedures for identifying the product from applicable drawings, specifications and other documents during all stages of production, delivery and installation.

7.4.2 Traceability of materials and equipment shall be documented in accordance with the Contract and the Quality Assurance Management Plan.

7.4.3 Notwithstanding the requirements of the Contractor's Quality System, the Contractor shall retain all Inspection Certificates, Test Certificates and Certificates of Conformity, which shall be collated to allow easy traceability and made available for inspection by the Engineer at the Contractor's premises.

7.5 Quality Audit

7.5.1 The Contractor shall make available on request any documents, which relate to their recent internal audits.

7.5.2 Periodically during the life-cycle of the Contract, the Engineer will conduct compliance audits of the quality system. During any audits by the Engineer, the Contractor shall provide qualified staff to accompany the auditor.

8.0 System Assurance

8.1 General

8.1.1 Specified in this section are the requirements for System Assurance, which the Contractor shall develop and implement. These requirements shall be applied to subcontractors and suppliers and shall be undertaken during the design, installation, testing and commissioning of the Works.

8.1.2 The Contractor shall prepare and submit for review and acceptance by the Engineer, a detailed Systems Assurance Plan (SAP).

8.1.3 The SAP shall delineate the Contractors approach, procedures and schedules for conduct of safety engineering, reliability engineering and maintenance engineering. Human factors engineering is an integral part of systems assurance and shall be considered and reflected within the SAP.

8.1.4 The SAP procedures shall be incorporated as part of the Contractor's System Assurance and Safety system and shall be subject to audits by the Engineer.

8.2 Systems Assurance Plan (SAP)

8.2.1 Within six (6) weeks from the Commencement Date, the Contractor shall submit the System Assurance Plan, based on the Outline System Assurance Plan submitted with the Bid. The System Assurance Plan shall demonstrate clearly the proposal for achieving effective and efficient safety procedures in the design, construction, installation, manufacture, transport, integrated testing and commissioning of the depot facilities and equipment. The System Assurance Plan should include the safety procedures and regulations and an implementation plan for ensuring safety including Hazard Analysis, Fire Control, Electromagnetic Compatibility/Electromagnetic Interference Control, reliability and maintainability.

The SAP shall be developed specifically for this Contract and shall address in particular the following items:

a) Safety engineering, which shall provide analyses for the minimization of the magnitude and seriousness of those events or malfunctions which could result in injury to passengers or staff and damage to plant or property.

b) Reliability, Availability, Maintainability and Safety (RAMS) analysis, which shall ensure a high degree of failure-free or fault-tolerant operation and minimize downtime during routine maintenance and failure repair.

8.2.2 Guideline documents to be used for reference shall be:

a) EN 50126 The Specification and Demonstration of Reliability, Availability, Maintainability and Safety

b) EN 61709 Reference Conditions for Failure Rates and Stress Models for Conversion

c) IEC 1025 Fault Tree Analysis

d) IEC 1078 Analysis Techniques for Dependability – Reliability Block Diagram Method

8.2.3 The Contractor shall formulate and document criteria to satisfy the requirements for systems assurance through all phases of the contract.

8.2.4 The Contractor shall produce a SAP, which integrates the systems assurance elements in all phases of the contract and incorporates a disciplined approach to evaluate the mechanical and electrical systems design. The Contractor shall prepare hazard identification, assessment and resolution; prediction of unreliability; and determination of the degree of maintainability.

8.2.5 The Contractor shall co-ordinate results of systems assurance analysis with design disciplines, particularly when the results affect design and hardware development. The Contractor shall

make recommendations for redesign or modification, as necessary, to assure compliance with specified requirements. This shall include, as necessary, installation of test points, built-in test capabilities and self-diagnostics; utilization of in-service status displays to enhance fault isolation and test; the utilization of high reliability components with easy accessibility and quick disconnect connectors; and, the use of mechanical keying to reduce errors during installation and repair.

8.2.6 The Contractor shall document instances where evaluations or analyses indicate an unresolved problem area. The Contractor shall formulate appropriate recommendations as well as maintain records, which show that follow-up action has been taken to resolve the problem.

8.2.7 The Contractor shall ensure participation of their systems assurance organization in all design reviews.

8.2.8 The Contractor shall maintain documents of systems assurance as part of their quality assurance system throughout the design and make them available to the Engineer for examination.

8.2.9 During consideration of precedence in the control of system hazards, the Contractor shall take account of human limitations as a design constraint. The Contractor shall take actions to satisfy requirements in the following order of precedence:

a) Incorporation of fail-safe or vital features which would allow the system to transfer from a high loss or risk mode to a lower loss or risk mode upon the occurrence of a critical failure; and

b) Reduction of the probability of occurrence of a failure by increased component reliability or by provision of supervised redundant components.

8.2.10 The Contractor shall use safety devices to reduce the magnitude of the loss or risk once a hazardous mode has been entered and:

a) Ensure, that the safety device does not introduce an additional hazard or system malfunction;

b) And/or the Contractor shall use warning devices and systems, which are audio/visual portions of a vital system, requiring human intervention; and

c) And/or the Contractor shall recommend special plant operating procedures to reduce the probability of a hazard event; provide for a training program as specified; and, recommend the level of training required based on the complexity of the task and anticipated trainee qualifications.

8.3 Safety Engineering

8.3.1 The Contractor shall as part of the safety engineering activity and as part of the safety and health file, prepare analyses of identified potential hazards.

8.3.2 The Contractor shall compile a list of critical/catastrophic items identified as a result of hazard analyses, or by other means.

8.3.3 The qualitative measures of hazard severity are defined as follows:

Hazard Category I – Catastrophic: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause death or system loss.

Hazard Category II – Critical: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause severe injury to personnel, severe occupational illness or major system damage.

Hazard Category III – Marginal: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause minor injury to personnel, minor occupational illness or minor system damage.

Hazard Category IV – Negligible: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies will not result in injury to personnel, occupational illness or damage to the system.

8.4 Reliability and Maintainability

8.4.1 Reliability and maintainability requirements and goals shall be developed in terms of Mean Time Between Failure (MTBF), Mean Time Between Service Failure (MTBSF) and Mean Time To Repair (MTTR).

8.4.2 Final reliability and maintainability predictions shall be verified by testing after system design has been completed.

8.4.3 The subsystems and plant shall be designed to maximize system availability during traffic hours, to minimize the amount of maintenance required and to ensure that any maintenance can be easily and quickly carried out at minimum cost. The RAM operational mission availability of each piece of Major Depot Maintenance Equipment shall achieve 99.5% outside of scheduled maintenance.

8.4.4 The Contractor shall perform reliability and maintainability analyses up to the point of interfaces with other systems.

8.4.5 The Contractor shall accomplish reliability prediction and apportionment in accordance with established techniques or standards; or, furnish properly documented and verifiable field failure data for identical or similar plant. The standards used or the source field data shall be identified.

8.4.6 Quantitative maintainability assessments to all significant functional levels of each system, subsystems or plant shall be allocated. Maintainability analyses during design, development and testing shall be used to evaluate the degree of achievement of the maintainability requirements. The Contractor shall identify the standards by which these allocations are made. In case minimum maintainability requirements are not specified in the system specification, the maintainability requirements for each equipment/system shall be as follows:

a) No routine inspection work shall be required on any component at more frequent intervals than monthly and no maintenance more frequently than bi-monthly, except for servicing/replacement of filters;

b) No item of equipment shall require general overhaul at intervals less than five years; and

c) All units or sub-assemblies requiring inspection, routine replacement or adjustment shall be arranged for easy access. This means that access to do the work should be achievable in less than 10 minutes without having to remove unrelated equipment.

In the event this maintainability cannot be achieved, the Contractor shall notify the Engineer during the design review/approval phase of the contract and provide the necessary explanation to obtain the Engineer's approval.

8.4.7 The Contractor shall develop predictions to judge the adequacy of the proposed design to meet quantitative maintainability requirements and shall identify design features requiring corrective action during early stages of design and development.

8.4.8 The Contractor may submit existing analyses that are properly documented and verifiable for plant and applications, which are identical or manifestly similar. Existing data need not conform to the agreed SAP format, but shall contain the same data, presented in a neat concise and logical manner.

8.4.9 The Contractor shall prepare a detailed Reliability and Maintainability Plan as an integral part of the SAP.

8.5 Reliability/Maintainability Demonstrations

8.5.1 Reliability and maintainability demonstration testing shall be carried out as detailed by the Contractor in the SAP and as approved by the Engineer.

8.5.2 All plant shall be included in the RDT and shall be fully operational. The Contractor shall perform failure/incident data analyses, component analyses and provide corrective action designs and tests. The Contractor shall submit bi-weekly status reports, which shall include as a minimum a statement of failures, status of failure dispositions, and achieved MTBF for each subsystem. The RDT shall be carried out over a period of not less than 12 months commencing during the warranty period once the equipment is suitably burned in, but shall be completed a minimum of 6 months before the end of the warranty period. This is to ensure that the equipment is in a relatively stable condition, which shall give rise to accurate availability data.

8.5.3 The Maintainability Demonstration Testing (MDT) shall be conducted on assemblies, components, and sub-systems jointly selected by the Engineer and the Contractor. The Engineer reserves the right to settle any disputes in the selection of sub-systems to be tested. The MDT shall be carried out from the commencement of the Trial Running period and be completed over a total period of not less than 12 months to fully demonstrate all aspects of maintainability.

8.6 Submissions

8.6.1 The Contractor shall submit six (6) copies of the SAP, within six (6) weeks from Commencement Date. This document, after acceptance by the Engineer, shall be maintained current and updates submitted at 180 day intervals thereafter.

8.6.2 The Contractor shall include a detailed Reliability Plan and a detailed Maintainability Plan as integral parts of the SAP.

8.6.3 The Contractor shall submit a plan and procedures for:

a) Demonstration testing and verification of design safety requirements;

b) Formal demonstration of compliance with specified and allocated reliability requirements; and

c) Formal demonstration of compliance with specified and allocated maintainability requirements.

These shall be submitted not later than twenty-one (21) weeks from Commencement Date.

8.6.4 The Contractor shall submit:

a) Reliability analyses to substantiate compliance with the specified goals and requirements; and

b) Maintainability analyses to substantiate compliance with the specified goals and requirements.

Not later than thirty (30) days prior to the first Final Design Review (FDR).

8.6.5 The Contractor shall submit a final reliability and maintainability demonstration test plan and procedures no later than sixty (60) days prior to the start of the demonstration.

8.6.6 The Contractor shall submit a final test report, which contains the reliability, maintainability and systems safety demonstration test results. This report shall include test data, test log summaries and, in the event of a reject decision, corrective action recommendations. This report shall be submitted prior to the final acceptance review.

8.6.7 The Contractor shall submit final acceptance report and summary results within sixty (60) days of completion of the reviews and summaries of **Sub-Clause 8.6.6** above.

9.0 Contract Procedures

9.1 Management of the Contract

9.1.1 On or before the Commencement Date, the Contractor shall prepare and submit for the approval of the Engineer, details supplemented by diagrams as necessary, of the organization which they proposes to adopt for the management of the Contract. The details shall cover all aspects of the Contract and the function, responsibility and authority of each person represented shall be defined.

9.1.2 Prior to their commencing work on the Contract, the Contractor shall submit for approval by the Engineer, names, qualifications and experience of all the key personnel in the organization referred to in **Sub-Clause 9.1.1** above.

9.1.3 Any changes or additions either to the organization or to key personnel shall be subject to the prior approval of the Engineer.

9.2 Planning and Progress Reports

9.2.1 Every month, the Contractor shall prepare and submit to the Engineer and the Employer six copies of a report covering the execution of the Works. The report shall be printed or typed and shall be delivered to the Engineer not later than seven days following the end of the period being reported.

The report shall be prepared in a form as may be defined from time to time by the Employer and the Engineer and shall include but not necessarily be limited to the following:

a) Updated Contractor's Final Time Schedule (in electronic form also) as specified in the Contract;

b) Summary presentation of Project progress percentages for each extension, location and responsible group;

c) Updated 3-month rolling schedule;

d) Updated contract drawing list as indicated in **Sub-Clause 9.7.6** of this General Specification;

e) Corrective action to be taken by the Contractor, to maintain the completion date;

f) Labor resources (by operative) for the period being reported and planned for the next period;

g) Contractor’s Equipment resources for the period being reported and planned for the next period;

h) Materials and Contractor’s Equipment to be delivered to Site during the next period;

i) Materials and Contractor's Equipment ordered during the period being reported and confirmed/unconfirmed delivery dates;

j) Information required from the Engineer during the next period;

k) Site Safety Report providing information as required in **Clause 4** of this General Specification; and

l) Progress photographs as required in **Sub-Clause 9.3** of this General Specification.

9.2.2 The Contractor shall attend progress meetings at monthly intervals at a time and place to be determined by the Engineer. The frequency of these meetings may be changed as deemed necessary by the Engineer.

9.2.3 The Contractor shall attend co-ordination/design meetings convened by the Engineer at whatever frequency he considers necessary, but in any event at no greater than monthly intervals to discuss and ensure that designs are correct and that conflicts in E&M services requirements between Designated Contractors are identified and resolved.

9.3 Progress Photographs

9.3.1 The Contractor shall arrange for a record of the execution of the Works by the taking of photographs by a professional photographer approved by the Employer. These photographs shall cover such extent of the Works as the Employer and the Engineer shall direct and be taken at four-weekly intervals or at such times as the Employer may require. The photographs generally shall be in color except that the Employer or the Engineer may require some monochrome photographs.

9.3.2 All prints shall be marked on the reverse side with the date of exposure, name and address of photographers, identification reference number (Year/Month/Day). The Negative Number (e.g. 010905.132) and a brief description of the work, including the km distance, location and direction of the view.

9.3.3 The copyright of all photographs shall be vested in the Employer and the Engineer and the negatives and three prints of a minimum size of 150 x 100 mm shall be delivered to the Employer and the Engineer within four weeks of exposure. Where digital photographs are used, the soft copy or jpeg electronic files of the photographs shall be provided to the Engineer and the Employer. The photographs shall not be used for any purpose whatsoever without the Employer's and Engineer's approval.

9.4 Copies of Correspondence and Orders

9.4.1 Two copies of the Contractor's correspondence with other contractors, and of orders placed by the Contractor for Plant or materials required for the Works, shall be forwarded to the Engineer at the time of issue with supporting drawings and documents as referred to hereafter. All orders shall state the Engineer's requirements for inspection, testing and quality assurance, shall bear the Contract reference, the Contractor's name and address and shall indicate, where applicable, the part of the Works and the date(s) for which the Plant or material is required. They shall also include the full specification of material ordered, together with all drawings and supporting documents.

9.5 Submission of Information – General

9.5.1 The Contractor shall submit to the Engineer, designs, general arrangement and detail drawings, specifications, reports and other technical literature, method statements, calculations, schedules, programs, samples, patterns and models for approval in accordance with the requirements of the Contractor's Final Time Schedule, as approved. The Contractor shall be responsible for the completeness of all information submitted.

Interfaces will exist between the different E&M Contracts forming the complete E&M Works for the Line 1 Expansion Project. The Contractor shall be responsible for coordinating the spatial requirements and for producing the combined co-ordination drawings.

9.5.2 The Contractor shall confirm to the Engineer all details that could affect the shape or strength of main structures, including loadings, access requirements, plinths, foundations, lifting hooks or beams, inserts, cut-outs and penetrations.

9.5.3 Installation Drawings prepared by the Contractor for review by the Engineer shall clearly show their requirements in terms of layout of equipment (including leading dimensions, clearances, weights, cables and pipe routes). Requirements in respect of all builder's work, whether such work is included in their Contract or not (including holes, fixings and plinths) and the interface point between their Contract and all other contracts to which his equipment is connected shall, also be confirmed to the Engineer.

9.5.4 The Contractor shall submit their designs for the works to the Engineer for approval. The design shall be submitted in the following stages:

a) Detailed Final Design I (DFD I)

This submission shall complete the Engineer's General Final Design (GFD) by identifying all the systems, sub-systems, equipment or other elements and manufacture details which,

will later be the subject of DFD II submissions and which together, comprise the whole design for the Works. It shall also finalize the function of each system, sub-system, equipment or other element within the overall design, and specify the relationships and interfaces between each element. A separate DFD submission may be submitted for each element of the overall design. This submission shall be in sufficient detail to evaluate the progress and technical adequacy of the selected design approach and shall, as a minimum, represent 60 % completion level. The submission shall clarify and confirm, as necessary, all functional aspects of all interfaces with other elements of the Works and of any interfaces between Civil and with in-service Electrical and Mechanical systems. This first phase of Detailed Final Design (DFD I) shall include design report, calculations, drawings, technical specifications and Technical Data Sheets (TDS) as described here below:

Design Report

The Design Report will refer to the particular part of the Works for which the first part of the Detailed Final Design (DFD I) is submitted for approval. The report will contain detailed descriptions of the following:

i. The proposed construction method;
ii. The assumptions and methodology of the designs;
iii. Other relevant data;
iv. Actions or approvals, etc., required by third parties prior to the continuation of design or construction work;
v. The interfaces between works of different E/M disciplines, e.g. Low Voltage, Power Supply, Ventilation/Air-conditioning, etc., or sections of the Works. The Contractor will include a declaration that all interfaces have been examined and the related problems solved in a satisfactory manner;
vi. The results of the surveying of properties/buildings along and adjacent to the Project corridors; and
vii. A list of Installation drawings necessary for the construction of that particular section of the Works.

Additionally the report will include a statement that the design is in accordance with the related stipulations of the Philippines Legislation, the regulations, etc., mentioned in the Technical Specifications and the other Tender Documents.

Calculations

Calculations checked separately for each E/M discipline will be submitted. The calculations will bear the date of their compilation, the signature of their compiler, and the signature of the controller. The controllers for the calculations must not be part of the compilation team and must be at least of equal experience to the compilers of the calculations. The calculations will be complete and will include:

viii. The title and table of contents (coding, etc.);
ix. The description of the installation or system to which the submitted calculations refer and the design assumptions;
x. List of computer programs used together with input and output data. In case one of the programs is unknown to the Engineer, data related to its utilization by others will be submitted; and
xi. List of Codes, Regulations, etc., that were used during the design together with photocopies of the relative pages of the texts.

Drawings

xii. The drawings shall include:
xiii. General layout of all installations including in every case the maximum weight of the machinery and details of main fixings;
xiv. Proposed method for equipment installation and method of moving (path) during installation;
xv. Plans (1:100) indicating the combination of all electromechanical networks, the inter-relationships of the various elements, the pipe layouts, ducts, etc. Details in larger scales and sections (1:20) will be provided for locations with limited space;
xvi. Proposals for earthing, bonding and corrosion protection;
xvii. Layout and study of track arrangement;
xviii. Layout and study of overhead contact wire arrangement; and
xix. All the above shall be coordinated with Architectural and Structural Detailed Designs as they will be produced by the Civil Contractor.

Technical Specifications

Technical specifications covering every equipment and installation in general, complementing the related Tender Documents shall be submitted.

Technical Data Sheets (TDS)

Technical Data Sheets (TDS) covering all equipment and related services in accordance with the approved technical specifications shall be submitted.

b) Detailed Final Design II (DFD II), Installation Drawings

This submission shall complete the DFD I design in sufficient detail to represent as a minimum, 95% design completion level. All the equipment, sub-systems, systems or other elements shall be sized and located, and their function and operation shall be finalized. Sufficient manufacturing and installation details shall be included, to allow implementation of the design. The submission shall clarify and confirm in detail, as necessary, all functional and operational aspects of all interfaces with in-service Electrical and Mechanical systems. This second phase of Detailed Final Design II (DFD II) shall include design reports, calculations, drawings, technical specifications, and Technical Data Sheets (TDS) as described below:

Design Report

The Design Report will include the possible modifications that have been made after the date of approval of the Detailed Final Design I. Additionally it will mention actions taken or to be taken by others necessary in order that the construction can progress according to the Time Chart.

Calculations

All calculations that have not been included in the DFD I or modifications thereof shall be included in the Detailed Final Design II.

Installation Drawings

The drawings that will be submitted with the Detailed Final Design (Installation Drawings) will be based on the ones submitted with the DFD I but will have the details necessary for the construction. These drawings will include the following:

i. Exact location i.e. actual distances of all Depot equipment from all structural members of the building;
ii. Final details for supports of electromechanical equipment;

iii. Final Drawings of manufacturers of electromechanical equipment;

iv. Details for track work and overhead contact wire arrangement;

v. Wiring diagrams;

vi. Termination Drawings;

vii. I/O lists;

viii. References to appropriate technical specifications and Material Submittal Sheets (MSS), etc.; and

ix. Final architectural details.

The scales of the above drawings will have to be suitable for the details covered. These drawings will have to be supported by results of measurements and tests, from the evaluation of these results, from calculations and whatever other text which is deemed indispensable.

9.5.5 Preparation of Installation Drawings

a) The Contractor shall prepare and submit Equipment Layout and Services Routing drawings to reflect the Engineer's Preliminary Drawings, incorporating any approved modifications;

b) The Engineer shall co-ordinate the Equipment Layout and Services Routing drawings submitted by the Contractor and other Contractors. The Engineer will review and comment on the submitted drawings to incorporate amendments which are essential to the safe and efficient operation of the Contractor's Plant. Marked up drawings reflecting the review will be issued to the Contractor so that the submitted drawings can be amended;

c) The Contractor shall prepare and submit for approval coordinated Installation Drawings and builders works information based on the amended drawings in b);

d) The Engineer will review the submitted drawings to incorporate approved amendments resulting from the Contractor's Installation Drawings and those of other Designated Contractors. Marked up drawings and comments reflecting the review will be issued to the Contractor; and

e) The Contractor shall amend their Installation Drawings in accordance with the comments by the Engineer. The amended drawings will become the final issue.

9.6 Submission of Information for Approval

9.6.1 Drawings, diagrams, specifications, calculations, technical details, material submittal sheets (MSS), reports, method statements, technical literature, schedules and all other documents submitted by the Contractor for approval shall comply with the following:

a) The drawings, diagrams, specifications, calculations, schedules and all other documents shall be complete, duly signed and of good legible quality;

b) Drawings and diagrams shall be submitted on "A" series sheets. Drawings shall be titled, numbered, dated, marked with the Contract number and, where applicable, shall incorporate a graphical scale, in accordance with the Engineer's Drawing Office Manual;

c) All specifications, calculations, schedules and documents shall have a front cover sheet stating the title, date, document reference number and contract number and sub-contract reference, if applicable, in accordance with the Engineer's Drawing Office Manual;

d) Technical details of the equipment to be installed in an area shall be supplied at the same time as the equipment general arrangements and layout drawings for the area are submitted. Such details shall include all space requirements for installation, maintenance and replacement, service connections required, environmental requirements, weights, foundation and fixing details, etc.;

e) When schematics or diagrams are submitted, they shall be accompanied by all the necessary supplementary information to describe the function and operation of the equipment;

f) When drawings, diagrams, specifications, calculations, schedules and other documents are revised and/or resubmitted for approval, all the revisions shall be clearly defined and located on all copies, and the document reference number shall contain a revision letter or number. The letter accompanying the drawings shall list the following information in tabular form:

i. The drawing number, including the current revision letter or number;

ii. The drawing title;

iii. A brief description of the latest revision; and

iv. The reference number of the Engineer's letter, to which the revisions are due;

g) The Contractor shall issue to the Engineer six prints of each drawing and a copy of the electronic files. The electronic format shall be as approved by the Engineer, but must allow the Engineer to clearly document future changes;

h) The Contractor shall provide to the Engineer six prints of all networks and programs and a copy of the electronic files. The electronic format shall be as approved by the Engineer; and

i) If original text of any technical literature provided by the Contractor is not in the English language, the Contractor shall submit an unofficial but accurate English translation of the text.

9.6.2 Unless otherwise required by the Technical Specifications, only one acceptable sample, pattern or model shall be submitted.

9.6.3 Detailed manufacturing drawings will not be required for approval, but shall be made available for examination or shall be submitted for comment if the Engineer so requires.

9.6.4 Nothing in the foregoing shall preclude the Engineer from requiring the Contractor to submit any further design, drawings, specifications, calculations, schedules, samples, patterns or models in connection with the Contact, or to explain any point of design, installation, operation or maintenance of the equipment.

9.7 Approval of Drawings, Documents and Other Information

9.7.1 Based upon the Final Time Schedule, the Contractor shall allow for a period of 21 days from the date of receipt of submittals by the Engineer to the issue of his comments or approval.

9.7.2 Any action taken by the Contractor to proceed with any part of the Works before the drawings are approved by the Engineer shall be entirely at the Contractor's risk, and any subsequent addition or modification to the Works requested by the Engineer shall be carried out by the Contractor at their own expense.

9.7.3 The Contractor shall also submit to the Engineer any further detailed drawings the Engineer may reasonably require of any item of plant or equipment, in order to assess the design and its compliance with the contract.

9.7.4 After review by the Engineer, the Contractor will be informed of the Code into which each such drawing/information/document is placed, according to the following:

a) Code 1 – **"No Objection"**

b) Code 2 – **"No Objection, Subject to Rectification of Comments Noted"**

c) Code 3 – **"Returned due to Objection"**

d) Code 4 – **"Information Noted"**

Code 1 shall mean that the Contractor may proceed with the relevant part of the Works.

Code 2 shall mean that the drawing shall be modified to incorporate the response to the comments by the Engineer and resubmitted to the Engineer to reach Code 1. The Contractor may proceed with the relevant part of the Works subject to the modification noted by the Engineer.

Code 3 shall mean that the Contractor must revise the drawing and resubmit it to the Engineer to reach Code 1. The Contractor may not proceed with the relevant part of the Works.

Code 4 shall mean that the Engineer has noted the information on the drawing and that it is a detail not required to be classified into Code 1. The Contractor may proceed with the relevant part of the Works.

9.7.5 Drawings in Code 2 or 3 shall be revised and resubmitted to the Engineer for approval within 7 days, calculated from the date of receipt by the Contractor of the Engineer's comments. All revisions to drawings by the Contractor shall be clearly identified on the drawings, together with the date when the changes are made.

9.7.6 The Contractor shall be responsible for preparing and keeping up to date a contract drawing list showing the numbers and titles of each drawing and the current status of approval by the Engineer. Two copies of the whole list shall be sent to the Engineer at monthly intervals. Copies of revised pages of the list shall be distributed whenever a drawing is revised and resubmitted.

9.7.7 Following approval of drawings, the Contractor shall issue to the Engineer six prints of each approved drawing and a copy of the electronic files. The electronic format shall be as approved by the Engineer, but must allow the Engineer to clearly document future changes.

9.7.8 No approval by the Engineer shall absolve the Contractor from any of his duties, responsibilities or liabilities under the Contract.

9.8 Crating and Storage of Plant and Materials

9.8.1 Storage

a) The Contractor shall prepare, protect and store in an approved manner all Plant and materials so as to safeguard them against loss or damage from repeated handling, from climatic influences and from all other hazards arising during shipment or storage on or off the Site; and

b) Secure and covered storage shall be provided by the Contractor for all Plant and materials other than those parts of the Works approved by the Engineer as suitable for open storage.

9.8.2 Crating

a) Each case, crate or package, hereinafter called the crate, shall be rot and insect-proof, of robust construction and suitable for the intended purpose. The contents of each crate shall be protected against the ingress of water by the inclusion of a heavy-duty waterproof membrane;

b) Each crate shall be legibly and indelibly marked in large letters with the address, Contract number, international "right way up" pictogram, opening points and other markings as necessary to permit materials to be readily identified and handled during transit and when received at Site;

All packing procedures shall be approved by the Engineer;

c) Each crate shall contain a comprehensive packing list showing the number, mark, size, weight and contents, together with any relevant drawings. A second copy of the packing list shall be enclosed in a watertight enclosure on the outside of each crate. Distribution of additional copies of each packing list shall be in accordance with the Engineer's instructions;

d) In addition, all items heavier than 100 kg shall be marked on the outside of the crate to show the gross and net weights, the points for slinging and where the weight is bearing;

e) Care shall be taken to prevent movement of equipment within containers by the provision of bracing, straps and securing bolts, as necessary. Bags of loose items shall be packed in cases and shall be clearly identified by well-secured metal labels on which the quantity and name of the part and its index or catalogue number have been stamped; and

f) Electronic circuit boards connected by plugs shall be removed from their racks and shipped separately.

9.8.3 Packing Precautions for Spares

a) Spare parts shall be packed for storage over prolonged periods without deterioration. Electrical and other delicate items or equipment shall be properly protected, as approved by the Engineer;

b) Cable ends, cable entry points into equipment and other similar termination and openings, including tube ends, shall be thoroughly cleaned and then sealed or blanked off to prevent the harmful ingress of dirt, moisture, vermin or insects, and to provide protection against damage; and

c) Particular care shall be taken to prevent damage to, or corrosion of, shafts and journals where they are supported. At such points, wrappings impregnated with anti-rusting compositions shall be used, of sufficient strength to resist chafing under the pressures and movements likely to occur in transit.

9.8.4 Removal of Empty Crates

All empty crates, excluding containers, shall be removed from the Site by the Contractor at their cost within one month of their being emptied and on a daily basis for underground locations.

9.9 Assembly Marks

9.9.1 All Plant, equipment and fittings to be assembled at the Contractor's premises, on Site or elsewhere shall have part numbers stamped on them in accordance with the Contractor's normal practice, which shall be subject to approval. Care shall be taken to differentiate between match marks for the component parts of identical assemblies. Stamping shall not be permitted on any stress-bearing part.

9.9.2 Match marks and any other identification markings to assist in assembly and future maintenance shall be legibly applied in two places and shall be of a durable nature.

9.9.3 Galvanized or plated parts shall be stamped or otherwise marked prior to treatment. Care shall be taken to ensure that markings are not obliterated by galvanizing or painting and do not deface finished surfaces and/or damage equipment.

9.9.4 Principal assembly drawings shall, wherever practicable, indicate the nature and positions of part numbers.

9.10 Interaction during Installation

9.10.1 The Contractor shall be responsible for coordinating his installation activities and co-operating with all other Contractors. The Contractor shall ensure that there is no interference with the work of the other Contractors and shall maintain close co-operation with others working on or adjacent to his Works to ensure that their work can progress in a smooth and orderly manner.

9.10.2 Two copies of all correspondence, meeting notes and documentation on agreements between the Contractor and the other Contractors or any Utility Company shall be provided to the Engineer by the Contractor. The Contractor shall give sufficient notice to the Engineer of any proposed meeting to enable the Engineer to be present. The Engineer may ask for a meeting to be postponed if inadequate notice is given.

9.10.3 The Contractor shall be given access to the various parts of the Site by the dates given by the Engineer. The Engineer also specifies the dates by which the Contractor shall complete certain parts of their Works, to enable work to be undertaken by the other Contractors. The dates shall be subject to adjustment by the Engineer in consultation with the Contractor and the other Contractors to ensure the progress of the Project.

9.10.4 The Contractor's responsibility shall include provision to and receipt from other Contractors or the Engineer of information required for construction of the Works and the installation of the Contractor's Plant, insofar as that requirement is specified in or reasonably to be inferred from the Contract. Where the execution of work by any other Contractor depends upon the Contractor's site management or upon information to be given by the Contractor, the Contractor shall provide to the other Contractor, either the required services or the correct and accurate information required to enable him to meet his program for the design, construction or installation of their works. In the event of any disagreement as to the extent of services or information required to be passed between the Contractor and the other Contractor, the Engineer shall determine the requirements and their determination shall be final and binding on the Contractor and the other Contractor.

9.11 Access to and from the Site

9.11.1 The Contractor shall use such routes and points of entry into the Site as may be notified by the Employer/ Concessionaire and the Engineer from time to time.

9.11.2 Prior discussion on particular routes for very large or very heavy loads shall be held with the Employer/ Concessionaire and the Engineer and such routes shall not be used without obtaining the agreement of the Employer.

9.11.3 Extraordinary loads may be moved from docks or other receiving points to areas of the Site over public highways by Police escort where necessary and on a route and at a time determined by the appropriate Authority. The Contractor shall be responsible for all associated costs.

9.11.4 The Contractor shall be responsible for obtaining permission from the appropriate Authorities to move extraordinary loads and for arranging Police escorts as necessary.

9.11.5 Construction equipment and vehicles carrying construction materials shall be routed over streets and routes which will cause the least disturbance to residents in the vicinity of the Work site(s).

9.12 Restrictions on Access within the Site

9.12.1 Access to Defined Areas will be restricted due to the operation of works trains and shall be limited to periods arranged and agreed in advance through regular works train meetings, which the Contractor shall attend. During agreed periods of occupation of a Defined Area, the Contractor's personnel shall comply with all instructions issued by the Employer's/ Concessionaire's staff, who are responsible for the safe operation of works trains.

9.12.2 Subsequent to the Test Running Date, access to all areas of the Track will be restricted in accordance with the Employer's/ Concessionaire's requirements, which will generally be in accordance with relevant requirements of the Rule Book as are considered appropriate. All work will be supervised by authorized staff of the Employer. Access shall be arranged through the Employer/ Concessionaire in advance of the intended date of the work. Access may be restricted to night hours only.

9.12.3 Subsequent to the Trial Running Date, access to all areas will be restricted in accordance with the Employer's/ Concessionaire's requirements, which will generally be in accordance with the full requirements of the Rule Book.

9.12.4 From the dates given by the Employer, access to certain plant rooms may be subject to prior arrangement with Employer/ Concessionaire at regular co-ordination meetings.

9.12.5 Subsequent to energization, access to rooms containing switchgear and equipment will be subject to temporary restrictions during periods when testing is carried out.

9.12.6 The Contractor shall comply with any training requirements described elsewhere in the Specification which apply to Contractor's personnel who may wish to obtain access to the LRT Line or the Track.

9.13 Works Area

9.13.1 Works areas will be made available to the Contractor for the storage and staging of his Plant prior to installation. These areas will be part of a general area allocated for use by E&M Contractors.

9.13.2 The Employer through the Engineer will advise the Contractor of the date when the works areas are expected to be available and the Contractor shall give three days notice prior to occupying the works areas allocated to him. The works areas will be cleared and leveled, but not necessarily surfaced, and the outer perimeter fenced by others prior to the Contractor taking possession. General background lighting will be provided in the area, but no lighting will be provided in the specific area allocated to the Contractor. The Contractor will control the entrance and provide security for the general area, but will not be responsible for the security of the Contractor's specific area, possessions, plant or equipment.

9.13.3 The Contractor shall provide and maintain all facilities required by him in the area allocated for his exclusive use, and shall make good and remove them on completion of the contract. These facilities shall include such items as the provision of hard standings, access roads, surfacing, drainage, provision of utility services from metered supply points provided by others, security fencing of his own area, lighting and all other work required to allow the Contractor to fulfill his obligations under the Contract.

9.13.4 The Contractor shall be responsible for the cost of all Electric Power and telephone charges incurred in their works area, which shall include the one incurred by the Engineer's and Employer's office.

9.13.5 The Contractor shall also be responsible at their own cost for any accidents and untoward incidents caused by them at the Works Area.

9.14 Internal Coordination of the Contractor and Site Services

9.14.1 The Contractor shall maintain proper Co-ordination and liaison between the Sub-Contractors for the Civil Works and other Groups and ensure the following:

a) Proper fixing of equipment in general accordance with the specifications;

b) The provision of holes or openings through walls for ducts or sleeves and sealing up around the duct or sleeve after completion of installation by the Contractor;

c) Provision of proper chases in concrete or block work or brickwork surfaces and making good thereof; and

d) Provision of temporary power facilities.

9.14.2 Limitation of Drilling

a) The Employer will strictly control and limit the extent of on-site drilling undertaken by the Contractor. No holes for fixings shall be drilled into any part of the structure without the prior approval of the Employer, at each and every location;

b) Wherever practicable, the Contractor's Plant shall be fixed using screwed sockets, of appropriate diameter and length, or approved cast-in concrete types or by the use of expanding anchors installed in preformed holes. The Contractor shall provide all the fixings, together with details and locations of all items to be cast in or holes preformed in the structure;

c) In all areas where the Contractor requires to fix Plant to a structural wall or floors they may be required to provide and fix a saddle member between adjacent sockets and to

install their equipment to such saddles (using packers where necessary) for adjustment of plane and level; and

d) All saddles shall be designed to carry a load of at least twice the load resulting from the equipment supplied and fixed to the saddle by the Contractor.

9.14.3 Provision of Site Services

a) The Contractor will provide background or perimeter lighting for safety purposes where necessary.

b) The Contractor will provide a temporary 480 V, 3-phase or 240/220 V single phase power supply point on a distribution board at each depot at a location to be determined by the Employer/ Concessionaire for the exclusive use of the Contractor.

c) The provision and maintenance of all temporary electrical installations shall be in accordance with the relevant standards.

9.15 Facilities for the Execution of E&M Works

9.15.1 The Contractor will provide all reasonable facilities for the proper execution of his E&M works.

9.16 Use of Facilities by Other Designated Contractors

9.16.1 The Contractor shall allow reasonable facilities to the Designated Contractors, if any, for the proper execution of their work, where it interfaces with the work of the Contractor. This will include the free, but not exclusive, use of any scaffolding, ladders and lighting already assembled by the Contractor for executing their own work.

9.17 Controlled Environment for Erection and Commissioning of E&M Plant

9.17.1 The Contractor shall be responsible for ensuring, in co-operation with other Contractors as necessary, that their Plant is assembled, maintained in good condition and commissioned under appropriate environmental conditions, which shall be approved by the Engineer.

9.18 Employer's Plant, Equipment and Property

9.18.1 Plant forming part of the Works may be used by the Contractor only with the approval of the Employer/ Concessionaire and if so used the Contractor shall be responsible for restoring it to an 'as new' condition before carrying out the completion tests.

9.18.2 The Contractor shall be responsible for the protection, security, lighting and safe custody of all Service's plant, equipment and property being used by the Contractor for the Works or left on the Site.

9.18.3 If and when such plant or equipment is loaned free of charge to the Contractor, the Employer/ Concessionaire will reserve the right to provide operators, attendance, fuel and lubricants together with routine maintenance required for the operation of the plant or equipment. If the equipment is not self-propelled, the Contractor shall be responsible for the collection and transportation of the equipment to and from the Site.

9.18.4 If and when the Employer's/ Concessionaire's plant or equipment is hired to the Contractor, the Contractor will be required to enter into a formal agreement setting out the conditions of hire.

9.18.5 The Employer/ Concessionaire will not accept liability for any loss or damage caused or alleged to be caused to the Contractor in the event of breakdown or non-availability of any plant, equipment, etc.

9.19 Minimizing of Nuisance and Disturbance

9.19.1 All work on site shall be undertaken in such a manner as to minimize nuisance and disturbance to others working on the site, or to persons outside the site, from smoke, fumes, noise, vibration, discharge of water from the site or from any other cause.

9.19.2 All plant and equipment used by the Contractor on the Works shall be effectively attenuated by means of efficient silencers, mufflers, acoustic linings, shields, acoustic enclosures or screens. Plant and equipment shall be maintained in good order and operated to minimize noise emissions. Plant and equipment shall be located, as far as practicable, away from adjacent occupied buildings.

9.19.3 Sound levels shall be monitored by the Contractor in accordance with the methods set out in the Philippines Decrees. All measurements shall be made on a sound level meter. The monitoring shall be carried out by a suitably qualified practitioner and a program shall be agreed with the Employer.

9.19.4 In general night time surface working shall be kept to a minimum. For any worksite, the noise generated by the Contractor's plant and equipment, including the movement of vehicles to and from the Site, shall not exceed the values indicated in **Table 9.25** of this General Specification. For occupied buildings, these values shall be measured or calculated 1 meter in front of exposed windows and doors.

The Contractor shall submit to the Employer for approval, full details of all surface plant and equipment at any Contract worksite, showing proposed layouts and equipment and supporting calculations for predicting the sound levels generated from plant and equipment and showing that the limiting noise values will not be exceeded. Work will not commence until the Employer is satisfied that the predicted sound levels do not exceed the limiting values.

9.19.5 In the event that it is impractical for whatever reason to comply with the above limiting noise levels as shown by the predictions, such that any of the criteria will be exceeded for more than 10 consecutive days then the affected dwellings, hospitals, offices, theatres, churches, schools, etc., will have to be suitably insulated against the noise by the Contractor.

9.19.6 The requirements of **Table 9.25** of this General Specification will not apply if the background noise level measured for over the relevant time period can be shown by the Contractor to exceed the limits of the Tables in which case the Employer/ Concessionaire will determine revised limits that shall apply.

9.19.7 The provisions of this **Sub-Clause 9.19** shall not be applicable in the case of emergency work necessary for the saving of life or property, or the safety of the Works.

9.19.8 Truck loading, unloading and hauling operations shall be conducted so that noise is kept to a minimum.

9.20 Pollution Control

9.20.1 The Contractor shall ensure that there shall not be nor continue to exist conditions causing air, water or soil pollution within the area of execution of works, starting from the date of his installation at the worksite until acceptance of the works or in any areas or installations occupied by same outside the worksite boundaries, throughout the occupation.

9.20.2 In case pollution is observed, the Contractor shall immediately take all necessary measures in order to stop the pollution and to remove the reasons causing it, as per the directions of the Employer/ Concessionaire.

9.21 Electromagnetic Interference Control

9.21.1 The Contractor’s installations or machinery that could cause or cause interference to radio or TV transmissions shall be equipped with devices reducing the said interference within permissible limits as per the applicable provisions.

9.22 Manpower

9.22.1 The Contractor shall from time to time as required by the Engineer submit details of their proposed Manpower resource levels, managerial, skilled and unskilled, as will be required for the execution of the Works.

9.22.2 The Contractor shall ensure that all necessary measures are taken to maintain good industrial relations in connection with the installation of the Works.

9.22.3 The Contractor shall recognize the aspirations of trade unions concerning membership for the employed labor and the Contractor shall operate an equal opportunities policy.

9.22.4 The Contractor shall make every effort to ensure that local labor with the requisite skills and experience are made aware of the employment opportunities arising within the Contract and that personnel trained under local construction industry training schemes are employed when available.

9.22.5 The Contractor shall submit to the Engineer for their information details of the personnel, technician and management training schemes they will operate and state the number of trainees employed on the Works.

9.23 Plant and Labor Returns

9.23.1 The Contractor shall submit to the Engineer every month a statement of the Contractors Equipment on Site.

9.23.2 The Contractor shall submit each week statements of daily labor and supervisory staff on Site.

9.24 Supply and Fix Items

9.24.1 Appendix B contains a general listing of supply and fix items of Civil Works Sub-Contractors or Group and E&M Works Specialist Sub-Contractors or Groups of the Contractor. The listing, which is for the General Guidance of the Contractor, includes the following:

a) Items to be supplied and installed by the Civil Works Sub-Contractor or Group;

b) Items to be supplied and installed by the E&M Works Specialist Sub-Contractors or Group; and

c) Items to be supplied by the E&M Works Specialist Sub-Contractors or Groups and installed by the Civil Works Sub-Contractors or Groups.

9.24.2 The Contractor shall supply and/or install these items detailed in the Technical Description, or on the Drawings and generally as listed in Appendix B.

9.25 Engineering Hours Occupation of the LRT System (Line)

9.25.1 Engineering Hours are defined as the time period at night when the main traction current on the LRT Line is turned off.

9.25.2 Occupation of the line in Engineering Hours, where essential for the execution of the Works, will be arranged by the Employer/ Concessionaire, but the duration of the period of occupation may be restricted and may be interrupted by the passage of passenger trains or works vehicles. Such occupations shall be arranged as part of the agreed program of works and advance notice of not less than 48 hours will normally be required in respect of each period of occupation. The traction current will be switched off on the lines to be occupied.

9.25.3 Together with any request for occupation of the LRT Line, the Contractor shall submit for the Employer's/ Concessionaire's approval, details of work to be done and plant and labor to be employed. The Employer/ Concessionaire may refuse to arrange an occupation of the line, if it is the opinion that the Contractor does not propose to make adequate use of that occupation. It will be incumbent upon the Contractor to complete the work as detailed during any such occupation. If further occupations have to be arranged because of the Contractor's failure to complete the work, the costs of the Employer/ Concessionaire for the provision of Protection Personnel and administration staff will be charged against the Contractor.

9.25.4 In the event of non-use by the Contractor of any booked occupation, the cost to the Employer/ Concessionaire for the Provision of Protection Personnel will be charged against the Contractor, unless the Contractor gives at least four days notice to the Employer/ Concessionaire to cancel the occupation. Also, the costs of the Employer for the provision of Protection Personnel and

use of the Employer's equipment for the correction of poor workmanship during the warranty period shall be charged against the Contractor.

9.25.5 Occupation will normally be obtained approximately 20 minutes after the current is switched off. All personnel, equipment and materials must be clear of the tracks 20 minutes, or such other period as the Employer may decide, before the current is switched on again.

9.25.6 Where normal Engineering Hours do not give sufficient working time for the task to be undertaken, then it may be possible to negotiate extended track occupations with the Employer. If required by the Contractor, and booked by him at least 6-weeks in advance, extended occupation of the LRT system, the dates and times of these occupations will be subject to the operational and other requirements of the Employer/ Concessionaire and the Contractor shall give to the Employer/ Concessionaire a minimum of 6-week's notice of their requiring such extended occupation.

9.25.7 Occupations may have to be curtailed or interrupted at times due to the necessities of LRT operation.

9.25.8 As indicated above, it may be necessary to pass passenger trains or work vehicles during occupation of the LRT system. Under no circumstances will mechanized plant on, or within reach of the LRT line, be allowed to work after the approach of a train / vehicle has been signaled or warning given of the approach of a train / vehicle, until such train / vehicle has been passed clear of the site of the work, and all work shall be suspended as and when directed by the Employer/ Concessionaire, during the passage of the train /vehicle.

9.25.9 Notwithstanding any provisions made elsewhere in this Specification, the Contractor shall provide suitable stand-by plant during any occupation of the metro to enable completion of the work within the specified time, if breakdown occurs. Noise level shall be in accordance with the "Philippines Environmental Quality Standards for General Areas".

Table 9.25 Environmental Quality Standards for Noise in General Areas

Category of Area	Daytime (dBA)	Morning and Evening (dBA)	Nighttime (dBA)
AA	50	45	40
A	55	**50**	**45**
B	65	60	55
C	70	65	60
D	75	70	65

Note:

Category of the Area

Class AA - A section or contiguous area which require quietness such as area within 100 meters from school sites, nursery schools, hospital and special home for the aged.

Class A - A section or contiguous area which is primarily used for residential purposes.

Class B - A section or contiguous area which is primarily a commercial area

Class C - A section of contiguous area primarily reserved as a light industrial area.

Class D - A section or contiguous area primarily reserved as a heavy industrial area.

Division of 24-hour Period

Morning	-	5:00 A.M. to 9:00 A.M.
Daytime	-	9:00 A.M. to 6:00 P.M.
Evening	-	6:00 P.M. to 10:00 P.M.
Nighttime	-	10:00 P.M. to 5:00 A.M.

10.0 Project Implementation Program

10.1 Performing and Scheduling

The Contractor shall prepare the schedules for the timely completion of the project taking into consideration the provisions in **Sub-Clauses 8.2 and 8.3** of Part 3 Conditions of Contract and Contract Forms Section VII General Conditions. The Contractor shall have an experienced full time scheduler at site for regular updating of the schedules.

10.2 Revising and Updating the Master Works Program and Schedule

If the Contractor wishes to change the logic or sequence of scheduled activities then they shall detail to the Engineer for their reference. Once every month, the Contractor shall review the Master Works Program in consultation with the Engineer. Whenever required by the Engineer, the Contractor will demonstrate to the satisfaction of the Engineer that the construction resources shown in the Master Works Program are available and are being or will be utilized in the manner indicated by the Program. Following review, the Contractor shall prepare an updated Master Works Program to be included in the monthly report which shall incorporate all or any change in methods, times or sequence of activities, and show the Contractor's planned progress towards the Time for Completion. The level of detail required for the updated schedule shall be as specified for the original Master Works Program. If approved in writing by the Engineer, the updated schedule shall become the Master Works Program. The submission to and approval by the Engineer of such Programs or the furnishing of information in the form of method statements shall not relieve the Contractor of any of his duties or responsibilities or contractual responsibilities to complete the work within the contract period or any extended period, under the contract. In order that the Programs may be maintained or amended where necessary it is incumbent upon the Contractor to notify the Engineer whenever there is the likelihood of a delay occurring in his own work or material supplies or in those of any of his sub-contractors. Failure of the Contractor to take such action will be prejudicial to consideration being given to requests for extension of time.

10.3 Schedule Definitions

10.3.1 **Time Schedule** is the time schedule for the execution of the project submitted by the Contractor, and approved by the Engineer, showing the whole of the Works.

10.3.2 **Final Time Schedule (FTS)** is the approved version of the time schedule, which must be prepared in Precedence Network Diagram (PDM) format and computerized using the current, and always latest, version of project planning software.

10.3.3 **The FTS Coding Structure** shall contain no less than **5 levels** of breakdown as follows:

Level 1 – Identifies the specific **Expansion**

Level 2 – Identifies the **Location** or **Work Area**

Examples are; Baclaran Depot, Zapote Depot, Stabling Yard

Level 3 – Identifies the **Responsible Group** for the work

Examples are; Rolling Stock, Civil, Building, Mechanical, Low Voltage

Level 4 – Identifies the **Category** of work

Examples are; Rolling Stock, Civil Works, Building Works, Depot Equipment

Level 5 – Identifies the **Type** of work

Examples are; Design, Procurement, Installation, Testing, Commissioning

10.4 Time Schedule Format

10.4.1 The Time Schedule that the Contractor shall submit to the Employer in accordance with the Conditions of Contract shall be in Critical Path Method (CPM) network form and technology and computerized using the current, and always latest, version of project planning software.

Activities shall be discrete items of work which, when complete, produce definable, recognizable elements, components or stages within the Contract. Activity descriptions shall clearly convey the nature and scope of the activities of Utility Companies, Designated Contractors and any other activities, which may affect progress. Activities of 30 days duration or greater, other than procurement lead times, shall be broken down into discreet activities of shorter duration. The activities shall be linked with relationships identifying the sequence of works and the logic of the schedule. Mandatory constraints shall not be used in the time-schedule development and maintenance.

10.4.2 The Time Schedule will be submitted both in hard copy and in electronic form in the English language.

10.4.3 At monthly intervals the FTS is to be reviewed, updated and revised as necessary by the Contractor, taking into account the latest available information on activities completed, in progress and not yet started which information shall be agreed with the Engineer.

10.4.4 In addition, the Contractor shall prepare and submit at such intervals as may be required by the Engineer a time-related bar chart showing in detail all the activities that are in progress or due to start within three months of the date of issue of the bar chart. The activities shown on the bar chart shall be an amplification of the activities in the approved FTS, with which they shall be compatible in all respects.

10.5 Time Schedule Submission

10.5.1 Within four (4) weeks from Commencement Date, the Contractor shall submit the three months look-ahead section of the Time Schedule with all the Contractor's planned activities but also including in detail the design submittals and the co-ordination design requirements with other Employer's Contractors.

10.5.2 Within nine (9) weeks from Commencement Date, the Contractor shall submit the full Time Schedule of the complete project. The Time Schedule shall be consistent with and reflect the key dates, completion dates and deadlines contained in the conditions of contract. The contractual deadlines shall be confirmed through the Project Time Schedule logic and the sequence of activities.

10.5.3 The **Design** content shall include preparation, approval by the Engineer of all drawings, specifications, supported by manufacturing method statements and details of packaging of all items of Plant and materials. The Design section shall also show the preparation, submission and approval by the Engineer, of all installation drawings. The Design section shall identify the dates when interface information is required from Designated Contractors and the dates when interface information will be made available by the Contractor to Designated Contractors. The Design section shall also show the development, submission and approval by the Engineer of all commissioning, maintenance, operations and training manuals and spare parts lists required by the Contract.

10.5.4 The **Procurement** Production content shall show the manufacture, assembly, factory testing, inspection, packing and shipment of all the Plant and materials to be supplied for the whole of the works.

10.5.5 The **Installation** Section of the Time Schedule shall show the transport to Site, installation, testing and commissioning of the Plant, and shall be supported by detailed method statements, as deemed necessary by the Engineer for the proper understanding of the sequence of activities and the extent of constraints, which may be applicable to the schedule.

10.5.6 In preparing his overall Time Schedule the Contractor should note the following conditions that will apply:

a) The Contractor shall not have exclusive access to any part of the Site except by specific agreement with the Employer;

b) The Contractor shall take note that the same time allocations for certain areas have been given to more than one contractor;

c) The absence of a schedule date or installation period for the Contractor in a specific area, shall not prejudice the right of the Engineer to establish a reasonable date or installation period for the area;

d) The Contractor shall complete by specific dates at particular locations as referred to in the Technical Specifications, general installation works such as conduit, ductwork, cable trays, pipes, switches, isolators, cables, fixtures and fittings which obstruct major architectural builder's and finishers work and E&M installation by other Designated Contractors;

e) The Contractor shall deliver all equipment for stations by road and via temporary access openings, unless agreed otherwise by the Employer; and

f) Works vehicles may be provided for the purposes of installing trackside plant and cables upon application to the Employer. These resources are limited and no guarantee can be given that such facilities can be available.

10.5.7 Following the development of the coordinated Installation Time Schedules of the expansion by the Employer it may be necessary for the Installation activities to be amplified and adjusted by the Contractor, as may be required by the Employer.

11.0 Parts List, Special Tools and Test Equipment

11.1 Details of Supply

11.1.1 Not later than two months before manufacture of a system/sub-system, the Contractor shall submit to the Engineer a parts list for their delivery, including parts numbers, description/name and quantities for all delivery to be done.

11.1.2 In conjunction with 11.1.1, the Contractor shall submit for approval for the systems/sub-system one copy of a complete list of spare parts, special tools, jigs, fixtures and gauges, supplementing, adding or elaborating the list submitted with their Bid and finalized during the award, for the supply of spares during Defects Notification Period. All additions shall be at no extra cost to the Employer.

11.2 Manufacture and Delivery

11.2.1 Spares shall be manufactured, works tested and delivered to the Employer by the Contractor, at such times as required by the Engineer, suitably packed and identified for prolonged storage. They shall be considered and delivered in accordance with the Engineer's instructions. The Engineer reserves the right to order spares to be inspected or tested on receipt and re-packed if approved. The information supplied in respect of each spare part or special tool shall include, but not be limited to, the following:

a) The manufacturer's part number;

b) Space for the Employer's part number;

c) Description - a full description of the spare part, including a note as to whether it is a sealed unit or whether it is an assembly or sub-assembly which can be broken down into component parts. The detail of the break down need not be specified here, but shall be included as part of the submission under **Sub-Clause 13.4** of this General Specification;

d) Quantity supplied;

e) Expected utilization in twelve months;

f) Overall dimensions and weight including packing (if any) for shelf space purposes;

g) A note as to interchangeability or otherwise with similar part;

h) The unit price;

i) The source - the manufacturer's name and address and that of his Philippine agent where appropriate; and

j) The normal manufacturing and shipment lead times for additional quantities.

11.2.2 The presentation of the above information shall be to the prior approval of the Engineer and the Employer.

11.3 Special Tools and Test Equipment

11.3.1 One set of special tools, test equipment, jigs, fixtures and gauges required to carry out all functions described in the Maintenance Instructions or as required by the Technical Specifications shall be delivered before the Issue of Taking-Over Certificate, which shall not be less than the list of equipment provided by the Contractor, along with his Bid. The Contractor may add any additional equipment required, but, at no extra cost to the Employer. The extent of supply shall include protective or carrying cases, as may be appropriate for the storage and use of each item.

11.4 Capital Spares

11.4.1 The Contractor shall provide sufficient number of capital spares which shall not be less than the list of equipment provided with his Bid and finalized during the award, to ensure that the operation of the LRT Line shall not be interrupted for longer than it takes to install the capital

spare or to ensure that the operation of the system is not degraded longer than the time it takes to transport the spare parts from the closest depot and then install the capital spare. The Contractor also shall provide the capital spare parts during Defect Notification Period. The Contractor may provide additional capital spares, but at no extra cost to the Employer.

11.5 Consumable Spares

11.5.1 The Contractor shall provide all spare parts for all of its supplied equipment necessary, during the Defects Notification Period, the price of which should have been included in the Price Schedule. The Contractor also shall provide the necessary consumables during Defect Notification Period.

11.6 Start-up Material

11.6.1 The Contractor shall provide all material for testing and commissioning and sufficient material to start the extension for operation. Material shall include, but not limited to such items as computer paper, printer ink cartridges, CD-ROMS, Room Light bulbs, etc.

11.7 Spare Parts Installation Support

11.7.1 The contractor shall provide sufficient maintenance support staff to ensure that the Employer staff can install all spares during the Defects Notification Period.

11.7.2 The Employer may order additional spares required for next 15 years from the recommended spare parts and consumables list as provided by the Contractor.

11.8 Spare Parts Required During Defects Notification Period

11.8.1 Prior to issuing the Taking Over Certificate, the Contractor shall supply Capital Spares, Consumable Spares and necessary consumables for Defect Notification Period for Depot operation and maintenance works.

The Contractor shall provide a complete listing of all such parts to be supplied, including the following information:

a) Contractor part number, and

b) Part description.

The Contractor shall submit the Original Equipment Manufacturer part number at the time of supply of the spares.

In case any of these spares and consumables are used during Defects Notification Period, they shall be replenished immediately at no extra cost to the Employer.

Immediately after Defects Notification Period, the Contractor shall handover to the Employer additional Capital Spares and Consumable Spares, if any, to complete the total of these items, as per the list.

If any additional Capital Spares and Consumable Spares, including parts replacement, become necessary during Defects Notification Period, the same shall be added to the list and shall be provided by the Contractor, along with one additional set for any further requirement at no additional cost. The cost for the same shall be deemed to have been included in the Price Schedule.

11.9 Spare Parts and Consumables Required After the Defects Notification Period

11.9.1 The Contractor shall submit a list of recommended spare parts and consumables deemed required and needed after the Defects Notification Period.

The list shall quote the unit rates with guaranteed prices valid up to one (1) year after the date of issuing the Taking-Over Certificate, all price escalation shall be considered.

The Contractor shall give an escalation formula to be applied to the quoted price, in case spares are ordered later than one year after the date of issuing the Taking-Over Certificate.

The recommended spare parts list shall be reviewed and finalized based on the experience of operation of the system in the first year of the Defect Notification Period.

A final list of ordered spare parts and consumables shall be supplied by the Contractor immediately after they are ordered.

12.0 Testing and Commissioning

12.1 General

12.1.1 The Contractor shall perform all necessary testing and commissioning activities in order to ensure satisfactory operation of the completed system and compliance with the requirements of the Technical Specifications. Tests shall be witnessed as appropriate by Employer's staff.

Should the Concessionaire request through the Employer within a reasonable requirement to participate in the part of the testing and certification process, The Contractor shall allow the Concessionaire to partake in the testing, certification process and integration testing etc. of Depot Works in accordance with the Concession Agreement.

12.1.2 All inspections, testing and commissioning shall be clearly identified in the Quality Assurance Management Plan identifying the witness, inspection and hold points as required by the Contractor, the Engineer or both. The Quality Assurance Management Plan shall be submitted by the Contractor to the Engineer for approval in accordance with **Sub-Clause 7.2** of this General Specification.

12.1.3 All tests shall be carried out by the Contractor with the presence of the Engineer and Employer staff in accordance with the agreed Quality Assurance Management Plan.

12.1.4 The Contractor shall give not less than 3 working days advance notice (in writing) of any testing and/or commissioning for the Employer and Engineer staff to witness.

12.1.5 Testing procedures shall be in accordance with requirements of this section, the Technical Specifications and as determined by current International and Philippine standards as deemed necessary to ensure satisfactory system performance.

12.1.6 Regarding the requirements for inspection and testing of the equipment whether at the place of manufacture or on site, the Engineer shall liaise with the Contractors regarding the timing of the tests and the arrangements to be made for measuring or assessing parameters affected by the interface.

12.1.7 Tests at places of manufacture to be witnessed by the Engineer shall be grouped together as far as reasonably practicable, so that as many tests as possible can be witnessed on each visit.

12.1.8 The manufacturers and places of manufacture, testing and inspection for the various items of equipment shall not be varied without the prior approval of the Engineer.

12.1.9 All costs associated with Testing shall be borne by the Contractor, including any expenses incurred due to re-testing caused by defects or failure of equipment to meet the requirements of the Contract in the first instance.

The management of wastes generated during the testing and inspection activities should be the responsibility of the Contractor. Management as regards to the temporary storage of waste, hauling and disposal should confirm with internal (LRMC) and regulatory standards. In case of regulated wastes, proper permitting as regards transport and disposal should be secured by the Contractor.

12.2 Schedule of Tests

12.2.1 Not more than one (1) year from Commencement Date nor less than ninety (90) days before the tests are due to be carried out, whichever is the sooner, the Contractor shall submit to the Engineer for approval a schedule of tests giving full details of all tests to be carried out under the Contract with standards or limits to be achieved.

12.2.2 No tests shall be carried out until the schedule has been approved by the Engineer. The schedule may be submitted in stages extending beyond the initial year, provided a list of stages has previously been approved.

12.2.3 All test procedures shall be submitted at least three (3) months prior to conducting any test. Test procedures shall show unambiguously the extent of testing covered by each submission, the method of testing, acceptance criteria, the relevant drawing (or modification) status, and the location.

12.3 Test Instrumentation

12.3.1 All test instruments used during the testing and commissioning phases shall have been subjected to approve calibration tests in accordance with approved industry standards.

12.3.2 Calibration test certificates shall be supplied in duplicate at the Contractor's expense and shall be signed and dated clearly identifying the type of test equipment, serial number, date of calibration test and expiry date of the calibration period. All calibration checks shall be undertaken prior to testing and, if required by the Engineer, shall be repeated afterwards.

12.3.3 All test instrumentation shall carry a self-adhesive calibration identification label which clearly identifies the serial number of the equipment, the date when calibrated and the expiry date of the calibration

12.4 Commissioning Lots

12.4.1 It shall be necessary for the purposes of commissioning to divide the primary systems into a certain number of functional sub divisions called “Commissioning Lots”.

12.4.2 A commissioning lot takes into account the following constraints:

a) **Functional Man Sized Units**: Whether the different operating modes of a commissioning lot are manual or automatic, they must be quickly assimilated. The unit must also be as autonomous as possible and interchange with other lots or primary systems and be restricted and/or limited to interfaces.

b) **Unity and Reduction of Geographical Area**: A commissioning lot shall occupy a restricted geographical area and is relatively small in relation to the size of the primary system to which it is attached. It should be noted that several commissioning lots belonging to various primary systems may occupy the same geographical area.

c) **Synchronization of Construction**: The geographical extent and time constraints of the Project means that the size of a commissioning lot is partially determined by the progress of the construction of the installations.

d) **Level of Partial Operation**: The size of the commissioning lot corresponds to that portion of an item of equipment, which it is intended to be put into operation.

e) **Progression of Commissioning of a System**: The commissioning lots of a single primary system form part of the same whole but do not physically overlap and are quite separate.

12.4.3 Each commissioning lot shall have a unique identifying code, which shall be entered onto every testing and commissioning test sheet.

12.5 Testing and Commissioning Phases

12.5.1 It shall be necessary for the purposes of commissioning to delineate the testing and commissioning into phases as follows:

a) **Factory Acceptance Tests (FAT)**: As appropriate, these tests are to be performed at the factory, before equipment is shipped;

b) **Installation Tests (IT)**: Visual inspection of all the equipment within the identified commissioning lot together with all equipment, cable and earthing tests to demonstrate

that the equipment has been installed in accordance with the approved design and that is safe to be energized with permanent power;

c) **Partial Stand Alone Tests (PSAT)**: Test of components and sub-systems, to prove functionality and compliance with the Technical Specifications based on the equipment contained within the identified commissioning lot;

d) **Stand Alone Tests (SAT)**: Test of components, sub-systems and systems alone, to prove functionality and compliance with the Technical Specifications. This testing phase combines all identified commissioning lots of one primary system;

e) **Design Qualification Test (DQT)**: As part of design verification, type tests shall be carried out to demonstrate that systems are fully in compliance with the requirement;

f) **Acceptance Test (AT)**: Acceptance tests include Type Tests and Routine Tests. Type Tests shall be conducted to first equipment set and Routine Tests shall be conducted all other sets. Acceptance tests shall be completed before conducting following tests;

g) **System Integration Tests (SIT)**: Tests to prove the functionality of the different systems together, especially the technical interfaces between the different primary systems;

h) **System Performance Tests (SPT)**: To prove the overall inter-operable functionality of all independent pre-commissioned systems. This includes the proof of compliance with the overall system Technical Specifications;

i) **System Performance Test Phase**: The period of time to carry out the System Performance Tests;

12.5.2 It shall be necessary at the end of the identified test phases to formally review the test results with the Engineer. At this review stage the formal punch list shall be created which shall identify any deficiencies and or deviations from the approved detailed design for the installation, testing and performance of the equipment and or system.

12.5.3 The Contractor shall set up and maintain a database, which shall contain every punch list item identified. As a minimum each punch list shall have a unique identifying code, a full description of the punch list item, date created, responsible person for clearance and a clearance date once the punch list item has been cleared.

12.5.4 The Contractor for the primary system shall be responsible for the production of testing and commissioning procedures and reports, and shall take the lead role in performing the System Integration testing and System Performance testing. This shall include the necessary co-ordination and co-operation with other contractors of other systems not covered by this contract including the availability of sub systems to be tested.

12.5.5 Conversely, when the contractor is called upon to support the system integration and system performance testing by a contractor of another primary system not covered by this contract, the contractor shall provide all necessary co-ordination, co-operation and availability of sub systems to be tested, to enable the successful completion of the testing.

12.6 Test Reports

12.6.1 The Contractor shall prepare and forward to the Engineer an original and four copies of a Test Report no later than fifteen (15) days after completion of each test, whether witnessed by the Engineer or not.

12.6.2 If the Engineer is satisfied that the test has been carried out in accordance with the contract and the test procedure, the Engineer's representative will sign for this part of the test on the appropriate test sheet. Upon signatures from the Engineer for all part of the test, the test is successful and the Contractor shall issue and submit to the Engineer the appropriate test report.

12.6.3 Before testing and commissioning commences, the contractor shall set up a System Commissioning file for each system, which shall contain as a minimum the following information in the following sections:

a) List of Commissioning Lot Numbers (by Location);

b) Diagram of Commissioning Lot Logic;

c) Installation Test Reports (IT) (by Lot);

d) Installation Release Notices (IRN) (by Lot);

e) Partial Stand Alone Test Reports (PSAT) (by Lot);

f) Partial Stand Alone Test Certificates (PSATC) (by Lot);

g) Stand Alone Test Reports (SAT) (by Lot);

h) Stand Alone Test Certificates (SATC) (by Lot);

i) Acceptance Test Report (AT);

j) Acceptance Test Certificate (ATC);

k) Light and Heavy Maintenance System Integration Test Report (SIT);

l) System Integration Test Certificate (SITC);

m) Punch list History Log of Field Change Requests (FCR's);

n) History Log of Non Conformance Reports (NCR's);

o) History Log of all Modification Requests;

p) History of all Planned Preventative Maintenance (PPM) including Repair Log;

q) List of all As Built Drawings and Specifications;

r) List of supplied Spare Parts and status;

s) List of all Special Tools and Equipment and status; and

t) List of Operation and Maintenance Manuals.

12.6.4 When the System commissioning file is complete, the contractor shall submit to the Engineer six (6) copies of the file within one month of completion of the tests.

12.6.5 A separate Commissioning file shall be maintained by the Contractor for the System Performance Test and Trial Running Test phases of commissioning.

12.7 Test Procedures

12.7.1 The Contractor shall furnish for the approval of the Engineer six (6) copies of his proposed testing and commissioning procedures. These shall be submitted 3 months prior to commencement of the testing schedule.

12.7.2 Together with the procedures and based upon the Final Time Schedule (FTS), the Contractor shall submit six (6) copies of the Contractor's detailed Commissioning Schedule showing testing and commissioning of the system. The Contractor's Commissioning Schedule shall show the detailed interface testing of the system with the works of Designated Contractors, with the works of Utility Companies and the Employer's and systems of the existing LRT Line.

12.7.3 The Engineer will consult with, the Employer/ Concessionaire, the various contractors individually, and where necessary collectively, to finalize a Trial Running Schedule. The program will set out the separate and interrelated activities to achieve the overall testing of the Works up to hand-over to the Employer. The Contractor shall participate fully in the production of the Trail Running Schedule to the requirements of the Engineer and the Employer.

12.7.4 The procedures shall be appropriately subdivided for the various parts of the System provided under the Contract and shall cover the electrical and mechanical tests, modifications to drawings and diagrams and "as-constructed" data to be attested to by the Contractor and verified by the

Engineer in the course of installation, testing and completion work of the System, so as to record details for the later inclusion on the "As Built Drawings".

12.7.5 The Contractor shall during the execution of the works, prepare such reports and records of design, manufacture, installation and testing as may be required in order to demonstrate that the Specification has been met and/or that a license may be issued or that the statutory requirements have been achieved or approval given for the operation of all parts of the System Extension. Such reports or records shall be adequate to enable each part of the System to be commissioned and to meet the requirements of the appropriate government regulations, and shall meet the approval of the Engineer.

12.8 Commissioning Coordination

12.8.1 The Contractor shall appoint a Commissioning Manager, who will work very closely with the Engineer's Commissioning Manager to co-ordinate all activities of the commissioning schedule.

12.8.2 The commissioning schedule shall ensure that completion, testing, and commissioning of the system is carried out without hindrance and in a safe and satisfactory manner.

12.8.3 For the system performance and trial running test phases the co-ordination of the testing will be undertaken by the Engineer's Commissioning Manager.

12.9 Conditions Pre-requisite to Inspection by Engineer

a) Written notice submitted by the Contractor requesting any total or partial Completion Inspection shall mean that the work is substantially completed and the Contractor has;
b) Inspected and checked all work installed;
c) Compared all work with the drawings, specifications, and submittals as approved;
d) Confirmed that all conditions, provisions and requirements of Contract Documents have been fulfilled, other than any maintenance and incidental work and procedures necessary to follow;
e) Cleanup and cleaning operations completed as specified under **Sub-Clause 4.5.4 a)** of this General Specification**;**
f) Temporary facilities and utilities properly disconnected and removed;
g) Systems, equipment and devices properly adjusted, serviced, tested and fully operable;
h) Equipment instructions and identification labeling completed;
i) Materials and finishes neat, clean and undamaged, and accessory parts and items securely attached;
j) Broken or damaged work repaired or replaced as required;
k) Spare parts delivered and stored as required;
l) Test reports and other required documentation assembled and delivered to the Engineer;
m) Operation and Maintenance Manuals, and Warranties, assembled and delivered to the Engineer; and
n) Written notice of readiness for completion inspection submitted to the Engineer.

12.10 Reinstatement of Site and Structures

The Contractor shall establish, to the approval of the Engineer, procedures for carrying out cleaning of works in accordance with this Clause, any relevant operating demonstrations, and completion of inspections, to ensure that:

The Works and Site are in a clean and orderly condition on completion;

The workmanship is in accordance with the requirements of the Contract; and

The Works are ready for the completion inspection.

a) General Civil Works

All areas within the limits of the Works shall be trimmed and shaped to the finished cross section to produce smooth surfaces and slopes with uniform cross sections and proper drainage.

Stockpiles of material shall be removed from Site and finished pavements or surfaces shall be cleaned free from all dirt and foreign material.

Slopes of embankments, excavations, road approaches, or crossings, ditches, channels, shall be trimmed and finished to the lines, grades and tolerances shown or specified.

Ditches and channels within or adjacent to the limits of work shall be cleared of debris and obstructions. All sewers, culverts and other drainage facilities, pipes and conduits, and their associated structures constructed under the Contract shall be cleaned out. Excess earth, debris, stones, roots and other waste material shall be removed and disposed of. All loose rock larger than 6 cm in maximum dimension shall be removed from the finished grades and disposed of.

All vegetation and other objectionable growths shall be removed and disposed of from areas that were previously cleared and grubbed by the Contractor.

All materials resulting from the above specified operations shall be removed from Site and disposed of by the Contractor.

Certificate of final disposal from sanitary landfill approved by DENR or from the Local Government Unit (LGU) on the proper disposal of construction spoils, cleared vegetation and other materials removed from the site should be provided by the Contractor and submitted to the Engineer not less than thirty (30) days upon removal of the said materials from the site. Disposal method should conform to the Philippine regulation such as the RA 9003 or RA 696.

b) Final Cleaning of Structures

The entire structure shall be thoroughly cleaned and put into neat, acceptable condition. All construction waste and unused materials, dumps, dunnage, loose rock and stones, weeds, roots, and all debris of any description resulting from the work shall be removed.

All surfaces, new pavement and walks, and adjacent existing pavement and walks as necessary shall be lose down and scrubbed where necessary. All sweeping, brushing, dry and wet mopping, polishing, buffing and other operations, including supplies and equipment required, necessary to leave all work in a clean condition ready for immediate occupancy and use, shall be undertaken. Protective tapes, wrappings, labels and other temporary coverings not required to remain shall be removed and roofs and decks as necessary, shall be cleaned.

13.0 Operating and Maintenance Manuals, Record Drawings

13.1 General

13.1.1 No later than six months prior to commissioning, the Contractor shall submit to the Employer and the Engineer for approval, six preliminary copies of operating instructions, maintenance instructions, maintenance drawings and illustrated parts lists for the whole of the Plant, in accordance with the requirements stated herein.

13.2 Operating and Maintenance Instructions

13.2.1 The instructions shall be in sufficient detail to enable the Employer/ Concessionaire to operate, maintain and repair each part of the Electrical and Mechanical Plant. This shall include but not be limited to the following:

a) A description of all the equipment and its component parts;

b) Original equipment manufacturers brochures, if applicable;

c) The characteristics, ratings and any necessary operating limits for all the equipment;

d) Instructions for lubrication and maintenance of the equipment and/or stripping and re-assembly at overhaul, with reference to any special tools required at any stage. This section shall also include instructions for such procedures as shaft changing, rewinding, rebinding, commutator pressing, making of connections for machines and setting and testing of control gear and electronic equipment, together with all the necessary insulation data and drawing references, etc. This information shall be in pictorial form whenever possible and shall include step-by-step instructions and views of the particular equipment, exploded views, etc.;

e) Testing and re-commissioning procedures after re-assembly, overhaul or replacement of equipment assemblies, and sub-assemblies, etc.;

f) Equipment data including electrical resistance numbers of turns and insulation details of all coils and machine armatures with copper sizes and insulation, bearing details, and running clearances, detail of magnetic circuit spacer washers, contact gaps, etc. Where wear can be expected, tolerance dimensions shall be given. The critical values, characteristics and ratings of resistors, capacitors, inductors, diodes, thyristors, transistors, etc., shall be given. If it is necessary to replace any such item with a particular proprietary item, this shall be stated;

g) Programmable equipment shall be supplied with sufficient flow charts and fully documented programs, to enable faults to be quickly identified and system modifications to be undertaken at any time;

h) Charts and tabulations, instructions, etc., for fault finding and fault diagnosis;

i) A list of recommended lubricants, cleaning and re-insulating materials; and

j) A comprehensive alphabetical list of suppliers, manufacturers, agents and distributors of all proprietary articles provided and incorporated into the Works. This list shall include trade names, business names, addresses, telephone and facsimile numbers, e-mail addresses, web sites, etc., in the Philippines or elsewhere. Six (6) copies in a durable loose-leaf binder, complete with index and alphabetical dividers shall be provided to the Employer.

The approved version of all manuals shall be provided in electronic format, the format to be approved by the Employer (which must allow the Employer/ Concessionaire to clearly document future changes), along with six properly bound oil and dirt resistant hard copies. The material for the hard copies shall be approved by the Employer.

13.3 As-Built Drawings

Drawings showing the Works as-built, shall be prepared by the Contractor and submitted for approval. The Contractor shall issue to the Employer six prints of each drawing and a copy of the electronic files. The electronic format shall be as approved by the Employer, but must allow the Employer to clearly document future changes. In addition to electronic format, the Contractor shall submit one 4 mils thick Mylar film reproducible copy, one microfilm copy, and six prints of each drawing. Should microfilm copies be provided, the Contractor shall be required to supply one high quality microfilm reader/printer to the Service.

Weights of assemblies shall be shown on the drawings.

13.4 Maintenance Drawings

13.4.1 The Contractor shall provide such drawings as may be required for the operation and maintenance of the Plant by the Employer/ Concessionaire. Drawings shall be provided as detailed by the Technical Specifications. Drawings previously submitted in this form under **Sub-Clause 13.2** of this General Specification and approved, need not be resubmitted providing the approval expressly covers the requirements as to content and quality called for in this **Sub-Clause**.

13.4.2 Information contained on the drawings shall include but not be limited to:

a) Sizes of all fixtures and threads;

b) Manufacturers code drawing and reference numbers;

c) Wiring diagrams to appropriate Standards, including internal wiring of sealed unit items; and

d) Setting dimensions and tolerances.

13.5 Illustrated Parts Lists

13.5.1 The Contractor shall submit six copies of complete illustrated parts lists and overall "exploded views" of assemblies and sub-assemblies for all Plant which shall include also reference to all assemblies, sub-assemblies special tools, jigs, fixtures and gauges required for the operation and maintenance of the Plant by the Employer/ Concessionaire.

13.5.2 The illustrated parts lists shall be provided in electronic format, the format to be approved by the Employer (which must allow the Employer/ Concessionaire to clearly document future changes), and in properly bound oil and dirt resistant hard copies. The material for the hard copies shall be approved by the Employer.

13.5.3 All sub-assemblies shall be broken down into individual parts or sealed units and quantities thereof, in a logical manner, which shall be to the Employer approval. Space shall be left against each item for insertion of the Employer's reference number.

13.5.4 Different parts shall be differently named where possible and identical parts occurring in more than one location shall bear the same number and name in each location. Where the part is a standard nut, bolt, fixing, resistor, capacitor, inductance, electronic component or the like, it shall be so described and shall not require a part number, but the description shall include the material and necessary ordering parameters and shall be sufficient to identify the item.

13.6 Modifications

13.6.1 Following the Employer's and Engineer's approval of the preliminary issue, the Contractor shall make a submission within one month of installation of the equipment of the complete Operating and Maintenance Instructions and Illustrated Parts Lists, in a form and in a quantity to be agreed with the Employer. The binding shall allow for all subsequent changes and additions to be readily effected.

13.6.2 The Contractor shall make such amendments to his submissions as may prove necessary during commissioning of the Plant and during the Defects Notification Period. Amendments found

necessary during commissioning shall be completed within one month of taking over the relevant part of the Plant. Subsequent amendments shall be completed one month prior to the expiration of the Defects Notification Period for each part of the Plant.

13.6.3 Operating and Maintenance Instructions, Maintenance Drawings, As-built Drawings and Illustrated Parts Lists are part of the total work under the Contract, and until they are delivered by the Contractor any amount due to him may be withheld until they or amendments thereto are delivered.

14.0 Training

14.1 Training Requirement

The Contractor shall be required to train, or arrange training for nominated personnel. These nominated personnel shall include the Employer's/ Concessionaire's training instructors, who will require training in technical matters according to their intended function.

14.2 Training Objectives

The content, timing and duration of the training program shall be such that personnel trained by the Contractor will be able to operate and maintain the equipment/systems in the designed manner with maximum reliability and economy.

Training objectives in terms of minimum standards to be achieved by each trainee shall be clearly defined by the Contractor, for each trainee post, including the instructors.

14.3 Selection of Trainees

14.3.1 The Contractor shall submit for the approval of the Employer/ Concessionaire the range of staff, including the Service's Instructors, for which training is recommended.

14.3.2 The Contractor shall submit measurable selection criteria for entry to each trainee post, indicating minimum standards desired in each case, in terms of:

a) Qualification and/or educational standards required;

b) Skills and knowledge levels desired, or any special aptitudes necessary, such as manual dexterity; and

c) Oral and written ability.

14.3.3 The Employer/ Concessionaire will select personnel who most closely meet the minimum established criteria, and will advise the Contractor of the names of the staff and their intended function for training, not less than one month before the start of their training.

14.4 Training Methods

14.4.1 The training shall be planned and carried out in a manner suitable for the intended occupation, and shall consist of:

a) Formal off -the-job theory and practice; and

b) Practical on-the-job follow-up experience.

14.4.2 The Contractor shall demonstrate that the trained staff, including the instructors, has achieved the minimum standards established for each trainee post as defined under **Sub-Clause 14.2** herein.

14.4.3 The Contractor shall submit for the approval of the Employer and the Engineer not later than twenty-six (26) weeks from Commencement Date, programs and syllabus of training and measures for monitoring the progress of both the training programs and individual trainees. Programs shall clearly show commencement and completion dates and number of trainees for each training course. The program shall clearly identify whether the training is off-the-job or on-the-job.

Syllabi shall clearly indicate:

a) Course title and objectives;

b) Course content or attachment objectives;

c) Location of training course and/or attachments; and

d) Methods of training.

Methods for monitoring progress shall relate to:

e) Theoretical tests;

f) Practical tests; and

g) Progress reports.

14.4.4 Records of all trainee's progress shall be kept up-to-date and made available to the Employer or to his representative for examination when required to do so.

14.4.5 Copies of individual trainee's records showing all test results and reports of progress shall be sent to the Employer on completion of each training course or attachment.

14.5 Contractor's Training Staff

14.5.1 For all off-the-job formal training, in both theory and practice, the Contractor shall ensure that qualified staff are provided, who shall be employed by the Contractor as Instructors to the Employer's trainees and instructors.

14.5.2 Where the trainees are attached to the Contractor (or his Subcontractors) for the purposes of gaining job experience, all such trainees shall be properly supervised and monitored by a qualified training supervisor to ensure that each trainee has the best opportunity to benefit from the theoretical and practical experience.

14.6 Training Locations

14.6.1 The training shall be carried out at such locations where the greatest benefit for trainees may be gained. This may be in the Philippines, at places of manufacture, assembly or testing, or at such other locations as may be necessary. All places of training shall be to the approval of the Employer.

14.6.2 Dedicated accommodation for training shall be provided, of a type suitable for use as a class room or lecture room. Facilities shall include, but not be limited to:

a) Sufficient desks and chairs for up to twelve (12) trainees;

b) Large table and three (3) chairs for lecturers; and

c) Visual aids, including video player/monitor, overhead projector/screen, large white board, flip chart easel, etc.

14.7 Training Equipment

14.7.1 In general, the Contractor shall use Plant specifically set aside for training purposes. However, he may use as may be agreed, Plant being erected, tested or commissioned for the training of the Employer's staff, when no other such Plant is available. The Contractor shall not use for this purpose spare parts that are to be delivered to the Employer.

14.7.2 The Contractor shall provide, at no cost to the Employer, such written or printed matter, samples, models, cut-away equipment, slides, films and other instructional material as may be necessary for training. Such materials shall be retained by the Employer at the end of the training program(s).

14.7.3 The supply of equipment and materials shall be sufficient both for the persons trained by the Contractor and for those to be subsequently trained.

14.8 Administration

14.8.1 The Contractor shall:

a) Be responsible for the general welfare of trainees under his control;

b) Submit for the Employer's approval, procedures which will enable him to control, and to repatriate where necessary, those trainees not found to be responding to training as a result of:

i. Aptitude;

ii. Discipline;

iii. Incorrect Selection; and

iv. Any other cause.

14.9 Training Duration

14.9.1 The Contractor shall provide training support and/or additional retraining for all systems and equipment not presently used by the metro for one year after the start of Trial Running.

15.0 Equipment Identification

15.1 All labels on any piece of equipment, cable, pipe, duct, etc., shall show the same identification as shown on the approved drawings and or circuit diagrams.

15.2 All equipment and materials supplied shall be indelibly labeled or otherwise identified to show its identity, type, version, function, location, rating or limitation as appropriate.

15.3 Removable modules such as relays, circuit breakers, etc., shall have the same indelible labeling on the fixture to which the module is attached. The label shall be adjacent to or on the module and shall not be obscured.

15.4 All Warnings, instruction or Identification Labels shall conform to current Directives and a unified system of labeling for all services shall be used subject to the approval of the Engineer.

15.5 All cables and cable trays shall carry identification labeling at the following points:

a) At each final terminal i.e. adjacent to glands on cable boxes or to lugs where cables are terminated onto tracks. Such markings shall be outside any individual switchgear cubicle or enclosure, so that the cable can be identified without access to the equipment;

b) At the point of entry and exit from any area. Thus either side of wall and floor junctions that the cables pass through;

c) At any cable joint;

d) At each change of direction.

e) In every cable pit in the Depot environs; and

f) All cable cores inside equipment shall also be labeled by use of proprietary cable ferrules which shall carry the same identification marks as the approved drawings and or circuit diagrams.

15.6 All pipes and ducts shall carry color coded identification labeling to meet current Directives at the following points:

a) At each service appliance;

b) At the point of entry and exit from any area. Thus either side of wall and floor junctions that the pipes and or ducts pass through;

c) At any bulkhead;

d) On long continuous runs every 10m on the viaduct and station environs;

e) At each change of direction;

f) Either side of every valve and or pump;

g) In every pipe trench pit in the Depot environs; and

h) All pipes and ducts shall also be marked to clearly identify direction of flow.

15.7 All labels used shall be highly durable, scratch and chemical resistant and have high UV resistance.

15.8 Labelling for electrical/electronic equipment shall be in accordance with current Directives.

16.0 Provisions of Employer's/Engineer's Facilities and Inspection

16.1 Site Facilities for Employer and Engineer

Pursuant to **Sub-Clause 4.1** of Part 3 Conditions of Contract and Contract Forms Section VII General Conditions, the Contractor shall provide brand new Project service vehicles, including drivers, fuel and consumables, maintenance and required comprehensive insurance, for the exclusive use of Employer's Personnel, including the Employer and the Engineer, as indicated in the following schedule:

Table 16.1 Service Vehicle

Item	User	Type of Vehicle	Quantity
1	Employer	SUV (eq. Innova)	4 x 48MM

a) All service vehicles shall be the latest models, with engine displacement of not less than 2000 cc. Vehicles shall be fully equipped (spare wheel/tire, lifting jack and tools etc.), all power operations and air conditioning and with automatic transmission.

b) Drivers shall be provided by the Contractor inclusive of all employment costs including their salary, parks and all overtime during the operating months without time restrictions.

c) The operation and maintenance costs of the vehicles including cost of gasoline shall be provided and borne by the Contractor without distance (kilometer) restriction.

d) Service vehicles that will be used by the inspection engineers and site staff may require drivers on 18-hours per calendar day basis. In such case, a driver may have to work overtime or another shift driver replacement may be provided.

16.2 Office and Office Equipment

Pursuant to **Sub-Clause 6.6** of Part 3 Conditions of Contract and Contract Forms Section VII General Conditions the Contractor shall provide an office space for the Employer/Engineer that shall be in agreement and coordination with the Concessionaire in case the location is within the area under the Concessionaire's responsibility. The Contractor shall provide and maintain new office equipment, supplies and consumables and Personal Protection Equipment (PPE) for the Employer's/Engineer's office as indicated in the following schedule:

Table 16.2 Office Equipment

No.	Item	User	Quantity	
			Baclaran Depot	Zapote Depot
1	Office Space	Employer	$20m^2$	$20m^2$
		Engineer	$20m^2$	$20m^2$
2	Post-Paid Cellphones with e-mail capability	Employer	2 units x 24 months	2 units x 24 months
			Max. monthly expenditures : Php 3,000/month	
		Engineer	3 units x 24 months	3 units x 24 months
			Max. monthly expenditures : Php 3,000/month	
3	Sufficient Parking Area	Employer	Yes	
		Engineer	Yes	
4	Office Facilities	Employer	Desktop Computer 2units, Color Printer (for A3) 1unit, Working Desk and other facilities for 4 persons, Shelf 1unit	Desktop Computer 2units, Color Printer (for A3) 1unit, Working Desk and other facilities for 4 persons, Shelf 1unit
		Engineer	Desktop Computer 2units, Color Printer (for A3) 1unit, Working Desk and other facilities for 4 persons, Shelf 1unit	Desktop Computer 2units, Color Printer (for A3) 1unit, Working Desk and other facilities for 4 persons, Shelf 1unit
5	Office Operation and Maintenance Expenses	Employer	Yes	
		Engineer	Yes	
		Utility Staffs	3 persons x 24 months	
		Guard Man	3 persons x 24 months	
6	Office supply, Utility Staff and consumables	Engineer	P50,000/month	P50,000/month
		Engineer	P50,000/month	P50,000/month
7	Personal Protective Equipment: Safety helmet, Safety shoes, Safety Jacket, etc.	Employer	15 sets	15 sets
		Engineer	15 sets	15 sets

a) **Desktop** shall be ITB HDD 4GB NVIDIA GTX 850M Graphic/ Windows 10
b) **Color Printer** shall be good for A3 print.

16.3 Provision for Inspection/Verification of Works in Foreign Countries

Pursuant to **Sub-Clause 7.3** of Part 3 Conditions of Contract and Contract Forms Section VII General Conditions, the Employer's/Engineer's personnel shall visit the Contractor's manufacturing/fabrication plant/ equipment of Depot civil, architectural and maintenance equipment works to inspect or verify its performance, quality, quantity and capability in foreign countries for a total of about 10 round trip group visit not exceeding 300 days.

One group of Employer's Personnel on each occasion shall be comprised of one or more persons. The level of travelling expenses, staying expenses and inspection fees to be provided by the contractor are as follows:

Table 16.3 Inspection Trip

No.	Item	User	Quantity
1	Inspection Trip	Employer	5 round trip x 5 person x 7 days
		Engineer	5 round trip x 3 person x 7 days

Flights: Economy Class

Allowance per person per day: JPY12,000/day

Hotel Accommodation Allowance per day: JPY25,000/day

If the Contractor pays for the hotel rooms directly, he shall pay 30 % of the above accommodation allowance for meals, laundry etc. The hotel shall at least be of international 4-star class.

APPENDIX A DEFINITIONS AND ABBREVIATIONS FOR DEPOT CONSTRUCTION PROJECT

DEFINITIONS:

This section defines terms used in the Employer's Requirements – this General Specifications and the Technical Specifications for Civil Engineering and Architectural Works.

Acidity	The presence of an excess of hydrogen ions over hydroxyl ions.
Administration Building	New Administration Building to be constructed by LRMC (if required) except for the renovation works stipulated in Technical Specification C. Architectural Works and Finishes Clause 2.12 Renovation of existing Administration Building/ Structures
Adze	To cut into the top surface of a tie to provide proper bearing for a tie plate.
Alkalinity	The presence of an excess of hydroxyl ions over hydrogen ions.
Anaerobic	Lacking free oxygen. This refers to the state of the electrolyte adjacent to the metal structure.
Anode	The electrode through which direct current enters an electrolyte.
Anode Bus	An assembly of rigid conductors in a metal enclosure with associated connections, joints and insulating supports connecting the output (secondary winding terminals) of a rectifier transformer to a rectifier.
Anodic area	That part of a metal surface which acts as an anode.
Approach Slab	A concrete slab located at interface of ballasted track with embedded or direct fixation track to provide a transition from embedded or direct fixation track to ballasted track.
Audio Frequency Track Circuit	Track circuit energized by electrical current in the audio frequency range.
Automatic Train Control (ATC)	A former abbreviation of a system similar to ATP. In this specification used as an overall term for ATP, ATS and Interlocking.
Automatic Train Protection (ATP)	The subsystem of Automatic Train Control that, through train detection, train separation and speed limit enforcement maintains safe train operation.
Automatic Train Regulation (ATR)	The subsystem of Automatic Train Supervision that provides various function for train regulation in compliance with time table
Automatic Train Supervision (ATS	The sub-system of Automatic Train Control that monitors and provides control necessary to direct the operation of a system of trains in order to maintain intended traffic patterns and minimize the effects of train delays on the operating schedule.
Available Fault	The maximum fault current at rated voltage that the power system can deliver to a point in the system.

Backfill	A low-resistance moisture-holding material immediately surrounding a buried anode for the purpose of increasing the effective area of contact with the soil.
Ballast	An integral part of the ballasted track structure, composed of crushed stone, in which the sleepers and bearers are embedded.
Bearer	A transverse member of the track form structure at turnouts or crossovers, which supports the rails.
Bond	A piece of metal, usually in the form of rectangular strip, circular solid wire or stranded conductor, usually of copper, connecting two points on the same, or on different, structures to prevent any appreciable change in the potential of one point in respect of the other.
Bonded Joint	A rail joint that uses high-strength adhesives in addition to bolts to hold rail together. The bonded joint may be insulated or non-insulated. The non-insulated type shall be referred to as a standard bonded joint.
Band Resistance	The ohmic resistance of a bond including the contact resistance at the points of attachment of its extremities.
Bumping Post or Wheel Stopper	A device attached to the rail, designed to stop a rail vehicle at the end of a track. A sliding type of friction arrestor is designed to slide along the track before it brings a rail vehicle to a complete stop in the main line or depot area while a wheel stopper is used where appropriate in the depot area.
Cab	A compartment in the vehicle with full facility and equipment necessary to operate the train consist in all operating modes.
Cant	Rising of the level of the outer rail relative to that of the inner, on horizontally curved track. Also referred to as track super elevation. Inward inclination of the running rails, nominally 1:20.
Cant Gradient	The rate at which the raising or lowering of the outer rail level (relative to the inner) is applied or removed on horizontally curved track.
Cathode	The electrode through which direct current, leaves an electrolyte.
Cathodic area	These parts of a metal surface which act as a cathode.
Cathodic protection	A means of rendering a metal immune from corrosive attack by causing direct current to flow from its electrolytic environment into the metal.
Cell	A complete electrolytic system comprising a minimum of a cathode, an anode and an intervening electrolyte.
Circuit Breaker	A device designed to open an electric circuit, when the current in the circuit exceeds a predetermined level. Differently designed breakers can be reset manually, automatically or from remote locations.

Component	An identified part of an assembly, which may, by itself be an assembly of other components.
Conductor	A substance (mainly a metal or carbon) in which electric current flows by the movement of electrons.
Configuration	The specification of the arrangement describing the components and their interconnections within an assembly.
Connection Diagram	Also called wiring diagram. Shows the connections (within or among) an installation or equipment.
Consist	Any collection of cars, serviceable and operable, of minimum 2 vehicle length and maximum 4 vehicle length with a cab at each end.
Console	A desk with a concentration of controls and indications from which an operator can supervise operations and give commands. These controls and indications may be mounted on a number of panels located on the console.
Contact Wire	Electric conductor of an overhead current collection system with which the train pantographs (current collectors) make contact.
Continuity Bond	A bond designed and installed specifically to ensure the electrical continuity of a structure. This may be permanent or temporary, in which latter case it is used to connect two sections of a structure, which would otherwise be disconnected during the course of modification or repair.
Contractor	The Company or Consortium, as the case may be, to whom the Project has been awarded and who secured all contract obligation and rights to the project.
Corrective Maintenance	Unplanned repair or replacement of items of equipment due to failure.
Corrosion	The chemical or electrochemical reaction of a metal with its environment, resulting in its progressive degradation or destruction.
Corrosion interaction	Increase or decrease in the rate of corrosion, or the tendency towards corrosion, of a buried or immersed structure caused by the interception of part of the cathodic protection current applied to another buried or immersed structure.
Corrosion product	The chemical compound or compounds produced by the reaction of a corroding metal with its environment.
Coupler	A device that mechanically connects one vehicle to another, including compressed air interconnections.
Cross-bond	Usually a cable or cables connecting two or more traction return current circuits in parallel.

Cross-bonding	The term used to describe cables used to electrically link parallel sets of running rails forming the traction return system together, to reduce voltage drop and leakage currents in a dc electrified traction system.
Cross Level	The vertical relationship of the top of one running rail to that of the opposite running rail at any point in the track.
Crossing	A portion of a turnout, where the point of divergence occurs between the two tracks.
Crossovers	
- Single	Two turnouts, with plain track placed between the crossings and arranged to form a continuous passage between two adjacent parallel or diverging tracks. Two turnouts, with track located between the frogs and arranged to form a continuous passage between two adjacent and generally parallel tracks.
- Double	Two single crossovers, which intersect each other between two adjacent parallel or diverging tracks, forming a connection between them. Also referred to as a "scissors" crossover. Two single crossovers which intersect each other between the two adjacent and generally parallel tracks forming a connection between them. Sometimes referred to as a “diamond” crossover or “scissors” crossover.
- Diamond	A special track work assembly, consisting of two obtuse crossings which together make up the central portion of a double or scissors crossover. A special track work assembly consisting of two end frogs and two center frogs that together comprise the central portion of a double crossover.
- Facing	A single crossover positioned with the switches facing the direction of prevailing traffic.
- Tandem	A pair of facing and trailing crossovers placed adjacent to each other on the same pair of lines.
- Trailing	A single crossover positioned with the switches facing away from the direction of prevailing traffic.
Curves	
- Circular curve	A horizontal curve defined by an arc and specified by a radius.
- Spiral Curve	A transition curve connecting a tangent to a circular curve and defined by the Barnett Spiral.
- Transition curve	A spiral curve (clothoid) connecting a tangent to a circular curve, or two adjacent circular curves.

- Vertical curve	A parabolic curve connecting different profile grades.
Dap	A recess cut into a switch tie to depress the switch machine.
Data Acquisition	A general term for the capture of data from various sensors and the processing of the data for presentation to the operator in the form of VDU displays, printed logs, charts, etc.
Derail	A device that protects main track by derailing rolling LRT vehicles or maintenance equipment, thereby preventing rolling vehicles or equipment from entering or obstructing the track.
Direct Fixation Rail Fastener	A resilient device for securing running rail to a concrete track bed in direct fixation track.
- Rail Clip Assemblies	One or more components of the direct fixation rail fastener used to attach the running rail to the body of the direct fixation rail fastener.
- Anchorage Assemblies	One or more components of the direct fixation rail fastener used to attach the body of the direct fixation rail fastener to a concrete track bed.
- Anchorage Insert	A component of the Anchorage Assemblies that is embedded in the concrete and is threaded to hold the anchor assembly bolts.
Disadvantage Passenger	Are passengers who are physically handicapped or has physical difficulty. These shall include senior citizens, the blind, people on wheelchair, pregnant woman, and the likes.
Driving EMF (galvanic anode system)	The difference between the structure/electrolyte potential and the anode/electrolyte potential.
Dutchman	A short piece of running rail temporarily placed between the ends of CWR to reduce the damage which would occur to the rail ends as a result of rail mounted track equipment passing over those ends.
Earth	Means the Conducting mass of the earth or any conductor in direct electrical connection there with.
Earth Bus	An un-insulated electrical conductor to intentionally provide multiple low resistance connections from the equipment enclosure(s) to earth.
Earth Fault	Failure of insulation of a conductor having a potential above earth resulting in a short circuit to earth.
Earth - General	The conducting mass of earth or of any conductor in direct electrical connection therewith. In this context, earth includes all geographical and geological features. A connection, whether intentional or unintentional, between a conductor and the earth.
Earth Mat	A system of bare conductors and/or bare driven conductor rods/pipes usually installed as a totally interconnected grid and buried in the earth

	to provide a low impedance and high current capacity connection to the earth.
Earth - Particular	
- Substation or System Earth	The purposely provided earth system to which power supply equipment is solidly connected. Substation earth does not include Meralco earth, which may be separate or electrically different.
- Traction Earth (TE)	The running rails of both main tracks. Traction earth and system earth shall be separated at all times.
Earthing	Synonymous with grounding. The connection of equipment enclosures and non-current carrying metal parts to earth to provide safety to personnel, public and to the equipment.
Electrical Isolation	The electrical resistance required between the running rail and the ground to prevent harmful levels of stray current from the DC Traction Power circuit.
Electrode	A conductor of the metallic class (including carbon) by means of which current passes to or from an electrolyte. It is also the conductor from an earth rod or mat, which for this Section is defined as "earth-electrode".
Electrolyte	A liquid, or the liquid component in a composite material such as soil, in which electric current flows by the movement of ions.
Electromagnetic Compatibility (EMC)	The ability of equipment and systems to function as designed without degradation or malfunction in the intended operational electromagnetic environment, without adversely affecting or being adversely affected by any other equipment, Systems, or the outside environment.
Electro-Magnetic Interference	Degradation of the performance of a device, equipment or system by an electromagnetic disturbance.
Electronegative	A qualification applied to a metallic electrode to indicate that its potential is negative with respect to another metallic electrode in the system.
Electropositive	A qualification applied to a metallic electrode to indicate that its potential is positive with respect to another metallic electrode in the system.
Employer	Light Rail Transit Authority (LRTA) and Department of Transportation and Communication (DOTr)
Engineer	CMX Consortium
Engineering Hour	Time period at night when the main traction current on the LRT Line is turned off.
EPC Contractor	LRMC's Railway System Contractors

Expansion joint	A joint in the running rail for contraction or expansion requirements.
Factory Acceptance Tests (FAT)	Tests performed by the Contractor at Contractor's or manufacture's facilities, prior to shipment to verify compliance with specifications and quality standards.
Fail-Safe	A characteristic of a system which ensures that a fault or malfunction of any element affecting safety shall cause the system to revert to a state that is safe; alternatively, a system characteristic which ensures that any fault or malfunction shall not result in an unsafe condition.
Failure	The inability of an item of equipment to continue to perform its intended function.
Failure Rate	The failure rate of an article is the ratio of the total number of independent article failures to the total article operating hours.
Fault-Tolerant	Provides that the system deteriorates only within the permissible design criteria, the design principles ensure that any failure will not interrupt the consistent functions of the overall system or any portion thereof.
(Field) Stand Alone Tests (SAT)	On-site tests performed by the Contractor to verify proper installation and operation of equipment and subsystems.
Floating Slab Track (FST)	A concrete slab mounted on resilient bearings supporting the track form, so as to dampen noise and vibrations.
Fouling Point	The position at the convergence or divergence of two tracks where the kinematic envelopes of trains, (one on each line), would align.
Functional Design	The design of the functional units of a system restricted to its functional aspects as opposed to the physical ones.
Grade Crossing	The crossing of a railway track and a vehicular roadway at the same elevation. Conventionally constructed of timber, asphalt, rubber, or concrete.
Ground bed	A system of buried or submerged electrodes connected to the positive terminal of an independent source of direct current, in order to lead to earth the current used for cathodic protection of a buried or immersed metallic structure.
Heartwood Face	The side of a timber tie about which the growth rings are concave.
Heavy Maintenance Workshop	New Workshop to be constructed in Baclaran Expansion Depot
High Speed Circuit Breaker	A direct current circuit breaker protecting the positive output side of a rectifier.
High Voltage	As applied for this Contract, the high voltage is 34.5kV ac.

Impedance Bond	An assembly having low resistance and relatively high reactance that provides a continuous or shunting path for the return propulsion current and provides an impedance match for audio frequency track circuits.
Impedance bond or equivalent circuit	Electromagnetic device used to provide continuity for traction return current at signaling track circuit insulated rail joints and connection points for interconnection of tracks (cross-bonding) and for providing the connection to traction substation negative.
Impressed current	The current supplied by a rectifier or other direct current source to a protected structure in order to attain the necessary protection potential.
Insulated flange	A flanged joint between adjacent lengths of pipe in which the nuts and bolts are electrically insulated from one or both of the flanges and the jointing gasket is non-conducting.
Insulated Rail Joint (IRJ)	A joint in running rails, placed between abutting rail ends to insulate them from each other electrically.
Interlocking	An arrangement of signals and control apparatus so interconnected that functions must succeed each other in a predetermined sequence which prevents conflicting selections from being achieved, thus permitting train movements along routes only if safe conditions exist.
Interrupt	A suspension of a process caused by an event external to that process and performed in such a way that the process can be resumed.
Interrupting Capacity	This is the capability to interrupt a maximum rated short circuit or fault current at a rated maximum voltage. This it is usually expressed in volt-amperes, kilovolt amperes, or megavolt amperes.
Ion	An atom or group of atoms, carrying a charge of positive or negative electricity.
Isolating joint	A joint or coupling in a pipe or cable sheath to provide electrical discontinuity.
Isolation	The electrical separation of two or more circuits by the use of isolating devices such as isolating transformers or optical couplers. Usually employed as a safety feature for the protection of circuit components or as a means of increasing the common mode voltage tolerance of a circuit.
Kinematic Envelope	The cross-section profile which may be occupied by a train under all “worst case” conditions of loading, suspension, speed, track and rolling stock condition, etc.
Light Maintenance Shop	New Light Maintenance Shop to be constructed in Baclaran Expansion Depot and Zapote Satellite Depot
Line Voltage	Actual voltages measured at the catenary line.

Lowest Level Replaceable Unit	The smallest unit of equipment which may be replaced in the event of failure.
Low Voltage	Refers to voltage not exceeding 480V ac or 220V dc between conductors.
Low Voltage Power Supply (Vehicle)	A power conversion device providing vehicle control power, including supply voltage for 440Vac, 220Vac, 110Vdc, 24Vdc and battery charging.
LRT System	The premises and land in use for LRTA's operational rail system and ancillary purposes including station approaches and fore courts where these are owned by LRTA.
Main Circuit Breaker	A circuit breaker has the capability and provides protection to break high line currents.
Main Line	All tracks over which trains carry fare paying passengers, including all berths, plus sidings and connections between, up to the limits leading into a yard.
Maintainability	The inherent characteristics of a design or installation that determines the ease, economy, safety and accuracy with which maintenance actions can be performed. Also, the ability to restore a product to service, or to perform preventive maintenance within required limits.
Maintenance	The combination of all technical and corresponding administrative actions intended to retain an item in or restore it to, a state in which it can perform its required functions.
Maintenance Action	Any type of maintenance activity, whether it involves a preventive or repair action.
Mean Distance Between Failure	The average distance traveled by a product between breakdowns.
Mean Time To Repair	The average time to restore a system or subsystem to its "available" condition. Also, the average time to fix a failed component.
Negative busbar	The negative poles of the rectifiers at traction substations and connected to the running rails via impedance bonds.
Network	An interconnected grouping of partially independent units or subsystems.
Normal Direction	The prescribed direction of train traffic as specified by the rules; usually, the direction in which all regularly scheduled revenue service operations are conducted.
Operating System	Software for controlling the execution of computer programs and that may provide scheduling, debugging, input-output control, accounting, compilation, storage allocation, data management and related services.

Other Track Material (OTM)	Miscellaneous materials required to complete track construction, other than rail, special track works, ties, and ballast.
Override	The temporary suspension of an automatic control function and its replacement by manual control.
Overrun Protection	The measure taken in the flank protection to detect that no train has occupied the track between a protecting signal and the point of conflict.
Partial Route Release	The release of points in a portion of a route after a train has traversed them and has been proved clear of them but before the train has cleared the entire route so that the points can be made available for alternate routes.
Performance	The functional effectiveness obtained by a component, system, person, team, or other entity, as specified.
Plates	
- Gauge Plate	A steel plate installed at the switch or the frog to maintain the gauge.
- Special Plate	A steel plate for use in special track work designed to replace the standard gauge, switch, heel and hook twin tie plates commonly used under switches and frogs.
Pocket Track	A track located between the two main tracks on which a train may lay over or reverse direction.
Point Machine	An electric motor for remote control of a turnout switch or derailing device.
Portable Test Unit (PTU)	Units used for and during fault tracing of train line or system. It consists of laptop computer (PC) with special interface software.
Position Light Signal	Signal Light the indication of which, are given by the relative position of points and colors of the lights shown.
Positive bus bar	The positive pole of the rectifiers at the substations and connected to the dc switchgear bus bar via circuit breakers. NB The positive bus bar is connected to the low-level conductor rail via feeder circuit breakers.
Preconditioning	Energizing a switch control relay for an opposing position in a route that has been cleared for a train.
Prevent Shunt of A Track Circuit	Maximum value of the resistance, which placed between the two rails of a track circuit, shall prevent the energization of the track relay.
Preventive Maintenance	The maintenance carried out at predetermined intervals or corresponding to prescribed criteria, and intended to reduce the probability of failure or the performance degradation of an item. Overhaul or replacement of items of equipment at a fixed interval determined by the theoretical life of the equipment.

Profile Grade Line (PGL)	The datum line which defines the vertical alignment of the track, applied at the top of the low rail.
Programmable Logic Controller (PLC)	PLC is a programmable controller, which utilizes ladder diagram programming and advanced instructions for use in Automation environment.
Protection and Control Unit (PCU)	PCU is an intelligent microprocessor based, self-diagnostic, protection, control and metering unit. The PCU consists of Protection relay module, control module and metering module functioning as a complete unit for continuous controlling, monitoring, metering and protection of the system.
Provisions For	Future functions/requirements not needed for initial procurement, but for which compatibility, software, cut-outs, space, and wiring, etc., shall be provided to accommodate them when needed.
Qualification Test	A test performed by the Contractor prior to production to verify that the components proposed meets the requirements of this Contract.
Rail	
- Continuous Welded Rail (CWR)	Sections of rail welded together at their ends, to form a continuous length of track, of infinite length without physical breaks or discontinuity. A number of standard length rails welded together into a single length.
- Jointed Rail	Rails with a nominal length of 24 meters or less joined together by means of fishplates or joint bars and bolts.
- Running Rail	A rail that supports and guides the flanged wheels of the rail vehicle.
- Special Track Work Rail	Rails in the special track work area to be manufactured in a shop rather than fabricated in the field.
- Inside Rail	On horizontal curved track, the running rail closest to the curve centre; the running rail with the smaller radius. Also referred to as the "low rail."
- Outside Rail	On horizontal curved track, the running rail farthest from the curve centre; the rail with the largest radius. Also referred to as the "high rail."
Rail Anchor	A track device in ballasted track designed to resist longitudinal rail movement due to traffic and temperature variations.
Rail Bond	Means an electrical connection across a joint or between adjacent lengths of running rail.
Rail Brace	A device that provides lateral support on the field side of stock rails to maintain the track gauge.
Rail Field Side	The side of the rail farthest from the center of track.

Rail Gauge Side	The side of the rail nearest the center of the track.
Rail insulation	Insulation between rail foot and earth (track bed) of running rails throughout the system. Resistance is given in single-track ohm km, meaning the insulation resistance for one kilometer of two rails in parallel.
Rail Stop	A steel plate welded to a special plate to provide lateral restraint to the rail.
Reaction (anodic, cathodic)	A process of chemical or electrochemical change, particularly taking place at or near an electrode in a cell.
Rectifier Substation	Rectifier substation receives incoming supply from Meralco Power Grid and transforms the 34.5KV AC to 750 volts DC for power distribution to LRT system.
Relay	An electric device that is designed to interpret input conditions in a prescribed manner and after specified conditions are met, to respond to cause contact operation or similar abrupt change in associated electric control circuits.
Relay Interlocking	An interlocking in which locking is accomplished electrically by interconnection of relay circuits.
Reliability	The probability that a product or component will perform its intended function without failure for a specified time period under specified conditions.
Remote Control	Control of equipment from a remote location. Remote control necessarily involves remote indication.
Remote Terminal Unit (RTU)	Interface unit between PCU and SCADA
Repair	To restore serviceability to an item by correcting specific damage, fault, malfunction or failure in, or recalibration of part, subassembly, module, component, assembly, end item, or system.
Response Time	The elapsed time between the arrival of a stimulus to a system and the start of the response.
Return Conductor	Means a conductor which carries return current from the tracks to the substation.
Reverse Direction	Train movement opposite to the normal direction.
Reverse Route	A route opposite to the normal route.
Reverse Running	Operation of a train in the reverse direction.
Roadbed	The earth bed or foundation which supports the ballast, ties and rail of a track structure.

Rod	
- Front Rod	A rod connecting the switch rails to the lock or detector rod (whichever rod is furthest away from the turnout frog).
- Switch Rod	A rod which connects two switch rails together.
- Operating Rod	A rod connecting the switch rod to the switch operating mechanism.
- Lock Rod	A rod connecting the front rod to the lock mechanism.
Route	A path through an interlocking starting at an entry signal and ending at a following signal. Once established, routes are locked to prevent unsafe conditions.
Route Initiation	Where applicable, the same momentary pushbuttons shall serve as both an entrance and exit pushbutton. Signal indication lights shall not be an integral part of the pushbuttons, but shall be separate spotlights located in the vicinity of the pushbutton.
Route Locking	Locking which prevents the alteration of the position of the points of a route.
Safety Bond	A bond connecting the metallic enclosure of electrical apparatus with earth, in order to limit the rise in potential of the enclosure above earth caused by the passage of any fault current or excessive stray current, and so reduce the risk of electric shock to anyone touching the enclosure.
Safety Critical	A function that has direct influence upon the safety integrity of a system.
Safety Speed (Limit)	The maximum speed at which a train can continuously safely negotiate a given section of track under the conditions prevailing at the time of passage (the safety speed limit may be less than or equal to the civil speed).
Semi-Permanent Coupler	A coupling that shall normally be coupled or uncoupled only inside the workshop or at maintenance depot. Tools will normally be required for the coupling and uncoupling activities.
Signal Bond	A conductor of low resistance placed around rail joints, crossings, and switch points to ensure continuity of track circuits.
Sleeper	A transverse member of concrete or timber, which supports the rails on plain track. Applicable to ballasted and non-ballasted track forms.
Speed (Limit)	The maximum speed allowed in a specified section of track as determined by physical limitations of the track structure, train design, and passenger comfort.
Sub-ballast	A material superior in composition to the roadbed material that provides a layer between the track ballast and the roadbed.

Sub-Contractor	Any Company that may be contracted by the Contractor to supply equipment, assemblies, sub-assemblies or perform manufacturing or fabrication works as part of the project.
Sub-system	A major part or an assembly of parts of a vehicle, or of another system, as indicated.
Super Elevation	The design vertical distance that the outer rail is set above the inner rail on a curve.
Support Bracket	An assembly that supports the conductor rail cover boards.
Switch or Point Detection	Checking of the position of the blades of a point/switch.
Switch Rail or Point	A tapered moveable rail, which diverts the wheel flanges to the desired track.
Switch Machine	A tapered rail that diverts the wheel flanges to the desired track.
Switchgear	Means Isolator Switches, Circuit Breakers, Interrupters, Cut-outs and other apparatus used for the operation, regulation and control of electrical circuits.
System	A configuration of hardware, people, or software subsystems that are integrated to perform a specific operational function or functions.
Systems Design	The process of defining the hardware and software architecture, components, modules, interfaces and data for a system to satisfy specified requirements.
Systems Integration Tests (SIT)	On-site tests performed by the Contractor to ensure that Project systems and facilities function properly together.
System Performance Tests (SPT)	Tests performed by the Contractor to prove the overall functionality and compliance with the overall System Technical Specifications
Terminal Station	Station, where turn back moves are normally made, at the beginning or end of the revenue section of track.
Testing	The process whereby the Contractor and the Customer verifies that components, equipment, subsystems, systems, and interfaces function as specified and interface safely and properly with each other.
Tie	
- Cross Tie	The transverse member of the track structure which is centered on the track and holds the rails in position and distributes the rail loads to the roadbed.
- Switch Tie	A transverse member of the track structure which functions as a cross tie but is longer and supports a crossover or turnout.
Touch potential	The voltage difference between earth and the running rail or low level negative conductors, arising from the traction return current flowing

	in the rails, which may be perceptible to the public when touching or boarding a train.
Track	
- Block Support (BS) Track	Pre-cast concrete blocks for rail support, embedded in track bed.
- Ballasted Track	Track laid on ballast. Track constructed of rail, ties, OTM, and ballast.
- Direct Fixation (DF) Track	Rails directly attached to a concrete surface through fasteners. Track constructed of rail and direct fixation rail fasteners attached to a concrete surface.
- Embedded Track	Track similar to DF track but with other materials such as asphalt added to bring the surface grade up close to the top of rail, allowing rubber tired road vehicles to operate easily along or across the track.
- Non-Ballasted Track	Track resiliently laid on a concrete base or cast within a slab. Also referred to as un-ballasted track, ballast less track, concreted track or track slab.
Track Bed	The track embedment or/and supporting medium.
- Non-Ballasted Track	Track resiliently laid on a concrete base or cast within a slab.
Track Circuit	A part of a track, insulated electrically from the rest of the track in order to be able to detect occupancy by an applied electrical circuit.
Track Isolation (a general term and not only related with rail isolation)	The electrical isolation between the running rail and the electrical ground required to prevent harmful levels of stray traction power current from damaging metallic structures.
Track Relay	A relay, which hands over information to the Interlocking Logic whether a certain section of track is free or occupied. The relay is an important part of the electrical separation of the running rails and the Interlocking Logic.
Tractive Effort	Propulsion or braking force developed by the vehicle.
Train Driver	The railway employees on board the train having direct and immediate control over the movement of the train.
Train Identification	A method of designating trains by means of such information as train number, destination, or length; may be accomplished automatically for functions such as routing or dispatching.
Train Line	A wire or cable that runs through the whole train set. Train lines are used for driver commands and other control functions e.g.; door commands. Train lines may also be used for power supply.

Train Speed	The "true" speed of the train, determined from the individual vehicle speeds of the train.
Transceiver	Combined Transmitter and Receiver equipment.
Trial Running Tests (TRT)	Tests performed by the Contractor with AM Operations staff to prove the overall functionality and compliance with the Operational system Performance Specifications.
Turn back Move	The reversal of the direction of a train at an interlocking.
Turnout	An arrangement of points and crossings with closure rails that permits trains to be diverted from one track to another.
Turn-Up	Activate system for the first time.
Vehicle	A functional carriage, complete with all component subsystem including without limitation the carriage body, bogies, inter vehicle components, access components, ventilation and air conditioning, traction equipment, auxiliary power equipment, primary power equipment, lighting, communications, fire and emergency equipment, as appropriate.
Vehicle Speed	The "true" speed of a vehicle, determined from the individual axle speeds of that car.
Wayside	Area between and adjacent to the tracks within the right-of-way.
Wiring Diagram	Also called connection diagram. Shows the connection (with in or among) an installation or equipment.
Withstand Capability	Rated capability of equipment to survive without damage the mechanical forces of a short circuit downstream from the equipment. Also the rated capability to withstand without damage for a short time a specified power frequency over voltage and/or a specified voltage surge or impulse.
Zero Thermal Stress Temperature	The temperature at which a string of continuous welded rail will have no stress in it due to thermal expansion or contraction.

ABBREVIATIONS:

μsec	Micro second
°C	Degree Celsius
A or Amp	Ampere
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
AC or ac	Alternating Current
ACI	American Concrete Institute
ACU	Air-Conditioning Unit
AFC	Automatic Fare Collection System
AG	Automatic Gates
AISI	American Iron and Steel Institute
AISC	American Institute of Steel Construction
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standard Institute
APSE	Auxiliary Power Supply Equipment
AREA	American Railway Engineering Association
ARS	Automatic Route Setting
AS	Australian Standards
ASC	Automatic Speed Control
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASS	Auxiliary Substation
ASTM	American Standard for Testing and Materials
ATC	Automatic Train Control
ATP	Automatic Train Protection
ATS	Automatic Train Supervision
AWG	America Wire Gauge
AWPA	American Wood Preserver's Association

AWS	American Welding Society
BER	Bit Error Rate
BGM	Back Ground Music
BIL	Basic Insulation Level
BIT	Built in Test Diagnostics
BPS	Bureau of Product Standards of the DTI of the Philippines
BS	British Standards
BSI	British Standard Institution
BWA	Balance Weight Assembly
CAN	National Standards of Canada
CAPEX	Capacity Expansion
CAS	Controller Access Software
CATC	Continuous Automatic Train Control
CBT	Computer-Based Training
CD ROM	Compact Disk Read Only Memory
CFC	Chloro Fluoro Carbon
cm^2	Square Centimeter
COTS	Commercial-Off-The-Shelf
CPM	Critical Path Method
CPS	Central Processor System
CSC	Contactless Smart Cards
CT	Current Transformer
CTI	Computer Telephony Integration
CWR	Continuous Welded Rail
DBA	Decibels (A Scale)
DC or dc	Direct Current

DCC	Depot Control Center
DFD	Detailed Final Design
DIN	Deutsches Institut fur Normung
DNP	Defects Notification Period
DOTC	Department of Transportation and Communications
DP	Double Pole
DPCS	Digital Protection Control System
DPWH	Department of Public Works and Highways
DVAS	Digital Voice Announcement System
EEPROM	Electrically Erasable Programmable Read Only Memory
EMC	Electro-Magnetic Compatibility
EMI	Electro Magnetic Interference
EPS	Environmental Policy Statement
ETFE	Ethylene Tetrafluoroethylene
ETI	Employer's Training Instructor
ETS	Emergency Trip System
EVA	Ethyl Vinyl Acetate
FACI	First Article Configuration Inspection
FAI	First Article Inspection
FAT	Factory Acceptance Tests
FCC	Federal Communications Commission
FDR	Final Design Review
FEM	Finite Element Model
FEP	Front End Processor
FIS	Fault Indication System
FRLSZH	Fire Retardant Low Smoke Zero Halogen

FMI	Field Modification Instruction
FRP	Fiber Reinforced Plastic
FTS	Final Time Schedule
g/m^2	Grams per meter squared
G5/3	Limits for Harmonics in the United Kingdom Electricity Supply System
GI	Galvanized Iron
GIS	Gas Insulated Switchgear
GLVS	General Low Voltage Switchgear
GPS	Global Positioning System
GUI	Graphical User Interface
HMI	Human Machine Interface
Hr	Hour
HSCB	High Speed Circuit Breaker
HHMA	Hand Held Magnetic Analyzers
HT	High Tension
Hz	Hertz
IEC	International Electromechanical Commission
IPC	Illustrated Parts Catalogs
IRJ	Insulated Rail Joints
ISO	International Organization for Standardization
IT	Installation Tests
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
JTC	Joint less Track Circuit

kA	Kilo Amperes
KD	Kiln Dried
kg	Kilogram
kgf	Kilogram force
km	Kilometer
km/h	Kilometers per hour
kPa	Kilo Pascals
kV	Kilovolt
kVa	Kilovolt Ampere
kVAR	Kilovolt Ampere Reactive
kVp	Kilovolt pulse (peak)
kW	Kilowatt
kWh	Kilowatt hour

L/R	Ratio of Inductance to Circuit Resistance
LAN	Local Area Network
LBS	Load Break Switch
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LLRU	Lowest Level Replaceable Unit
LMH	Light Maintenance Hall
LNB	Low Noise Block
LRTA	Light Rail Transit Authority
LRU	Line Replaceable Units
LRV	Light Rail Vehicle
LSZH	Low Smoke Zero Halogen
LT	Low Tension

LVPS	Low Voltage Power Supply
M	Meter
ms	Millisecond
m/s/s	Meters per second per second
m/s/s/s	Meters per second per second per second
MBCC	Microprocessor Based Communication Controller
MCB	Miniature Circuit Breaker
MCCB	Motor Controlled Circuit Breaker
MDBF	Mean Distance Between Failure
MDF	Main Distribution Frame
MDP	Main Distribution Panel
MDT	Maintainability Demonstration Testing
MIL-STD	United States of America's Department of Defense Military Standard
mm	Millimeter
MOV	Metal Oxide Varistor
MRT	Mass Rapid Transit
MRTS	Mass Rapid Transport System
MS	Mild Steel
MSDS	Material Safety Data Sheet
MSL	Mean Sea Level
MTBF	Mean Time Between Failure
MTBSF	Mean Time Between Service Failure
MTTR	Mean Time To Repair
mV	Millivolt
MVA	Mega Volt Ampere
MW	Megawatt

N	Newton
NC	Normally Closed
NDT	Non Destructive Tests
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NO	Normally Open
NTC	National Telecommunications Commission
NTP	Network Time Protocol
O&M	Operation and Maintenance
OCC	Operation's Control Center
OCS	Overhead Catenary System / Overhead Contact Wire System
OEM	Original Equipment Manufacturer
OIS	Operator Interface Software
ONAF	Oil-Immersed Forced Air Circulation Cooled
ONAN	Oil-Immersed Natural Air Circulation Cooled
OSB	Optical Synoptic Board
OSHA	Occupational Safety and Health Administration
OVPD	Over Voltage Protection Device
P.E.	Professional Engineer
PAB	Passenger Assistance Booth
PABX	Private Automatic Branch Exchange
PAM	Passenger Agent Machines
PAS	Public Address System
PCB	Polychlorinated Biphenyls
PCE	Power Conversion Equipment
PCU	Protection and Control Unit

PDM	Precedence Diagramming Method
PEC	Philippine Electrical Code
PECE	Power Electronics Control Equipment
PGL	Profile Grade Line
Ph	Phase
PHA	Passenger Handling Area
PLC	Programmable Logic Controller
PMD	Polarization Mode Dispersion
PNS	Philippine National Standards
PPE	Personal Protective Equipment
PRF	Pulse Repetition Frequency
PSB	Platform Supervisor's Booth
PSAT	Partial Stand Alone Tests
PT	Potential Transformer
PTU	Portable Test Unit
PVC	Polyvinyl Chloride
QRA	Qualified/Quantified Risk Assessment
RAMS	Reliability, Availability, Maintainability and Safety
RCC	Reinforced Cast Concrete
RDSO	Research Design Standards Organization
RDT	Reliability Demonstration Testing
RES	Radio Equipment and Systems
RF	Radio Frequency
RFI	Radio Frequency Interference
RIS	Rolling Stock Industrial Standard
RMS	Root Mean Square

RRSW	Running Rail Sectionalizing Switch
RSC	Rigid Steel Conduits
RSS	Rectifier Substation
RTU	Remote Terminal Units
s	Second
S/S	Substation
SAA	Standards Association of Australia
SAD	Silicon Avalanche Diode
SAP	Systems Assurance Plan
SAT	Stand Alone Tests
SCADA	Supervisory Control and Data Acquisition System
SCB	Shunt Capacitor Bank
SCC	Standards Council of Canada
SCR	Station Control Room
SDH	Synchronize Digital Hierarchy
SE	System Earth
SEM	Structural, Electrical and Mechanical Drawings
SF6 or SF_6	Sulphur Hexafluoride
SHRP	Strategic Highway Research Program
SIT	System Integration Tests
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, Inc.
SOT	Station Operational Tests
SPS	Station Processor System
SPS	Small Steel Parts
SPS	Standard Positioning Service
SPT	System Performance Tests
Sq m	Square meter

Sq mm	Square millimeter
SRD	Inductive Short Range Device
SRU	Shop Replacement Unit
SVT	Stored Value Ticket
TBF	Turnback Facilities
TC	Trailer Coach
TDS	Technical Data Sheets
TE	Track Earth
TEFC	Totally Enclosed Fan Cooled
TER	Telecommunication Equipment Rooms
THD	Total Harmonic Distortion
TMS	Train Management System
TNMS	Transmission Network Management System
TP	Triple Pole
TRS	Trunked Radio System
TRT	Trial Running Tests
TSIE	Ticket Sorting and Issuing Equipment
TSS	Traction Substation
TVSS	Transient Voltage Suppression System
UHF	Ultra High Frequency
UIC	International Union of Railway Standards
UL	Underwriter Laboratories
UPS	Uninterruptible Power Supply
UTC	Universal Time Coordinated
UTP	Unshielded Twisted Pair

V	Volt
VA	Volt Ampere
Vac	Voltage alternative current
Vdc	Voltage direct current
VAC	Ventilation and Air-Conditioning
VDO	Voice Data Outlets
VDU	Visual Display Unit
VT	Voltage Transformer
VVVF	Variable Voltage Variable Frequency
W0	Vehicle Tare Weight
W1	W0 + Seated Passenger
W2	W1 + 4 passenger/meter standee
W3	W1 + 7 passenger / meter standee
W4	W3 + dynamic load and safety margin
XLPE	Cross-linked polyethylene

APPENDIX B DEPOT CONTRACTOR'S SCOPE AND EPC SCOPE SPLIT IN DEPOT WORKS

The purpose of this Appendix is to identify the split of the JICA Scope and EPC Scope in depot in terms of location and work item.

LOCATION	ITEM	EPC Scope	DEPOT CONTRACTOR's Scope
All Areas	HV power	Complete Works EPC Scope	N/A
	LV power	Buildings/ Structure/ Equipment in EPC Scope	Building/ Structures/ Equipment in DEPOT CONTRACTOR's Scope
	Track Work	Complete Works including ballast and geotextile (if required) under ballast	Up to track formation level (Zapote=4.60, Baclaran=2.87) include track under drain system
	Traction Power Supply	Complete Works EPC Scope	Below formation level cable trough/ duct
	Overhead Catenary System	Complete Works, Overhead line, post, beam, cable and other all necessary facilities include above formation level cable duct. Layout design, quantity and acting load data of each types of OCS Foundation	Design and construction of OCS Foundation except for anchor bolt, anchoring material etc. Below formation level cable trough/ duct, manhole of cable trough/ duct and plinth
	Signaling System	All systems	Below formation level cable trough/ duct
	Communication System	All systems	Below formation level cable trough/ duct
	Lighting	In Building in EPC Scope	In Building in DEPOT CONTRACTOR's Scope
	Illumination Tower	N/A	In Depot area DEPOT CONTRACTOR's Scope
	Security Camera System	N/A	Zapote Depot and Baclaran Expansion Depot DEPOT CONTRACTOR's Scope, 2 standalone system
	Fire protection system	In Building in EPC Scope	Building and Depot External area in DEPOT CONTRACTOR's Scope
	Toilets	In Building in EPC Scope	In Building in DEPOT CONTRACTOR's Scope

LOCATION	ITEM	EPC Scope	DEPOT CONTRACTOR's Scope
	Water supplies	Building/ Structure Inside of EPC Scope	Building/ Structure/ Depot external area and Water tank include water pump in DEPOT CONTRACTOR's Scope
	Sewage	Building/ Structure Inside of EPC Scope	Building/ Depot external area and Waste Water treatment system in DEPOT CONTRACTOR's Scope
	Air-con units	In Building in EPC Scope	In Building in DEPOT CONTRACTOR's Scope
	Soil Improvement	Outside of Depot ROW except Zapote access road	Track area Inside of Depot ROW
	Reclamation/ Embankment	N/A	Inside of Depot ROW and Zapote access road to Depot and slope embankment area
	Rain water drainage	N/A	In Depot area DEPOT CONTRACTOR's Scope
	Cable trough/ duct	Above formation level	Below formation level (=F.L) ZAPOTE F.L=+4.60 Baclaran F.L=+2.87
	Level Crossing	N/A	In Depot area DEPOT CONTRACTOR's Scope
	Height Limit	N/A	In Depot area DEPOT CONTRACTOR's Scope
	Road network, Access Road	N/A	Entrance Access Road and Depot Internal Road area DEPOT CONTRACTOR's Scope

APPENDIX C INTERFACE IDENTIFICATION WITH EPC CONTRACTORS OR THIRD PARTY

The following Interface Matrix shows the most prominent interface points and for better understanding the interfaces between EPC contractors works or third party and DEPOT CONTRACTOR's works:

1. Civil Works

DEPOT CONTRACTOR's Works	EPC Contractors Works or third party						
	LV Distribution	750 VDC TPS	OCS	Relocation Utilities	Telecomm	Signaling	Track work
Cable Ducts	X	X		X	X	X	X
Cable Duct Manholes	X	X			X	X	
OCS Foundations		X	X			X	X
Drainage				X			X
Lighting Tower Foundation	X						X
Concrete Pavement			X				X
Level Crossings							X
LRV Unloading Area			X				X
Light Maintenance shop		X	X				X
Inspection Pit Light Maintenance Shop							X
Heavy Maintenance Workshop			X				X
Substation	X	X		X	X		
Automatic Train Wash Machine		X	X				X

2. Architectural Works

The following Interface Matrix shows the possible interface points but not limited to:

	Track work	OCS and/ or 750 VDC
Light Maintenance shop	X	X
Heavy Maintenance Workshop	X	
Automatic Train Wash Machine	X	X
Substation		X

3. Interface with Utilities

The following Interface Matrix shows the possible interface points but not limited to:

	With Third Party						EPC (Zapote Station only)		
	Power Supply 34.5 kVAC Manhole ROW close to substation	Existing Mainline for Fresh Water	Existing Drainage or Creek	Relocation Water (Baclaran only)	Relocation Waste water (Baclaran only)	Relocation Power Supply (Baclaran only)	Power Supply to Station	Fresh Water Supply to Station	Waste Water Discharge from Station
Substation	B						X		
Manhole Zapote Station only							X		
Civil Work				X	X	X	C	X	X
Water Supply System		A							
Waste Water Drainage System/ Water Treatment Plant			A						

A: Stubs

B: Provisions in our scope are manhole and ducts only

C: Cable Trough/ Duct and manhole for AUX Power supply for the Zapote Station and 750VC Traction Power are in the scope of EPC.

APPENDIX D INTERFACE AND LIAISON WITH LRMC

1. GENERAL

1.1. The Manila LRT1 will be under the possession, control and responsibility of the Light Rail Manila Corporation ("LRMC") in accordance with its Concession Agreement in relation to the Manila LRT1 Extension, Operations and Maintenance Project ("Concession Agreement") with DOTC and LRTA (together the "Grantors"). Access and use of the Manila LRT1 shall therefore be in full coordination and cooperation with the Employer, Engineer and LRMC as set out below.

1.2. The Contractor is required to complete its Works adjacent to the Manila LRT1 and to test, commission and demonstrate functionality of the Works using Manila LRT1 assets that are under the use and control of LRMC. The interfaces and liaison with LRMC for undertaking the Works are as set out below.

1.3. Employer and LRMC shall separately agree on necessary terms and conditions to enable LRMC to meet the obligations set out below.

2. COORDINATION WITH LRMC

2.1. The Contractor understands that the Works to be performed under this Contract is in connection with the Manila LRT1; existing system, existing depot and the Cavite extension and satellite depot ("Manila LRT1"), and that the Manila LRT1 will be operational and in use during the period in which the Works is performed. The Contractor shall not interfere with or disrupt revenue service of the Manila LRT1 or the use by LRMC of the Manila LRT1, its depot(s) or the control room except as may be agreed upon in writing among the Contractor, Employer and the LRMC.

2.2. The Employer will cause the LRMC to provide the Contractor with reasonable access to the Manila LRT1 and the depot(s) as reasonably required by the Contractor to fulfil its obligations under the Contract in accordance with the Approved Contract Schedule.

2.3. For all parts of the Works which require access to the Manila LRT1, the depot(s) or the control room in the depot(s) or which may cause interference or disruption to revenue service, a procedure shall be established among the Employer, LRMC and the Contractor to coordinate all aspects of the requirements of the Contractor for performing the Works with the requirements of LRMC for revenue service and for maintenance of the Manila LRT1. The Contractor shall within 60 days of the Commencement Date prepare its proposed LRMC coordination procedure and submit the same to Employer for review and approval by Employer and LRMC. If the submitted procedure is not acceptable, the parties shall meet to discuss same until an agreed procedure is established, at which time the agreed procedure will become the "Approved LRMC Coordination Procedure".

2.4. The Contractor shall minimize all interferences with and disruptions to revenue service and maintenance of the Manila LRT1. In addition, the Contractor 's access to some or all parts of the Manila LRT1 shall be subject always to operating conditions, restrictions and exigencies to be reasonably anticipated for an operating system which would preclude or limit, at any time or from time to time, such access. In respect of all interferences or disruptions other than those agreed to pursuant to the Approved LRMC Coordination Procedure, the Employer shall, after consultation with the Contractor, have the right without additional cost to direct a reasonable postponement of any date or time for the performance of any Works that would or might interfere with or disrupt Revenue Service of the Manila LRT1. The Employer and LRMC shall be entitled to require postponement of any Works which might disrupt or interfere with emergency maintenance or emergency work required on the Manila LRT1.

3. EMPLOYER SUPPLIED FACILITIES AND SERVICES

3.1. The Employer shall provide, or cause to be provided, the following facilities and services (the "Facilities and Services") to the Contractor, at no cost to the Contractor except where specifically noted otherwise:

(a) subject to coordination by the Contractor with LRMC pursuant to the Approved LRMC Coordination Procedure, reasonable access to and use (but not exclusive use) of:

(i) the area of land shown on the drawing "CMX-L1/DP-CI-01-0003" attached in Bid Document Part 2 Employer's Requirement Section VI-3 Drawings – Baclaran Depot Expansion Area, within the existing Baclaran Depot for the construction and completion of Works related to the Baclaran Depot expansion, and;

(ii) the area of land shown on the drawing "CMX-L1/DP-CI-01-0005" attached in Bid Document Part 2 Employer's Requirement Section VI-3 Drawings – Zapote (Satellite) Depot Area, adjacent to the manila LRT1 Cavite extension for the construction and completion of Works related to the Zapote (Satellite) Depot,

(iii) for the purposes of testing, commissioning and demonstrating the Works:

(1) existing track in the depot(s) for the Works during daytime hours;

(2) existing vehicle maintenance facilities in the depot(s);

(3) existing mainline track of the Manila LRT1 for the Works during night time hours when Revenue Service is not taking place, and;

(iv) appropriate generation(s) of Rolling Stock,

As reasonably required and provided that such does not unduly interfere with necessary operating and maintenance requirements of the LRMC for the Manila LRT1 and with the understanding that the above is not an all inclusive list and reasonable access may be requested to other areas as required to perform the Works;

(b) operating and maintenance personnel required to be provided by Employer pursuant to Clause 4.0 below.

3.2. The cost of permanent power and water which is consumed in testing and commissioning by the Contractor as part of the Works shall not be the responsibility of the Contractor.

3.3. The Contractor shall be responsible for all costs associated with the provision of temporary power and water necessary for undertaking the Works.

3.4. With reference to the provision of the area pursuant to Clause 3.1(a) above, the Contractor shall be responsible for all building facilities and site improvements as he may deem necessary. The Contractor shall be responsible for all costs for the use of utilities, ongoing maintenance, and security.

3.5. With reference to the provision of the area pursuant to Clause 3.1(a)(i) above, the Contractor shall be responsible for providing a secure fence separating the area provided from the remaining Baclaran Depot. Any access gates to be provided between this area and the remaining Baclaran Depot shall be only as agreed with LRMC and secured and managed in accordance with the Approved LRMC Coordination Procedure.

3.6. All of the Facilities and Services shall be provided or made available to the Contractor on an "as is" basis, without any representation by the Employer or LRMC as to the condition of the Facilities and Services, or their adequacy, suitability or fitness for the Works.

3.7. Without prejudice to the Contractor's duties and obligations under the Contract, the Contractor shall:

(a) use the Facilities and Services only for the purposes of the Works;

(b) provide all tools, special tools, equipment, temporary works, materials, consumables and expendables necessary for the Works;

(c) not add any equipment permanently affixed to any Facilities and Services, or add any equipment or remove any equipment to or from any Facilities and Services except where necessary for the Contractor to carry out its testing and commissioning activities, and the Contractor shall return the Facilities and Services upon completion of the testing and commissioning activities for which they are required by the Contractor, in the same or better condition, subject only to normal wear and tear, to that in which they were received, including with the Contractor removing or replacing, as applicable, all equipment that was installed or removed by the Contractor and repairing all damage caused by the installation and removal of such equipment;

(d) be and remain responsible at all times for the performance of the Works using the Facilities and Services, including the responsibility for the direction and monitoring of the Works with respect to the Facilities and Services.

3.8. The Contractor shall be responsible for and shall indemnify the Employer and LRMC for:

(a) subject to Clause 3.10 below, all loss, damage or destruction to the Facilities and Services caused by the Contractor 's use thereof, and;

(b) all liabilities arising out of the Contractor 's use of the Facilities and Services.

3.9. The Employer shall cause LRMC to provide operators to the Contractor for operating any Facilities, tools and equipment under the possession and control of LRMC that by collective or other agreement must be operated only by the LRMC-trained and qualified LRMC employees, provided however, and the Contractor agrees, that such operators shall work under the direction, supervision and control of the Contractor with respect to the Works while operating the special tools and special equipment of LRMC, including during transit to and from the area in which the Contractor requires such tools and equipment to be used, and the Contractor shall be as responsible for those operators while they are engaged in performing work for the Contractor in the same manner and to the same extent as if the operators were hired directly by the Contractor. The Contractor shall be solely responsible for the manner, method, quality, accuracy, sufficiency and timeliness of the work performed by the operators, as well as for any damage caused by the operators as a result of their following the directions or instructions of the Contractor;

3.10. The Contractor shall not be responsible for the costs of Employer or LRMC personnel provided to the Contractor pursuant to Clause 3.9 above.

3.11. The Contractor shall not be responsible for the cost of routine maintenance of the equipment provided pursuant to Clause 3.9 above.

3.12. The Contractor shall not be responsible for damage caused to the Facilities and Services to the extent that such damage is caused solely by:

(a) the LRMC's staff performing routine tasks which they normally perform for the Manila LRT1 without instruction or direction;

(b) recklessness, gross negligence, incompetence or willful misconduct of the LRMC's personnel; or

(c) an event of Force Majeure.

4. OPERATING AND MAINTENANCE PERSONNEL

4.1. In the performance of the Works:

(a) The Contractor shall provide all engineers and technicians for their scope required to perform all testing and commissioning activities for the Works;

(b) The Contractor shall not be responsible for providing the operating and maintenance personnel that Employer is responsible to provide pursuant to Clause 3.1 (b) of this Appendix;

(c) Employer shall cause LRMC to provide the following:

(i) Operations and Maintenance personnel is required for training in the operation and maintenance of the Works; and

(ii) Provided that the Contractor has provided the necessary training for the operation of the Works to be tested, from the time testing is authorized by the Employer to commence on the Manila LRT1, reasonable levels of appropriately trained operating personnel including, but not limited to, control center operators and train operators to perform those functions which because of LRMC's internal operating procedures and policies governing safety of the Manila LRT1 can only be performed by the LRMC's personnel.

Provided, however, that in all cases:

(a) such personnel shall work under the direction, supervision and control of the Contractor with respect to the Works and the Contractor shall be solely responsible for their acts, omissions and performance during such periods in the same manner and to the same extent as if such personnel were not engaged by or employees of LRMC or Employer but hired directly by the Contractor. The Contractor shall be solely responsible for the manner, method, quality, accuracy, sufficiency and timeliness of the work performed by such personnel, as well as for any damage caused by such personnel while acting under the direction of the Contractor;

(b) where such personnel are required to operate or maintain equipment supplied by the Contractor as part of the Works, the Contractor has provided the training necessary to operate or maintain the equipment;

5. TESTING AND COMMISSIONING

The Employer allow the LRMC to be part of the testing and certification process and provide for integrated testing of Depot Works based on Concession Agreement Section 13

5.1 Requirements for integrated testing

(a) The list below indicates the depot integrated testing of the rolling stock and equipment: required by the Depot Contractor:

i. Track structure clearances are checked

ii. Depot equipment are installed and tested

iii. Civil water flow tested

(b) The list below is required to be ready by the Depot Contractor before integration testing can commence:

i. All reinforced concrete structural works including roof, rooms halls, completed and the area is clean, dry and weather proof

ii. Utility ducts, cable shafts and basements, if any, completed and water tight. The area clear of all obstruction, debris and water

iii. Earth mats installed and tested

iv. Water proofing and screed to plant rooms completed (where required)

v. Partition walls completed, except those to be constructed after system's plant delivery

vi. Trenches, ducts,

vii. plinths, penetrations, access openings, grooves for concealed conduits, holding down anchors as per system requirements stated in the relevant interfacing control documents completed

viii. Cast-in items installed including multiple cable transit support framing and items required for systems' plant. In case required items not within the Depot Contractor's scope, he shall fully coordinate with the systems plant contractor;

ix. All cast-in facilities for the systems are installed and tested. In case required items not within the Depot Contractor's scope, he shall fully coordinate with the systems contractor;

x. Pipe connection to drain and temporary sump pumps in place for use until such time the permanent pumps are operational. The rain water discharge route to prevent flooding of the track bed during heavy downpour should be identified;

xi. False work, formwork and all other temporary works related to the structure removed;

xii. All areas accessible for system installation and all roads/ routes to Depot/ rooms/ track areas available;

xiii. Permanent depot perimeter fencing completed;

xiv. Cable bridges, cable trenches/ ducts and pits completed. Cable trenches and pits are to be kept dry;

xv. Construction of air compressed pipes trenches and cable troughs connections completed;

xvi. Hot dipped galvanized anchorage shall be used for post drilling on the external slab

xvii. Maintenance gangways;

xviii. Load of the equipment inside the building; and

xix. Installation of concrete base foundation for the equipment.

(c) The list below is required to be completed and ready for the equipment testing by the Depot Contractor before the depot integrated tests on the rolling stock and equipment;

i. Train washing machine

ii. Mobile lifting jack

iii. Re-railing equipment

iv. Shunting locomotive (Car mover)

Part 2. Employer's Requirements
Section VI-2 Technical Requirements
VI - 2 -2 Technical Specification

Civil Works and Maintenance Equipment for Depots

EMPLOYER'S REQUIREMENTS – TECHNICAL SPECIFICATION

TABLE OF CONTENTS

A. Preliminaries and General Requirements

1.0 Definitions and Abbreviations

Definitions and Abbreviations used in this Technical Specification is specified in "APPENDIX A DEFFINITIONS AND ABBREVIATIONS FOR DEPOT CONSTRUCTION PROJECT" of Bid Document Part 2 Employer's Requirements Section Ⅵ-2-1 General Specification or in this Technical Specification.

2.0 Standards

The Contractor shall comply with the standards and design criteria given in the Employer's Requirements Section Ⅵ-2-1 General Specifications and in this Technical Specification.
The Standards adopted in this project shall be a consistent set of standards that specifically apply to the manufacture, construction and testing of Depot Civil Works, Buildings, Structures, E & M and Maintenance Equipment.
The standards adopted shall be Japanese Standard, American Standard, Philippine Standard or internationally recognized Standards where equivalent with corresponding international standards and/ or specified standard in Bid Document Part 2 Employer's Requirements Section Ⅵ-2-1 General Specification or Section Ⅵ-2-2 Technical Specification.

3.0 Design Criteria and Concept

3.1 Depot Track Layout

Track gauge	: 1,435mm,
Rail Profile	: UIC 54
Turn out	: minimum ♯4,
Minimum horizontal curve radius	: 30m,
Minimum vertical curve radius (access to Depot/ Depot Expansion)	: 2,000m,
Max gradient at access to Depot and/ or Depot Expansion	: 4.0%,
Max gradient inside of Depot site	: 0.00%,
Gradient curve restriction	: 600/R,
Top of Rail elevation	
a) Zapote Satellite Depot : +5.200,	
b) Baclaran Expansion Depot : +3.473	
Minimum distance between tracks at stabling track	: 3.2m,
Minimum distance between track in the shop or workshop	: 5.3m,

3.2 Vehicle (4th Generation) Physical Characteristics

Vehicle body length (excluding coupler)	: max. 26,000mm,
Overall length	: max. 26,350mm,
Train length	: max. 107,000mm,
Overall width	: max. 2,590mm,
Overall height from top of rail	: max. 3,910mm,
Floor height	: max. 920mm,
Pantograph lock down height	: max. 3,950mm
Pantograph working range	: 4,300 – 6,000mm,
Wheel diameter	: 660 (new) - 600 (worn out) mm,
Wheel base	: max. 2,100mm,
Distance between bogie center	: equal or less than 10,000mm,
Vehicle tare weight	: MC: max. 37,400kg, M: max. 36,500kg,

3.3 Design Concept

The Baclaran Expansion Depot and Zapote Satellite Depot shall comprise buildings and depot facilities which shall have the maintenance capacity for 77 trains in the future (in 2035). This will include the existing section of Baclaran Depot. The existing Baclaran Depot have the

maintenance capacity of 40 trains. An additional 30 trains will be procured for the increasing demand. The train fleet is comprised of 3 types of trains 1st generation, 2nd generation and 3rd generation. The 1st generation trains are aged and 9 trains are planned to be retired. Therefore, 61 trains are the target maintenance capacity of this project.
Design of Depot Works shall be in accordance with the prevailing Philippine Standards Requirement.

The main buildings and maintenance capacity of each depots are:

Baclaran Expansion Depot	Light maintenance building with 3 tracks Heavy maintenance building with 2 tracks 13 stabling tracks for 13 trains
Zapote Satellite Depot	Light maintenance building with 2 tracks 9 stabling tracks for 18 trains

3.3.1 Baclaran Expansion Depot

The role of this depot is to supplement the existing depot, and maintenance of 3rd and 4th generation trains is possible with the assistance of existing depot facilities. (Please refer to drawing #CMX-L1/DP-CI-01-0003)

Buildings, plants and facilities of Baclaran Expansion Depot are:

a) Heavy maintenance building with maintenance staff rooms;
b) Workshop track: Workshop track shall have common use with the existing track of Baclaran Depot;
c) Lead track: Lead track shall be provided for shunting trains in the new stabling yard and maintenance tracks;
d) Light maintenance building;
e) Three tracks with catenary, platform and roof walk board shall be constructed complete for regular light maintenance and emergency maintenance. As for the emergency, maintenance including exchange of air conditioner or pantograph, this work shall be done in existing depot where a crane is available;
f) Material Storage for maintenance tools and spare parts;
g) Waste Material Storage and Hazardous Material Storage;
h) Motor pool building: The existing motor pool building shall be demolished and removed to allow for the new tracks or building. Therefore, new motor pool building shall be constructed for existing shunting cars and for new cars;
i) Substation;
j) Gate House and entrance gate;
k) Switch Room;
l) Infrastructure Maintenance Equipment Storage;
m) Road and Car parking;
n) Level crossing;
o) Water supply system for expansion Depot;
p) Fire Protection System for expansion Depot;
q) Rain Water Drainage System including track under drain;
r) Domestic/ Industrial Waste water treatment system for expansion Depot;
s) Cable Trough/ Duct, Pit, Plinth for Power, Signal, Telecom Line distribution;
t) Design and Construction of OCS Foundation;
u) Illumination Towers;
v) Security Camera System for Expansion Depot Area;
w) Height Limit;
x) Perimeter fence and light for the part where it does not currently exist;
y) Landscaping;
z) Automatic car washing plant will not be constructed, and all trains shall be washed in existing automatic car wash plant.

aa) Manual train cleaning deck will not be constructed in expansion Depot. Because the work is done in light maintenance track in existing Depot, and same system will be done.

3.3.1.1 Heavy Maintenance Workshop

The Contractor shall provide a building for heavy maintenance of rolling stock for 3rd and 4th generation train in Baclaran Expansion Depot which comprises facilities for inspections, repairs, refurbishment, component overhaul, offices, toilets, locker and shower rooms, and building services. (Please refer to drawing #CMX-L1/DP-AR-01-0001 to 0003)

a) Trainset accommodation
The heavy maintenance building shall have two tracks for 4 cars.

b) Heavy Maintenance Workshop tracks
The length of heavy maintenance tracks is for 2 cars, each track provides center pit and lifting jacks for one car. In this building overhead cranes are installed and no catenary is provided. Cars are moved using car mover.

c) The Heavy Maintenance Workshop shall consist of the following facilities:

i. Center pit (between rails) shall be 1.7 m depth and length is approximately 32m including both side stairs.
ii. Two (2) Overhead cranes of 10/3 ton capacity shall be provided, and the cranes shall cover almost whole length of the building. The crane capacity shall be enough to hoist a bogie completely.
iii. Lifting Jacks shall be provided at half sections of a heavy maintenance track. A total of 16 jacks shall be provided (8 jacks for each car).
iv. 2 additional tracks for bogie movement shall be provided with 4 bogie turn tables.
v. A bogie wash booth shall be provided.

d) Workshops for components
In the building, several workshops for components are arranged as follows:

i. Bogie workshop for disassembling/assembling bogies which includes bogie wash booth and bogie stand shall be provided.
ii. Wheel and axle box workshop which includes wheel lathe and universal machine.
iii. Motor and door machine workshop where pantograph shall also be repaired.
iv. Air conditioner shop which includes test room for checking air conditioner's performance.
v. Workshop for air brake system where Air compressors can also be repaired.
vi. Workshop for electric components such as relays, circuit breakers and contactors
vii. Compressor room

3.3.1.2 Light Maintenance Shop

The Contractor shall provide a building for light maintenance of rolling stock. (Please refer to drawing #CMX-L1/DP-CI-01-0003)

a) Trainset accommodation
b) Light maintenance building shall have three tracks for 4-car trains.

The length of the track is approximately 125 m, which shall facilitate 4-car train. These maintenance tracks shall consist of center and side pit, platforms on both sides, board walk at roof level, and catenary. In this building, regular (light) maintenance and emergency repair will be carried out. When emergency repair which needs the handling of heavy components becomes necessary, that work shall be done at existing depot track with crane.

a) Depth of center and side pit is 1.7 m
b) Height of platform is 0.9 m above top of rail.
c) Height of board walk is 3.36 m above top of rail.

Before or after the heavy maintenance, inspection of train performance as one train set shall be necessary. The inspection will be carried out in this light maintenance track or in the heavy maintenance track of the existing depot (track #10 of existing depot)

3.3.2 Zapote Satellite Depot

The role of Zapote Satellite Depot is for ancillary services for existing depot, and light maintenance of trains are possible with the assistance of existing depot facilities. Buildings, plant and facilities of Zapote Satellite Depot shall consist of the following. (Please refer to drawing #CMX-L1/DP-CI-01-0005):

a) Light maintenance building with maintenance staff rooms: Two tracks with catenary, platform and roof walk board shall be prepared. Regular light and emergency maintenance shall be performed in this area. As for emergency maintenance including exchange of air conditioner or pantograph, the work shall be undertaken in the existing Baclaran Depot where a crane is available;
b) Workshop track: Two workshop tracks shall be provided for connecting Zapote station and depot yard;
c) Lead track: Lead track shall be provided for shunting trains in the depot yard;
d) Automatic train wash plant;
e) Working deck for the use of manual car cleaning;
f) Material Storage for maintenance tools and spare parts;
g) Waste Material Storage, Hazardous Material Storage and Oil Storage etc.
h) Substation;
i) Gate House and entrance gate;
j) Pump Room for Water Tank;
k) Switch Room;
l) Road and Car parking;
m) Level crossing;
n) Water supply system include water tank;
o) Fire Protection System;
p) Rain Water Drainage System including track under drain;
q) Domestic/ Industrial Waste Water Treatment System;
r) Cable Trough/ Duct, Pit, Plinth for Power, Signal, Telecom. Line distribution;
s) Design and Construction of OCS Foundation;
t) Illumination Towers;
u) Security Camera System;
v) Height Limit Gantries;
w) Perimeter fence and light;
x) Landscaping; and
y) Depot Entrance Access Road and necessary facilities.

3.3.2.1 Light Maintenance Shop

The Contractor shall provide a building for light maintenance of rolling stock in Zapote Satellite Depot. (Please refer to drawing #CMX-L1/DP-AR-01-0006 to 0007) The light maintenance shop shall consist of two (2) maintenance tracks for accommodation of 4-car trains. The length of each track shall be approximately 125 m long to facilitate the 4-car trains.

The maintenance tracks shall be completed with the following items:

a) Center and side pits with a depth of 1.7 m;
b) Platforms on both sides with the height of the platforms at 0.9 m above top of rail; and
c) Board walks for access to train roof level and catenary with the height of the board walks at 3.36 m above top of rail.

Within the light maintenance shop regular (light) maintenance and emergency repairs will be carried out. When emergency repairs requires handling of heavy components, such works shall be performed at the Existing Baclaran Depot Workshop.

4.0 Interface

There are design and construction works which require close coordination with third parties (Utility Provider, Concessionaire, EPC contractor etc.). Effective coordination with the various manufacturing units of the third parties shall assure that the interface related works are executed so that contract delivery schedules can be met.

Despite the relatively simple scope of works, interfaces between the present contractors, EPC and the Utilities represents a degree of organizational complexity.

Of critical importance to avoid delay to construction is coordination to ensure that the necessary inputs of the E&M and rail systems are provided to the Civil Works Design Team.

The detail of interface and liaison with LRMC (Concessionaire) shall refer to the Bid Document Part 2 Employer's Requirement Section VI-2-1 General Specification Appendix D "Interface and Liaison with LRMC"

4.1 Interface Management Plan

To achieve accurate and efficient interfaces, an Interface Management Plans (IMP) will be required to be developed, which shall include all concerned parties and correctly implemented Interface Management will be the key to the success of this project.

The IMP is a document that formalizes an agreement between two (2) or more organizations that are developing interface components of a system. Typically, IMP addresses the following:

a) Identification of interface requirements, i.e. Scope of Works, Design Development, Integration requirements, Installation requirements, Testing & Commissioning requirements;
b) Identification of sub-systems and sub-systems components that require interfacing;
c) Assignment of responsibilities and authorities;
d) Provide a platform for precise accurate information to be exchanged; and
e) Indication of requirements for coordination of civil works, structural works and other facilities associated with the interface.

4.2 Interface Stakeholders

The Contractor shall interface and liaise with his Subcontractors, the Concessionaire and the designated Contractor performing works under the EPC Concessionaires Agreement (EPC Contractor) as well as with other entities.

Effective coordination with the various manufacturing units of third parties shall assure that the interface related works are executed so that contract delivery schedules can be met.

4.3 Description of the Technical Interfaces

4.3.1 Interface with Rolling Stock

All construction work in the Zapote Satellite Depot and Baclaran Expansion Depot must be carried out to meet the requirements of the structure gauge to accommodate the 3rd and 4th Generation LRV's in the depot area.

4.3.2 Utilities – Fire/Fresh Water Supply and Waste Water Drainage

The Contractor shall be responsible for the coordination of the connection for the Fire/ Fresh Water Supply and Waste Water Drainage with the existing utility provider and Concessionaire (LRMC).

4.3.3 Utilities – Electrical Power

Power supply including transformers and Distribution Switch gear located in the Substation is in the scope of EPC Contractor.

4.4 Technical Interfaces due to Depot Contractor's Scope with EPC

4.4.1 Civil Works

The demarcation line for Civil Works is basically at the top of the sub ballast (top of the embankment work below the ballast) and the scope includes the drainage work; the Facilities to be built include the maintenance shop, Automatic Train Wash Plant and Water treatment Plant.

a) Cable troughs, Ducts below of formation level, Plinth and Manholes for Signalling Cable, Traction Power, OCS Cables and Aux Power are subject of this present scope. Please see annexed drawing for Baclaran Expansion Depot and Zapote Satellite Depot.

b) The interface point for external (existing Signaling System, Telephone System) fibre optic cables shall be defined during the detail design phase.

c) Services for Buildings provided by EPC shall interface with a Manhole to access the cabling Aux Power Supply and others.

d) The buildings under this contract shall have risers for the TEL and DATA cabling. Cable trays in substation and within the false ceiling are NOT in the scope of this contract.

e) Design and construction of OCS Foundation is Depot Contractors scope. Supply of OCS layout detail, quantity and acting load of each types of OCS Foundations are EPC Contractors scope. Material supply and installation of anchor bolt, anchoring and other associated material are EPC Contractors scope.

4.4.2 Track Work

Areas of interface with the EPC contractor for the Track work will be at Zapote Satellite Depot Light Maintenance Shop and in Baclaran Expansion Depot Heavy Maintenance workshop, road crossings, loading and unloading zone in the Baclaran Expansion Depot, as well as in Zapote Satellite Depot Automatic Train Wash Plant. It is foreseen, that the Tracks will be embedded directly fixed in a concrete bed

4.4.3 Low Voltage Works Interfaces with EPC

a) Power Source LV Distribution
The demarcation line shall be between the Substation and the Switch Room. The Contractor shall be responsible for the cable to the main isolator in the substation and the feeder breakers downstream, located in the switch room. Hence the interface to the Power supply shall be at the Output of the Main Isolation Breaker. The Contractor shall be responsible for the breakers located in the switch room, the cables, necessary to power the equipment and facilities.

b) Earthing and Lightning Protection
The Earthing concept to integrate MV Power Supply, Traction power supply 750 VDC, Aux Power Supply (Protection Earth) and COM Earth (clean Earth) in the Depot Area of the Baclaran Expansion Depot and the Zapote Satellite Depot shall be prepared by the EPC.
The overall responsibility for power supply shall be with EPC
Earthing: Provision of individual earth mat and an individual pigtail for a clean and protection earth shall be included. The demarcation line for the works shall be the pigtails in case of interface with third parties
Technical equipment rooms shall be equipped with a copper bus bar, separately installed for each clean and protection earth.
Substation, Automatic train wash plant and Light Maintenance shop shall be included in earthing concept provided by EPC.

i. Way side signalling and OCS equipment. These provisions are in the scope of EPC
ii. Lightning Protection System. The demarcation line for the works shall be the pigtails connected to the protection earth mat in case of interface with third parties.

c) Fire Alarm System

A standard TCP-IP based hardware communication interface shall be provided at the main fire alarm panel to enable the connection with a system wide Fire Alarm system.

Fire Alarm and Detection System shall be integrated with the existing Baclaran Depot Fire Detection and Alarm System and coordinated with the Concessionaire.

d) Local control Panels

The Local Control panel of the Lighting Towers, Automatic Train Wash Plant and Water Treatment Plant shall be equipped with a PLC with standard TCP-IP based hardware communication interface to enable the connection with a system wide control system. The design shall provide a detailed description.

e) Security Cameras

The scope includes 2 standalone Systems to be installed in Zapote and Baclaran Expansion Depot
A standard TCP-IP based hardware interface shall be provided at both locations to enable the connection with a system wide CCTV system. The design shall provide a detailed description of the functionality for interfacing.
Playback, a hardware device shall be provided at HMI in the equipment room.

4.5 Depot Area Layout Drawings

The scope shall include common drawings for the Zapote Satellite Depot Area and the Baclaran Expansion Depot Area for the coordination with others (SIG, COM OCS providers)

a) SIG Layout for SIG system related cables including signals, switch machines and track occupancy detection equipment shall be provided by EPC.
b) The interface point with signalling cables (EPC scope) are the manholes and main cable troughs, which are under Depot Contractor's scope. Surface cable ducts are excluded from this scope.
c) OCS Layout including the position of foundations for catenary poles and the foundations for Anchor blocks to be provided by EPC. The Design and Construction of OCS and Anchor foundation are included in this scope.
d) Layout for 750 VDC Traction Power including routing of the cables for OCS and negative return cables, Circuit Breakers and others shall be provided by EPC. The interface point with these cables (EPC) are the manholes and main cable troughs (Depot Contractor's scope)
e) 480 VAC Aux Power Layout for facilities provided by EPC including routing shall be provided by EPC. The interface points shall be the manhole (Depot Contractor's scope), where the transition to the surface cable duct is made. Surface cable ducts are excluded from this scope.

4.6 Interface Identification with the Scope of EPC Contractors

The major Interface items between Depot Contractor and EPC Contractor is shown in Part 2. Employer's Requirements Section VI-2-1 General Specification APPENDIX C "INTERFACE IDENTIFICATION WITH EPC CONTRACTORS OR THIRD PARTY":

5.0 Temporary Works

5.1 Plant, Tools and Scaffolding

a) The Contractor shall provide and maintain in good working order all necessary mechanical equipment, tools, ladders, plant, tarpaulins and any other articles required for the works. The Contractor shall also erect and maintain all necessary screens, gates, footways, hoardings, fans, temporary enclosures, barriers, etc., to the satisfaction of the Engineer and the representative of the Employer and remove them, on completion of the Works and make good all works, disturbed during erection and after their removal.

b) The Contractor shall erect, maintain, and alter if necessary, all necessary scaffolding and strutting that may be required during the course of the works to the satisfaction of the Engineer and the representative of the Employer and remove the same on completion.

c) The Contractor shall erect and maintain suitable and safe ladders and gangways for the Engineer and the representative of the Employer to inspect thoroughly any portion of the works, with complete safety.

d) Should the capacity of plant provided prove insufficient to maintain satisfactory progress, the Engineer may instruct the Contractor to supply such additional plant including that of Subcontractors as may be necessary at the Contractor's expense.

5.2 Temporary Support

a) The Contractor shall provide all necessary scaffolding, shoring, propping and strutting for the support of the works under construction. All scaffolding, shoring, propping and strutting shall be designed by the Contractor to the approval of the Engineer and the Applicable Authorities. The Contractor shall be responsible for the safety, throughout the period of the Works, and no approval or disapproval of such scaffolding, shoring, propping and strutting by the Engineer shall be interpreted, as in any way reducing the Contractor's responsibility in this respect.

b) Should the Engineer not approve the Contractor's design proposals then the Engineer may subsequently provide drawings detailing their requirements and if the Engineer obtains the approval of the Applicable Authority to their proposal, the Contractor shall construct the scaffolding, shoring, propping and strutting in accordance with such drawings at no extra cost.

c) These conditions shall also apply to the temporary works of all Subcontractors.

5.3 Contractor's Storage Sheds, Workshops and Offices

a) The Contractor shall provide and erect sheds, workshops and offices (including adequate office along with necessary furniture for the use of their authorized representative) of suitable construction for the storage of such materials as they may require and maintain them and keep them in good order to the satisfaction of the Engineer's Requirements.

b) Separate Inflammable Goods Storage Sheds in an approved location must be provided. No inflammable goods such as oil based, etc., paints, kerosene, thinners, cellulose lacquers, and bitumen or bitumen based products, etc., will be permitted to be stored in the building under construction.

c) Materials may be stored in completed sections of the works provided that no section of the structure is loaded in excess of the design loading and no hindrance is caused to the progress of the Works or access thereto or to partial completion of Works where this is required.

d) The shed, workshops and offices are to be removed on completion of the works and the sites made good.

e) The Contractor shall submit details of proposed storage load to the Engineer for approval before materials are stored in completed sections of the works and shall erect all necessary temporary propping for the support of the structure during the period of storage.

5.4 Offices for the Employer and the Engineer

a) The Contractor shall provide and maintain office space big enough for 4 tables of the Employers and the same space for 4 tables for Engineers for the use at field offices. The office shall include A/C, lighting and telephones at the Contractors Site Office located at Baclaran Expansion Depot and Zapote Satellite Depot.

b) The Contractor shall also provide adequate facilities and internet services for the use of the Employer/Engineer and their staff, in addition to the staff of all Subcontractors and suppliers. Adequate cell phones shall be provided until and wherever land lines are not available.

c) The Contractor shall provide adequate safety facilities, personal protective equipment for The Employer and The Engineer and for their staff at the site.

d) The contractor shall provide transportation for The Employer and for their staff between their Manila office and Depot sites and to the necessary places for inspection, testing etc.

e) The costs of all water, electricity telephone and internet services charges incurred in the office of the Engineer provided by the Contractor, shall be borne by the Contractor.

f) These office space shall be available in full working order to the satisfaction of the Engineer within sixty (60) days period from receipt of Notice to Proceed (NTP). These facilities shall be fully maintained, including provision of all consumables, and remain on Site until one (1) month after the Completion of the Whole of the Works.

g) The Contractor shall retain on the Site for the exclusive use of the Engineer all codes and standards referred to in the specifications, which shall remain in the custody of the Engineer for their exclusive use until the completion of the Whole of the Works but shall remain the property of the Contractor.

h) The Contractor shall also provide the Engineer and theirs staff with daily cleaning attendance for the office space with one attendant for serving refreshments, etc.

i) In the event that adequate municipal electric power is not available at the location of the field offices, the Contractor shall provide a generator and a backup generator capable to supply sufficient power to the offices at full load.

j) The Contractor shall employ security for the safety at the Site.

5.5 Temporary Toilets (Latrines)

a) The Contractor shall provide and maintain the required sanitary toilet for the use of the male and female labor employed on the works, Contractors staff and Employer/Engineer and their staff. The Contractor shall keep the whole of the site and buildings in a clean and sanitary condition to the satisfaction of the Engineer. The Contractor shall remove all of them on completion of the project and ensure that the site is made good.

b) The toilets must be cleaned daily. The attention of the Contractor is specifically drawn to the fact that he must instruct his workers and staff in addition to those of the Subcontractors, to use the temporary toilets provided and forbid them from urinating on the walls and floors of existing buildings and structures under construction which shall attract penalty and instant dismissal. The Contractor is advised that there are no existing municipal sewers within the vicinity of the site and the use of chemical latrine or toilet facilities should be considered.

5.6 Temporary Accommodation

The Contractor shall submit to the Engineer for approval, proposals for the location of all site office, temporary toilets (latrines), shed, etc. After receiving approval from the Engineer, the Contractor shall submit the proposals with the required form to the Applicable Authorities for permit if required. The Contractor shall not be entitled to any extension of time by reason of any delay on the part of any Applicable Authority in granting such permit.

5.7 Water, Temporary Lighting and Power for the Works

a) The Contractor shall allow for the provision of water for the execution of all the works, including any temporary pumping and storage. The Contractor shall remove the same after the completion of the Works, and the payment of all fees and charges.

b) The Contractor shall allow for supplying all temporary lighting and power necessary for carrying out the works including supplying and fixing all temporary wiring and accessories required, removing all temporary installation and making good all works disturbed, on completion of the works.

c) The level of lighting shall be adequate for safety, routine inspections and detailed inspections as the work proceeds and appropriate for the construction of the works, in progress.

d) The Engineer may instruct the Contractor to increase the amount of temporary lighting if in the Engineer's opinion the lack of sufficient lighting is affecting the quality of the installed works.

e) The whole of temporary installation is to comply with the latest edition of the Philippine Electrical Code and requirements of other relevant Authorities.

5.8 Temporary Roads

a) The Contractor shall provide such temporary roads or platforms as may be necessary for the proper execution of the works for their own use and convenience, in addition to the use and convenience of other nominated Contractors or Subcontractors employed on the Site.

b) The alignment and construction of any temporary roads or platforms within the Site shall be subject to approval by the Engineer. The temporary roads and platforms, including all their temporary structural members, strutting, etc., shall be removed on completion of the work and the Contractor shall ensure that the works and the site are made good after the removal of the same.

5.9 Hoarding and Fencing

The Contractor shall allow for providing and maintaining hoarding as needed and as instructed by the Engineer to the satisfaction of the authorities and/or the Engineer, and any dismantling and re-erection, including additional hoarding, as required, to suit the site conditions, during the progress of the works.

5.10 Signboard

a) The signboards showing the project and contract details shall be provided and erected by the Contractor at locations determined by the Employer;

b) No advertising notice boards of any kind shall be erected on the Site without the prior consent of the Engineer in writing. The proposed advertising board design, if any, shall be submitted to the Engineer for approval, well in advance of its intended erection; and

c) The signboards shall be maintained and kept in good condition by the Contractor.

6.0 Site Surveying

6.1 Scope of Works

The Scope of Works shall include, but shall not be limited to the following:

a) Providing qualified survey crews and team leader, necessary for the survey works undertaken by the Contractor and also to provide them to the Engineer, as and when required;
b) Undertaking "Existing Condition Surveys" of Buildings;
c) Undertaking all necessary surveys for The Contractors Design and Build Works of Civil works, Building Works and maintenance Equipment Works etc. if required;
d) Undertaking "As Built Surveys" of the completed Works;
e) Undertaking all construction and related surveys to the layout of the Works to control lines, levels and grades and to record the amount of Works performed; and
f) Monitor the existing LRTA structures, adjacent structures and utilities, for settlement and movement.

6.2 Definitions

a) "Original Surface" means the surface of the ground before any work has been carried out.
b) "Final surface" means the surface indicated in the Drawings to which construction is to be carried out.
c) "Commencing Surface" means, the surface of the ground, before any item of work, covered by a particular item, has been carried out.
d) "Excavated Surface" means, the surface to which excavation is to be carried out under a particular items. In relation to filling work, the excavated surface shall mean the ground level from which filling will commence (after topsoil removal and clearing and grubbing).

6.3 Quality Assurance

Each team crew shall be directed by a suitably-qualified Engineer or team leader, who shall be competent in the English language.
Surveys shall be conducted in accordance with the DPWH Design Guidelines, Criteria and Standards Vol. 1 Part 1: Survey and Investigation, Chapter 2.

6.4 Tolerances

Allowable error in profile levels between consecutive benchmarks shall not exceed 1 in 90,000.

6.5 Survey Program

Prior to construction, the Contractor shall develop and submit to the Engineer an overall survey program clearly showing where the surveys will be performed, along with the coordinates and elevation data for all benchmarks. Such program shall include a description of all survey work to be performed and, in particular, include the survey requirements, and shall be in conformity with this Technical Specifications. The program shall also include the name and qualifications of all party chiefs (team leaders) responsible for directing the survey work. This program shall be approved by the Engineer before the field work is implemented.
Topographical survey data is included in the Bid Documents, Section VI-4 Supplemental Information for reference.

6.6 Drawings and Survey Reports

Shall be prepared according to good Engineering practices and professional standards.

6.7 Execution

a) Preservation of Reference Marks

The Contractor shall be responsible for preserving all supplied benchmarks. If the benchmarks are destroyed or disturbed the Contractor shall replace them to the original condition.

b) Field Surveys

The Engineer will issue to the Contractor prior to Construction the necessary documentation and benchmarks for the Contract. The Contractor shall be responsible or field survey verification of all survey control stations within and adjacent to the Right of Way. The field survey verification shall be conducted in accordance with procedures approved by the Engineer.

The Contractor shall lay out the work in accordance with the lines and grades shown on the Drawings.

i. Readings for the levelling shall be taken at each station, at all breaks in the ground, and at critical points, for the purpose of drawing of profiles.
ii. Benchmarks shall be established by the Contractor, at the beginning of work and further at every 500 meters or part thereof, until the end of the Works. Check levels shall be run over the entire lines.
iii. All readings at ground points shall be taken to the nearest 10 mm, while those on turning points and benchmarks shall be taken to the nearest millimetre. Allowable error in profile levels between consecutive benchmarks in millimetres shall not exceed 1 in 90,000.
iv. The Contractor shall establish all slopes, grades, cut and fill lines and rough grade elevations from the benchmarks provided.

c) Existing Conditions Survey

i. This survey shall be based on "Commencing Surface" after stripping and grubbing has been performed.
ii. The levels and positions of the existing structures, adjacent structures and utilities, shall be recorded.
iii. The Contractor shall submit his proposals for the positioning of monitoring points and details of the required instruments to the Engineer for his approval before works are commenced.
iv. The Contractor shall locate settlement points to suit the site conditions and structural form.
v. Longitudinal Level, Cross Level, Vertical and Horizontal Alignment shall be checked and monitored continuously on the proposed structures over the existing LRT structures.
vi. Three copies of each set of readings shall be submitted to the Engineer, promptly.

d) Settlement and Damage to Adjacent Structures, Utilities and Rail Tracks

Should the following criteria be exceeded for any structure or critical utility adjacent to the works then the Contractor shall stop work in the affected area immediately and submit proposals to the Engineer to limit further movement or development:

i. 50 mm total settlement from commencement of the works,
ii. 5 mm of settlement per day, and
iii. Rotation or distortion of 1:1000.

The Engineer’s approval shall be required before work can re-commence.

e) Quantity Survey

i. The Engineer's approval shall be required for all surveys necessary for determining the quantities of work or damage for payment.
ii. During the progress of the “Existing Conditions Survey”, the Contractor shall prepare ground profile and cross section drawings, and make calculations necessary to determine the quantities of work progress, and shall submit the drawings and calculations to the Engineer for review and check.
iii. This contract is Design and Build scheme, different as Bill of Quantity scheme, therefore the result of quantity survey is used to determine monthly progress in percentage (%) for each work item.

f) Building Condition Survey Form

The following form shall be used for the execution of Existing Condition Survey and Monitoring Survey.

Building Condition Survey Form

Building Control No.:	Survey Date:
Construction Contract No.:	
Address:	
Number of Stories:	Number of Basement Levels:

Type of Structure:	**Type of Foundation:**
□ Timber	□ Footing
□ Brick	□ Mat Foundation
□ Timber and Brick	□ Pile Foundation
□ Strengthened Brick	
□ Reinforced Concrete	
□ Steel	
□ Light Steel Frame	
□ Others	

Building Envelope	**Material & Specification**	**Remarks**
Roof Covering		
Roof Structure		
Floor Structure		
Exterior Walls		
Finishes	**Material**	**Remarks**
Partitions		
Ceiling		
Floor		
Door &Window		
Mechanical System	**Material & Specification**	**Remarks**
Central air-conditioning		
Elevator		
Escalator		
Generator Room		
Roof : 1.Machine room 2.Cooling Water Tower		
Others :		
Check for Plumbness :		
Projecting Signboards :		

Contractor: _____ Owner: _____

7.0 Geological Investigation

7.1 Scope

The Work shall include, carrying out of all geological site investigations, checking of obstacles and public utilities and presentation of all field data in a Report.

In the event that the Contractor adjudges that existing soil investigation results are not enough as provided by the Employer within the Bid Documents, Section VI-4 Supplemental Information, exploratory drilling shall be carried out to verify the details of supporting soil strata at specific locations by the Contractor. The Contractor shall ensure safety of any excavation works, and to conduct tests in order to verify the design of spread foundation, pile foundation and any temporary supports.

The Contractor shall undertake underground utility survey, especially at Baclaran Expansion Depot Area large underground 2-box culverts run through the depot. . (Please refer to Bid Document Part 2, Section VI-4 – Supplemental Information -)
The result of the survey shall reflect the Contractors design of Civil and Building works, if necessary reflect road and buildings layout plan.

Underground utility survey also shall be done by the Contractor to check existence of unforeseen obstacles underground. In case of any relocation of existing utilities is required, the Contractor shall ensure smooth construction of their Design and Build Work.

The time and priority of completion of all geological investigations, including drilling, conducting standard penetration tests and reporting shall be determined by the Engineer.

7.2 Execution Control

a) Supervision of Investigation
The Contractor shall provide one technical person, a Geological Engineer, to supervise the geological investigation works.

b) Reporting of Results.
The Contractor shall prepare and submit the report of investigated results and data to the Engineer.

7.3 Submittals

The Contractor shall submit to the Engineer for review and approval the items listed herein. Submittals shall meet the requirements and be in quantities specified in **Sub-Clause 9.6** of Part 2 Employer's Requirements - General Specifications.

Before commencing Work, the Contractor shall submit a program comprising of:

a) Locations and planned time and duration of geological investigation,
b) Method of carrying out the work.
c) Outline of equipment to be employed in performing this work.

B. Civil Engineering Works

1.0 Drawings, Sample and Other Submittals

1.1 Shop and Working Drawings

1.1.1 Scale and Measurements

The Contractor shall prepare all drawings accurately to a scale sufficiently large enough to show all pertinent aspects of the item depicted and its relation to the overall Work.

1.1.2 Type of Prints Required

The Contractor shall submit one negative of all Drawings on stabilized film one for each sheet in addition to the required number of prints of each sheet.

1.1.3 Review of Drawings and Reproduction

Unless otherwise specified elsewhere in the Specifications the Contractor shall submit drawings of any part of the Works to the Engineer for their approval prior to the commencement of the work as detailed in the shop drawings, in accordance with the following:

a)	Concrete work	:	28 days
b)	Structural steel work	:	56 days
c)	Utility work	:	56 days
d)	Building work	:	28 days

The review comments of the Engineer will be communicated along with the negatives or prints when the negatives or prints are returned to the Contractor. The Contractor shall produce and distribute the required copies of the drawings after incorporation of the comments.

1.2 Manufacturer's Literature

1.2.1 General

Whenever contents of submitted literature from manufacturers would include data not pertinent to the submittal, the Contractor shall clearly indicate which portion of the contents is being submitted for review.

1.2.2 Number of Copies Required

The Contractor shall submit the required number of copies, which will be returned to the Contractor plus two copies, which will be retained by the Engineer.

1.3 Samples

1.3.1 Accuracy of Samples

Samples shall be of the precise articles and materials proposed.

1.3.2 Number of Samples Required

Unless otherwise specified, the Contractor shall submit all samples, which will be returned to the Contractor plus one, which will be retained by the Engineer.

1.3.3 Reuse of Samples

Under certain circumstances if so approved, the Engineer's retained sample may be used in the construction as one of the installed items.

1.4 Colour and Pattern Charts

Unless the precise colour and pattern is specifically described in the Contract Documents, and whenever a choice of colour or pattern is available in specified product, the Contractor shall submit accurate colour and pattern charts to the Engineer, for review and approval.

2.0 Earthwork

2.1 Clearing and Grubbing

2.1.1 Description

This item shall consist of clearing, grubbing, removing and disposing all vegetation and debris as designated in the Contract, except those objects that are designated to remain in place, are to be removed in conjunction with other provisions of these Specifications. The work shall also include the preservation from injury or defacement of all objects designated to be retained.

2.1.2 Construction Requirements

a) General

The Engineer will establish the limits of work and designate all trees, shrubs, plants and other items to be retained. The Contractor shall preserve all objects, designated to remain. Paint required for cut or scarred surface of trees or shrubs selected for retention shall be an approved asphaltum base paint prepared especially for tree surgery.
If required, the Contractor shall secure the necessary **Tree Cutting Permit** from the Forest Management Bureau (FMB) of the Department of Environment and Natural Resources (DENR), prior to any cutting/clearing of trees.
In case there are some conditions about **Tree Cutting Permit** of Baclaran Expansion Depot and/or Zapote Satellite Depot, the Contractor shall have the responsibility to fulfill the required conditions in coordination with the Grantor.

b) Clearing and Grubbing

All surface objects and all trees, stumps, roots and other protruding obstructions, not designated to remain, shall be cleared and/ or grubbed, including mowing as maybe required. Exceptions to this provisions are indicated below:

i. Removal of undisturbed stumps and roots and non-perishable solid objects with a depth of 1 meter below sub grade or slope of embankments will not be required;
ii. In areas outside of the grading limits of cut and embankment areas, stumps and non-perishable solid objects shall be cut off not more than 150 mm above the ground line or low water level;
iii. In areas to be rounded at the top of cut slopes, stumps shall be cut off flush or below the surface of the final slope line; and
iv. Grubbing of pits, channels and ditches will be required only to the depth necessitated by the proposed excavation within such areas.

Except in areas to be excavated, stump holes and other bore holes from which obstructions are removed shall be backfilled with suitable material within such areas.
Debris and perishable materials shall be disposed of by removing them to locations approved by the Engineer on or off the project site. If the disposal location is off the project, the Contractor shall make all necessary arrangements with the Employers in writing for obtaining suitable disposal locations, which are outside the limits of the project. A copy of such agreement shall be furnished to the Engineer. The disposal areas shall be seeded, fertilized and mulched at the Contractor's expense.
All merchantable items in the clearing area, which has not been removed from the right-of-way prior to the beginning of construction, shall remain the property of LRTA, unless otherwise provided.
Low hanging branches and unsound or unsightly branches of trees or shrubs shall be trimmed from the right of way prior to the beginning of construction. Branches of trees extending over the clearing area shall be trimmed to give a clear width of 1 meter away from the edge of structures. All trimmings shall be done by skilled personnel and in accordance with good practices of tree trimming.
Trees/Timber shall be cut and felled only within the area to be cleared.

c) Individual Removal of Trees and Stumps

Individual trees or stumps designated by the Engineer for removal and located in areas other than those established for clearing and grubbing shall be removed and disposed of as specified under **Sub-Clause 2.1.2b** except trees removed shall be cut flush with the ground as far as practicable, without removing any stumps.

2.2 General Excavation

2.2.1 General Scope

This clause specifies the requirements for general excavation, handling, and utilization or disposal of excavated materials. The Contractor shall furnish all labour, materials, tools, and equipment required to complete the works.

This work shall consist of all excavation operations required in the grading and construction of the works, but shall exclude types of excavation, which may be separately specified.

General excavation shall include the removal of all materials regardless of whether such materials are classified as unsuitable or surplus materials or otherwise, and regardless of how or where such materials are to be used or disposed of.

Prior to any excavation works, the following activities shall be undertaken:

a) Soil/sediment sampling from contaminated area at existing depot

b) Laboratory analysis of samples to determine content of the following hazardous wastes:

   i. Arsenic and its compounds (Total As concentration >1 mg/L

   ii. Barium and its compounds (Total Ba concentration >70 mg/L

   iii. Cadmium and its compounds (Total Cd concentration >0.3 mg/L)

   iv. Chromium and its compounds (Total Cr concentration >5 mg/L

   v. Lead compounds (Total Pb concentration > 1mg/L)

   vi. Mercury and organomercury compounds (Total Hg >0.1 mg/L)

   vii. Fluoride and its compounds (Total F concentration >100 mg/L)

c) If based on laboratory results the heavy metal contents exceed above concentrations then transport of excavated materials should be done by a EMB-accredited hazardous waste transporter.

d) Disposal of hazardous wastes shall be done through DENR-accredited Hazardous Waste Treatment/Storage/Disposal (TSD) Facilities.

e) Carrying out field surveys and preparation and submittal of drawings thereof;

f) Clearing and grubbing;

g) Sub grade preparation;

h) Construction of embankment and banking utilising general excavation materials;

i) Slope shaping and rounding, providing related details indicated, and complying with all associated requirements;

j) Proper disposal of surplus general excavation materials not utilised for the work, including unsuitable materials at DENR and LGU approved sites,

k) Prevention of erosion of exposed surfaces,

l) Installation of sediment traps in areas where run-off will drain towards natural waterways

m) Regular water spraying of exposed, loose, excavated materials to prevent/minimize suspension and re-suspension of particulate materials,

n) Provision of proper lighting (during night-time) safety barriers, and warning signs at all excavation work sites, at all times and

o) Temporary drainage and disposal of water.

2.2.2 References

Related work includes:

Sub-Clause 2.1 – Clearing and Grubbing;

Sub-Clause 2.5 – Filling, Grading and Embankment Construction; and
DPWH Standard Specifications Volume II, Item 105 – Subgrade Preparation

2.2.3 Submittals

The Contractor shall submit to the Engineer for review and approval a work program comprising an outline of the equipment and techniques to be employed in carrying performing this work, including any field-testing, required.

2.2.4 Products

Suitable Material:
Suitable material shall include any soil material derived from the excavation, which is capable of meeting the compaction requirements, for a particular location, where the material is to be used.
Compaction requirements shall be in accordance with the Specification, unless otherwise specified.
Unsuitable Material:
Highly organic clays and silts, peat, soil containing large amounts of roots, grass and other vegetable matter, domestic or industrial waste, shall be classified as unsuitable material. Materials that are soft or unsuitable merely because they are too wet or dry are not to be classified as unsuitable unless otherwise directed by the Engineer.

2.2.5 Execution

a) General Requirement

Excavation of ditches or channels shall be to the lines, grades and extent shown on the drawings; and shall comply with all requirements specified for general excavation, unless otherwise specified. Any excavation forming a flow line shall be uniformly sloped between the elevations shown.
Classification or identification of soil materials, where applicable, shall be as designated on the drawings or in this Technical Specifications.
Excavation in excess of the lines and grades or to the extent indicated shall be replaced using suitable material placed and compacted to a density at least equal to the density of the surrounding earth.
All excavation, embankment and banking construction shall be performed as specified herein and in accordance with **Sub-Clause 2.5.** Filling, Grading and Embankment Construction and the completed earthworks shall conform to the required alignment, levels, grades, and with any other relevant provisions specified in other clauses.
Where any material below the natural ground level whether under embankment or below formation level in cuttings is required to be excavated, it shall be removed to such a depth and over such areas as are indicated on the drawings, or as directed by the Engineer, and disposed of in a manner depending on its nature and condition at the time. The excavation shall be kept free of water by pumping. The whole of the excavation shall not be carried out in one operation but shall be progressively excavated and filled one layer/width at a time, such that the excavated surface is not left exposed or unsupported during wet weather, or overnight. It shall be the responsibility of the Contractor to ensure the stability and safety of the excavation at all times. All excavation below embankments and banking shall take place from ground level unless prior approval is given by the Engineer. Backfilling shall be done with suitable material.

b) Unsuitable Material

Material below the natural ground surface in embankment and banking areas, and sub-grade material in excavation areas, that are unsuitable for the planned use shall be excavated and disposed. The arrangement and provision of disposal sites outside the limits of the project shall be the Contractor's responsibility, and in agreement with the Engineer.

If after the removal of unsuitable material the Contractor allows the material exposed to reach a condition where compaction of backfilling complying with the Specification is not practicable they shall make good at their own expense either by additional excavation and filling in the manner specified, or by waiting until the condition of the exposed material is fit to receive the approved backfill.
When unsuitable material is removed, the resulting space shall be filled with material suitable for the planned use. Such suitable material shall be placed and compacted in layers conforming to **Sub-Clause 2.3** Excavation and Backfill for Structures**.**
In the event of material being contaminated by oil, grease or other materials to be used for the maintenance and repair work of rolling stock or vehicles, the Contractor shall be responsible for collection and disposal in the appropriate manner based upon current Philippine regulations.

c) Slides and Slip outs

Materials outside the planned excavation slopes, which is unstable and constitutes a potential slide, or material from slides, which has come into the railway or ditch, or material, which has slipped out of new or old embankments and banking, shall be excavated and removed. The materials shall be excavated to the designated lines or slopes by benching. Such materials shall be used in the construction of the embankments or disposed of as specified.

d) Slopes

Excavated slopes shall be finished in conformance with the required lines and grades. All debris and loose material shall be removed. When completed, the average plane of the slopes shall conform to the slopes indicated on the drawings and at no point, the completed slopes shall vary from the designated slopes by more than 10 cm measured at right angles to the slope.
In no case shall any portion of the slope encroach on any rail bed or roadbed.
The tops of excavated slopes and the ends of excavations shall be rounded, or shaped as shown on the drawings.

e) Disposal of Surplus Material

The disposal of surplus material shall include the loading, transporting, placing and shaping of earth materials at designated locations as shown on the drawings or as specified. For materials containing hazardous wastes please refer to Sub-Clause 2.2.1 above.
Disposal sites, except for wastes that will be disposed of by EMB-accredited TSD facilities, or areas not previously made available under this or other contracts, shall be prepared as specified under **Sub-Clause 2.1** Clearing and Grubbing.
Surplus material shall be disposed of in banks or strips, and shall be neatly constructed by dumping and shaping the loose material into a stabilised condition.
Top surfaces of all "disposal construction" shall be sloped transversely to drain free, from standing water, toward adjacent land areas which will most readily drain away the run-off water; and all completed surfaces shall be reasonably well levelled and smoothed off and left in a condition that will preclude heavy concentrations of run-off water that could cause severe erosion or flooding.
Different types of surplus material shall be disposed of separately.

f) Deficient Material

When from within the limits of work or other areas designated for this Contract, the quantity of suitable material from excavation is not sufficient to complete the work required under the Contract, the deficient quantity of material needed shall be borrowed from the materials obtained from the Contractor's own resources in accordance with the provisions of **Sub-Clause 2.5** Filling, Grading and Embankment Construction. Suitable

materials may also be obtained, if available, from the locations within the limits of the project as approved, in advance by the Engineer.

g) Grade Tolerances

At the time any covering layer of material is placed, the finished subgrade of the excavation shall comply with requirements specified under the Item 105 of the DPWH Standard Specifications Volume II – Subgrade Preparation, and shall not vary more than plus or minus 25 mm from the lines and grades shown.

h) Control of Water

The Contractor shall arrange for the rapid disposal of water entering earthworks or completed formation from any source during construction. Adequate means of trapping silt shall be provided on temporary drainage systems discharging into permanent drainage systems.
The Contractor shall provide where necessary temporary water courses, ditches, drains, pumping or other means of maintaining the earthworks free from water. Such provisions shall include carrying out the work of forming the drains with necessary cuttings and embankments in such a manner that their surfaces have at all times a sufficient minimum cross fall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding (or allowing small pools of water on the surface).
Pumping shall not be regarded as meeting the provisions of this Clause where a blockage temporarily obstructs the free drainage of a cutting. In such circumstances the Contractor shall construct temporary drains with a suitable out-fall or install the permanent drainage through the blockage.
The Works related to the control of water shall be considered as incidental to earthworks and shall not be measured or paid for.

i) Maintenance of the Work

The Contractor shall be responsible for maintaining the work free from slides, slip outs and erosion caused by action of the elements, and any other damage caused by any other reason during the Contract, and all such damages shall be repaired or restored by the Contractor.

j) Other Rights of Way

At locations, where the construction is close to roads, irrigation canals, rivers, and power transmission lines which have their own Right-of-Way, the Contractor must not, without instruction from or by the Engineer, remove any materials from such Right-of-Way belonging to other authorities or, by the operation of equipment or otherwise disturb their installations.

2.3 Excavation and Backfill for Structures

2.3.1 Description

a) Scope

This section specifies the excavation and backfill requirements for structures

This work shall consist of performing all operations necessary to excavate all materials, regardless of their condition or subsurface condition, required to be excavated and removed for the construction of structures; to place backfill for structures; and to provide or carry out all related works or operations necessary to complete the work.
The works shall include:

i. Excavation for structures;
ii. Installing and removing cofferdams, sheet piles, and other temporary facilities;
iii. Pumping, dewatering, and disposal of water from any source; and
iv. Disposal of excavated material.

This work shall also include excavation and disposal of unsuitable materials as specified, and excavation of recesses or embankment slopes at culvert inlets, to the shapes and dimensions indicated, and the disposal of the resulting material in embankments or as otherwise approved.

The Contractor shall carry out excavation by hand adjacent to utilities that are known, proven or suspected to exist.

It shall also include the furnishing and placing of approved foundation fill materials to replace unsuitable materials encountered below the foundation elevation of structures.

The Contractor shall reflect the information obtained by the trial pit excavation for their design of formation and related structures.

Those utilities identified and affecting the proposed structures might be relocated by the Contractor by the Provisional Sum subject to the Engineer's approval.

There is an existing RC box culvert in Baclaran Expansion Depot Area, of which the exact location shall be identified by the Contractor for the design of structure above and adjacent to the culvert (Refer to Box Culvert drawings under Section VI-4 Supplemental Information).

b) References

Related work includes:

i. Sub-Clause 2.1 – Clearing and Grubbing;
ii. Sub-Clause 2.2 – General Excavation;
iii. Sub-Clause 2.5 – Filling, Grading and Embankment Construction; and
iv. DPWH Standard Specifications Volume II, Item 105 – Subgrade Preparation

c) Applicable Codes and Standards

The following Codes and Standards are intended to provide an acceptable level of quality for materials and products. The Contractor may propose alternative codes and standards provided they give a degree of quality equivalent to the referenced codes and standards and shall be submitted for the Engineer's review and approval in advance of their use.

i. JIS Japan Industrial Standard
ii. A 1210 Test method for soil compaction using a rammer
iii. A1214 Test method for soil density by the sand replacement method
iv. AASHTO American Association of State Highway and Transportation Officials
v. M 57 Materials for embankments and sub-grades.

d) Submittals

The Contractor shall submit a "Method Statement", of how each item of Work will be performed, including the following:

i. Excavation plans, including sequence, phasing, and extent of excavations to ensure stability of the existing structures;
ii. Design and drawings of cofferdams, shoring and bracing, and other temporary works;
iii. Alternative materials; and
iv. Equipment to be used.

2.3.2 Products

a) Backfill Material

Suitable Fill Material shall comprise of appropriate excavated materials or borrowed materials. Such materials shall conform to **Sub-Clause 2.5** Filling, Grading and Embankment Construction, and shall be free from perishable and organic materials, scrap and rubbish, and shall not have particle sizes greater than 50 mm and/or total salts content in excess of one (1) percent.

When structure backfill is required within the limits of the railway embankment and banking the Specifications of backfill material shall be same as that of the embankment and banking material.

b) Sub-Base Material

Unless otherwise shown on the Drawings, the foundations shall be constructed on a layer of levelling concrete overlying a layer of rubble stone.
The levelling concrete shall be plain concrete as specified in **Sub-Clause 4.4.3** Reinforced Cement Concrete.
Rubble stone shall be hard, durable, angular in shape and unaffected by the action of water. Adobe stone shall not be used unless otherwise specified. The breadth and thickness of a single stone shall not be less than one-third its length. Rounded or boulder stone shall be rejected, as shell or stone containing shell bands. Gradation of rubble stone shall be in compliance to Table 2.3 -2 below.

Table 2.3.2 Gradation of Rubble Stone

Weight (Kg)	Equivalent cube dimension (mm)	Percentage total size smaller than given size
7.0	170	100
5.0	150	80
2.5	120	50
0.2	50	10

2.3.3 Execution

a) General Requirements

When excavating around existing foundations, and especially, when excavating for the new foundation cut-off walls, below the level of existing foundation, the Contractor shall take into consideration the stability of the existing structure. Accordingly, the construction of new foundation cut-off walls around the existing foundations shall be executed in stages, one stage/layer at a time, and the Contractor shall submit the sequence and stages of cut-off wall construction to the Engineer for approval.
Excavation for working space for placing formwork, or shoring, bracing, for reasons of safety or integrity of the work, or for other work or operations outside of 1.0 m beyond the face of the permanent structures as shown on the Drawings shall be the responsibility of the Contractor.
Structure excavations shall be sloped, or shored or sheeted and braced, as necessary as the excavation work progresses downward to ensure that work areas and spaces are safe at all times.
Shoring, sheeting and bracing shall be structurally designed and constructed and sufficient for the loads and forces involved. Slopes to the sides of excavation shall be sufficient to preclude slides, slip outs or other failures as warranted by the conditions and materials involved.
The Contractor shall submit to the Engineer for review drawings showing his proposed methods and designs for shoring and bracing or other temporary construction and other details left open to his choice, which are not fully shown on the drawings.
Shoring, sheeting and bracing shall be removed when the work is completed.
Structure excavation work shall be arranged so that the excavations remain open and exposed for the shortest time practicable.

b) Disposal of Water

The Contractor shall be responsible for keeping the excavations free from water at all times whether such water is classified as seepage, underground, rain or storm water, flood, or otherwise.

The Contractor shall provide all measures necessary for keeping the excavations free of water including providing pumps or other devices, pipe lines, ditches, dikes, shaping the surfaces, or other construction or operations necessary for the collection and disposal of water; and necessary for the proper execution of the work, and protection of all facilities and improvements within, or near the work areas.

Water disposal shall not damage terrain, plants, trees, construction or structures, and shall not lead onto nor across established roads, parking areas, planting areas, or adjacent properties, unless otherwise specifically approved by the Engineer.

The Contractor shall, during the course of the work maintain the work site free of standing water except at approved collecting ponds. The Contractor shall clean, trim and maintain all drainage ditches from time to time during the work to permit the free flow of water at all times. Damage to the work attributable to water, through failure to provide adequate countermeasures shall be repaired by the Contractor at no cost to the Employer.

The Contractor shall construct and maintain such temporary dikes, weirs and ditches, etc., until the work requiring such temporary structures is accepted by the Engineer. All such temporary measures as are required for construction shall be removed prior to final acceptance of the finished and completed work.

Disposal of surface water shall be done in such manner as not to damage or inconvenience work or facilities of other Authorities, contractors, or the public, and shall be carried out to the approval of the Engineer.

c) Related Requirements

To the extent applicable to allow excavation and in accordance with the prevailing conditions encountered at the work site. The following items under **Sub-Clause 2.2** General Excavation shall apply in the construction of structural excavation.

i. Slides and Slip outs,
ii. Surplus Material Disposal Requirements,
iii. Deficient Material,
iv. Grade Tolerance, and
v. Maintenance of the Work.

d) Cofferdams

The Contractor shall be responsible for determining the need for cofferdams; and, if required, shall be arranged and provided as part of the works under the Contract. The designs, methods, means, drawings and submittals for any cofferdam work shall comply with requirements as specified for shoring, sheeting and bracing under **Sub-Clause 2.3.3** Execution and General Requirements.

The Contractor shall submit drawings and calculations showing their proposed method of cofferdam construction. Approval of the drawings and calculations by the Engineer will not in any way relieve the Contractor of the responsibility for the adequacy of the design for strength and stability of the cofferdam, or for the safety of the people working therein.

Cofferdams for construction purposes shall be carried well below the bottom of the footing and shall be well braced and as watertight as practical.

Cofferdams which are tilted or moved out of position by any cause during the process of construction shall be corrected and/or strengthened as required.

When conditions are encountered which, in the opinion of the Engineer, render it impracticable to dewater the foundation before placing the footing, the Engineer may require the construction of a concrete foundation or seal of such dimensions, as they may consider necessary, and of such thickness as to resist any possible uplift.

Cofferdam walls shall be vented or ported at low water elevation to ensure equal hydrostatic pressure both inside and outside of the cofferdam during the period of placing and setting of seals.

No shoring will be permitted in cofferdams, which will induce stress, shock, or vibration in the permanent structure.

Cross-struts or bracing may extend through the foundation, but if practicable cofferdams shall be so designed that no cross bracing shall be left in place. If this is not practicable, bracing left in place shall be of structural steel. The end of such structural members that would be exposed when the structure is completed shall be boxed and cutback at least 70 mm behind the concrete face. The resulting holes shall be completely filled with cement grout.

After completion of the substructure, the cofferdams with all sheeting and bracing shall be removed by the Contractor, and such removal shall be performed in a manner that will not disturb or damage the finished work.

e) Foundation Sub-grade Treatment for Structures

When culverts or other structures are to rest on an excavated surface other than rock, care shall be taken not to disturb the bottom of the excavation and protect the excavated surface from water. If suitable material at the base of the excavation is disturbed or removed, it shall be replaced at the Contractor's expense. The excavated surface of the foundation shall be restored by the Contractor to a condition at least equal to the original undisturbed foundation sub-grade.

When a firm ground surface is not encountered, due to soft, spongy or other unsuitable material, the Contractor shall perform such work as necessary to assure adequate support of the structure and as approved in advance by the Engineer.

When footing concrete is to rest upon rock, the rock shall be fully uncovered and the surface thereof shall be thoroughly prepared to properly support the loads to be imposed by the structure. Any seams in the rock shall be especially treated to preclude development of unstable foundations at some future time.

When excavating for culverts, any solid rock, or other un-yielding material is encountered, the material shall be removed below the bottom of the culvert. The resulting trench below the base of the culvert shall be backfilled with structure backfill material in accordance with **Sub-Clause 2.4** of this Technical Specification Trenching, Bedding, Backfilling and Compacting.

Should swell or subsidence result from driving piles the Contractor shall excavate, or backfill with suitable material the footing area to the correct level for the bottom of the footing. If the material under footings is such that it would mix into the concrete during concrete placement, or would not support the weight of the fluid concrete, the Contractor shall provide a suitable platform on which to cast the footing.

f) Notification

The Contractor shall notify the Engineer whenever any structure excavation is substantially completed to the lower limits required for the work.

g) Structure Backfill

When the backfilling work is required at the location of railway or roadway embankments, backfilling work shall be performed in accordance with **Sub-Clause 2.5** of this Technical Specification Filling, Grading and Embankment Construction.

In locations other than those specified above, backfilling work shall be performed in the following manner:

Prior to the commencement of backfilling work the Contractor shall determine the optimum density of the backfilling material, which must be equal to the surrounding earth density when compacted.

When the amount of moisture contained in the backfill material exceeds optimum moisture content limit, the backfill material shall be dried until the surplus moisture evaporates.

Backfill material shall be placed in uniform layers and shall be brought up uniformly on all sides of the structure or facility. The thickness of each layer prior to compaction shall not be more than 300 (three hundred) millimetres.

Compaction equipment or methods, which may cause excessive displacement, or may damage structures, shall not be used.

No backfill material shall be deposited against the back of concrete retaining walls, or cast-in-place concrete structures until the concrete has developed a strength of not less than 150 kg/cm^2 (14.71 x 10^6 Pa or 14.71 MPa) in compressive strength, or until the concrete has been in place for 28 days, whichever occurs first.(**Note: MPa = Mega Pascal).**

Backfill behind retaining walls shall be placed before curbs, sidewalks or pavements and railways are constructed, over the backfill.

Material shall be compacted in accordance with the requirement as specified herein. Where structure excavation is performed and material is removed outside the limits shown on the drawings or specified, all backfill material placed in said excavated areas shall be compacted to a density of not less than that required for the adjacent structure backfill.

Compaction of the lower levels of structure backfill by ponding and jetting will not be permitted unless specifically approved in advance by the Engineer. If this method is proposed for use in the work, the Contractor shall submit for the Engineer's approval the locations, materials, methods and means for such work.

Material for structure backfill shall be furnished by the Contractor, except for materials extracted from excavations which the Contractor may use provided it is suitable for the purposes and locations where it is to be used.

h) Unsuitable Material

Unsuitable material encountered in the structure excavation work shall be removed and disposed of outside the limits of the project, and as provided for under **Sub-Clause 2.2** of this Technical Specification General Excavation, **Sub-Clause 2.2.5** of this Technical Specification Execution, Unsuitable Material, regardless of the location from which such material is removed.

When any unsuitable material is encountered at or below the lower limits of the excavation required for structures or other facilities, the Contractor shall immediately give notice to the Engineer as to the location and observed extent and apparent condition of such circumstances.

i) Surplus Material

Surplus structure excavation materials not utilised for the work shall be removed and disposed of outside the limits of the work, unless otherwise approved in advance by the Engineer.

2.4 Trenching, Bedding, Backfilling and Compacting

2.4.1 Description

a) Scope

This section covers the furnishing of all materials, equipment, and labor for trenching, bedding, backfilling and compacting for utility systems. "Utility Systems" shall include all underground pipes and fittings for liquids, and buried cables and conduits for electrical and communication lines. Whenever existing surface finishes are damaged as a result of placing the "Utility System", the surface finish shall be restored as part of the Work.

b) References

Related work shall include:

i. Sub-Clause 2.3 – Excavation and Backfilling for Structures;
ii. Sub-Clause 2.5 – Filling, Grading and Embankment Construction;
iii. DPWH Standard Specifications Vol. II Item 105 – Subgrade;
iv. DPWH Standard Specifications Vol. II Part D – Subbase and Base Course; and
v. DPWH Standard Specifications Vol. II Part E –- Surface Courses.

c) Applicable Codes and Standards

The following Codes and Standards are intended to provide an acceptable level of quality for materials and products. The Contractor may propose alternative codes and standards provided they give a degree of quality equivalent to the referenced codes and standards and are submitted for the Engineer's review and approval.

i.	JIS	Japan Industrial Standard
ii.	A 1210	Test method for soil compaction using a rammer
iii.	A1214	Test method for soil density by the sand replacement method
iv.	AASHTO	American Association of State Highway and Transportation Officials
v.	M 57	Materials for embankments and subgrades.

d) Submittals

The Contractor shall submit to the Engineer for review and approval the "Method of Construction" plan. The Contractor shall submit a "Method Statement" for how each item of Work will be performed, including the following:

i. Excavation Plan,
ii. Design and drawings of sheeting, shoring and bracing, and other temporary works,
iii. Alternative Materials, and
iv. Equipment to be used.

2.4.2 Products

Materials

Suitable Fill Material shall comprise of suitable excavated materials or borrowed materials. Such materials shall conform to **Sub-Clause 2.5** of this Technical Specification Filling, Grading and Embankment Construction, and shall be free from perishable and organic materials, scrap and rubbish, and shall not have particle sizes greater than 50 mm and/or total salts content in excess of one (1) percent.

2.4.3 Execution

a) Trenching

Excavations for trenches shall be to the lines and grades indicated on the Contract Drawings. Trenches shall be made as narrow as practicable or to the minimum widths specified on the Contract Drawings but shall nevertheless provide sufficient room for the laying, jointing and testing of pipe works and utilities. In no case shall the earth be scraped or dug by machinery so near to the base of the bedding formation level as to result in the disturbance of the material below. The last of the material above the bedding level shall be carefully removed by using hand tools, and this shall only be done immediately before the placing of the pipe, utility or bedding. If the bottom of the trench is excavated beyond the limits indicated on the Drawings or specification, the resulting void shall be backfilled with suitable fill material and compacted to a density at least equal to the density of the surrounding earth.

Sheeting, bracing and shoring shall be used to provide for the safety of all personnel and also to ensure that the stability of the surrounding ground is not impaired and that all adjacent structures are not endangered by excavation work. The lateral distance to the nearest edge of the trench excavation from the face of the foundation of adjacent structure(s) shall be at least equal to the depth of that part of the trench, which is lower than the bottom of the adjacent foundations, unless otherwise approved by the Engineer. Sheeting, bracing, and

shoring shall be designed and built to withstand all loads that might be caused by earth movement or possible surcharge loads from equipment used in the Works. The Contractor may slope the sides of the trench to the angle of repose of the excavated material.
Dewatering equipment shall be provided and maintained to remove and dispose of all surface and/or ground water entering excavations and other parts of the work. Each excavation shall be kept dry during sub-grade preparation and continually thereafter until the construction to be provided therein is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause shall result. Any excavation work shall not commence until approval is given by the Engineer.

b) Bedding

The types and sizes of bedding shall be in accordance with the requirements shown on the drawings. Sub-grade to receive bedding shall be prepared in accordance with the requirements specified in DPWH Standard Specifications Vol. II, Item 105 - Subgrade.

c) Backfilling and Compacting

Prior to commencement of backfilling work the Contractor shall determine the optimum density of fill material, which is to be equal to the density of the surrounding earth when that is compacted.
When the backfilling material contains moisture exceeding optimum moisture content limit it shall be dried until surplus moisture has evaporated.
Backfilling shall be carried out in all trenches in such a manner that the work will not damage and disturb the utility system. Backfill shall not be placed until dewatering work is completed. In all cases backfill material shall be deposited in uniform layers not exceeding 150 mm thick on the properly bedded utility systems and carefully tamped until the utility systems has a cover of 300 mm. In areas such as roadways the trenches shall be backfilled to sub-grade elevation in 150 mm layers and each layer shall be compacted in such a manner as specified in **Sub-Clause 2.5** of this Technical Specification Filling, Grading and Embankment Construction**.**
Sub-base, base course and pavement required to complete the backfilling shall meet the requirements specified in DPWH Standard Specifications Vol. II, Part D – Sub-base and Base Course, and Part E - Surface Courses.
Unless otherwise specified or indicated, trenches in non-paved areas shall have the remainder of the backfill, above the 300 mm cover to the utility system, deposited in 300 mm layers and compacted to the density as specified in this specification.
Material, which is not suitable for backfilling shall be disposed of in such a manner as specified in **Sub-Clause 2.2.5e** of this Technical Specification General Excavation, Execution, titled, "Disposal of Surplus Material".
Trenches improperly backfilled and not in conformance to these specifications shall be reworked, until such time, that the work is considered satisfactory by the Engineer, at the Contractor's expense.

2.5 Filling, Grading and Embankment Construction

2.5.1 Design Requirement

Zapote Satellite Depot

Final formation level of embankment for track area in Zapote Satellite Depot shall be 4.6m above sea level allowing subsequent ballast by others to form track which top of rail level shall be 5.2m above sea level.

Allowable consolidation settlement amount per year shall be within 10mm.

The Contractor shall design counter measures including but not limited to temporary surcharge, vertical drain, and/or sand compaction piles, for consolidation settlement and liquefaction in Zapote Satellite Depot Area in order to achieve allowable consolidation settlement within

construction period under the Contract. (Please refer to drawing #CMX-L1/DP-CV-01-0008 to 0009)
The Contractor shall monitor the consolidation settlement during and after construction of embankment and temporary surcharge with settlement plate in order to justify the achievement of the allowable settlement.

The Contractor shall submit his monitoring plan showing type of the settlement plate and method of the monitoring for the Engineer's approval prior to the actual operation.

In addition, the following hazards should be taken into considerations during the preparation of design of Zapote Satellite Depot.

a) Fluvial hazard such as flood overflow, riverbed scouring, channel erosion and migration, rill and gully erosion.

b) Coastal hazard such as coastal flooding, erosion, aggradation, storm surge.

Baclaran Expansion Depot

Final formation level for track area in Baclaran Expansion Depot shall be 2.87m above sea level allowing subsequent ballast by others to form track which top of rail level shall be 3.47m above sea level.

2.5.2 Scope

This Clause covers the material and construction requirements for embankments, banking, and filling and grading work as required at the locations indicated on the drawings. The Contractor shall furnish all labor, materials, tools, and equipment required to complete this work.
This work shall consist of embankment and banking, formed from borrowed material to be provided by the Contractor, including sub-grade preparation, and incidental or subsidiary work or operations required.
Borrowed material shall mean substances obtained from sites or locations outside of the Site of this Contract. The work shall include clearing and grubbing at borrowed sites, and at embankment and banking construction sites where borrowed material is to be placed, all as may be required according to the conditions encountered.
The work shall include all necessary benching and re-compacting benching materials; removing unsuitable embankment and banking material, placing and compacting approved material where unsuitable embankment and banking foundation material has been removed; filling and compacting of holes, pits and other depressions within the embankment and banking areas, and backfilling excavations resulting from the removal of structures and other facilities.
The work shall also include the subsidiary work as follows:

a) Carrying out field surveys at borrowed embankment and banking construction areas, preparation, submittal of drawings and calculations thereof;
b) Slope shaping at rounding as required, and complying with all associated requirements;
c) Disposal of all surplus materials; and
d) Testing materials.

Care of Works in Zapote Satellite Depot

This depot area is located adjacent to the Zapote River, which causes flooding in the area during heavy rains. The Contractor shall take special care of works for replacement of unsuitable material, subsequent embankment and ground stabilization in order to protect the working area from flooding. The Contractor shall adopt suitable temporary works to ensure such flood protection, including but not limited to, cofferdam, dike, ditch, pit and drainage pumping system etc.

2.5.3 References

Related work shall include:
Sub-Clause 2.1 of this Technical Specification - Clearing and Grubbing
Sub-Clause 2.2 of this Technical Specification - General Excavation

Sub-Clause 2.3 of this Technical Specification - Structure Excavation and Backfill

2.5.4 Applicable Codes and Standards

The following codes and standards are intended to provide an acceptable level of quality for materials and products. The Contractor may propose alternative codes and standards provided they are equivalent or better to the referenced codes and standards and are submitted for the Engineer's review and approval.

JIS Japan Industrial Standard

A 1204 Test method for particle size distribution of soils
A 1205 Test method for liquid limit and plastic limit of soils
A 1210 Test method for soil compaction using a rammer
A1214 Test method for soil density by the sand replacement method

AASHTO American Association of State Highway and Transportation Officials
M 57 Materials for embankments and sub-grades.

Standards and commentary of Railway structures design; soil structure
June, 2013 Railway Technical Research Institute, Japan

National Structural Code of the Philippines; seismic design

Standards and commentary of Railway structures design; basic structure
January, 2012 Railway Technical Research Institute, Japan

Standards and commentary of Railway structures design; soil retaining structures
January, 2012 Railway Technical Research Institute, Japan

Civil work of Road; soft ground measures Engineering Guidelines
(2012 fiscal year edition)
August, 2012 Japan Road Association

Deep Mixing Method design and construction manual revision in land construction
March, 2008 Public Work Research Center, Japan

The ground improvement manual by cement solidifying material 4th edition
Japan Cement Association

National Structural Code of the Philippines latest Edition.

2.5.5 Submittals

The Contractor shall submit to the Engineer for review and approval the items listed herein:

a) Work program comprising an outline of equipment and methods to be employed in carrying out the work;
b) Field survey drawings to clearly indicate the areas intended to be constructed utilising borrowed material, together with a summary of estimated quantities in such areas;
c) An outline, details and field survey drawing to clearly indicate the borrowed excavation intended to be carried out. A summary of estimated quantities shall also be submitted. Excavation within these areas shall then be limited to the lines, grades and extent indicated on such drawings as approved; and
d) Tests on borrowed material.

2.5.6 Products

a) Fill Material

Fill material for embankment and banking shall be suitable borrowed material as specified hereunder. Suitable material shall be any soil material derived from borrowed pit as approved by the Engineer, which when used in the work, is capable of meeting the requirements tabulated in these specifications.
Embankment and banking fill material shall be free from appreciable amounts of organic matter; shall be free from rocks, broken concrete or other solid material with a dimension over 10 centimeters.
Gradation of borrowed material, when tested in accordance with JIS A 1204 and 1205, shall be within the limits as follows:

Table 2.5.6-1 Gradation of Borrow Material

Sieve Size		Percent Passing, by Weight Individual Test Result
(Inch)	(mm)	%
3	75	100
1 .75	45	40 maximum
No. 200	0. 075	2-20

The portions of borrowed material passing the 0.425 mm (No 40) sieve shall conform to the requirements as follows.

Table 2.5.6-2 Sieve Requirement of Borrow Material

Characteristics	JIS Test	Requirement
Liquid Limit	1205	35 maximum
Plasticity Index	1205	Less than 9

Uniformity coefficient of borrowed material shall not be less than 6.

b) Sand Blanket

The material shall be natural sand, manufactured sand, or a combination of the two, and shall be free from any organic matter or deleterious substances, and in such condition that it can be readily compacted under watering and rolling to form a firm, stable base.

2.5.7 Execution

a) Placing

Transporting fill materials shall be carried out in accordance with the requirements of the Relevant Authorities, and the Contractor shall be responsible for obtaining all necessary licenses, permits, etc.
Prior to placing any fill the Contractor shall satisfactorily demonstrate that the compaction method or methods, and the equipment which he proposes to use will provide the degree of compaction hereinafter specified.
The Contractor shall place fill materials in horizontal loose layers and spread, mix and place in such manner as to produce a uniform thickness of material. Placement shall start in the deepest area and progress approximately parallel to the finished grade.
No fill material shall be placed on areas where free water may be standing. Hard lumps shall be broken before compacting the material in embankments and banking.
When the construction of embankments and banking would cut off water-ways, or severely restrict draining of run-off water, or otherwise result in blockage or damming of

water, temporary cross channels shall be cut through the embankment and banking to provide drainage; these shall be maintained for as long as necessary until drainage facilities are completed and operational.

b) Compacting

i. General

Compaction work shall conform to the requirements as specified hereunder.
The placing and compacting of suitable material where unsuitable material has been removed, and the filling of holes, pits and other depressions within the limits of work shall conform to all of the requirements herein.
Trenches, holes, piers and other depressions outside the areas where embankments and banking are to be constructed but are within the limits of work shall be graded to provide a presentable and well-drained area. Where embankments and banking are to be constructed across low swampy ground or ponds, the water shall be drained and the base dried prior to the permanent construction.
Pits, holes or other depressions below adjacent ground levels shall be filled with suitable material and compacted.
Construction work shall not be permitted when the weather is rainy and material, which contains excessive moisture, shall not be compacted until the material is dry enough to obtain the required compaction.
At locations where it would be impracticable to use mobile power compacting equipment, embankment and banking layers shall be compacted to the specified requirements by any method that will obtain the specified compaction.
Embankments and banking shall be constructed in layers of uniform thickness and each layer shall be tested in accordance with JIS A 1214.

ii. Testing and Compacting

Embankment and banking shall be compacted and tested in accordance with the requirements as specified in hereunder.
Test shall be carried out for each layer and top surface of embankment and banking. In the case of a small section of fill shall be performed in the center of each layer.
When tested in accordance with JIS A 1214 the result of the test shall not be less than 95 (ninety five) percent of the optimum density of the fill material.
When the length of embankment and banking constructed is limited to less than 50 (fifty) meters, or interrupted by structure(s) across the embankment and banking, tests shall be carried out in each section of embankment and banking at less than 50 (fifty) meter intervals.
Thickness of each spreading layer shall be not greater than 30 (thirty) cm in thickness.
The slope of embankment and banking shall be graded, rounded and shaped as indicated simultaneously with embankment and banking construction work, and shall be compacted thoroughly as specified immediately after embankment and banking construction has been completed, and also shall be temporarily protected from erosion by water in a suitable manner approved by the Engineer until such time that permanent slope protection has been completed.
Embankment and banking shall be constructed so that each layer shall have a cross-fall not exceeding 0.3 (zero point three) meters in 10 meters.

c) Sand Blanket

Immediately prior to commencement of placing the sand blanket, the sub-grade to receive the sand blanket shall be cleared of all vegetation, such as trees, logs, upturned stumps, roots of downed trees, brush, grass, weeds, and all other objectionable material, including concrete or masonry or debris, and shall also be free from irregularities.

Each layer shall be filled until the thickness as specified in advance of compaction work is obtained, and each layer shall be compacted in accordance with the approved work program. The finished thickness of each layer shall be not more than 25 (twenty five) cm.

d) Maintenance of the Work

Embankments and banking shall be maintained in accordance with the requirements specified under **Sub-Clause 2.2** of this Technical Specification General Excavation.

2.6 Slope Protection

2.6.1 Description

At the slope of embankment in Zapote Satellite Depot slope protection work is required. This shall consist of furnishing and installation of coconut coir fibers made into geonets for controlling soil erosion and slope stabilization.
The area in which this material is to be placed is at the "Slope of Embankment" and will be shown on the drawing. The Slope Protection shall comply with relevant Philippine Standards, DPWH Standards, etc.

2.6.2 Property

Coconut coir/fiber materials for use in fabrication of coconut geonets shall be a multi-cellular fiber with 12 to 24 microns in diameter and the ratio of length to diameter shall be 35. The fiber shall also be hygroscopic, with moisture content of 10% to 12% at 65% humidity and 22% to 55% at 95% relative humidity.
The hand spun coco coir twine that is to be woven into coconut geonets shall have a diameter of 5 mm plus or minus 10%. The coco coir twine shall have a tensile strength of not less than 150 N.

Physical Properties of Coco-net

Type of Coco-net	Average Number of Twines at Crosswise Direction	Average Number of Twines at Lengthwise Direction	Density (min) (gm/m^2)
Coco-net 400	40	40	400
Coco-net 700	40	70	700
Coco-net 900	70	70	900

2.6.3 Construction

Site for net installation shall be graded and sloped to the approved design.
For anchoring, a combination of bamboo pegs and U-shaped wire staples may be used for compacted, hard to penetrate soil. An average of 3 pegs/staples per square meter shall be used to ensure uniform contact of coco-net to the ground surface. Coco-nets shall be placed and anchored on the graded surface of the slope to maximize net contact with the slope surface. Installation shall begin at the edge of the slope by folding underneath the loading edges of the coco-net to ensure that no twines would come loose. After which the coco-nets shall then be unrolled downslope in the direction of the water flow. Adjacent coco-nets/coco-mats shall be installed side-by-side and shall be sewn together using coco coir twine. The coco-nets shall be laid loosely (not stretched) on the ground. Coco-net shall then be fastened and secured firmly to the ground and anchoring shall be at right angle to the ground surface.

After the installation of coconut geonets, coco coir peat-soil mixture shall be distributed evenly on the net protected slope. Thumping and raking shall follow to make the mix settle underneath

to ensure appropriate soil moisture and nutrient release as grasses and other planting materials shall be planted.

Live hedgerow of vetiver grass (or any local suitable species) slips shall be planted on the slopes at 10 to 50 cm. plant interval depending on the erosiveness of the soil, the steepness of the slope, and the design waterflow. Row distance shall likewise depend on the steepness of the slope, and shall range from 1m to 4m. Fast growing leguminous creeping/twining grass cover shall be used for slope faces requiring immediate vegetative cover. It shall be applied to the soil at a rate depending on the desired plant density and the calculated on-site mortality rate of the plants.

3.0 Demolition Works

3.1 Demolition, Dismantling Removal, and Relocation of Structures and Obstruction

3.1.1 General

a) Submittals

The Contractor shall submit proposed salvage, dismantling and demolition procedures to the Engineer for approval before work commences. Procedures shall provide for careful removal and disposition of materials specified to be salvaged, a disconnection schedule of utility services, a detailed description of methods and equipment to be used for each operation and of the sequence of operations.

b) Requirements

The work includes demolition or dismantling of existing structures as indicated or specified. All materials resulting from demolition work, except as indicated or specified otherwise, shall become the property of the Contractor and shall be removed from the limits of the Employer's property. The Contractor shall remove the rubbish and debris from project area daily, unless otherwise directed and shall not allow accumulations inside or outside the buildings. The Contractor shall store all the materials, which cannot be removed daily, in areas specified by the Engineer.

c) Dust Control

The Contractor shall take appropriate action to safeguard against the spread of dust in the project site and avoid the creation of a nuisance in the surrounding area. The Contractor shall not use water, if it results in hazardous or objectionable conditions, such as flooding or pollution and shall comply with all dust regulations imposed by local air pollution agencies. - Republic Act No. 8749 Act providing for a comprehensive Air Pollution Control Policy.

d) Protection

Weather Protection: The Contractor shall protect building interiors and all materials and equipment from the weather at all times. Where removal of existing roofing is necessary to accomplish work, the Contractor shall have materials and personnel ready to provide adequate and approved temporary covering of exposed areas. Temporary coverings shall be securely attached, as necessary, to ensure effectiveness and to prevent displacement.

e) Explosives

Use of explosives is strictly not permitted.

3.1.2 Execution

Existing Facilities to be Dismantled and Demolished:

a) Buildings/Structures:

i. All the buildings, structures, facilities etc. to be demolished as shown in the topographic survey drawing or existing in the Baclaran Expansion Depot site and included in the Scope of Works.
ii. Portions of the track with ballast and sub-ballast and any facilities affected by their respective expansion, as specified and described in the Drawings and in the Scope of Works.

b) Utilities and Related Equipment

Disposal of utility lines encountered that are not used and shown on the drawings in accordance with instructions of the Engineer.

3.1.3 Filling

Fill holes, and other hazardous openings in accordance with **Clause 2** Earthwork**.**

3.1.4 Disposal of Material

a) Entitlement of Materials
Entitlement of all materials and equipment to be removed and disposed, except as specified otherwise, is vested in the Contractor upon receipt of the Notice to Proceed. The Employer will not be responsible for the condition or loss of, or damage to, such property after the Notice to Proceed. Materials and equipment shall not be viewed by prospective purchasers or sold on the site.

b) Salvage of Materials and Equipment
The Contractor shall carefully remove materials and equipment that are specified by the Engineer to be removed and salvaged by the Contractor, and that are to remain the property of the Employer, and delivered to designated storage site. The Contractor shall remove items in a manner that will prevent damage.

3.1.5 Clean up

a) Debris and Rubbish

The Contractor shall remove and transport debris and rubbish in a manner that will prevent spillage on streets or adjacent areas. The Contractor shall clean up spillage from streets and adjacent areas.

b) Hazardous Contaminated Soil

Any hazardous contaminated soil which exists shall be removed and disposed off.

c) Regulations

The Contractor shall comply with local regulations regarding transportation and disposal of the abovementioned materials.

3.2 Removals and Relocations

3.2.1 General

a) Removals

Removals shall be performed without damage to adjacent retained work however, where such work is damaged, the Contractor shall repair or otherwise restore same to its original condition. All existing materials, fixtures, and equipment which have been removed or disconnected but are not indicated or specified for reuse in the new work shall remain the property of the LRTA and shall be removed from the site at contractor's expense and delivered to the Depot or storage area as instructed by the Engineer. Removals shall be as indicated and as specified herein, and shall be performed in an efficient and workmanlike manner to the limits indicated or specified, or to the minimum extent necessary or required for the proper installation of new work. Existing surfaces remaining after removals to which new work is to be applied shall be left in a condition suitable for the application of the new work.

b) Relocations

Relocations shall be as indicated and shall be performed by skilled staff in the task required. The removal and reinstallation of relocated items shall be performed in an efficient and workmanlike manner and items to be relocated, which are damaged, shall be repaired or replaced with new undamaged items as approved by the Engineer.

c) Debris

Debris shall be placed in approved Contractor furnished containers to prevent the spread and accumulation of dust and dirt. Debris shall be removed from the area of work as often as necessary, but not less than at least once at the end of each workday.

d) Protection

The Contractor shall take all necessary precautions to adequately protect personnel and private property in the areas of work. Approved barriers and warning signs shall be provided to reroute personnel around areas of dangerous work.

e) Dust Control

The dust resulting from removals shall be controlled so as to prevent its spread to occupied portions of the building and to avoid creation of a nuisance in the surrounding areas.

f) Conveyances

Conveyances used on roofs or within the building to transport removed debris shall be limited to 0.28 cubic meter (three eights cubic yard) capacity.

3.2.2 Execution

a) Removals

Removals shall include:

All demolished existing buildings, structures, debris, garbage, unused materials, etc. which are existing in Baclaran Expansion Depot Site and instructed to remove by the Employer or by the Engineer.

Building(s) and Structures:

Existing Buildings and Structures shall be removed at Baclaran Expansion Depot area. Wherever utilities need to be disconnected either permanently or temporarily, they shall be disconnected and terminated in an approved manner. No utility shall be disconnected without the prior clearance, in writing, from the Engineer. Water services line shall be terminated at the main and shall be removed. Storm and sanitary sewer lines shall be terminated at the main and shall be removed. Electrical services shall be terminated on the utility pole and lines shall be removed at manholes and wires and duct/conduit shall be removed. Meters and related equipment shall be removed and delivered to a location as directed by the Engineer.

Paving:

i. **Concrete Pavements:** Where it is necessary to excavate a trench across concrete paved areas, the Contractor shall first scour the concrete in neat straight lines to a depth of not less than 50 mm with an approved concrete cutting saw prior to removing con

ii. **Bituminous Pavements:** Where it is necessary to excavate a trench across bituminous paved areas, the Contractor shall cut paving along neat straight lines using an approved pneumatic spade.

iii. **Restoration of Paved Areas:** The Contractor shall restore all paved areas to their original condition using material of like type and quality as that of the removed

paving, as approved by the Engineer. Repaired surfaces shall correspond with existing adjacent paving.

b) Relocations

Relocations shall be as indicated on the drawings or specified by the Engineer.

4.0 Concrete Works

4.1 Scope

The Work specified in this section includes the furnishing of all labor, materials and equipment required to supply and place concrete, inclusive of transport, in accordance with these Specifications and where shown in the Drawings.
This section includes all cast-in-place and precast concrete and related works required under the Contract, together with all necessary formwork, false work, mild steel and high tensile reinforcement

4.2 General Provisions

4.2.1 Applicable Publications

The publications listed below form a part of this specification to the extent referenced.

a) American Concrete Institute (ACI) Publications:

i.	ACI 224R-01	Control of Cracking in Concrete Structures
ii.	ACI 301-10	Specifications for Structural Concrete
iii.	ACI 302.1 R-04	Guide for Concrete Floor and Slab Construction
iv.	ACI 304R-00	Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
v.	ACI-305R-99	Hot-Weather Concreting
vi.	ACI 315-99	Details and Detailing of Concrete Reinforcement
vii.	ACI 318-08	Building Code Requirements for Structural Concrete
viii.	ACI 347-04	Guide to Formwork for Concrete
ix.	ACI 350-06	Code Requirements for Environmental Engineering Concrete Structures

b) American Society for Testing and Materials (ASTM) Publications:

i.	C 39-05	Compressive Strength of Cylindrical Concrete Specimens
ii.	C 94-06	Ready-Mixed Concrete
iii.	C 920-08	Elastomeric Joint Sealants
iv.	D 1751-04	Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

c) American Welding Society (AWS) Publication:

i.	D 1.4-98	Structural Welding Code-Reinforcing Steel

d) Product Standards Agency (PSA) Philippines:
Philippine National Standards:

i.	PNS 07	Specifications for Portland Cement
ii.	PNS 18	Specifications for Concrete Aggregates
iii.	PNS 49	Specifications for Steel Bars for Concrete Reinforcement

e) Standards Administrative Order (SAO)

i.	SAO-6	Philippine Plywood

4.2.2 Quality Assurance

a) Quality Control of Concrete

i. General

The Contractor shall be responsible for the quality control of all materials during the handling, blending, and mixing and implementation.

ii. Quality Control Plan

The Contractor shall furnish the Engineer a Quality Control Plan detailing their production control procedures and the type and frequency of sampling and testing to insure that the concrete product complies with the Specifications. The Engineer shall be provided free access to recent plant production records, and if requested, informational copies of mix design, materials certifications and sampling and testing reports.

iii. Qualification of Workmen

Experienced and qualified personnel shall perform all batching or mixing operation for the concrete mix, and shall be present at the plant and job site to control the concrete productions whenever the plant is in operation. They shall be identified and duties defined as follows:

1. **Concrete Batcher:** The person performing the batching or mixing operation shall be capable of accurately conducting aggregate surface moisture determination and establishing correct scale weights for concrete materials. They shall be capable of assuring that the proportioned batch weights of materials are in accordance with the mix design.
2. **Concrete Technician:** The person responsible for concrete production control and sampling and testing for quality control shall be proficient in concrete technology and shall have a sound knowledge of the Specifications as they relate to concrete production. They shall be, capable of conducting tests on concrete and concrete materials in accordance with these Specifications. They shall be capable of adjusting concrete mix designs for improving workability and Specification compliance and preparing trial mix designs. They shall be qualified to act as the concrete batcher in the batcher's absence.

iv. Quality Control Testing

The Contractor shall perform all sampling, testing and inspection necessary to assure quality control of the component materials and the concrete.
The Contractor shall be responsible for determining the gradation of fine and coarse aggregates and for testing the concrete mixture for slump, air content, water-cement ratio and temperature. They shall conduct his operations so as to produce a mix conforming to the approved mix design. Refer for further testing on cement and concrete **Sub-Clause 4.2.2d to 4.2.2f** of this Technical Specification below (Cement Testing, Aggregate Testing, and Concrete Testing)

v. Documentation

The Contractor shall maintain adequate records of all inspections and tests. The records shall indicate the nature and number of observations made, the number and type of deficiencies found, the quantities approved and rejected, and nature of any corrective action taken.
The Engineer may take independent assurance samples at random location for acceptance purposes as he deems necessary.

b) Equipment

Equipment and tools necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity and mechanical condition. The equipment shall be delivered to the site in a timely manner ahead of the start of construction operations and shall be examined thoroughly and approved by the Engineer.

Batching Plant and Equipment:

i. General

The batching shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, a hopper, and separate scale for cement shall be included. The weighing hopper shall be properly sealed and vented to preclude dusting operation. The batch plant shall be equipped with a suitable non-resettable batch counter which will correctly indicate the number of batches proportioned.

ii. Bins and Hoppers

Bins with adequate separate compartments for fine aggregate and for each size of coarse aggregate shall be provided in the batching plant.

iii. Scales

Scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type. They shall be accurate within one-half percent (0.5%) throughout the range of use. Poises shall be designed to be locked in any position and to prevent unauthorized change.
Scales shall be inspected and sealed as often as the Engineer may deem necessary to assure their continued accuracy.

iv. Automatic Weighing Devices

Unless otherwise allowed on the Contract, batching plants shall be equipped with automatic weighing devices of an approved type to proportion aggregates and bulk cement.

c) Cost of Tests

All the cost for tests specified in this section shall be borne by the Contractor.

d) Cement testing

Samples of cement shall be obtained in accordance with AASHTO T127.
All cement shall be certified by the manufacturer as complying with the requirements of the Specifications. Before orders are placed, the Contractor shall submit details of the proposed supplier(s) together with such information on the proposed methods of transport, storage and certification to the satisfaction of the Engineer, that the quantity and quality required can be supplied and maintained throughout the construction period. Where necessary, the Engineer may require further samples of the proposed cement to be taken and forwarded to a nominated laboratory for analysis and testing before the source is approved.
Having obtained the Engineer's approval of the source(s) of supply, transport, storage and certification of the cement, the Contractor shall not modify or change the agreed arrangement without Engineer's Permission.
In addition to routine test certificates which shall be supplied by the manufacturer to show the results of sample tests made on batches of cement produced on the works, each consignment dispatched to the site of concrete production shall be sampled and tested by the Contractor and the results of the standard 3 day and 7 day tests (in accordance with ASTM C150 and ASTM C114) shall be submitted promptly to the Engineer. The date of manufacture of the consignment shall be stated on the test certificates.

The Engineer may also make further tests, which he shall consider necessary or advisable to satisfy that the cement at the site of production complies with the Specifications and has not suffered deterioration in any manner during transit.

e) Aggregate Testing

At least 28 days prior to commencing the work, the Contractor shall inform the Engineer of the proposed source of aggregates and provide access for sampling.
Gradation tests shall be made in accordance with ASTM C136 on each sample without delay. All other aggregates tests shall be made on the initial source samples, and shall be repeated whenever there is a change of source. The tests shall include an analysis of each grade of material and an analysis of the combined material representing the aggregate part of the concrete mix.
Aggregate test standards to be complied are:

i.	ASTM C 40	Organic Impurities in Fine Aggregate for Concrete.
ii.	ASTM C88	Aggregate Soundness by use of Sodium Sulphate or Magnesium Sulphate.
iii.	ASTM 127	Relative Density (Specific Gravity) and absorption of coarse aggregate
iv.	ASTM 128	Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate.
v.	ASTM C131	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact Testing in the Los Angeles machine.
vi.	ASTM C142	Clay Lumps and Friable Particles in Aggregates.
vii.	ASTM C 535	Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact Testing in the Los Angeles machine.
viii.	ASTM C 289	Potential Alkali-Silica Reactivity of Aggregate (chemical method).

f) Concrete Testing

i. Cylinder Test (Test for Compressive Strength)

As the work progress, test cylinders shall be taken and tested in accordance with ASTM C172, C31 and C39. At least one set of four cylinders shall be made from each $50m^3$ or fraction thereof of each particular grade of concrete placed. However, at least one set shall be made per day for each class of concrete placed in each 8-hour shift.
All cylinders in a set will be marked with a unique number on one end. The Site Engineer will record this number on the record of concrete placed.
From each set of cylinders cast, one cylinder will be tested at seven days and two cylinders at 28 days in accordance with ASTM C39. If the 28-day tests are satisfactory, the fourth cylinder will be discarded.
In the event the 28-day test are below the specified strength requirements, the Laboratory will then test the fourth cylinder at the age selected by the Engineer.

ii. Test of Hardened Concrete taken from the Structure

When the results of the strength tests of the concrete specimens indicates the concrete as placed is 3.45N/mm2 (3.45 MPa) below specified strength or where there is other evidence that the quality of the concrete is below the requirements in the opinion of the Engineer, tests on cores of in-place concrete shall be made in conformity with ASTM C42. **(Note: MPa = Mega Pascal)**
The core holes shall be filled in accordance with the requirements or as instructed by the Engineer.

iii. Rejection of Concrete; Repair and Replacement:

The Engineer shall have authority to reject the concrete work, which does not meet the specification requirements, and to request repair or replacement as necessary to complete the Work.

g) Additive Testing

A five-liter sample of any additive or admixture proposed by the Contractor shall be submitted for testing at least 30 days in advance of use, which shall require approval of the Engineer. Testing of additives proposed by the Contractor including test mixing and cylinder test shall be at the Contractor's expense.
Test shall conform to:

i.	ASTM C260	Air entraining
ii.	ASTM C494	Water reducing
iii.	ASTM C618	Pozzolanic
iv.	ASTM C1017	Plasticizing

Admixtures containing chlorides, sulphides or nitrites are not acceptable.

h) Testing of Reinforcement

The Contractor shall furnish the Engineer with two copies of the mill test certificates for the steel reinforcement to be supplied. The Engineer may, however, order independent tests to be made and any steel which does not comply in all respects with the appropriate ASTM (A706, A82, A184, A185, A196, A497 and A704) specifications will be rejected.

i) Joining Materials and Curing Compound Samples

At least 28 days prior to commencing the work, the Contractor shall submit to the Engineer for his approval samples of the following materials proposed for use together with the manufacturer's certificate:

i. 10 kg. of joint sealant,
ii. 1 m length of joint filler,
iii. 5 (0.005 cum) litters of curing compound, and
iv. 1 m length of joint backing.

The Engineer shall deliver to the Contractor his assessment on the material within (7) days after receiving them.

j) Testing Laboratories

To help ensure the quality of materials being used in infrastructure projects, the Bureau of Research and Standards (BRS) of the DPWH or the Department of Science and Technology (DOST) shall accredit, in accordance with industry guidelines, the testing laboratories whose services are engaged or to be engaged in infrastructure projects. All government infrastructure project Employers must accept results of material test(s) coming only from DOST/BRS - Accredited Laboratories.

4.2.3 Submittals

a) Shop Drawings and Erection Drawings

The Contractor shall submit shop drawings and erection drawings for formwork and scaffolding at least 14 days prior to commencing the works.
The contractor shall submit bar lists, bending schedules and details of all reinforcing steel, including weights.
Each shop drawing and erection drawing shall bear the signature of a Contractor's qualified Engineer. Details of all proposed formwork to be fabricated and formwork to produce special finishes shall be submitted to the Engineer for approval before any materials are ordered. If the Engineer so requires, samples of proposed formwork shall

be constructed and concrete placed at the Contractor's expense so that the proposed methods and finished effect can be demonstrated.
Reproductions of contract drawings are unacceptable.

i. Shop Drawings for Reinforcing Steel shall conform to ACI 315 and shall provide and show bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing rods.
ii. Shop Drawings for Formwork shall conform to ACI 347 and shall include design calculations indicating arrangement of forms, sizes and grade of supports (lumber), panels, and related components. The shop drawings shall show placement schedules, construction, and location and method of forming control joints. The shop drawings shall include locations of inserts, pipe work, conduit, sleeves, and other embedded items. Furnish drawings and descriptions of shoring and re-shoring methods, proposed for suspended slab, spandrel beams, and other horizontal concrete members. Furnish schedule of form removal of structures not included in paragraph entitled "Removal of Forms".
iii. Shop Drawings for Construction Joints shall conform to ACI 318 and the drawings shall clearly indicate sequence of pouring for all footings, columns, beams and slabs.

b) Contractor Mix Design

Thirty days minimum prior to concrete placement, the Contractor shall submit a mix design for each strength and type of concrete. Furnish a complete list of materials including type, brand, source and amount of cement and admixtures, applicable reference specifications and copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Submit additional data regarding concrete aggregates if the source of aggregate changes.

c) Certified Laboratory Test Results

Before delivery of materials, certified copies in 5 copies of the reports of all tests required in referenced publications or otherwise specified herein shall be submitted to and approved by the Engineer. The testing shall have been performed within one year of submittal of the test reports for approval by an independent laboratory approved by the Engineer. Test reports on previously tested materials shall be accompanied by notarized certificates from the manufacturer certifying that the previously tested material is of the same type, quality, manufacture, and make as that proposed for use in this project. Certified test reports are required for the following:

i. Aggregates,
ii. Reinforcement, and Cement.

d) Certificates of Compliance

The Certificates of Compliance shall be submitted for the following:

i. Chemical compounds and materials for curing concrete,
ii. Joint sealant,
iii. Joint filler,
iv. Vapor barrier, and
v. Admixtures.

e) Catalogue Data

The Catalog Data shall be submitted for the following:

i. Chemical compounds and materials for curing concrete,
ii. Joint sealant,
iii. Joint filler,
iv. Vapor retarder (barrier), and

v. Admixtures.

4.3 Products

4.3.1 Concrete

Contractor-Furnished Mix Design shall be in accordance with ACI 211.1 and ACI 301. Unless indicated otherwise in the drawings, the following shall apply:

Unless otherwise specifically provided, concrete for structures exposed to salt or brackish water shall be Class AAA for concrete placed under water and Class A for concrete above water and shall conform to the construction requirement and formwork removal of section 8.6.6 of AASHTO Standard Specification for Highway and Bridges 17th Edition 2012

To address the concrete cracking cause by the generation of heat from the hydration of cement and attendant volume change, concrete of Class AAA and Class A, 460mm thick or more, shall conformed to the requirements of ACI 301-10 Section 8 Mass Concrete and ACI 207.2R-07 Report on Thermal and Volume Change Effects on Cracking of Mass Concrete

Table 4.3.1-1 Concrete Mix Design

LRT LINE 1 – Depot Structures	Concrete Class	28-Day Compressive Strength (MPa)	Maximum Agg Size (mm)	Slump (mm)
Retaining wall along the river banks and property lines at Zapote Satellite Depot:	AAA	34.5	20	50-100
Retaining wall at Baclaran Expansion Depot	A	27.6	20	50-100
Bored Pile	AA	31.0	25	50-100
Underground Tanks	A	27.6	20	50-100
Pile caps	A	27.6	20	50-100
Footings	A	27.6	20	50-100
Footing Tie Beams	A	27.6	20	50-100
Columns	A	27.6	20	50-100
Pedestals	A	27.6	20	50-100
RC Wall	A	27.6	20	50-100
Suspended Beams	A	27.6	20	50-100
Suspended Slabs	A	27.6	20	50-100
Underground Pit (inside bldg)	A	27.6	20	50-100
Aboveground Tanks	A	27.6	20	50-100
Drainage Structures	A	27.6	20	50-100
Manholes and Trenches	A	27.6	20	50-100
Equipment pads	A	27.6	20	50-100
Precast Concrete Members	A	27.6	20	50-100
Transition Slab	A	27.6	20	50-100
Slab on grade	B	24.1	25	50-100
PCC Pavement	C	20.7	25	50-100
Sidewalks and Ramps	C	20.7	25	50-100
Curbs and Gutters	C	20.7	25	50-100
Other Concrete (Normal use)	C	20.7	25	50-100
Lean Concrete	D	13.8	25	50-100
Driven Pile	P	34.5	20	50-100

Slump shall be between 125 mm and 150 mm when pumpcrete is adopted.
Maximum water / cement ratio shall conform to section 4.4.3.a
Concrete cover for reinforcement shall conform to section 4.4.2.e

4.3.2 Materials

a) Cement: PNS 07, Type I

Except when specifically approved by the Engineer, only one brand of cement shall be used for any individual structure. In determining the approved mix, only Portland cement shall be used. Cement which for any reason, has become partially set or which contains lumps of caked cement will be rejected. Cement salvaged from discarded or used bags shall not be used.

b) Water

Water shall be fresh, clean, and potable.

c) Aggregates

PNS 18, except as modified herein. Obtain aggregates for exposed concrete surfaces from one source. Aggregates shall not contain any substance which may be deleteriously reactive with the alkalis in the cement.

d) Non-shrink Grout

ASTM C827 non-metallic.

e) Admixtures

i. Accelerating: ASTM C 494, Type C.
ii. Retarding: ASTM C 494, Type B or D.
iii. Water Reducing: ASTM C 494, Type A or E.
iv. Air Entraining: ASTM C 260 or equivalent.

f) Materials for Forms

Materials for Forms shall be of wood, plywood, or steel. Plywood or steel forms shall be used where a smooth form finish is required. Lumber shall be square edged or tongue-and-groove board, free of raised grain, knotholes, or other surface defects and shall be used only for mass concrete in foundations. Plywood shall conform to SAO 6, Type I, Grade A or better surfaces. Steel form surfaces shall not contain irregularities, dents, or sags. (See **Sub-Clause 4.3.5**)

g) Reinforcement

Reinforcing Bars: PNS 49. All reinforcing steel shall be hot-rolled weldable deformed steel bar. Reinforcing steel shall have minimum yield strength as follows:
ϕ 12 and smaller shall be 275 Mpa (Grade 40)
ϕ 16 and larger shall be 414 Mpa (Grade 60)
Pre-stressing Steel: ASTM A416. All pre-stressing steel shall be high strength low-relaxation strand with a minimum yield strength of 1860Mpa (Grade 270)

h) Vapor Retarder (Barrier)

ASTM E1745-polyethylene sheeting, minimum 10 mil thickness.

i) Materials for Curing Concrete

i. **Impervious Sheeting:** ASTM C 171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.
ii. **Pervious Sheeting: AASHTO M 182.**
iii. **Liquid Membrane-Forming Compound:** ASTM C 309, white-pigmented, Type 2, Class B, free of paraffin or petroleum.
iv. **Liquid Chemical Sealer-Hardener Compound:** Compound shall not contain petroleum resins or waxes. Compound shall not reduce the adhesion of resilient flooring, tile, paint, waterproofing, or other material applied to concrete.

j) Expansion/Contraction Joint Filler

ASTM D 1751 or ASTM D1752.

k) Joint Sealants

i. **Horizontal Surfaces** (3 percent slope, maximum)

1. Outside Buildings: ASTM D1190.
2. Inside Buildings: ASTM D1190 or ASTM D1850.

ii. **Vertical Surfaces** (greater than 3 percent slope)

ASTM C 920, Type M, Grade NS, Class 25, Use T.

l) Water stop

ASTM D 412-06, neoprene hi-tensile rubber water stop, 150 mm wide x 6mm thick, dumbbell with center bulb type.

4.3.3 Delivery, Storage and Handling of Materials

a) Cement

The Contractor shall ensure that the arrangement for the storage of the cement on the Site of production as hereinafter specified is sufficient for the segregation and identification of each consignment until the results of sampling and testing referred to in **Sub-Clause 4.2.2d** Cement Testing are available.

Cement shall be delivered to the Site in bulk or in sound and properly sealed bags and while being loaded or unloaded and during transit to the concrete mixers whether conveyed in vehicles or in mechanical means, cement shall be protected from the weather by effective coverings. Efficient screens shall be supplied and erected during heavy winds.

If the cement is delivered in bulk, the Contractor shall provide approved silos of adequate size and numbers to store sufficient cement to ensure continuity of work and the cement shall be placed in these silos immediately after it has been delivered to the Site. Approved precautions shall be taken during unloading to ensure that the resulting dust does not constitute a nuisance.

If the cement is delivered in bags, the Contractor shall provide, at his own cost, perfectly waterproofed and well-ventilated sheds having a floor of wood or concrete raised at least 0.5m above the ground. The sheds shall be large enough to store sufficient cement to ensure continuity of the work and each consignment shall be stacked separately therein to permit easy access for inspection and approval. Upon delivery, the cement shall at once be placed and shall be used in the order in which it has been delivered.

All cement shall be used within two months of the date of manufacture. If delivery conditions render this impossible, the Engineer may permit cement to be used up to three months after manufacture, subject to such conditions including addition of extra cement, if necessary.

b) Aggregate

All fine and coarse aggregates for concrete shall be stored on close fitting, steel or concrete storage of approved design with drainage slopes or in bins of substantial construction in such manner as to prevent segregations of sizes and to avoid the inclusion of dirt and other foreign materials in the concrete. All such bins shall be emptied and cleaned at intervals of every six months or as required by the Engineer. Each size of aggregate shall be stored separately unless otherwise approved by the Engineer.

Stockpiles of coarse aggregate shall be built in horizontal layers not exceeding 1.2 m (4 feet) in depth to minimize segregation.

c) Reinforcement

Reinforcement of different sizes shall be stored in racks, raised above the ground with accurate identification. Reinforcing steel shall be protected from contaminants such as grease, oil, and dirt.

d) Admixtures

Admixtures shall be stored in a manner that will not damage the containers.

4.3.4 Tolerance

The surface of all concrete members after the formwork has been struck shall not vary from the dimension shown on the Drawings by more than the tolerance given below, all in compliance with ACI 347.

a) The distance between the axis of two adjacent columns shall not exceed ±10 mm.

b) No column face shall exceed ±5 mm in relation to the corresponding faces of the two adjacent columns in the same vertical plane.

c) Vertical concrete members shall not exceed ±10 mm from the plumb in a height not exceeding 4.50 m, ±12 mm in height over 4.50 m and not exceeding 6 .00 m, and ±15 mm in a height over 6.00 m.

d) The horizontal elevations of concrete members shall not exceed ±10 mm. The sum in absolute value, of the height differences of the three points on any excessive support shall not exceed 5 mm. Wall and slab surface shall not exceed 3 mm from the true line under 1.00 m straight edge and 10 mm under 3.00 m straight edge. No minus tolerance is permitted.

e) The cross-sectional dimension of all concrete members to be covered shall not exceed ±6 mm, and for all exposed members ±3 mm. No minus tolerance is permitted.

Particular care must be taken to obtain accurate cross section and thicknesses.
The Engineer may order the Contractor to cut back, make good or cut out at his own expense poured concrete that does not conform to the above tolerances.
To avoid undue delay and expense, the dimensions of all members shall be checked after removing the formwork and the Engineer shall be informed immediately of any discrepancies.

4.3.5 Forms (ACI 301)

a) General Requirements

Forms shall be provided for all concrete not indicated or specified otherwise which shall conform to ACI 301. Forms shall be set true to line and grade and maintained so as to insure completed work within the allowable tolerance specified, and shall be mortar-tight. The Contractor shall be responsible for the adequacy of forms and form supports. Bolts and rods used for internal ties shall be arranged so that when the forms are removed, all metals will have concrete cover not less than that indicated in the drawings. Bolts or rod type form ties that must be removed when forms are removed shall not be used for watertight forms. Wire ties shall not be used where the concrete surface will be exposed to weathering and where discoloration will be exposed. All formwork shall be provided with adequate clean-out openings to permit inspection and easy cleaning after all reinforcement has been placed. Where forms for continuous surfaces are placed in successive units, the forms shall be fitted over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Panel forms shall be constructed to provide tight joints between panels. All forms shall be constructed so that they can be removed without damaging the concrete. All exposed joints, edges, and external corners shall be chamfered a minimum of 20 mm unless specified otherwise herein. Forms for heavy girders and similar members shall be constructed with a proper camber as indicated.

b) Materials for Forms

As laid down in **Sub-Clause 4.3.2f** of this Technical Specification forms shall be of wood, plywood, or steel. Wood forms for surfaces exposed to view in the finished structure and requiring a smooth form finish, shall be plywood. For mass concrete in foundations, undressed square-edge lumber may be used. Forms for surfaces requiring special finishes shall be plywood, or shall be lined with plywood, a non-absorptive, hard-pressed fiberboard, absorptive-type lining or other suitable material. Plywood, other than for lining, shall be concrete-form plywood not less than 16 mm thick, free of raised grain, torn surfaces, worn edges, patches, or other surface defects, which would impair the texture of the concrete surface. Surfaces of steel forms shall be free from irregularities, dents, and sags.

c) Coating

Before placing the concrete, the contact surfaces of forms shall be coated with a non-staining mineral oil or suitable non-staining form coating compound or shall be given two coats of nitrocellulose lacquer, except as specified otherwise. Mineral oil shall not be used on forms for surfaces that are to be painted. For surfaces not exposed to view in the finished structure, sheathing may be wetted thoroughly with clean water. All excess coating shall be removed by wiping with cloths. Reused forms shall have the contact surfaces cleaned thoroughly; those that have been coated shall be given an additional application of the coating. Plaster waste molds shall be sized with two coats of thin shellac or lacquer and coated with soft or thinned non-staining grease.

d) Tolerance and Variations

The Contractor shall set and maintain concrete forms to ensure that, after removal of the forms and prior to patching and finishing, no portion of the concrete work will exceed any of the tolerances specified. Variations in floor levels shall be measured before removal of supporting shores. The Contractor shall be responsible for variations due to deflection, when the latter results from concrete quality or curing, other than that which has been specified. The tolerances specified in **Sub-Clause 4.3.4** of this Technical Specification shall not be exceeded by any portion of any concrete surfaces; the specified variation for one element of the structure will not be applicable when it will permit another element of the structure to exceed its allowable variations. Except as otherwise specified herein, tolerances shall conform to ACI 347.

4.3.6 Accessories

Reinforcement accessories, consisting of bar supports, spaces, hangers, chairs, ties, and similar items as required for spacing, assembling, and supporting reinforcement in place shall be provided; conforming to CRSI referenced standards and the following requirements:

a) For footings, grade beams, and slabs on grade, provide supports with precast concrete or mortar bases or plates or horizontal runners where wetted base materials will not support chair legs;
b) For exposed-to-view concrete surfaces, where legs of supports are in contact with forms or are in close proximity to finish surfaces, provide supports with legs which are galvanized, plastic-protected, or stainless steel; and
c) For epoxy-coated reinforcement, provide accessories which are nylon-epoxy, or plastic coated.

4.3.7 Tie Wire

Tie wire shall be plain, cold drawn annealed steel wire, 0.46 mm diameter and shall comply with Philippine Bureau of Standards SAO No. 69-1 Series of 1977.

4.3.8 Joining Materials

Joint Filler shall be pre-molded, of sizes and thicknesses indicated, and conforming to ASTM D994, ASTM D1751, or ASTM D2628. For structural joints and joints subject to movement, joint filler conforming to ASTM D2628 shall be provided.

4.3.9 Construction Joints

a) Construction joints shall be prepared and constructed and water stops installed in accordance with the applicable requirements of ACI 301, Section 2, and ACI 304R, Section 6 and ACI 224.3R.

b) Make construction joints straight and as inconspicuous as possible, and in exact vertical and horizontal alignment with the structure, as the case may be.

c) Approved key, at least 40mm in depth, shall be used at all joints, unless otherwise indicated.

d) Thoroughly clean the surface of the concrete at construction joints and remove laitance prior to placing adjoining concrete. As an allowance for shrinkage, do not place concrete against the hardened side of a construction joint for at least 12 hours.

e) Reinforcement shall be continuous across construction joints.

f) Where bonding of the joint is required, use epoxy adhesive specified and apply in accordance with ACI 504R.

g) Joints not indicated shall require the prior approval of the Engineer.

h) Forms shall be retightened and concrete surfaces dampened before placing of concrete is continued.

4.3.10 Structural Lightweight Concrete

Structural lightweight concrete fill on steel deck shall be in accordance with ACI 213R, ACI 211.2, and shall have a density of 1,600 kg/m3 of the hardened concrete. Fine lightweight aggregates shall be composed of expanded minerals, properly graded, with 85-100% passing the 5 mm (3/16 in) screen, having a dry loose bulk density less than 1120 kg/m3 (70 lb/ft3). The expanded aggregates shall exhibit small-size well-distributed non-interconnected pores produced from suitable natural deposit of shale, clays or slates, or as by-products of other industries, such as iron blast furnace slag or fly ash from the burning of powdered coal in thermoelectric plants.

4.3.11 Epoxy-Resin Base Bonding Systems

Specified systems shall be in conformity to ASTM C881-90 with Type II adhesive for non load bearing concrete and Type V for load bearing concrete.

4.4 Execution

4.4.1 Formwork

a) General Requirements

The Contractor shall construct formwork in accordance with approved shop drawings and maintain tolerance of finished concrete work as specified in **Sub-Clause 4.3.4.** (Also, See **Sub-Clause 4.3.5d**)

Forms shall be installed so that they can be removed without shock or vibration to the concrete. No part of any metal tie or spacer remaining permanently embedded in the concrete shall be nearer than 50mm to finished surface and the cavity shall be so formed as to permit satisfactory filling as specified hereafter.

All joints shall be closed tightly to prevent leakage of cement grout. At construction joints the Contractor shall secure the formwork tightly against previously cast or hardened concrete to prevent ridges to expose surfaces.

The Contractor shall make allowances in setting the forms for any deflections that will occur during the placing of concrete within the forms. The Contractor shall make panels with true edges to permit accurate alignment and provide a neat line with adjacent panels and at all construction joints and fix all panels with joints either vertical or horizontal, unless otherwise specified or approved.

All exposed corners both horizontal and vertical shall be chamfered 25 mm x 25 mm. Chamfer fillet shall be accurately cut to size to provide smooth and continuous chamfer.

Install conduit, pipe sleeves, boxes, and frames for items recessed in walls, door frames, and drains and fastening devices for anchorage attachment of other work. Secure products in position prior to concrete placement. Use dovetail anchor slots for positions where masonry walls will be tied to the concrete construction.

b) Preparation of Form for Concreting

Before concrete is placed, the Contractor shall clean the form thoroughly and remove sawdust, shavings, dust or other debris by hosing with water and compressed air and provide temporary openings to assist in removal of the water and rubbish.

Forms shall be coated with approved form oil, which shall not bond with stain or adversely affect concrete surfaces. Surplus coating on form surfaces and coating on reinforcing steel and construction joint shall be removed before placing concrete.

All formwork shall be inspected and approved by the Engineer before concrete is placed within it, though, this shall not relieve the Contractor from the requirements as to soundness, finish and tolerances of the concrete specified.

c) Removal of Formwork

Forms shall be removed in such a manner that will not damage the concrete. No forms shall be removed until the concrete has gained sufficient strength to support itself. Scaffolding may be removed when the member being supported has gained sufficient strength to carry itself and the load to be supported on it with a reasonable factor of safety. The following table is a guide to the minimum periods that must elapse between the completion of the concreting operations and the removal of formwork. Notwithstanding this table, no scaffolding shall be removed without the permission of the Engineer and such permission shall not relieve the Contractor of his responsibilities for the safety of the permanent works.

Minimum stripping and striking times shall be as follows unless otherwise approved by the Engineer:

Table 4.4.1 Formwork

Conditions	Minimum Periods	Remarks
Forms for walls and columns, lift not exceeding 4.2 m	1 day	see note 1 below
Forms for walls and columns, lift exceeding 4.2 m	2 days	see note 1 below
Side forms of beams, girders and other vertical surfaces	1 day	see note 1 below
Floor Slab soffit	10 days	see note 2 below
Beams and Girders soffit : Not exceeding 6m clear span	14 days	see note 2 below
Beams and Girders soffit : Over 6m clear span	21 days	see note 2 below

For concrete beams, girders, slabs and other structural members supporting construction loads, shoring supports for these members shall not be removed until in-place strength of concrete is at least equal to f'c , the specified compressive strengths of concrete at 28th days.

Note 1. Where such forms also support formwork for slab or beam soffits, the removal times of the latter should govern.

Note 2. Where forms can be removed without disturbing shores, use half of the value shown

4.4.2 Reinforcement and Miscellaneous Materials

General Requirements: All reinforcement bars, stirrups, hanger bars, wire fabric, spirals and other reinforcing materials shall be provided as indicated in the approved shop drawings to be prepared by the Contractor in accordance with DPWH Standard or required by this specification, together with all necessary wire ties, chairs spacers, supports and other devices necessary to install and secure the reinforcement properly. All reinforcement, when placed shall be free from rust, scale, oil, grease, clay, and other coatings and foreign substances that would reduce or destroy the bond. Rusting of reinforcement shall not reduce the effective cross sectional area to the extent that the strength is reduced beyond specified values. Heavy, thick rust or loose, flaky rust shall be removed by rubbing with burlap or other approved method, prior to placing. Reinforcement which has bends not shown on the Drawings or on approved shop drawings, or is reduced in section by rusting such that its weight is not within permissible ASTM tolerances, shall not be used. Unless directed otherwise by the Engineer, reinforcement shall not be bent after being partially embedded in hardened concrete. Detailing of reinforcement shall be in accordance with ACI 315. Where cover over reinforcing is not specified or indicated it shall be in accordance with ACI 318

a) Bending and Splicing

Reinforcement shall be fabricated to shapes and dimensions shown and shall be placed where indicated on the approved shop drawings.
Reinforcement shall not be bent or straightened in a manner injurious to the steel or concrete. The use of heat to bend or straighten reinforcement shall not be permitted. Bars that develop cracks or splits shall be rejected and replaced. Reinforcement Splices shall conform to ACI 318. Lap lengths shall be not less than 36 times the reinforcing bar diameter or as shown on the Drawings. All laps shall be staggered or be made at points where steel stress has fallen to less than half the allowable stress. Where laps shall not be staggered or be made at points of reduced stress, lap lengths shall be increased by 30%. Where splices in addition to those indicated on the drawings are necessary, they shall be approved by the Engineer prior to their use. Splices shall not be made in beams, girders and slabs at points of maximum stress. Lap splices shall not be used for bars larger than 36 mm Ø. Welded or mechanical splices shall be used for these bars. Welded splices when used shall conform to AWS D1.4-98. Certification of weldability of the reinforcement by the manufacturer shall be submitted, to the Engineer. If butt splices are used the Contractor shall ensure the splices meet the requirements specified herein by performing at least three splices to be submitted for testing in a testing laboratory that has been approved for such testing by the Engineer.

b) Placing

The Contractor shall maintain the number, size, form and position of all steel reinforcing bars, ties, links, stirrups and other parts of the reinforcement exactly in accordance with the Drawings and keep them in the correct position and with the required cover without displacement during the process of compacting the concrete in a manner approved by the Engineer.
All necessary distance pieces and space bars shall be provided to maintain the reinforcement in the correct position in accordance with **Sub-Clause 4.4.2g** of this Technical Specification
The type of distance pieces shall be subject to the approval of the Engineer. Timber blocks for wedging the steel off the formwork shall not be allowed. Any ties, links or stirrups connecting the bars shall be tight so that the bars are properly braced and the inside of hooks and bends shall be in actual contact with the bars around which they are intended to fit.
Reinforcement shall be supported by suitable chairs or spacers or by metal hangers. On the ground, and where otherwise subject to corrosion, concrete or other suitable non-corrosive materials shall be used for supporting reinforcement.

Tolerances and Variations: The minimum concrete cover for reinforcement specified in the contract documents takes precedence over all permissible reinforcement placement variations, nothing in the variations listed below is construed as permitting violation or compromise thereof:

Table 4.4.2-1 Tolerance and Variations

Height of bottom bars	plus or minus 6 mm above form
Lengthwise positioning	plus or minus 50 mm of bars
Spacing of bars in walls	plus or minus 25 mm and solid slabs
Spacing of bars in beams and footings	minus 0 plus 6 mm
Height of top bars	minus 0 plus 6 mm
Stirrup spacing: For any one stirrup For overall group of Stirrup	 plus or minus 25 mm plus or minus 25 mm

c) Tying and Cleaning

Tie reinforcement where spacing in each direction is:

i. Less than 300 mm - tie at alternate intersection
ii. 300 mm or more - tie at each intersection

Reinforcing bars shall be cleaned before placing concrete.

d) Exposed Reinforcing Bars, Dowels and Plates

Exposed reinforcing bars, dowels and plates intended for bonding with future extensions shall be protected from corrosion.

e) Concrete Cover for Reinforcement

The minimum net concrete cover of reinforcement shall be as indicated on the Drawings or as specified.

Table 4.4.2-2 Minimum Concrete Cover Requirement

	Minimum Net Concrete Cover in Depot Area
i. Concrete cast against and permanently exposed to earth	75 mm
ii. Concrete exposed to earth, liquid, weather, or bearing or work mat or slabs supporting Earth cover:	
Slab	50 mm
Beams and Columns:	
Stirrups, spirals, and ties	50 mm
Primary reinforcement	65 mm
Walls	50 mm
Footings and base slabs:	
Formed surfaces	50 mm
Top of footings and base slabs	50 mm

iii. Condition not covered in 4.4.2.e (i) and (ii)	
Slab	20 mm
Beams and Columns:	
Stirrups, spirals, and ties	40 mm
Primary reinforcement	50 mm
Walls	40 mm
iv. Concrete bored pile	100 mm
v. Concrete exposed to salt water	
Retaining wall	100 mm

f) Inspection Before Placing Concrete

No concrete shall be placed until the Engineer or his authorized representative has inspected and approved in writing reinforcement work in place. The Contractor shall allow a minimum of 24 hours for the Engineer's inspection, correction of deficiencies and re-inspection before placing concrete.

g) Wire-Mesh, Dowels, Tie-Bars and Supports

i. Wire-mesh reinforcement shall be continuous between crack control joints in slabs on grade and shall be continuous between expansion joints in other slabs. Laps shall be at least one full mesh plus 50 mm staggered to avoid continuous lap in either direction and securely wired or clipped with standard clips.

ii. Tie bars on grade shall be placed at right angles to construction joints. Tie bars shall be accurately aligned parallel to the finished surfaced, and shall be rigidly held in place and supported during placing of the concrete.

iii. Supports shall be provided in conformity with ACI 318 unless otherwise specified. Wire ties, when used, shall be of 16-gauge annealed wire and shall have end pointing away from the forms.

For Slabs on Grade:
Reinforcement shall be supported on precast structure units spaced at intervals required by size of reinforcement used, to keep the reinforcement to the minimum height specified or indicated above the underside of slab or footing.
For Slabs other than on Grade:
Supports for which any portion will be less than 25 mm from concrete surface that will be exposed to view or painted shall be plastic-coated steel conforming to ACI 315, stainless steel, precast concrete units or plastic.

h) Setting Miscellaneous Embedded Material:

Anchors and bolts, including but not limited to those for machine and equipment bases; frames or edgings, hangers and inserts, door bucks, pipe supports, pipe sleeves, pipes passing through walls, metal ties, conduits, flashing, drains and other materials in connection with concrete construction shall, where practicable be placed and secured in position when the concrete is placed.

4.4.3 Reinforced Cement Concrete

a) Classes of Concrete and Their Usage

i. Strength Requirement

Concrete or various classes unless specified in other Sections or indicated on the Drawings or directed by the Engineer shall be proportioned and mixed to achieve the following strengths:

Table 4.4.3-1 Reinforced Cement Concrete

Concrete Class	Specified Min. Compressive Strength - 28 Days fc' - N/mm2 (MPa)	Maximum water / cement ratio
AAA	34.5	0.40
AA	31.0	0.45
A	27.6	0.45
B	24.1	0.45
C	20.7	0.45
P	34.5	0.45
D	13.8	-
(Note: MPa = Mega Pascal)		

ii. Usage and Applications

The concrete of various classes shall be used as follows unless otherwise specified in other Sections or shown on the Drawings or directed by the Engineer:

Grade	**Applications**
Class AAA concrete	For concrete exposed to saltwater
Class AA concrete	For concrete bored piles
Class A concrete	For reinforced concrete on buildings, concrete tank Precast concrete member
Class B concrete	For slab on grade
Class C concrete	For pavement, sidewalk, ramps, curb and gutter
Class D concrete	For leveling
Class P concrete	For prestressed concrete, driven pile

b) Proportioning of Concrete Mixes

i. Trial Design Batches and Testing

Trial design batches and testing to meet requirements of the classes of concrete specified shall be the responsibility of the Contractor. The design mix shall be of consistencies specified in this sub-section. The tests for unit weight, and air content shall be performed in the field in the presence of the Engineer.

ii. Entrained-Air Content

Air entrainment, if approved by the Engineer, shall be produced by adding an air-entraining agent at the mixer. The air content in concrete by volume shall be maintained at 5-7% as determined by ASTM C 233.

iii. Concrete Proportioning

Samples of approved aggregates shall be obtained in accordance with the requirements of ASTM D 75. Samples of materials other than aggregate shall be representative of those proposed for the work and shall be accompanied by the manufacturer's test reports indicating compliance with applicable specified requirements.

Trial mixes having proportions, consistencies and air content suitable for the work shall be made based on ACI Standard 211.1 using at least three different water-cement ratios which will produce a range of strength encompassing those required for the work. Trial mixes shall be designed for maximum permitted slump and air content.

For each water-cement ratio, at least three cylinders for each test age shall be made and cured in accordance with ASTM C 39. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength.

iv. Required Average Strength

For each portion of the structure, proportions shall be selected so that the maximum permitted water-cement ratio is not exceeded and so as to produce an average strength to exceed the specified strength fc' by the amount indicated below. Where production facility has a standard deviation record determined in accordance with ACI 214, based on 30 consecutive strength test of similar mixture proportions as proposed, it shall be used in selecting average strength.
Required average compressive strength when data are available to establish a sample standard deviation (ss)

Table 4.4.3-2 Average Compressive Strength (Data Available)

Specified Compressive Strength, fc' (MPa)	Required Average Compressive Strength, f'cr (MPa)
fc' ≤ 34.5	f'cr = fc' + 1.34 ss f'cr = fc' + 2.33 ss – 3.5. Use the larger value between the two
fc' > 34.5	f'cr = fc' + 1.34 ss f'cr = 0.90fc' + 2.33 ss Use the larger value between the two

Required average compressive strength when data are not available to establish a sample standard deviation (ss)

Table 4.4.3-3 Average Compressive Strength (Data Not Available)

Specified Compressive fc' (MPa)	Required Average Compressive Strength, f'cr (MPa)
fc' < 20.7	f'cr = fc' + 6.9
20.7 ≤ fc' ≤ 34.5	f'cr = fc' + 8.3
fc' > 34.5	f'cr = 1.1 fc' + 4.8

c) Test for Slump

Test shall be made in conformity with ASTM C 143, and unless otherwise specified by the Engineer, the results of the slump test shall be within the following limits:

Table 4.4.3-4 Structural Elements Slump for Vibrated Concrete

	Minimum	**Maximum**
Pavement concrete	25 mm	50 mm
Precast concrete	50 mm	70 mm
Wall, column and beam 25 cm. Max. beam	50 mm	70 mm
Other concrete	50 mm	90 mm
Lean concrete	100 mm	200 mm
Pumped concrete	70 mm	120 mm

d) Batching and Mixing

i. Batching

The Contractor shall provide the concrete from a semi-automatic or enhanced batching plant and concrete mixing equipment having a sufficient capacity to satisfy concrete placement requirements.

ii. Concrete Mixers

Concrete mixers shall be stationary mixers, transit mixers, or paving mixers of approved design.
The mixers shall have a rated capacity of at least 0.76 m3 of mixed concrete, and shall not be charged in excess of the capacity recommended by the manufacturer. Mixer shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. Stationary and paving mixers if used shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed.

e) Concrete Placing

i. Preparation for Placing

Hardened concrete, debris and foreign materials shall be removed from the interior of forms and from the inner surface of mixing and conveying equipment. Reinforcement shall be secured in position, and shall be inspected, and approved by the Engineer, before placing concrete.
Forms splashed with concrete and reinforcement splashed with concrete or form coating shall be cleaned in advance of placing subsequent lifts.

ii. Handling

Concrete shall be handled from mixer and transported to place of final deposit in a continuous manner, as rapidly as practicable, and without segregation or loss of ingredients until the scheduled concrete placing is completed. Placing will not be permitted when limitations of facilities furnished by the Contractor prevent proper finishing and curing of the concrete. Concrete shall be placed in the forms, as close as possible in final position, in approximately uniform horizontal layers not over 300 mm deep.

iii. Concrete Temperature and Hot Weather Concreting

Temperature of concrete during the period of mixing, transport, and or placing shall not be permitted to rise above 32 degrees C. Any batch of concrete, which had reached a temperature greater than 32 degrees C in the aforesaid period shall not be placed but rejected, and shall not thereafter, be used in any part of the permanent works.
Water cooler facilities and procedures to control or reduce the temperature of cement, aggregates and mixing-handling equipment to such temperature that, at all times during mixing, transporting, handling and placing, the temperature of the concrete shall not be greater than 32 degrees C shall be provided.
Where cold joints tend to form or where surfaces set and dry too rapidly or plastic shrinkage cracks tend to appear, concrete shall be kept moist by fog sprays, or other approved means, applied shortly after placement, and before finishing.
When the aforementioned precautions are not sufficient to satisfy these requirements, they shall be supplemented by restricting work to evening or night. Procedures shall conform to ACI 305.

iv. Placing Concrete

The Contractor shall provide construction joints to ensure that the maximum single pour does not exceed 250 m^2 or 20 m in any one direction. Shrinkage crack control shall be provided with 3 mm x 50 mm deep concrete saw cuts at locations shown on the Drawings or not more than 4 m c/c. Saw cuts shall be made within 3 hours of initial set.
If pumping is authorized by the Engineer, the Contractor shall:

1. Arrange equipment such that there are no vibrations, which might damage freshly placed concrete,

2. Operate pump so that a continuous stream of concrete without air pockets is produced, and
3. When pumping is discontinued and concrete remaining in pipeline is to be used, pipeline shall be cleaned in a manner that prevents contamination of concrete or separation of ingredients.

Unless otherwise specified, concrete shall be consolidated with high-speed internal vibrators.

Concrete shall be placed in the positions and sequences indicated on the construction method statement approved by the Engineer. Except where otherwise directed, concrete shall not be placed unless the Engineer is present and has previously examined and approved the positioning, fixing and conditions of reinforcement and any other items to be embedded and the cleanliness, alignment and suitability of the containing surfaces of formwork.

Placing Concrete in Water

The placing of concrete under water shall not be permitted except where agreed by the Engineer.

In placing under water, concrete shall not be dropped into or through the water but shall be carefully placed in position by means of bottom dumping bucket or tremie, or by continuous discharge by pump through pipes leading from the mixer. Full details shall first be submitted to the Engineer for his approval.

The surface of the concrete deposited under water shall be kept as nearly horizontal as possible and at no time shall concrete be placed in running water or in water liable to be disturbed by pumping. Placing shall be such as to require the minimum amount of spreading. Tamping to such an extent that segregation takes place, shall be avoided. Sufficient time shall be allowed for concrete to set before it is subjected to any form of loading and also to ensure that it shall suffer no damage from subsequent pumping or dewatering operations.

Concreting in Adverse Weather

No concreting shall be allowed to take place in the open during storms or heavy rains. In places where such conditions are likely to occur, arrange for adequate protection of the materials, plant and formwork so that the work may proceed under proper cover. Where strong winds are likely to be experienced; additional precautions shall be taken to ensure protection from rain and dust.

f) Compaction

Immediately after placing, each layer of concrete shall be compacted by internal concrete vibrators supplemented by hand spading, rodding, and tamping. Tapping or other external vibration of forms will not be permitted unless specifically approved by the Engineer. Vibrators shall not be used to transport concrete inside the forms.
Internal vibrators submerged in concrete shall be maintained at speed of not less than 7,000 impulses per minute. The vibrating equipment shall at all times be adequate in number of units and power to properly consolidate all concrete.
Spare units of vibrating equipment shall be on hand as necessary to insure such adequacy.
Duration of use of vibrating equipment shall be limited to the time necessary to produce satisfactory consolidation without causing objectionable segregation. The vibrator shall not be inserted into lower courses that have begun to set.
Vibrators shall be applied vertically at uniformly spaced points not further apart than the visible effectiveness of the machine.

g) Joints

i. General

No reinforcement, or other fixed metal items shall be run continuous through joints containing expansion-joint filler, through crack-control joints in slabs on grade and vertical surfaces.

ii. Construction Joints

Concrete shall be poured continuously up to construction joints, the position and arrangement of which shall be as indicated on the Drawings or as previously approved by the Engineer.
Work shall be made beyond ordinary working hours where necessary in order that each section of concrete may be completed without any lapse while the work is in hand.
All construction joints shall be formed square to the work. Keyways shall be formed in all horizontal and vertical construction joints except where ordered to be omitted by the Engineer. When the work is resumed on a surface, which has set, the whole surface shall be roughened or scrabbled by suitable tools so that no smooth skin of concrete remains may be left. Roughened surfaces shall be cleaned though by compressed air and water jets or other approved means and brush with water immediately before depositing concrete.

iii. Design Joints

The Contractor shall make construction joints, where specified, as deliberated planes of discontinuity in the concrete structure. To form such a joint, the face of the concrete slab or block first formed shall be painted with two coats of approved rubber bitumen paint before the adjoining slab or block is concrete.

iv. Expansion Joints

The Contractor shall make expansion joints in the same way as construction joints, but, in addition, an approved compressible sheet or filler shall be supplied and placed in the joint to provide freedom for two adjacent concrete slabs or blocks to expand. In certain situations, a highly compressible joint of expanded polyethylene or other approved material shall be used. The exposed edges of the joints shall be sealed with the specified resilient sealing compound or similar approved product.

v. Joint Sealing

1. For preparation of joint sealing, the Contractor shall:
   Remove dust, paint, loose mortar and other foreign matter. Dry joint surfaces,
   Prepare concrete and metal surfaces to sealant manufacturer's instructions.
   Install joint backing to achieve correct joint depth,
   Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking,
   Apply bond breaker tape where required by manufacturer's instructions, and prime sides of joints to sealant manufacturer's instructions immediately prior to caulking.
2. For application of joint sealing, the Contractor shall:
   Apply sealant, primers, joint backfilling, bond breakers to manufacturer's instructions and apply sealant using gun with proper size nozzle.
   Use sufficient pressure to fill voids and joints solid. Superficial pointing with skin bead shall not be acceptable.
   Form surface with sealant of full bead, smooth, free from ridges, wrinkles, sags, air pockets, and embedded impurities. Neatly tool surface to a slight concave joint, and

Clean adjacent surfaces immediately and leave work neat, clean and remove excess sealant and droppings using recommended cleaners.

h) Finishes of Concrete

i. General Provision

No remedial work on concrete surfaces shall be commenced before the concrete has been inspected by the Engineer and approval given for the repair or finishing work to proceed.

As soon as the forms are removed, surface defects shall be remedied as specified herein. Fine and loose material shall be removed. Honeycomb, aggregate pockets, voids over 12 mm in diameter, and holes left by the rods or bolts shall be cut out to solid concrete, reamed, thoroughly wetted, brush-coated with neat cement grout, and filled with mortar.

Cement mortar for patching shall be the same composition as that used in the concrete, except that for exposed surface, part of the cement shall be white Portland cement so as to provide a finished color, matching the surrounding concrete. The mortar shall be mixed approximately 1-part Portland Cement to not more than 2-parts fine aggregate passing the No. 16 mesh sieve, and minimum amount of water. Mortar shall be thoroughly compacted in place. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through to the outside face. Other holes, if any, shall be packed full; patchwork shall be finished flush and the same plane as adjacent surfaces. Exposed patchwork shall be finished to match adjoining surface in texture and color. Patchwork shall be damp cured for 72 hours.

ii. Concrete Finish for Slab

1. Slabs Receiving Concrete Topping
   After concrete is placed and consolidated, slabs shall be screeded or struck off. No further finish is required.
2. Smooth Finish
   Smooth finish shall be required only where specified. After surface moisture has disappeared and laitance has been removed, the surface shall be finished by float and steel trowel.
3. Broom Finish
   The concrete for topping, stairs and landings shall be screeded and floated to required finish level with no coarse aggregate visible. After surface moisture has disappeared and laitance has been removed, the surface shall be float finished to an even, smooth finish. The floated surfaces shall be broomed with a fiber bristle brush in a direction transverse to the direction of the main traffic.
4. Tolerance
   Smooth and broom finished surfaces shall be true to plane with no deviation in excess of 3 mm in any direction when tested with a 3 m straight edge.

iii. Finishes of Concrete other than Floor Slabs

1. Smooth Finish

After the general provisions have been completed, smooth finish shall be given to interior and exterior concrete surfaces that are to be painted or exposed to view. Smooth finish shall consist of thoroughly wetting and then brush-coating the surfaces with cement grout composed by volume of a part Portland cement grout to not more than 2-parts fine aggregate passing the No.30 mesh sieve and mixed with water to the consistency of thick paint. White Portland cement shall be used for all or part of the cement, proportioned by trial mixes, so that the final color of grout when dry, will be approximately the same as the color of the surrounding concrete. Grout shall be cork or woo-floated to fill all pits and

or bubbles; and surface rubbed with burlap to remove any visible grout film. The grout shall be kept damp by means of fog spray during the setting period. The finish of any area shall be completed in the same day and the limits of a finished area shall be made at natural breaks in the finished surface.

2. Rough Finish

Slabs to receive fill and mortar-setting beds shall be screeded with straightedges to bring the surface to the required finish plane with no aggregate visible.

3. Broom Finish

Broom finish shall be given to exterior surfaces where specified, except concrete stair treads, entrances, and landings for buildings. The concrete shall be screeded and floated to the required finish level with no coarse aggregate visible. After the surface moisture has disappeared and laitance has been removed, surfaces shall be steel-troweled to an even, smooth finish. The troweled surfaces shall be broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.

i) Curing

i. General Provision

Concrete shall be protected adequately from injurious action by sun, rain, flowing water, and mechanical damage, and shall not be allowed to dry out from the time it is placed until the expiration of the minimum curing period of 7 days. Curing shall be accomplished by moist curing, or by application of liquid membrane-forming compound, except as specified otherwise herein. Membrane-forming compound shall not be used on surface where its appearance would be objectionable, on formed surfaces for which special finish is specified, or on any surface to be painted, waterproofed, or where coverings are to be bonded. Curing shall be initiated immediately following the removal of forms.
The temperature within closures shall not exceed 37.8 degrees C and adequate moisture shall be applied to the concrete surface during the heating period to prevent it from drying out.
When the 7-day compression-test cylinders, representative of parts of a structure already placed indicate that the 28-day strengths may be less than 90 percent of the design strengths, those parts of the structure shall be given additional curing, as directed by the Engineer.

ii. Moist Curing

Surfaces shall be covered with burlap or mats, wetted before placing and over-lapped at least 150 mm. Burlap or mats shall be kept continually wet and in close contact with the surface.

iii. Impervious Sheet Curing

All surfaces shall be thoroughly wetted with a fine spray of water and be completely covered with waterproof paper, polyethylene sheeting or with polyethylene coated burlap having the burlap thoroughly saturated with water before placing.
Covering shall be lapped not less than 300 mm and securely weighted down or shall be lapped not less than 100 mm and taped to form a continuous cover with completely close joints. Covering shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

iv. Membrane-forming Curing Compound.

Before applying the curing compound, tops of joints that receive sealant shall be tightly closed with temporary material to prevent entry of the compound and to prevent moisture loss during curing period.

The curing compound shall be applied on a damp surface as soon as the moisture film has disappeared. The curing compound shall be applied by power spraying using a spray nozzle equipped with a wind guard. The compound shall be applied in two-coat, continuous operation at coverage of not more than 10 sq.m. per liter for each coat. When application is made by hand sprayers the second coat shall be applied in a direction approximately at right angles to the direction of the first coat. The compound shall form a uniform, continuous adherent film that shall not check, crack, or peel and shall be free from pinholes or other imperfections. Surfaces subjected to rainfall within 3 hours after compound has been applied, or surface damaged by subsequent construction operations within the curing period, shall be immediately re-sprayed at the rate specified above.

Membrane forming compound shall not be used on surface that depends on adhesion of bonding to the concrete. Where membrane-forming compounds are permitted, permanently exposed surfaces shall be cured by use of a non-pigmented membrane-forming curing compounds containing a fungitive dye. Where non-pigmented type curing compounds are used, the concrete surface shall be shaded from direct rays of the sun for the duration of the curing period.

Surfaces coated with curing compounds shall be kept free of impacts from traffic, and from other causes of abrasion and contamination during the curing period.

4.4.4 Precast Concrete

Concrete members as specified shall be fabricated as precast units with concrete for the specified class placed into grout-tight mould. If so required, the mould shall be laid on a vibrating table and vibrations applied while the concrete is placed.

Permanently exposed surfaces shall have a finish provided by moulds of closely jointed steel material. The surface shall be improved by carefully removing all fins and other projections. After inspection by the Engineer, any concrete surfaces which have been accepted but contain blemishes, air holes, etc., shall be thoroughly washed down and the surface blemishes filled with a cement and fine aggregate paste matching the color of the concrete.

Surfaces, which will subsequently receive grout or concrete to complete a structural connection or other composite structural component of which the precast unit forms a part, shall be prepared for surface treatment as early as possible after casting. This preparation shall be carried out preferably when the concrete has set but not hardened, by using a fine jet spray of water or brushing with a stiff brush, sufficient to remove the outer mortar skin and to expose the larger aggregate without its being disturbed. Where this treatment is impractical, sand blasting or the use of a needle gun should be used to remove the surface skin and laitance. Hacking shall be avoided.

The Contractor may obtain precast concrete units from outside suppliers provided that they comply with the Specifications and that the Contractor obtains the Engineer's approval for each supplier.

The Contractor shall give to the Engineer full details of proposed methods of handling and stacking precast concrete units. The Engineer will examine these details and will either approve the methods or cite other modifications designed to ensure that no excessive stresses are set up in the units. The finally approved methods shall be adhered to at all times and the Contractor shall be deemed to have included in their rates for all times, measures required to handle and stack beams and units safely and without undue stressing.

4.4.5 Non-Shrink Grout

The top of concrete under structural steel columns and beam plates shall be finished to the correct elevation. Base Plates will be set and shimmed in accordance with Clause 8 Structural Steel.

The void beneath the base plate shall be filled with non-shrink grout. Mixing, pouring, curing and finish shall be in accordance with the manufacturer's instruction. The Contractor shall ensure that the grout seals all voids. Before use the material the Contractor shall submit the brochure of the material to the Engineer for his approval.

5.0 Piles

5.1 Bored Concrete Piles

5.1.1 Description / Scope

This section specifies the furnishing, boring and construction of large diameter reinforced concrete piles in accordance with the Drawings and these specifications. Such piles will be excavated using the Bentonite slurry or head of water method. The Contractor shall allow for soil sampling and tests in order to produce a bore log during excavation of the pile and to confirm the depths and types of the various soil layers. Disturbed samples shall be submitted to the Engineer as requested. During the pile excavation, if the ground conditions are different from those observed in the pre-bore, the Contractor shall notify the Engineer at once. The Contractor shall not be compensated for any possible delays.

5.1.2 Trial Pit Excavation

The Contractor shall carry out trial pit excavations by hand in order to determine the positions of and expose underground utilities adjacent to piles before piling work commences.
The Contractor shall reflect the information obtained by the trial pit excavation for their design of the piles and related structures.
There is an existing RC box culvert in the Baclaran Expansion Depot Area, of which the exact location shall be identified by the Contractor for the design of the structure above and adjacent to the culvert (Refer to Box Culvert drawing under Section VI-4 Supplemental Information).

5.1.3 Site Investigation Pre-bores and Pile and Foundation Design

Prior to the commencement of pile boring, if the Contractor judges necessary, they should perform out of site investigation pre-bores near the piling areas (as specified in A. Preliminaries and General Requirements – Clause 7 Geological Investigation). The site investigation may include standard penetration tests and disturbed soil sampling. The report of the site investigation boreholes have to be informed to the Engineer a minimum of twenty eight (28) days in advance of the commencement of the piling works. At the same time the Contractor shall prepare design calculations, based on the Engineer's calculation sheets, adjusting the length of the pile in accordance with the results of the borehole investigation, and prepare shop drawings of the piles, pile caps and other foundations and their steel reinforcement.

5.1.4 References

Related work includes:

a) Clause 4, Sub-Clause 4.4.2 – Reinforcement and Miscellaneous Materials
b) Sub-Clause 4.4.3 – Reinforced Cement Concrete
c) Preliminaries & General Requirements – Clause 7 - Geological Investigation

5.1.5 Applicable Codes and Standards

The following codes and standards are intended to provide an acceptable level of quality for materials and products. The Contractor may propose alternative codes and standards provided they give a degree of quality equivalent to the referenced codes and standards and are submitted for the Engineer's review and approval.

Table 5.1.5 Applicable Codes and Standards

JIS	Japanese Industrial Standards
SSDCCS	Standard Specification for Design and Construction of Concrete Structures (1986 Part 2) - Japan Society of Civil Engineering (JSCE)
AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society for Testing and Material

5.1.6 Submittals

5.1.6.1 General

The Contractor shall submit to the Engineer for review and approval all items listed herein.

5.1.6.2 Before Commencing Work

a) Geological Survey Report including bore logs, geological profile, and results of Standard Penetration Tests;
b) Material report as required in related Sections;
c) Construction programs and work method statements including details of equipment to be used in carrying out the work;
d) Safety measures to ensure the safety of LRT trains, the public, workers, and anti-pollution measures; and
e) Shop drawings of steel reinforcement cages, showing the bar layouts, bar types, bar sizes, bar marks, location of splices, and bar bending schedules, all to suit the final pile length designed as a result of the site investigation boreholes.

5.1.6.3 During the Work

a) Piling records;
b) Disturbed soil samples; and
c) Bearing layers soil sample.

5.1.7 Tolerances

Piles shall be straight and the inclination of the geometric center of the pile shall be within 1/100. No radius from the geometric center shall be 20 mm less than the radius shown on the drawings, nor shall the average radius be less than the radius shown on the Drawings.

After pile construction the position of the pile head shall be within 15 cm in any direction of the position shown on the drawings.

5.1.8 Products

5.1.8.1 Materials

a) Concrete shall be class AA (316 kg/sq.cm or 31.0 MPa); and
b) Reinforcement shall comply with requirements of **Sub-Clause 4.3.2g** of this Technical Specification.

5.1.8.2 Temporary Casings

Temporary casings shall be used to maintain the stability of the pile excavation, which might otherwise collapse. Temporary casings shall be free from significant distortion. They shall be of uniform cross-section throughout each continuous length. During concreting they shall be free from internal projections and encrusted concrete, which might prevent the proper formation of piles.

5.1.9 Execution

5.1.9.1 General

The Contractor shall submit to the Engineer for his approval particulars of proposed materials and methods of constructing bored concrete piles, including:

a) method of supporting bore hole sides;
b) methods of placing concrete by tremie; and
c) methods of cleaning the pile toe.

The Contractor will be responsible for extending the pile to at least 1D (distance equal to the diameter) above the bottom level of the pile cap or footing.
The pile head shall be cut down until sound concrete is reached and adjudged to be acceptable by the Engineer.

In general, the pile head cutting is to be provided down to 50mm above the bottom level of the pile cap or footing.
The pile reinforcement shall extend above the bottom level of pile cap or footing for the distance shown on the drawings.

5.1.9.2 Pile Installation

a) Sequence

Piles shall not be bored close to other piles which have recently been cast and which contain plastic or unset concrete in order to avoid causing a flow of concrete or damage to any of the adjacent piles. No pile shall be bored or a pile casing driven nearer than five pile diameters (measured center to center) to an adjacent pile which is not completed or in which the concrete has been completed less than 24 hours previously. The sequence of piling shall be submitted to the Engineer for approval. During and after concreting, care shall be taken to avoid damage to the concrete from pumping and de-watering operations.

b) Pile Excavation

The level of the drilling fluid in the excavation shall be maintained so that the fluid pressure always exceeds the forces exerted by the soils and external groundwater. The fluid level shall be maintained at a level not less than 2 m above the level of the external groundwater.
In case of type of bored pile is bearing pile into the bearing layer, the toe of each bored pile shall penetrate at least 3D (diameter) of the pile.

c) Pumping from Bored Holes

Pumping from a bored hole shall not be permitted unless a casing has been placed into a stable stratum, which prevents the flow of water from other strata in significant quantities into the bore, or unless it can be shown that pumping will not have a detrimental effect on the surrounding soil or adjacent property.

d) Cleanliness of Pile Bases

On completion of boring, loose, disturbed or remolded soil shall be removed from the base of the pile, using appropriate and approved methods, which may include airlifting, and which shall be designed to clean while at the same time minimizing ground disturbance below the pile base.

e) Inspection of Verticality of Bored Holes

The Contractor shall provide an approved means by which inspection of the verticality of bored holes and reinforcement cages can be performed.

f) Concreting

Immediately after the boring has been completed the Engineer's approval to the commencement of concreting shall be sought and, when this has been obtained, concreting shall start forthwith and continue without interruption.
Before placing concrete, measures shall be taken to ensure that there is no accumulation of silt or other material at the base of the bore.

g) Tremie Pipe

i. In a boring which contains water or drilling fluid the concrete shall be placed by a tremie pipe in such a manner that segregation does not occur.

The lower end of the supply pipe will constantly be immersed in the fresh concrete mass.

ii. The hopper and pipe of the tremie shall be clean and watertight throughout. The pipe shall extend to the base of the pile and a sliding plug or barrier shall be placed on the pipe to prevent direct contact between the first charge of concrete in the pipe

of the tremie and the water. The pipe shall at all times penetrate the concrete, which has previously been placed and shall not be withdrawn from the concrete until completion of concreting. At all times a sufficient quantity of concrete shall be maintained within the pipe to ensure that the pressure from it exceeds that from the water or fluid.

iii. The internal diameter of the tremie pipe shall be not less than 150mm for concrete made with 25mm aggregate. It shall be so designed that external projections are minimised, allowing the tremie to pass through reinforcing cages without causing damage. The internal face of the pipe of the tremie shall be free from projections.

iv. Measurement of the level of the concrete surface shall be taken immediately before and after any vertical movement of the tremie pipe.

v. During the concreting, the bottom elevation of the tremie pipe shall be at least 2m embedded under the concrete top elevation at all the time except starting time of concreting. The piling engineer shall carefully monitor and ensure the above requirement especially during the partial extracting of the tremie pipe.

h) Temporary Casings

i. Temporary casings shall be used to maintain the stability of pile excavation passing through the upper soft clay layers.

ii. Temporary casings shall be extracted while the concrete within remains sufficiently workable to ensure that the concrete is not lifted.

iii. When the casing is being extracted a sufficient quantity of concrete shall be maintained within to ensure that pressure from any external water or soil is exceeded and that the pile is neither reduced in section nor contaminated.

iv. No concrete is to be placed in the boring once the bottom of the casing has been lifted above the top of the concrete. Concrete shall be powered continuously as the casing is extracted until the desired head of concrete is obtained.

v. Adequate precautions shall be taken in all cases where excess hydraulic heads could be caused as the casing is withdrawn because of the displacement of water by the concrete as it flows into its final position against the walls of the shaft.

vi. The use of vibrating casing extractors shall be subject to the approval of the Engineer.

5.1.9.3 Piling Records

The Contractor shall keep records, as indicated in the table appended to this section, of the installation of each pile and shall submit two signed copies of these records to the Engineer not later than noon of the next working day after the pile was installed. The signed records shall form a record of the work. The record shall contain the following details:

Pile Record

a) Contract Number,
b) Pile reference number (location),
c) Pile Type,
d) Nominal cross-sectional dimensions or diameter,
e) Nominal diameter of under ream,
f) Standing groundwater level,
g) Date and time of boring,
h) Date of concreting,
i) Ground level at commencement of installation of pile,
j) Working level,
k) Depth from working level to pile toe,
l) Toe level,
m) Depth from working level to pile head level,
n) Length of temporary casing,
o) Verticality of borehole,

p) Soil samples taken and in-place tests carried out,
q) Length and details of reinforcement,
r) Concrete mix,
s) Strength of corresponding concrete cubes,
t) Volume of concrete supplied to pile where this can be measured in practice and corresponding levels of concrete and casing, and
u) All information regarding obstructions, delays and other interruptions to the sequence of work.
v) Table of excavation and concreting of bored pile which shows all the data of each elapsed time and excavated depth, bore hole bottom cleaning, reinforcement bar installation, tremie pipe installation, concrete top elevation during concreting, tremie toe elevation during tremie extracting and casing toe elevation etc.

5.2 Driven Piles

5.2.1 Scope

This work shall consist of precast reinforced concrete piling, furnished, driven, cut and spliced in accordance with this Specification and in conformity with the Plans.

5.2.2 General

5.2.2.1 Trial Pit Excavation

The Contractor shall carry out trial pit excavation by hand in order to determine the positions of and expose underground utilities adjacent to piles before piling work commences.
The Contractor shall reflect the information obtained by the trial pit excavation for their design of the piles and related structures.
There is an existing RC box culvert in the Baclaran Expansion Depot Area, of which the location shall be identified for the design of the above structure and adjacent to the culvert.

5.2.2.2 Reference

a) American Society for Testing and Materials (ASTM):

ASTM D1143 Method of Testing Piles Under Static Axial Compressive Load
ASTM D4945 Method for High Strain Dynamic Testing of Piles

5.2.2.3 Submittals

a) Shop Drawings: The submission of Shop Drawings of the piles shall indicate typical details of sizes, configuration, class of concrete, lifting devices, and curing methods.
b) Pile Driving Sequential Layout. The Contractor shall submit the following:

i. Layout drawings showing the proposed sequence of driving the piles.
ii. The sequential layout shall show each pile by identification, its driving sequence number, type, size, load bearing capacity, and pile tip elevation as planned.
iii. A pile numbering plan that clearly identifies and numbers each pile for reference.

c) Pile Driving Record:

The Contractor shall retain records as indicated below of the installation of each pile and shall submit two signed copies of these records to the Engineer not later than noon of the next working day after the pile is installed. The signed records shall form a record of the work.
The following data is required:

i. Contract
ii. Pile reference number (location)
iii. Pile type
iv. Nominal cross-sectional dimensions or diameter
v. Length of preformed pile
vi. Date and time of driving or re-driving

vii. Ground level at commencement of installation of pile
viii. Working level
ix. Depth from working level to pile toe
x. Toe level
xi. Type, weight, drop and mechanical condition of hammer and equivalent information for other equipment
xii. Number and type of packing used and type and condition of dolly used during driving the pile
xiii. Set of pile in mm per 10 blows or number of blows per 300 mm of penetration
xiv. If required, the sets taken at intervals during the last 3 m of driving
xv. If required, elastic compression of ground and pile from time of a marked increase in driving resistance until pile reaches its final level
xvi. The elastic compression of the pile recorded at the final set, and the final set
xvii. All information regarding obstructions, delays and other interruption the sequence of work

d) Equipment Review and Drawings:

i. The Contractor shall submit a complete list of the equipment proposed for use, including a description of the characteristics of each piece of driving equipment.

The Engineer will review the proposed driving equipment, accessories, and methods as a check of the adequacy of the equipment and methods for the conditions expected to be encountered.
Should the equipment used by the Contractor prove to be inadequate to drive the scheduled types of piles at the locations indicated, or should the use of accessories show damage to the piles, or should it be found that the Progress Schedule cannot be maintained because of inadequate equipment or methods, the Contractor shall replace or use different types of equipment and accessories, or both, as appropriate for the conditions encountered.

ii. Submit Shop Drawings of driving accessories showing compatibility with the size, configuration, handling, and driving requirements of each type of pile indicated.
iii. Submit Shop Drawings showing the methods and equipment proposed for loading test piles.

5.2.2.4 Tolerance

a) Casting Tolerance

The dimensions of precast reinforced concrete pile shall confirm to the requirements of tolerance specified in JIS A 5372 and JIS A 5373 respectively.

b) Installation Tolerances:

i. Position : 150 mm in any direction at cut-off level
ii. Verticality : 1 in 50 deviation from vertical
iii. Rake for Rake Pile: 1 in 20 deviation from specified rake
iv. No forcible method of correction of the position or line of any pile shall be permitted.
v. Should the piles be installed outside these tolerances, then the Contractor shall propose and complete rectification measures or take other measures as may be agreed to the satisfaction of the Engineer.

5.2.2.5 Defective Piles

Any piles cracked, bowed, chipped and/or under size shall be rejected for use.
The procedure for the driving of piles shall not subject them to excessive and undue force producing crushing and spalling of the concrete.
Manipulation of piles to force them into proper position, considered by the Engineer to be

excessive, will not be permitted. Any pile damaged by reason of internal defects, or by improper driving or driven out of its proper location or driven below the elevation fixed by the plans shall be corrected at the Contractor's expense by one of the following methods as approved by the Engineer:

a) The pile shall be withdrawn and replaced by a new and if necessary, a longer pile;
b) A second pile shall be driven adjacent to the defective or low pile; and
c) The pile shall be spliced or built up as otherwise provided herein or a sufficient portion of the footing extended to properly embed the pile.

5.2.3 Products

Pre-cast concrete piles, of sizes and requirements to be designed by the Contractor subject to the Engineer's approval.

5.2.4 Execution

5.2.4.1 Determination of Length

a) The length of the piles shall be as necessary to develop the required pile capacity to obtain the specified penetration, and to extend into the pile cap or footing block as required. The Contractor shall determine length of piles based on geotechnical data. Determined pile length shall be proven by pile load tests;
b) Lengths of production piles shall be determined by the Contractor from the data obtained from the driving of load-testing of test piles; and
c) The Contractor shall furnish with the production-piles' order list after completion of driving and load-testing of test piles.

5.2.4.2 Test Piles

a) Based upon the information indicated, the Contractor shall order and drive the test piles. Compression capacities of the test piles shall be determined by methods hereinafter specified;

b) From the driving methodology, test pile data and the subsurface exploration data, the Contractor shall determine the required length of production piles subject to the Engineer's approval. The Contractor shall also determine the required penetration, subject to the Engineer's approval, based upon settlement criteria or any other factors that in the opinion of the Contractor are applicable to the work;

c) The test piles shall be driven at the locations and to the lengths proposed by the Contractor and approved by the Engineer. Piles shall be driven with impact hammers unless otherwise indicated. In general, the specified length of test piles shall be greater than the estimated length of production piles in order to provide for variation in soil conditions.

d) Equipment used for driving test piles shall be identical to that what the Contractor proposes to use for the driving of production piles;

e) The Contractor shall excavate the ground at each test pile to the elevation of the base of the pile-cap footing before the pile is driven, or the Contractor may employ "followers" to compensate for the extra depth;

f) The test piles shall be driven to a hammer blow count proposed by the Contractor and approved by the Engineer at the estimated tip elevation. Test piles that do not attain the hammer blow count specified above at a depth of 300mm above the estimated tip elevation indicated shall be allowed to "set up" for 12 to 24 hours before being re-driven. A cold hammer shall not be used for re-drive. The hammer shall be warmed up before driving begins by applying at least 20 blows to another pile;

g) If the specified hammer blow count is not attained on re-driving, the Engineer may direct the Contractor to drive a portion or all of the remaining pile length and repeat the "set up" – re-drive procedure. Piles shall be driven to the planned grade and, when not having the

hammer blow count required, shall be spliced and driven until the required bearing is obtained; and

h) A record of driving of test piles shall be prepared by the Contractor that will include the number of hammer blows per 300mm for the entire driven length, the as-driven length of the test pile, cut off elevation, penetration in ground, and any other pertinent information. If a re-drive is necessary, the Contractor shall record the number of hammer blows per 25mm of pile movement for the first 300mm of re-drive. The Contractor shall not order production piles until test pile data has been reviewed and pile order lengths are authorized by the Engineer in writing.

5.2.4.3 Axial Compression Load Tests

The Contractor shall perform the following:

a) Install test piles as permanent piles, in the locations indicated or at other locations as required by the Engineer;

Reinforce test piles for the full length.
Install test piles vertically.

b) Test piles that pass the load test in an undamaged condition may be utilized as permanent piles in the work;

c) Either extract damaged test piles and remove from the site, or cut them off 1.0 meter below any structure to be installed above. Holes shall be backfilled with concrete or grout;

d) Compression Load Tests: Tests shall be performed in accordance with ASTM D1143. Method of load test shall follow "Quick Load Test Method for Individual Piles" as specified in ASTM D1143, Section 5.6;

i. Commence loading of test piles not sooner than 72 hours after installation of piles.
ii. The maximum test load shall be at least twice the design load as proposed by the Contractor and approved by the Engineer. Apply the load in increments equal to 10 percent of the maximum test load, with a constant time interval between increments of 5 minutes. Maintain the maximum test load for not less than 15 minutes, unless the shaft has failed as determined by the Engineer.
iii. Remove the test load in increments equal to 25 percent of the maximum test load, with a constant time interval between increments of 5 minutes.
iv. Measure the settlement and rebound of the test pile to the nearest 0.25mm.

e) Allowable bearing capacity of the test pile shall be defined as 40 percent of the failure load. For piles 600mm or less in diameter or width, the failure load of a pile tested under axial compressive load is that load that produces a settlement at failure of the pile head equal to:

$Sf = S + (3.81 + 0.008D)$
Where:
Sf = Settlement at failure in mm
D = Pile diameter or width in mm
S = Elastic deformation of total unsupported pile length in mm

f) The Engineer may require the Contractor to make additional load tests, in the event that the behaviour of the test pile or any other pile shows any peculiarity, erratic action, or otherwise causes suspicion as to the reliability of the pile capacity;

g) Immediately following completion of load testing, submit two copies of the test report for each test pile to the Engineer for record purposes including the data as required by ASTM D1143; and

h) Following the completion of load tests, the Contractor shall make a determination of the required penetration for the Engineer's approval.

5.2.4.4 Dynamic Pile Testing

a) Dynamic measurements shall be taken by the Contractor during the driving of test piles designated as dynamic load test piles;

b) Prior to placement in the leads, the Contractor shall make each designated concrete pile available for taking wave speed measurements and for pre-drilling the required instrument attachment holes. When wave speed measurements are made, the piling shall be in a horizontal position and not in contact with other piling;

c) The Contractor shall furnish the equipment, materials, and labor necessary for drilling holes in the piles for mounting the instruments. Instruments will be attached near the head of the pile with expansion-type bolts for concrete piles;

d) The Contractor shall provide access to the pile for attaching instruments after the pile is placed in the leads. A platform with minimum size of 1.20m by 1.20m (1.44 sq. m.) designed to be raised to the top of the pile while the pile is located in the leads shall be provided by the Contractor;

e) The Contractor shall furnish electric power for the dynamic test equipment. Field generators used as the power source shall be equipped with meters for monitoring voltage and frequency levels;

f) The Contractor shall drive the pile to the design tip elevation or other depth as specified by the Engineer. The stresses in the piles will be monitored during driving with the dynamic test equipment to ensure that the values determined do not exceed the allowable values. If necessary, the Contractor shall reduce the driving energy transmitted to the pile by using additional cushions or reducing the energy output of the hammer in order to maintain stresses below the allowable values. If non-axial driving is indicated by the dynamic test equipment measurements, the Contractor shall immediately realign the driving system; and

g) The Contractor shall wait up to 24 hours and, after the instruments are re-attached, re-tap the dynamic load test pile. A cold hammer shall not be used for the re-drive. The hammer shall be warmed up before re-drive begins by applying at least 20 blows to another pile. The maximum amount of penetration required during re-drive shall be 150mm, or the maximum total number of hammer blows required will be 50, whichever occurs first. After re-tapping, the Engineer will either provide the cut-off elevation or specify additional pile penetration and testing for that dynamic load test pile. CAPWAP analysis of dynamic pile testing data shall be performed on data obtained for the beginning of re-drive of the driven piles.

5.2.4.5 Handling and Storage of Piles

The method and sequence of lifting, handling, transporting and storing piles shall be such that the piles are not damaged.
Only the designated and marked lifting and support points shall be used.
During transport and storage, piles shall be stored on adequate supports located under the lifting points of the piles.
The procedures for handling and storage shall be submitted by the Contractor and approved by the Engineer.
All piles within a stack shall be in groups of the same length. Packing of uniform thickness shall be provided between piles at the lifting points.

5.2.4.6 Preparation for Driving

a) Caps

The heads of all precast concrete piles shall be protected by caps having a suitable cushion next to the pile head and fitting into a casting which in turn supports a timber shock block.

b) Splicing piles

Full length piles shall be used where practicable. However, should circumstances require, splicing of piles shall be permitted. The method of splicing shall be proposed by the Contractor and approved by the Engineer.

c) Lengthening concrete piles

Lengthening of precast reinforced and pre-stressed precast piles shall not be permitted unless such piles have been designed to provide for lengthening as shown on the approved Drawings and a provision for pile lengthening was incorporated at the time of manufacture. The extra length of pile shall be sufficient to reach the elevation of the bottom of the cap with adequate length of reinforcement tied into pile caps as shown on the approved Drawings. Any method for lengthening shall be such that joints are capable of taking the stresses safely during driving and under load.

After piles have been lengthened, driving shall not be resumed until the specified characteristic strength of the added concrete has been attained. Subject to the consent of the Engineer in writing, the Contractor may use rapid hardening cement for pile lengthenings in order to expedite the work but driving shall not be resumed until the consent of the Engineer has been received.

Prior to carrying out any work for the lengthening of piles, the Contractor shall submit a detailed method statement to the Engineer for consent.

5.2.4.7 Installation of Piles

a) Strength of Piles

Penetration and Bearing. The Contractor shall install piles to the required penetration, or to the required bearing, as determined by the various load tests performed for the purpose. Water jetting will not be permitted unless specifically approved in writing by the Engineer for the location.

b) Pile Driving

The Contractor shall perform the following:

i. Completion of embankment construction, filling, and backfilling to the required elevations before starting of pile-driving operations.
ii. Piles not to be driven within the 6.0meters distance from any concrete structures less than seven days old.
iii. Drive interior footing piles before driving perimeter piles.
iv. If necessary, provide adequate lateral support for installed individual piles to prevent excessive temporary flexural stresses or movement of the pile top out of tolerance.
v. Maintain the hammer coaxial with the pile during the driving operation by using a combination of driving cap and leads.
vi. Investigate any sudden decrease in driving resistance for possible breakage of the pile. If a sudden decrease in driving resistance cannot be correlated to boring data or some incident in the driving, and if the pile cannot be inspected, such decrease in driving resistance will be cause for rejection of the pile.
vii. Re-drive any pile that is raised during driving of adjacent piles, to the original tip elevation.
viii. Splice piles only by methods and at places approved by the Engineer in writing.
ix. Cut off piles at top elevation indicated. Repair piles that are damaged when cut off requires written approval of the Engineer.
x. Protect the heads of piles from direct impact of the hammer by acceptable cushion head block, so that no cracking, spalling, or chipping occurs.
xi. All cut-off lengths of piles shall become the property of the Contractor. Cut-off lengths of piles may be incorporated in the work if consented in writing by the Engineer, otherwise pile cut-off lengths shall be disposed of to the satisfaction of

the Engineer.

xii. If piles have extended reinforcing steel and protective concrete for driving, remove such protective concrete to expose the reinforcing steel upon completion of driving.

xiii. When piles are driven or cut off below the elevation of the bottom of the cap, extend the pile to the elevation of the bottom of the cap by means of a reinforced concrete extension. Submission of details for approval prior to fabrication.

5.2.4.8 Final Set

The final set of the driving piles shall be determined by the Contractor subject to the Engineer's approval.
Penetration of pile for last ten (10) blows shall not exceed 25 mm.
When a final set is being measured the following requirements shall be met:

a) The final set of each pile shall be recorded the penetration in millimeter per ten (10) blows.
b) The exposed part of the pile shall be in good condition without damage or distortion;
c) The packing (cushion) shall be in sound condition.
d) The hammer blows shall be in line with the pile axis and the impact surfaces shall be flat and at right angle to the pile and hammer axis.
e) The hammer shall be in good condition and operating correctly.
f) The elastic compression of each pile shall be recorded and submitted together with the pile driving record.

Water jetting shall not be allowed without the Engineers written consent.

5.3 Static Pile Load Test

In order to verify the capacities for designed working load of the bored piles and the driven piles, specified numbers of static pile load test shall be carried out on each diameter of permanent piles in accordance with the instruction of the Engineer.
Unless otherwise directed by the Engineer, the pile load test shall be conducted in accordance with ASTM D1143-81 (1994).
The Contractor shall submit to the Engineer the method statement of the Static Pile Load Test for his approval. After obtaining Engineers approval, all the test shall be carried out under the Engineer or his staff attendance. The test result shall be submitted within 48 hours of the completion of the pile test for each pile tested, a detailed record of testing and, in addition, graphs indicating the following:

a) Load – Settlement relationship;
b) Settlement – Time relationship; and
c) Load – Settlement – Time relationship.

A full comprehensive written report shall be submitted to the Engineer within 10 working days for approval. After the completion of loading tests, all equipment and weight used shall be removed from the Site.

6.0 Reinforced Masonry (Concrete Hollow Block)

6.1 General

The work includes furnishing labor, equipment and materials, and performing all operations required to install Concrete Hollow Block (CHB) masonry wall as shown in the drawings and as specified herein exclusive of applied finishes.

6.2 General Provision

6.2.1 Applicable Publications

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

a) American Concrete Institute (ACI) Publication:

i. ACI 315 Details and Detailing of Concrete Reinforcement

b) American Society for Testing and Materials (ASTM) Publications:

i.	ASTM C39	Compressive Strength of Cylindrical Concrete Specimens
ii.	ASTM C91	Masonry Cement
iii.	ASTM C144	Aggregate for Masonry Mortar
iv.	ASTM C270	Mortar for Unit Masonry
v.	ASTM C404	Aggregates for Masonry Grout
vi.	ASTM C426	Drying Shrinkage of Concrete Block
vii.	ASTM D1056	Flexible Cellular Materials-Sponge or Expanded Rubber
viii.	ASTM D1667	Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Sponge)
ix.	ASTM E447	Compressive Strength of Masonry Prisms

c) Product Standards Agency (PSA) Publications (Philippines):

i.	PNS 07	Specifications for Portland Cement
ii.	PNS 16	Specifications for Concrete Hollow Blocks
iii.	PNS 18	Specifications for Concrete Aggregate
iv.	PNS 49	Specifications for Steel Bars for Concrete Reinforcement
v.	SAO 181	Industrial Quicklime and Hydrated Lime

6.2.2 Definitions

a) Concealed Masonry Surfaces

i. Surfaces of foundation walls against which backfill is placed.
ii. Surfaces covered by furring and wallboard plaster, stucco, or masonry facings
iii. Surfaces above suspended ceilings.
iv. Surfaces within attic spaces, crawl spaces, pipe or duct chases and elevator shafts.

b) Exposed Masonry Surfaces

Masonry surfaces other than those listed above including those to be painted.

c) Grout Lift and Grout Pour

A grout lift is the layer of grout placed in a single continuous operation. A grout pour is the entire height of grout fill placed in one day and is composed of a number of successively placed grout lifts.

d) Reinforced Hollow Unit Masonry

Hollow concrete masonry units reinforced vertically and horizontally with steel bars located within cells or kerfs in the units and with cells containing reinforcing bars filled solidly with grout.

e) Additional Definitions

Back-Up: That part of masonry walls which is behind the exterior facing.
Bed Joint: The horizontal layer of mortar on which a masonry unit is laid.
Head Joint: The vertical mortar joint between ends of masonry units. Sometimes called a cross-joint.
Kerf: A cut or notch made with a saw, or with a cutter, part way through a portion of a unit.
Low Lift Grouting: The technique of grouting masonry in 0.20 to 1.8 meters lifts as the wall is being laid.
Reinforced Masonry: Masonry in which reinforcement is embedded in such a manner that the component act together to resist lateral forces.

6.2.3 Delivery, Storage and Handling

The Contractor shall handle, store and protect masonry units to avoid chipping, breakage or contact with the soil. Keep steel reinforcing bars free of rust and loose scale. Reject rusted steel reinforcing bars. Deliver cement and lime in unbroken bags, barrels, or other sealed containers. Keep cementitious materials dry. Store and handle cement to prevent the inclusion of foreign materials. Store aggregates in a manner to avoid contamination or segregation. Plainly mark and label containers with the manufacturer's names and brands.

6.3 Products

6.3.1 Masonry Units

a) Concrete Masonry Units (CHB)

i. Aggregates: ASTM C33
ii. Linear Drying Shrinkage: Not to exceed 0.065 percent when tested in accordance with ASTM 426
iii. Types and Shapes:
In addition to the requirements specified, concrete masonry units of the various kinds shall conform to PNS 16, Type I for 150 mm thick (f'm = 7 MPa for exterior walls and f'm = 5 MPa for interior walls) and Type II for 100 mm thick (f'm = 2.5 MPa). Include closer, jamb, lintel and bond beam units and special shapes and sizes to complete the work as indicated.

6.3.2 Centering Device

Provide centering clips that prevent displacement of reinforcing bars during the course of construction.

6.3.3 Deformed Reinforcing Bars

ASTM A615, Grade 275 (40,000 psi).

6.3.4 Materials for Mortar and Grout

a) Admixtures

i. Admixtures:

May be used in mortar or grout provided that the admixture does not adversely affect bond or compressive strength of mortar or grout.

ii. Prohibited Ingredients: Do not use air entraining compounds, calcium chloride salts or other chemicals that will adversely affect metals or the coatings of metals embedded in the mortar or grout.

b) Aggregate for Mortar

ASTM C144, except that not less than 3 percent nor more than 15 percent shall pass the No. 100 sieve. Aggregate used in mortar for joint 6 mm or less shall have 100 percent passing the No. 8 sieve with 10 percent being retained on the No. 16 sieve.

c) Aggregate for Grout:

i. Fine Aggregate: ASTM C404, Size No. 2 or ASTM C144.
ii. Pea Gravel: ASTM C404, except that 100 percent shall pass the 9 mm screen and not more than 5 percent shall pass the No. 8 sieve.
iii. Coarse Aggregate: ASTM C404, size No. 8.

d) Portland Cement

ASTM C150, Type I.

e) Lime Putty

Slaked according to manufacturer's instructions.

i. Hydrated Lime: SAO 181.
ii. Pulverized Quicklime: SAO 181 except 100 percent shall pass the No. 20 sieve and 90 percent shall pass the No. 50 sieve.
iii. Lime Paste: Lime paste shall be made with pulverized quicklime or hydrated lime. Hydrated lime processed by the steam method shall be allowed to soak not less than 24 hours. Quicklime and other hydrated lime shall be allowed to soak not less than 72 hours. In lieu of hydrated lime paste for use in mortar, the hydrated lime may be added in the dry form.

f) Water: Potable.

6.3.5 Mortar Mixes

a) Proportions

Type M in accordance with the proportion specifications of ASTM C270. The mortar shall have a flow, after 11 minutes, of 75 percent or more when tested for water retention in accordance with ASTM C91 except mortar shall be mixed to an initial flow of 105 to 115 percent.

6.3.6 Grout Mixtures

a) Proportions

Mix in laboratory established proportions to in a compressive strength at 28 days of not less than 17.20 MPa (2500 psi) when tested in accordance with ASTM C91 for fine aggregate and ASTM C39 for grout containing coarse aggregate. Grout shall be classified as fine and low lift types.

i. Fine Grout: Portland cement, fine aggregate, and sufficient water to obtain a pouring consistency without segregation of the constituents. Slump shall be approximately 125 mm.
ii. Low Lift Grout: Portland cement, lime paste or hydrated lime, fine aggregate and coarse aggregate, and sufficient water to obtain a pouring consistency without segregation of the constituents. Slump between 200 and 250 mm.

6.3.7 Source Quality Control

Prior to delivery of masonry units to the site, select by random sampling nine individual whole units from the units proposed for use. Select units free from cracks or other structural defects. Test shall be performed in accordance with PNS 16.

6.4 Execution

6.4.1 Preparation

a) Protection

i. Forms and Shores

Where required, construct forms to the shapes, lines, and dimensions of the members indicated. Construct forms sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Do not remove supporting forms or shores until the supported masonry has acquired sufficient strength to support its weight and construction loads to which it may be subjected. In no case shall supporting forms or shores be removed in less than 10 days. The Contractor shall wait at least 16 hours after grouting masonry walls after applying uniform loads and an additional 48 hours waiting period should occur before applying concentrated loads.

ii. Wall Bracing

Walls shall be braced walls against wind and other forces during construction. Sufficient time between lifts shall be allowed to prevent cracking of face shells of hollow masonry units. If blowouts, misalignment, or cracking of face-shells should occur during construction, the wall shall be torn down and rebuild at no additional cost to the Owner.

b) Surface Preparation

Clean laitance, dust, dirt, oil, organic matter or foreign materials from concrete surface upon which reinforced masonry is to be placed. Use sandblasting, if necessary, to remove laitance from pores and expose to the aggregate.

6.4.2 Laying Masonry Units

a) Wet Masonry Units

Do not wet concrete masonry units. Do not lay units having a film of water on the surface.

b) Embedded Items

Build in wall plugs, accessories, flashings pipe sleeves and other items required being built in as the masonry works progresses. Fill cells receiving anchor bolts and cells of the first course below bearing plates with mortar or grout. Fill spaces around metal doorframes and other built-in items with mortar. Point openings around flush-mounted electrical outlet boxes in wet locations, including the flush joint above the box with mortar. Do not embed aluminum items.

c) Bond Beams and Lintels

Install bond units, reinforced as indicated, filled with grout. Install open bottom type bond beam units over cells to be filled. Place wire mesh or small mesh metal lath under open bond beam units if used over cells not to be filled.

d) Unfinished Work

Step back-unfinished work for joining with new work. Do not use toothing without the written approval of the Owner's Representative. Remove loose mortar and thoroughly clean the exposed joints before laying new work.

e) Placing Units

Lay hollow masonry units so as to preserve the vertical continuity of cells filled with grout. The minimum clear horizontal dimensions of vertical cores shall be 50 mm by 75 mm. Masonry bond units at corners. Anchor intersections by reinforcing bars as indicated. Adjust each unit to its final position while mortar is still soft and plastic. If any unit is disturbed after

mortar has stiffened, remove and relay in fresh mortar. Keep chases, raked out joints, and spaces to be grouted, free from mortar and other debris.

f) Bond Pattern

Lay masonry units in running bond.

g) Cutting and Fitting

Wherever possible, use full units of the proper size in lieu of cut units. Use power masonry saws for cutting and fitting. Concrete masonry units shall be wet cut. Edges shall be cut clean, true and sharp. Construct openings carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will be aligned at the bottom with the masonry joints. Cut webs of hollow masonry units to the minimum required for proper installation. Provide reinforced masonry lintels, above openings over 300 mm wide for pipes, ducts and cables trays unless steel sleeves are used.

h) Mortar Joints

Spread bed joints with mortar for the full thickness of the face shells. Where only cells containing reinforcement are to be grouted, spread cross webs around such cell with mortar to prevent leakage of grout. Butter head joints for full thickness of the face shell and place the units. Avoid fins of mortar that protrude into cells to be grouted.

i) Jointing

Tool joints when the mortar is thumbprint hard. Tool horizontal joints first. Brush joints to remove loose and excess mortar. Mortar joints shall be finished as follows:

i. Flush Joints: Flush cut joints in concealed masonry surfaces and joints above electrical outlet boxes in wet areas. Construct flush cut joints by cutting off the mortar flush with the face of the wall.
ii. Tooled Joints: Tool joints in exposed exterior and interior masonry surfaces slightly concave. Use a jointer of sufficient length to obtain a straight and true mortar joints.

j) Joint Width: 9 mm wide.

6.4.3 Placing Reinforcing Steel

Prior to placing grout, clean, reinforcement of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond with the grout. Details of reinforcement shall be in conformance with ACI 315. Do not bend or straighten reinforcing in a manner which may be injurious to the steel. Do not use bars with kinks or bends not shown on the drawings. Placement of reinforcement shall be inspected and approved prior to placing grout.

a) Positioning Bars

Position vertical bars accurately at the centerline of the wall. Maintain a minimum clearance between the bars and masonry units of 12 mm and between parallel bars of one diameter of the reinforcement. Hold vertical reinforcing in place using metal support, centering clips, spacers, ties or caging devices located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement.

b) Splices

Locate splices only as indicated. Stagger splices in adjacent bars at least 600 mm. Lap bars a minimum of 40 diameters of the reinforcement or 600 mm, whichever is greater. Welded or mechanical connections shall develop the full strength of the reinforcement.

6.4.4 Placing Grout

Use a hand bucket, concrete hopper or grout pump. Place grout in final position within 1-½ hours after mixing. Where grouting is discontinued for more than one hour, stop the grout 25-mm below the top of a course to form a key at pour points. Place grout to completely fill the grout spaces without segregation of the aggregates.

a) Low Lift Grout Method

Place grout as masonry is erected at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. If mortar has been allowed to set prior to grouting, remove fins protruding more than 12 mm into the grout space. Rod or puddle grout during placement using a long 25-mm by 50-mm wood stick or a mechanical vibrator.

6.4.5 Tolerance

Lay masonry plumb, true to line, with course level. Keep bond patterns plumb throughout.

6.4.6 Field Quantity Control

a) Grout

A qualified testing laboratory shall be employed to proportion and test grout. Do not change laboratory established proportions or use materials with different physical or chemical characteristics in the grout for the work unless additional evidence is furnished that the grout meets the specified requirements.

6.4.7 Cleaning

After mortar joints have attained their initial set but prior to hardening, completely remove mortar and grout daubs or splashing from exposed masonry surfaces. Before completion of the work, make out defects in joints in exposed masonry surfaces fill with mortar and tool to match existing joints. Immediately after grout work is completed remove scum and stains which have percolated through the masonry using a high pressure steam of water and a stiff fiber bristled brush. Do not use metal tools or metal brushes for cleaning. Dry brush exposed concrete masonry unit surfaces at the end of work each day.

6.5 Method of Measurement

The quantity to be paid for shall be the number of square meters of reinforced concrete masonry completed in place and accepted. Projections extending beyond the faces of the walls shall not be included. In computing the quantity of payment, the dimensions used shall be those shown on the Plans. No deductions shall be made for weep holes, drainpipes or other openings of less than one square meter in area.

7.0 Non Shrink Grout

7.1 Description

7.1.1 Scope

This section covers the material and construction requirements for the treatment of various types of non-shrink grout work, which are to be used for fixing column base plates in steel frame building, at the locations and in the types and sizes indicated on the Drawings. The Contractor shall furnish all labor, materials, tools, and equipment required to complete the works.

7.1.2 References

Related work includes:
Clause 4 - Concrete Works
Clause 8 - Structural Steel

7.1.3 Applicable Codes and Standards

The following codes and standards are intended to provide an acceptable level of quality for materials and products. The Contractor may propose alternative codes and standards provided they give a degree of quality equivalent to the referenced codes and standards and are submitted for the Engineer's review and approval.
JIS - Japanese Industrial Standards

7.1.4 Submittals

General
The Contractor shall submit to the Engineer for review and approval the items listed herein.

a) Before commencing Work:

   i. Manufacturer's Product Information - comprising an orderly compilation of the following.

      1. Current published catalogues or manuals containing complete product specifications, technical performance data, details and illustrations clearly marked to readily identify the specific items involved;
      2. Applicable material and test standards;
      3. Grouting instructions, including requirements of products, execution and preparation of substrata;
      4. Recommendations for safe and secure product transport, storage and handling;
      5. Precautions against injury to health, or other hazards, with emergency first-aid instructions, if any; and
      6. List of representative projects where products have been used and proven successful, adequate and durable under environmental conditions similar to those for this project,

   ii. Certificates of Compliance from the manufacturer for each production lot of materials delivered to the site, indicating that the products are in accordance with the applicable specifications;
   iii. The report of the preliminary mixing trials and tests; and
   iv. Twenty eight (28) days before the commencement of grouting work the Contractor's construction programme and work methods and quality control procedures.

b) During the Progress of the Work

   i. The construction report for each use of grout, including date, structure building name, location of grout, and volume of grout installed, and
   ii. The quality control report of grouting in accordance with the approved procedures.

7.1.5 Product Handling

Products shall be at all times transported, protected, stored and handled such as to preclude damage. Items found damaged or "not in proper condition" shall be removed from the site and replaced with compliant products.
While in transit or in intermediate storage, materials shall be maintained in suitable warehouses or otherwise as is appropriate for the items involved, and shall be maintained within the extremes of temperature and humidity as recommended by the respective manufactures such as to preclude any deterioration or damage due to any adverse ambient conditions.

7.2 Products

7.2.1 General

Products proposed for this work shall be determined by the Contractor to be in compliance with these specifications, and substantiated by way of his submittals. Proposed manufacturers and suppliers and proposed products are subject to approval by the Engineer.

7.2.2 Non-shrink Grout

a) Non-shrink grout shall be selected from the types which attain a strength of 60kgf/cm^2 (5.88MPa), 3 (three) hours after the beginning of mixing, and 400 kgf/cm^2 (39.23 MPa), 7 (seven) days after the beginning of mixing.
b) Non-shrink grout shall consist of admixtures, cement, sand, and water. Available goods are classified into three types, admixture only, pre-mixed compound of admixture and cement, and pre-mixed compound of admixture, cement, and sand. The Contractor may select any of the three types.
c) The volume of material in each package shall be chosen to match the quantity needed for each pour, as once opened the entire contents of the package must be used on the same day, as the material is sensitive to humidity.
d) When mixing cement with non pre-mixed goods, normal Portland cement in compliance with JIS R 5210 shall be used.

7.2.3 Sand

White sand for use with non-shrink grout shall be screened to remove coarse particles before mixing, and be free of clay, dirt, and chloride. Sand particles shall be hard enough to match the strength of the mortar.

7.2.4 Water

Water shall be clean, and free from oil, acid, salt, alkali, chloride, organic matter, and other deleterious substances.

8.0 Structural Steel

8.1 Description of Work

The work includes the furnishing of all labor, materials, equipment and other incidentals necessary for the fabrication and installation of structural steel and miscellaneous metal works as specified in relevant items of these Specifications and as indicated on the Drawings.
The structural steel and metal works shall involve the fabrication of steel columns, roof beams and trusses, purlins, rafters, guardrails, and handrails for ramps platform and stairs and other structural steel works required for the various buildings and structures under this Contract.

8.2 Applicable Publications

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

a) American Institute of Steel Construction (AISC) Publications:

i. Manual of Steel Construction, 9TH Edition, 1989
ii. Detailing for Steel Construction, 1984
iii. Engineering for Steel Construction, 1984

b) American National Standards Institute (ANSI) Publications:

i. B18.22.1 Plane Washers

c) American Society for Testing and Materials (ASTM) Publications:

i. A36 Structural Steel
ii. A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
iii. A108 Steel Bars, Carbon, Cold-Finished, Standard Quality
iv. A307 Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
v. A325 High-Strength Bolts for Structural Steel Joints
vi. A370 Mechanical Testing of Steel Products
vii. A563 Carbon and Alloy Steel Nuts
viii. C827 Early Volume Change of Cementitious Mixtures

d) American Welding Society (AWS) Publications

i. D 1.1 Structural Welding Code, Steel

e) Steel Structures Painting Council (SSPC) Publications:

i. SSPC SP1 Surface Preparation Specification No. 1, Solvent Cleaning
ii. SSPC SP3 Surface Preparation Specification No. 3, Power Tool Cleaning.
iii. SSPC SP10-91 Surface Preparation Specification No. 10, Near White Blast

8.3 Submittals

8.3.1 Shop Drawings and Erection Plan

Before placing orders for materials for the steel and metal works, the Contractor shall submit to the Engineer for approval shop drawings for the whole steelwork. All such shop drawings shall indicate the dimensions of all parts, method of construction, bolts, welding sectional areas and other details.
The details of connections shown on the shop drawings shall be such as to minimize formation of pockets to hold condensation, water or dirt. A minimum gap between abutting angles and the like shall be provided wherever possible to eliminate any traps and facilitate maintenance of painting.
The contractor shall submit descriptive data to illustrate the structural steel erection procedure including the sequence of erection and temporary shoring and bracing, and written description of the detailed sequence of all welding, including each welding procedure to be performed.
No materials shall be ordered nor fabrication commenced until the shop drawings and erection plans are approved by the Engineer.

8.3.2 Certificates of Conformance

Certificates of Conformance shall be submitted for the following:

a) Steel;
b) Bolts, Nuts and Washers;
c) Welding Electrodes and Rods;
d) Shop Painting Materials; and
e) Non-shrink Grout

8.3.3 Certified Test Reports

a) Structural Steel: Chemical analysis and tensile strength test required by ASTM A36;
b) High Strength Bolts and Nuts: Chemical analysis, tensile strength and hardness test required by ASTM A325; and
c) Anchor Bolts: Chemical Analysis Tensile Strength and Hardness Test required by ASTM A307.

8.4 Quality Assurance

Refer to **Sub-Clause 8.7.1a** Qualification, Steel Fabricator

8.5 Products

8.5.1 Materials

Unless specified herein all steel structures and metals shall (where details are not specified or indicated herein) be designed in accordance with the American Institute of Steel Construction (AISC), Manual of Steel Construction, latest edition.

a) Steel

Structural steel for columns, roof beams and trusses, and other steelworks consisting of channels, angles, gusset plates, and other structural steel shapes shall be as indicated on the Drawings and shall be of structural carbon steel conforming to ASTM A36-01 or JIS G3101. Shapes shall be as given in AISC, Manual of Steel Construction.
Steel Pipe shall conform to ASTM A53, Type E or S, Grade B or ASTM A501.

b) Bolts, Nuts and Washer

High Strength bolts for structural steel joints shall conform to ASTM A325.
Anchor bolts shall conform to ASTM A307.
Nuts: ASTM A563, Grade A, heavy hex style, except nuts under 38 mm may be provided in hex style or equal.
Washers: ANSI B18.22.1, Type B or equal.

c) Welding Electrodes and Rods

Steel structural members (built up columns, built up beams, beam to beam, beam to column, and base plate connections, trusses) shall use E70XX electrodes conforming to AWS D1.1
Tests are required under the ASTM Standards for steel to be used in the Works and shall be carried out in the presence of the Engineer and at least four days notice must be given to him of the dates proposed for such tests. Four calendar days notice on which fabricated steelwork will be ready for inspection in the Contractor's yard will be given to the Engineer.
Tests and Inspection procedure shall be:

i.	Non-destructive evaluation of welds:	AWS D1.1
ii.	Radiographic testing:	AWS D1.1
iii.	Ultrasonic inspection of welds:	AWS D1.1
iv.	Magnetic particle inspection:	ASTM E165
v.	Liquid penetration inspection:	ASTM E165

vi. Correction of defective welds AWS D1.1

d) Non-shrink Grout

Non-shrink Grout shall be non-metallic and shall conform to ASTM C827.

8.6 Delivery and Storage of Materials

The Contractor shall handle ship, and store material in a manner that will prevent distortion or other damage. Structural materials, either plain or fabricated, shall be stored above the ground upon platforms, skids, or other supports. Materials shall be kept free from dirt, grease, and other foreign matter and shall be protected from corrosion. All damaged material shall be replaced with new material or repair damaged material in an approved manner at no additional cost to the owner

8.7 Execution

8.7.1 Qualifications

a) Steel Fabricator

The Steel Fabricator shall have minimum of 5 years experience in the manufacture of structural steel structures of similar size. The Contractor shall submit a written description of their fabrication ability including facilities, personnel and a list of similar completed projects, including quality control capability and specifically the type and extent of quality control procedure, which the fabricator intends to employ on this project.

b) Steel Erector

The Steel Erector shall have minimum of 5 years experience in the erection of structural steel structures of similar size to the proposed structures. The Contractor shall submit a written description of structural erection ability including equipment, personnel and a list of completed projects.

c) Qualified Welder and Welding Process

Welders, Tackers, Welding procedures and operations shall be in accordance with AWS D1.1. The Contractor shall submit for the Engineer's approval, welder's qualifications and the test results of each type of welding to be performed.
Procedures shall be developed for welding all metals included in the work. The Contractor shall not start welding until procedures; welder's qualifications, welding operators and tackers have been qualified by an approved testing laboratory, or by the Contractor if approved by the Engineer. Cost of such testing shall be borne by the Contractor.
The Contractor shall qualify each welder, welding operator and tacker assigned to work on this project by test using equipment, positions, procedures, base metal and electrodes that will be encountered in his assignment. The Contractor shall furnish to the Engineer for approval Certification that each welder, welding operator and tacker is qualified in accordance with the requirements of AWS D1.1 or any other standard equal to the same and approved by the Engineer.

8.8 Fabrication

8.8.1 Workmanship

a) Fabrication

Fabrication shall be performed within the permissible tolerance by the approved fabricator. All workmanship shall be of high quality with respect to internationally recognized standards of practice.

b) Cutting

Low-carbon structural steel shall be cut by machine-guided torch instead of by shears or saw.

The surface shall be free from harmful notches, burrs, irregularities, etc.

c) Contact Faces

Contact surfaces between bases of bearing and columns and other elements bearing directly upon such plates shall be ground or milled as necessary for full effective bearing.

d) Bolt Holes

Bolt holes shall be according to structural drawings.
Gas burning of holes for high strength bolt assemblies will not be permitted, and bolt holes shall be made only as specifically approved by the Engineer.

e) High Strength Bolt Assembly Preparation

Surface of high strength bolted parts in contact with bolt head and nut shall have a slope of not more than 1:20 with respect to a plane normal to bolt axis.
Where surface of a high strength bolted part has a slope of more that 1:20, a beveled washer shall be used to compensate for lack of parallelism.
High strength bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials.
When assembled, all joint surfaces including those adjacent to washers shall be free of scale except tight mill scale, and shall be free from dirt, loose scale, burrs, and other defects that would prevent solid seating of parts.
Contact surfaces of friction-type joints shall be free from oil, paint, lacquer or galvanizing.

f) Welding

All welding shall be done only by welders certified as to their ability to perform in accordance with accepted testing requirements.
Welding of parts shall be in accordance with Structural Standard Drawing and the Standard Code for Arc and Gas Welding in Building, Construction of AWS, and shall only be done where shown, specified, or permitted by the Engineer.
Damage to galvanized areas by welding shall be thoroughly cleaned with wire brushing and all traces of welding flux and loose or cracked zinc coating shall be removed prior to painting. The cleaned area shall be painted with two coats of zinc oxide-zinc dust paint. The paint shall be properly compounded with a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight. As an alternative to the above, the Contractor may submit for approval the use of a galvanizing rod or galvanizing solder to repair damage areas.
The welding machine shall be stable welder, and have suitable function for the dimension of materials to be welded. The auxiliary tools used for welding shall perform satisfactorily.
The welding machine used for field welding shall be readily adjustable for electric current.

g) Shop Assembly

Structural units furnished shall be assembled in the shop.
An inspection shall be made to determine that the fabrication and the matching of the component parts are correct.
Jigs shall be used for the assembly of units as much as possible to maintain appropriate position of mutual materials.
Approval of the Engineer shall be required when drilling temporary bolt holes or welding temporary support to the assembled structure.
The tolerances shall not exceed those shown on the Drawings and each unit assembled shall be closely checked to insure that all necessary clearances have been provided and that binding does not occur in any moving part.
In order to maintain accurate finished dimensions and shape, appropriate reverse restraint shall be provided as required.

Assembly and disassembly work shall be performed in the presence of the Engineer, unless waived in writing by the Engineer. Any errors or defects disclosed shall be immediately remedied by the Contractor.
Before disassembly for shipments, component parts of the structures shall be match marked to facilitate erection in the field.

8.9 Fabrication Tolerances

8.9.1 Dimensional Tolerances for Structural Work

Dimensions shall be measured by means of an approved calibrated steel tape at the time of inspection. Unevenness of plate work shall not exceed the limitation of the standard mill practice as specified in the American Institute of Steel Construction," Manual of Steel Construction".

8.9.2 Camber

Reverse camber in any structural steel members in excess of 1/1,000 of the span length shall cause rejection. The minimum camber as required for any structural steel members shall be provided, as shown on the Drawings, or otherwise specified.

8.10 Inspections and Test Welding

8.10.1 Inspection of Welding

Inspection of welding shall be executed for the following work phases.

a) Before Welding

Scum, angle of bevel, root clearance, cleaning of surface to be welded, quality of end tab, drying of welding rod.

b) During Welding

Welding procedure, diameter or coil and wire, type of flux, welding current and voltage, welding speed, welding rod position, length of arc, melting cleaning of slag of each level under the surface chapping, supervision of welding.

c) After Execution of Welding

Assurance of bead surface, existence of harmful defects, treatment of crater, quality of slag removal, size of fillet, dimension of extra fill of butt welding, treatment of end tab.

8.10.2 Testing of Welding

Twenty (20) percent of welds contributing in the overall strength of the structure and which will be inaccessible for the inspection in service shall be tested.
Welding shall be tested by ultrasonic test to the extent specified or as directed by the Engineer. Where partial inspection is required, the ultrasonic test shall be located at random on the welds so as to indicate typical welding quality.

8.11 Corrections

In lieu of the rejection of an entire piece of member containing welding that is considered unsatisfactory or which indicates inferior workmanship, corrective measures may be permitted by the Engineer whose specific approval shall be obtained before making each correction. Such defects may include:

a) Excessive convexity or overlap shall be repaired by grinding.
b) Undercut, lacking of weld shall be repaired with necessary reinforcement of weld after removal of any foreign materials such as slag, dust, oil, etc.
c) Any defects such as slag inclusions, incomplete fusion, or inadequate joint penetration, shall be completely removed, cleaned and re-welded.
d) Cracks in weld or base steel, shall be removed to sound steel throughout its length and 5 cm beyond each end of the crack, followed by welding. The extent of the crack, depth and

length, shall be ascertained by the use of acid etching, magnetic particle inspection or other equally positive means.

e) The removal of welded steel shall be done by chipping, grinding, oxygen gouging, or air carbon arc gouging and in such a manner that the remaining welded steel base steel is not nicked or undercut. Defective portions of the welding shall be removed without substantial removal of the base steel.

8.12 Installation

a) Installation Program

Prior to executing steel fabrication and field installation, the Contractor shall prepare a comprehensive installation program including an engineering supervision organization, fabrication procedure, field installation procedure, material application, machinery application, inspection procedure, scope and standard of quality judgment, and submit the same to the Engineer for approval.

b) Installation requirement

i. Setting of Anchor Bolts and Others

1. Anchor bolts shall be set in accurate position by using templates.
2. Setting method shall be submitted to the Engineer for his approval before setting starts.
3. The thread of bolts shall be cured as appropriate against rust and/ or any damage before tightening.
4. Non-shrink mortar shall be placed under the base plate, well cured to obtain the sufficient strength before bearing loads are applied to base plate.

ii. Temporary Bracing

1. Temporary bracing shall be installed as necessary to stay assemblies and to withstand the loads against forces due to transport, erection operations or other work.
2. Temporary bracing shall be maintained in place until permanent work is properly connected and other construction installed as necessary for support, bracing or staying or permanent work.
3. Extent and quality of temporary bracing shall be as necessary against wind and other loads, including seismic load not less than those for which the permanent structure is designed to resist.

iii. Adequacy of Temporary Connections

During erection, temporary connection work shall be securely made for bolting and/or welding for all dead load, wind and erection stresses.

iv. Alignment

No permanent bolting or welding shall be done until the alignment of all parts with respect to each other shall be true within the respective tolerances required.

v. Field Welding

1. Any shop paint or surfaces adjacent to joints where field welding is to be executed shall be wire-brushed to remove paint/ primer.
2. Field welding shall conform to the requirements specified herein, except as approved by the Engineer.

vi. High Strength Bolts

Final tightening shall be done using manufacturer's power operated equipment without overstress to the threads.

vii. Correction of Errors

1. Correction of minor misfits by use of drift pins, and reaming, chipping or cutting will be permitted and shall be provided as part of erection work.
2. Any errors to be corrected or adjusted, preventing proper assembly, shall be immediately reported to the Engineer, and such corrections or adjustments shall be made as necessary and approved by the Engineer.

Cutting or alterations other than as approved will not be permitted.

viii. Erection

1. Erection and installation shall be as per approved shop drawings.
2. Each structural unit shall be accurately aligned by the use of steel shims, or other approved methods so that no binding in any moving parts or distortion of any members occurs before it is finally fastened in place.
3. Operations, procedures of erection and bracing shall not cause any damage to works previously placed nor make overstress to any of the building parts or components. Damage caused by such operations shall be repaired as directed by the Engineer.

8.13 Galvanizing

8.13.1 Preparation

a) Mild Steel Parts

Mild steel parts, if specified, shall be hot-dipped galvanized after fabrication in accordance with the requirements of JIS H641-82. Prior to galvanizing, the surface shall be cleaned of dirt, weld splatter, grease, slag, oil, paint or other deleterious matters. The steel surfaces shall be chemically de-scaled and cleaned with the same abrasive blast or other suitable method as approved by the Engineer.

b) Galvanizing

The zinc coating shall consist of uniform layer of commercially pure zinc free from abrasion, cracks, blisters, chemical spots or other imperfections, and shall adhere firmly to the surface of the steel. The weight of zinc coating per square meter of actual surface shall not be less than 550 grams. Any surface damaged subsequent to galvanizing shall be given two coats of approved zinc rich paints.

8.14 Painting

8.14.1 General

This work shall consist of the preparation of the metal surfaces, the application, protection and drying of the painted surfaces, and supplying of all tools, tackles, scaffolding, labor and materials necessary for the entire work. Painting shall be applied in the field or shop as approved by the Engineer.
Unless otherwise specified or approved, all painting work for structural steel shall comply with the requirements of this Section.

8.14.2 Preparation of Surface

a) Unless otherwise hereunder specified, surface preparation of structural steel shall be in accordance with the DPWH Standard Specification for Highway, Bridges and Airport, Volume II, 2013.
b) Removal of dirt, rust, mill scale and loosely adhering paint shall be done by power wire brushing or by sand-blasting. Pieces of mill scale weld spatter, etc., which resist removal will be removed by chipping.
c) Oil, wax and grease shall be removed by the use of gasoline or benzene.

d) All weld areas shall be completely scrubbed hard with stiff steel brush, washed down with water to remove acidic solder flux and then wiped off with flux thinner remover.

e) Construction Requirement provisions of section 411.3.6 DPWH Standard Specification for Highway, Bridges and Airport, Volume II, 213, shall be followed wherever applicable.

8.14.3 Shop Painting

a) All structural steel shall be given a shop primer after fabrication and cleaning before delivery to the Site.

b) All steel work shall be thoroughly dried and cleaned of all loose mill scale, rust and foreign matters by means of sand blasting or other suitable methods approved by the Engineer followed by solvent washing before shop painting shall be applied. Each individual piece shall be painted prior to assembly. Any section of steel where field welding or field contact with concrete is required shall not be painted.

8.14.4 Field Painting

After erection, the Contractor shall thoroughly prepare and clean the entire surface of all structural steel from dirt, grease, rust or other foreign matter. Only then the entire surface of all members shall then be field painted.

8.14.5 Materials

a) Structural Steel Work

After surface preparation, steel shall be given one coat of approved prefabricating primer, consisting of 70 microns two pack epoxy zinc dust/zinc oxide.
Before final assembly of steelwork, at the fabricator's shop, two coats of undercoat shall be applied to the surface of the section in permanent contact, meeting faces and all other concealed surfaces. After final assembly, but before delivery to the project site, the steelwork shall likewise be given two shop coats of undercoat.
The undercoat shall consist of 100 micron two pack epoxy micaceous iron oxide (high build).
The finish coat applied to the steelwork after site erection shall be 70 micron two pack epoxy (high build) colored paint.

b) Galvanized Steelwork

All galvanized steelwork shall be treated with zinc chromate two-pack etch primer followed by one coat of non-etch zinc chromate primer. Two coats of chlorinated rubber shall be given as final coats to the installed galvanized steel work.

c) Miscellaneous Metal Work

Unless otherwise specified in other Sections of the Specifications or shown on the Drawings, miscellaneous metal work such as ladder, ladder rung, steel doors and partition, etc., shall be given two shop coats of epoxy primer and two coats of epoxy enamel.

8.14.6 Construction Methods/ Surface Preparation

a) Cleaning of Surfaces

Surfaces of metal to be painted shall be thoroughly cleaned; removing rust, loose mill scale, dirt, oil, or grease and other foreign substances. Unless cleaning is to be done by sand blasting, all weld areas, before cleaning is started shall be neutralized with a proper chemical, after which they shall be thoroughly rinsed with water.
Three methods of cleaning are provided herein. The particular method to be used shall be as directed by the Engineer.

b) Hand Cleaning

The removal of rust, scale, and dirt shall be done by the use of, metal brushes, scrapers, chisels, hammers, or other effective means. Oil and grease shall be removed by the use of gasoline or benzene.
Bristle or wood fiber brushes shall be used for removing loose dirt.

c) Sandblasting

All steel shall be cleaned by sandblasting. The sandblasting shall remove all loose mill scale and other substances. Special attention shall be given to cleaning of corners and re-entrant angles. Before painting, sand adhering to the steel in corners and elsewhere shall be removed. The cleaning shall be approved by the Engineer prior to any painting, which shall be done as soon as possible before rust forms.

d) Flame Cleaning

All metal, except surface inside boxed members and other surfaces, which shall be inaccessible to the flame cleaning operation after the member is assembled, shall be flame cleaned in accordance with the following operations.

i. Oil, grease and similar adherent matter shall be removed by washing with suitable solvent. Excess solvent shall be wiped from the work before proceeding with subsequent operations
ii. The surface to be painted shall be cleaned and dehydrated (free from occluded moisture) by the passage of oxyacetylene flames which have an oxygen to acetylene ratio of at least 1.0. The inner cones of these flames shall have a ratio length to port diameter of at least 8 and shall not be 4mm center to center.
iii. The oxyacetylene flames shall be applied to the surfaces of the steel in such a manner at such speed that the surfaces are dehydrated; dirt, rust, loose scales in the form of blisters or scrabs, and similar foreign matters are freed by the rapid, intense heating by the flames. The number arrangement and manipulation of the flames shall be such that all parts of the surfaces to be painted are adequately cleaned and dehydrated.
iv. Promptly after the application of the flames, the surfaces of the steel shall be wire brushed, hand scraped wherever necessary, and then swept and dusted to remove all free materials and foreign particles. Compressed air shall not be used for these operations
v. Paint shall be applied promptly after the steel has been cleaned while the temperature of the steel is still above that of the surrounding atmosphere.

e) Weather Conditions

i. Exterior Coatings: Do not apply coatings to surface during foggy or rainy weather, or under the following surface temperature condition:

Over 35 degrees C, unless approved by the Engineer.

ii. Interior Coatings: Apply coatings when surfaces to be painted are dry and the following surface temperatures can be maintained:

Between 18 to 35 degrees C during application.

f) Application

Painting shall be done in a neat and workmanlike manner. Paint may be applied with hand brushes or by spraying, except aluminum paint that preferably shall be applied by spraying. By either method the coating of paint shall be smoothly and uniformly spread so that no excess paint shall collect at any point. If the work done by spraying is not satisfactory to the Engineer, hand brushing shall be required.

i. Paint

Paint shall be factory tinted and mixed. All paint shall be field mixed before applying in order to keep pigments in uniform suspension.

ii. Field Painting

When the erection work is complete, including all bolting and straightening of bent metal, all adhering rust, scale dirt, grease or other foreign materials shall be removed. As soon as the Engineer has examined and approved all field bolts, all welds, and any surfaces from which the top or first coat of paints has become worn off, or has otherwise come defective shall be cleaned and thoroughly covered with one coat of paint. Surfaces to be bolted and surfaces which shall be in contact with concrete shall not be painted. Surfaces that shall be inaccessible after erection shall be painted with such field coats as required. When the paint applied for retouching the shop coat has thoroughly dried, and the field cleaning has been satisfactorily completed, such field coats as are required shall be applied. On no account shall a succeeding coat be applied until the previous coat is dry throughout the full thickness of the paint film. All small cracks and cavities that were not sealed in a watertight manner by the first field coat shall be filled with a pasty mixture of red lead and linseed oil before the second coat is applied.

The following provision shall apply to the application of both coats: To secure a maximum coating on edges of plates or shapes, bolt heads and other parts subjected to special wear and attack, the edges shall first be striped with a longitudinal motion and the bolt heads with a rotary motion of the brush, followed immediately by the general painting of the whole surface, including the edges and bolt heads. The application of the second field coat shall be deferred until adjoining concrete work has been placed and finished. If concreting operations have damaged the paint, the surface shall be re-cleaned and repainted.

iii. Brushing

When brushes are used, the paint shall be so manipulated under the brush as to produce a smooth uniform, even coating in close contact with the metal or with previously applied paint, and shall be worked in to all corners and crevices.

iv. Spraying

Power spraying equipment shall be used to apply the paint in a fine, even, spray. The sprayed area shall have a uniform coverage and shall have no wrinkling, blistering and air holes.

v. Removal of Paint

If the painting is unsatisfactory to the Engineer, the paint shall be removed and the metal thoroughly cleaned and repainted.

9.0 Road and Pavement Works

9.1 General

The main access road shall begin at the Main Entrance and feed all major facilities.

A secondary road network including perimeter and feeder roads shall be included to provide access to all functional parts of the Depot. These shall be sized to permit access to emergency services vehicles including large firefighting equipment.

The road design shall be in accordance with DPWH Standards Specifications.

Walkways for maintenance crew and Depot workers shall be provided to facilitate access to various parts of the Depot.

The walkways shall be located in a safe area and be protected from or away from vehicular or train movements.

The walkways shall be of non-slip type concrete surfaces. Walkways shall have the edges marked with reflective material.

Access routes shall be provided throughout and around the various depot facilities and for all fork lift trucks and other similar vehicles. Where these are inside buildings, the edges of the right of way shall be clearly marked with reflective material and all access doors within these routes shall be designed to facilitate free passage of the vehicles. Walking routes under working overhead cranes shall be avoided.

Operational parking space should provide for maneuvering space to enable vehicles to exit the site properly and safely.

Paved concrete approaches to the station should provide appropriate and proper identifying markings for the riding public such as for elderly, people with disabilities and for general patronage

Concrete level crossing shall be provided when the access road is located across the track area.

In Baclaran Expansion Depot, Train Unloading Area and the area in front of Light Maintenance Shed and Heavy Maintenance Workshop shall be paved with concrete.

In Zapote Satellite Depot, the access to the both end of Light Maintenance Shed shall be paved with concrete.

Entrance Access road and necessary road facilities from Alabang Zapote Road to Zapote Satellite Depot also included in the Depot Contractors Scope.

Zapote entrance access road consist of width 13.4m (3.35m × 4lanes) carriage way and 2.5m width walk way. The work include all necessary earthwork, retaining wall and road facilities (drainage, pavement, street light, road signage, road marking, guard rail and handrail etc).

The provision of the concrete level crossing and the concrete pavement at the end of the maintenance shed and workshop will form interface between ballast track and non-ballast track. Transition concrete slab shall be provided at such interface in order to avoid adverse effect, caused by differential settlement, to track over the interface.

(Please refer to drawing #CMX-L1/DP-CV-01-0001 and 0003)

9.2 Subgrade Preparation

9.2.1 Description

This item shall consist of the preparation of the subgrade for the support of overlying structural layers. It shall extend to full width of the roadway. Unless authorized by the Engineer, subgrade preparation shall not be done unless the Contractor is able to start immediately the construction of the pavement structure.

9.2.2 Material Requirements

Unless otherwise stated in the Contract and except when the subgrade is in rock cut, all materials below subgrade level to a depth 150 mm or to such greater depth as may be specified shall meet the following requirements:
Selected Borrow, for topping – soil of such gradation that all particles will pass a sieve with 75 mm (3 inches) square openings and not more than 15 mass percent will pass the 0.075 mm (No. 200) sieve, as determined by AASHTO T 11. The material shall have a plasticity index of not more than 6 as determined by AASHTO T 90 and a liquid limit of not more than 30 as determined by AASHTO T 89.

9.2.3 Construction Requirements

a) Prior Works

Prior to commencing preparation of the subgrade, all culverts, cross drains, ducts and the like (including their fully compacted backfill), ditches, drains and drainage outlets shall be completed. Any work on the preparation of the subgrade shall not be started unless prior work herein described shall have been approved by the Engineer.

b) Subgrade Level Tolerances

The finished compacted surface of the subgrade shall conform to the allowable tolerances as specified hereunder:

Permitted variation from design LEVEL OF SURFACE	+20mm -30mm
Permitted SURFACE IRREGULARITY measured by 3-m straight-edge	30mm
Permitted variation from design CROSSFALL or CAMBER	± 0.5%
Permitted variation from design LONGITUDINAL GRADE over 25 m length	± 0.1%

c) Subgrade in Common Excavation

Unless otherwise specified, all materials below subgrade level in earth cuts shall be to a depth of 150 mm or other depths as shown on the Plans or as directed by the Engineer shall be excavated. The material, if suitable, shall be set aside for future use or, if unsuitable, shall be disposed off or as directed by the Engineer in accordance with the requirements of **Sub-Clause 2.2.5** Unsuitable materials.
Where material has been removed from below subgrade level, the resulting surface shall be compacted to a depth of 150 mm and in accordance with other requirements of **Sub-Clause 2.5.7** Filling, Grading and Embankment Construction.
All materials immediately below subgrade level in earth cuts to a depth of 150 mm, or to such greater depth as may be specified, shall be compacted in accordance with the requirements of **Sub-Clause2.5.7** Filling, Grading and Embankment Construction.

9.3 Aggregate Sub-base Course

9.3.1 Description

The Item shall consist of furnishing, placing and compacting an aggregate sub-base course on a prepared subgrade in accordance with this Specification and the lines, grades and cross sections shown on the Plans, or as directed by the Engineer.

9.3.2 Material Requirements

Aggregate for sub-base shall consist of hard, durable particles or fragments of crushed stone, crushed slag, or crushed or natural gravel and filler of natural or crushed sand or other finely divided mineral matter. The composite material shall be free from vegetation matter and lumps or balls of clay, and shall be of such nature that it can be compacted readily to form a firm, stable sub-base.

The sub-base material shall conform to Table 9.3.2 below.

Table 9.3.2 Grading Requirements

Sieve Designation		Mass Percent Passing
Standard mm	Alternate US Standard	
50	2”	100
25	1”	55 - 85
9.5	3/8”	40 - 75
0.075	No. 200	0 - 12

The fraction passing the 0.075 mm (No. 200) sieve shall not be greater than 0.66 (two thirds) of the fraction passing the 0.425 mm (No. 40) sieve.
The fraction passing the 0.425 mm (No. 40) sieve shall have a liquid limit not greater than 35 and plasticity index not greater than 12 as determined by AASHTO T 89 and T 90, respectively.
The coarse portion, retained on a 2.00 mm (No. 10) sieve, shall have a mass percent of wear not exceeding 50 by the Los Angeles Abrasion Tests as determined by AASHTO T 96.
The material shall have a soaked CBR value of not less than 25% as determined by AASHTO T 193. The CBR value shall be obtained at the maximum dry density and determined by AASHTO T 180, Method D.

9.3.3 Construction Requirements

a) Preparation of Existing Surface

The existing surface shall be graded and finished as provided under **Sub-Clause 9.2,** Subgrade Preparation, before placing the sub-base material.

b) Placing

The aggregate sub-base material shall be placed as a uniform mixture on a prepared subgrade in a quantity, which will provide the required compacted thickness. When more than one layer is required, each layer shall be shaped and compacted before the succeeding layer is placed.
The placing of material shall begin at the point designated by the Engineer. Placing shall be from vehicles especially equipped to distribute the material in a continuous uniform layer or windrow. The layer or windrow shall be of such size that when spread and compacted the finished layer be in reasonably close conformity to the nominal thickness shown on the Plans.
When hauling is done over previously placed material, hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer, to minimize rutting or uneven compaction.

c) Spreading and Compacting

When uniformly mixed, the mixture shall be spread to the plan thickness, for compaction. Where the required thickness is 150 mm or less, the material may be spread and compacted in one layer. Where the required thickness is more than 150 mm, the aggregate sub-base shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 150 mm. All subsequent layers shall be spread and compacted in a similar manner.
The moisture content of sub-base material shall, if necessary, be adjusted prior to compaction by watering with approved sprinklers mounted on trucks or by drying out, as required in order to obtain the required compaction.
Immediately following final spreading and smoothening, each layer shall be compacted to the full width by means of approved compaction equipment. Rolling shall progress gradually from the sides to the center, parallel to the centerline of the road and shall

continue until the whole surface has been rolled. Any irregularities or depressions that develop shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform. Along curbs, headers, and walls, and at all places not accessible to the roller, the sub-base material shall be compacted thoroughly with approved tampers or compactors.
If the layer of sub-base material, or part thereof, does not conform to the required finish, the Contractor shall, at his own expense, make the necessary corrections.
Compaction of each layer shall continue until a field density of at least 100 percent of the maximum dry density determined in accordance with AASHTO T 180, Method D has been achieved. In-place density determination shall be made in accordance with AASHTO T 191.

d) Tolerances

Aggregate sub-base shall be spread with equipment that will provide a uniform layer, which when compacted will conform to the designed level and transverse slopes as shown on the Plans. The allowable tolerances shall be as specified hereunder:

Permitted variation from design THICKNESS OF LAYER	+20mm
Permitted variation from design LEVEL OF SURFACE	+10mm -20mm
Permitted SURFACE IRREGULARITY measured by 3-m straight-edge	20mm
Permitted variation from design CROSSFALL or CAMBER	± 0.3%
Permitted variation from design LONGITUDINAL GRADE over 25 m length	± 0.1%

9.4 Aggregate Base Course

9.4.1 Description

This Item shall consist of furnishing, placing and compacting an aggregate base course on a prepared subgrade/sub-base in accordance with this Specification and the lines, grades, thickness and typical cross-sections shown on the Plans, or as established by the Engineer.

9.4.2 Material Requirements

Aggregate for base course shall consist of hard, durable particles or fragments of crushed stone, crushed slag or crushed or natural gravel and filler of natural or crushed sand or other finely divided mineral matter. The composite material shall be free from vegetation matter and lumps or balls of clay, and shall be of such nature that it can be compacted readily to form a firm, stable base.
The base course material shall conform to Table 9.4.2 below.

Table 9.4.2 Grading Requirements

Sieve Designation		Mass Percent Passing	
Standard	Alternate US	Grading A	Grading B
mm	Standard		
50	2”	100	
37.5	1 ½"	-	100
25.0	1”	60 - 85	-
19.0	3/4"	-	60 - 85
12.5	1/2"	35 - 65	-
4.75	No. 4	20 - 50	30 - 55

0.425	No. 40	5 - 20	8 - 25
0.075	No. 200	0 - 12	2 - 14

The fraction passing the 0.075 mm (No. 200) sieve shall not be greater than 0.66 (two thirds) of the fraction passing the 0.425 mm (No. 40) sieve.
The fraction passing the 0.425 mm (No. 40) sieve shall have a liquid limit not greater than 25 and plasticity index not greater than 6 as determined by AASHTO T 89 and T 90, respectively.
The coarse portion, retained on a 2.00 mm (No. 10) sieve shall have a mass percent of wear not exceeding 50 by the Los Angeles Abrasion test determined by AASHTO T 96.
The material passing the 19 mm (3/4 inch) sieve shall have a soaked CBR value of not less than 80% as determined by AASHTO T 193. The CBR value shall be obtained at the maximum dry density (MDD) as determined by AASHTO T 180, Method D.
If filler, in addition to that naturally present, is necessary for meeting the grading requirements or for satisfactory bonding, it shall be uniformly blended with the base course material on the road or in a pugmill unless otherwise specified or approved. Filler shall be taken from sources approved by the Engineer, shall be free from hard lumps and shall not contain more than 15 percent of material retained on the 4.75 mm (No. 4) sieve.

9.4.3 Construction Requirements

a) Preparation of Existing Surface

The existing surface shall be graded and finished as provided under **Sub-Clause 9.2**, Subgrade Preparation, before placing the base material.

b) Placing

This shall be in accordance with all the requirements under **Sub-Clause 9.3.3b** Construction Requirements, Placing.

c) Spreading and Compacting

This shall be in accordance with all the requirements of **Sub-Clause 9.3.3c** Spreading and Compacting, except that the field density required of each layer is not less than 100 percent of the maximum dry density determined in accordance with AASHTO T 180 Method D. The field density is determined in accordance with AASHTO T 191.

d) Trial Sections

Trial sections shall conform in all respects to the requirements specified **Sub-Clause 9.3.3.**

e) Tolerances

The aggregate base course shall be laid to the designed level and transverse slopes shown on the Plans. The allowable tolerances shall be in accordance with following:

Permitted variation from design THICKNESS OF LAYER	±10mm
Permitted variation from design LEVEL OF SURFACE	+5mm -10mm
Permitted SURFACE IRREGULARITY measured by 3-m straight-edge	5mm
Permitted variation from design CROSSFALL or CAMBER	±0.2%
Permitted variation from design LONGITUDINAL GRADE over 25 m length	±0.1%

9.5 Portland Cement Concrete Pavement

9.5.1 Description

This Item shall consist of pavement of Portland Cement Concrete, with or without reinforcement, constructed on the prepared base in accordance with this Specification and in conformity with the lines, grades, thickness and typical cross-sections shown on the Plans.

9.5.2 Material Requirements

a) Portland Cement

This shall conform to the applicable requirements of **Sub-Clause 4.3.2a.**

b) Fine Aggregate

This shall consist of natural sand, stone screenings or other inert materials with similar characteristics, or combinations thereof, having hard, strong and durable particles. Fine aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of concrete without the approval of the Engineer.
It shall not contain more than three (3) mass percent of material passing the 0.075 mm (No. 200 sieve) by washing nor more than one (1) mass percent each of clay lumps or shale. The use of beach sand will not be allowed without the approval of the Engineer.
If the fine aggregate is subjected to five (5) cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 10 mass percent.
The fine aggregate shall be free from injurious amounts of organic impurities. If subjected to the colorimatic test for organic impurities and a color darker than the standard is produced, it shall be rejected. However, when tested for the effect of organic impurities of strength of mortar by AASHTO T 71, the fine aggregate may be used if the relative strength at 7 and 28 days is not less than 95 mass percent.
The fine aggregate shall be well-graded from coarse to fine and shall conform to **Table 9.5.2-1** below.

Table 9.5.2-1 Grading Requirements for Fine Aggregate

Sieve Designation	Mass Percent Passing
9.5 mm (3/8 in)	100
4.75 mm (No. 4)	95 - 100
1.18 mm (No. 16)	45 - 80
0.300 mm (No. 50)	5 - 30
0.150 mm (No. 100)	0 - 10

c) Coarse Aggregate

This shall consist of crushed stone, gravel, blast furnace slag, or other approved inert materials of similar characteristics, or combinations thereof, having hard, strong, durable pieces and free from any adherent coatings.
It shall contain not more than one (1) mass percent of material passing the 0.075 mm (No. 200) sieve, not more than 0.25 mass percent of clay lumps, nor more than 3.5 mass percent of soft fragments.
If the coarse aggregate is subjected to five (5) cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 12 mass percent.
It shall have a mass percent of wear not exceeding 40 when tested by AASHTO T 96.
If the slag is used, its density shall not be less than 1120 kg/m^3 (70 lb./cu. ft.). The gradation of the coarse aggregate shall conform to **Table 9.5.2-2** below.
Only one grading specification shall be used from any one source.

Table 9.5.2-2 Grading Requirements for Coarse Aggregate

Sieve Designation		Mass Percent Passing		
Standard	Alternative	Grading	Grading	Grading
mm	U.S. Standard	A	B	C
75.0	3 in.	100	-	-
63.0	2-1/2 in.	90 - 100	100	100
50.0	2 in.	-	90 - 100	95 - 100
37.5	1-1/2 in.	25 - 60	35 - 70	-
25.0	1 in.	-	0 - 15	35 - 70
19.0	3/4 in.	0 - 10	-	-
12.5	1/2 in.	0 - 5	0 - 5	10 - 30
4.75	No. 4	-	-	0 - 5

d) Water

Only potable water shall be used in mixing, curing or other designated application and shall be reasonably clean and free of oil, salt, acid, alkali, grass or other substances adverse to the finished product.

e) Reinforcing Steel

This shall conform to the requirements of **Sub-Clause 4.3.2g** of this Technical Specification Dowel and tie bars shall conform to the requirements of AASHTO M 31 or M 42, except that rail steel shall not be used for tie bars that are to be bent and re-straightened during construction. Tie bars shall be deformed bars. Dowels shall be plain round bars. Before delivery to the site of work, one-half of the length of each dowel shall be painted with one coat of approved lead or tar paint.
The sleeves for dowel bars shall be metal of approved design to cover 50 mm (2 inches), plus or minus 5 mm (1/4 inch) of the dowel, with a closed end, and with a suitable stop to hold the end of the sleeve at least 25 mm (1 inch) from the end of the dowel. Sleeves shall be of such design that they do not collapse during construction.

f) Joint Fillers

Poured joint fillers shall be mixed asphalt and mineral or rubber filler conforming to the applicable requirements of AASHTO M 173.
Preformed joint filler shall conform to the applicable requirements of AASHTO M 33, M 153, M 213 or M 220. It shall be punched to admit the dowels where called for in the Plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint.

g) Admixtures

Air-entraining admixtures shall conform to the requirements of AASHTO M 154.
Chemical admixtures, if specified or permitted, shall conform to the requirements of AASHTO M 194.

h) Curing Materials

Curing materials shall conform to the following requirements as applicable:

vi. Burlap Cloth made from Jute or Kenaf — AASHTO M 182
vii. Sheet materials for curing concrete — AASHTO M 171 (ASTM C 171)
viii. Liquid Membrane Forming Compounds for Curing Concrete — AASHTO M 148 (ASTM C 309)

i) Calcium Chloride

It shall conform to AASHTO M 144, if specified or permitted by the Engineer.

j) Proportioning, Consistency and Strength of Concrete

The Contractor shall prepare the design mix based on the absolute volume method as outlined in the American Concrete Institute (ACI) Standard 211.1, "Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete".
It is the intent of this Specification to require approximately 9.0 bags of cement per cubic meter of concrete based on a 40 kg per bag of cement. However, leaner or richer mixes may be used in order to meet the minimum strength requirements. The Engineer shall determine from laboratory tests of the materials to be used, the cement content and the Proportions of aggregate and water that will produce a workable concrete having a slump of between 40 to 75 mm (1-1/2 and 3 inches) if not vibrated or between 10 and 40 mm (1/2 and 1-1/2inches) if vibrated, and a flexural strength of not less than 3.8 MPa (550 psi) when tested by the third-point method or 4.5 MPa (650 psi) when tested by the mid-point method; or a compressive strength of 24.1 MPa (3500 psi) when tested at fourteen days in accordance with AASHTO T 97, T 177 or T 22, respectively.
Slump shall be determined using AASHTO T 119.
The designer shall consider the use of lean concrete (econocrete) mixtures using local materials or specifically modified conventional concrete mixes in base course and in the lower course composite, monolithic concrete pavements using a minimum of 75 mm (3 inches) of conventional concrete as the surface course.
The mix design shall be submitted to the Engineer for approval and shall be accompanied with certified test data from an approved laboratory demonstrating the adequacy of the mix design. A change in the source of materials during the progress of work may necessitate a new design mix.

9.5.3 Construction Requirements

a) Quality Control of Concrete

Quality Control of Concrete shall conform to the requirements of **Sub-Clause 4.2.2** of this Technical Specification unless otherwise provided in the following sub-clauses.

b) Equipment required for Road Works

i. Mixers

1. General

Concrete may be mixed at the Site of construction or at a central plant, or wholly or in part in truck mixers. Each mixer shall have a manufacturer's plate attached in a prominent place showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

2. Mixers at Site of Construction

Mixing shall be done in an approved mixer capable of combining the aggregates, cement and water into a thoroughly mixed and uniform mass within the specified mixing and discharging and distributing the mixture without segregation on the prepared grade. The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and released it at the end of the mixing period. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, provided that each batch is mixed 90 seconds. The mixer shall be equipped with a suitable non-resettable batch counter which shall be correctly indicate the number of the batches mixed.

3. Truck Mixer and Truck Agitators

   Truck mixers used for mixing and hauling concrete, and truck agitators used for hauling central-mixed concrete, shall conform to the requirements of AASHTO M 157.

4. Non-Agitator Trucks

   Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation.

ii. Paving and Finishing Equipment

The concrete shall be placed with an approved paver designed to spread, consolidate, screed and float finish the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement in conformance with the Plans and Specifications.
The finishing machine shall be equipped with at least 2 (two) oscillating type transverse screed.
Vibrators shall operate at a frequency of 8,300 to 9,600 impulses per minute under load at a maximum spacing of 60 cm.

iii. Concrete Saw

The Contractor shall provide sawing equipment in adequate number of units and power to complete the sawing with a number of units and power to complete the sawing with a water-cooled diamond edge saw blade or an abrasive wheel to the required dimensions and at the required rate. They shall provide at least one stand-by saw in good working condition and with an ample supply of saw blades.

iv. Forms

The forms shall be of steel, of an approved section, and of depth equal to the thickness of the pavement at the edge. The base of the forms shall be of sufficient width to provide necessary stability in all directions. The flange braces must extend outward on the base to not less than 2/3 the height of the form.
All forms shall be rigidly supported on bed of thoroughly compacted material during the entire operation of placing and finishing the concrete. Forms shall be provided with adequate devices for secure setting so that when in place, they will withstand, without visible spring or settlement, the impact and vibration of the consolidation and finishing or paving equipment.

c) Preparation of Grade

After the subgrade of base has been placed and compacted to the required density, the areas which will support the paving machine and the grade on which the pavement is to be constructed shall be trimmed to the proper elevation by means of a properly designed machine extending the work at least 60 cm beyond each edge of the proposed concrete pavement. If loss of density results from the trimming operations, it shall be restored by additional compaction before concrete is placed. If any traffic is allowed to use the prepared subgrade or base, the surface shall be checked and corrected immediately ahead of the placing concrete.
The subgrade or base shall be uniformly moist when the concrete is placed.

d) Setting Forms

i. Base Support

The foundation under the forms shall be hard and true to grade so that the form when set will be firmly in contact for its whole length and at the specified grade.

(Any roadbed, which at the form line is found below established grade, shall be filled with approved granular materials to grade in lifts of 3 (three) cm or less, and thoroughly rerolled or tamped.)
Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary.

ii. Form Setting

Forms shall be set sufficiently in advance of the point where concrete is being placed. After the forms have been set to correct grade, the grade shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. The forms shall not deviate from true line by more than 1 (one) cm at any point.

iii. Grade and Alignment

The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. Testing as to crown and elevation, prior to placing of concrete can be made by means of holding an approved template in a vertical position and moved backward and forward on the forms.
When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

e) Conditioning of Subgrade or Base Course

When side forms have been securely set to grade, the subgrade or base course shall be brought to proper cross-section. High areas shall be trimmed to proper elevation. Low areas shall be filled and compacted to a condition similar to that of surrounding grade. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed.
Unless waterproof subgrade or base course cover material is specified, the subgrade or base course shall be uniformly moist when the concrete is placed. If it subsequently becomes too dry, the subgrade or base course shall be sprinkled, but the method of sprinkling shall not be such as to form mud or pools of water.

f) Handling, Measuring and Batching Materials

The batch plant site, layout, equipment and provisions for transporting material shall be such as to assure a continuous supply of material to the work. Stockpiles shall be built up in layers of not more than one (1) meter in thickness. Each layer shall be completely in place before beginning the next which shall not be allowed to "cone" down over the next lower layer. Aggregates from different sources and of different grading shall not be stockpiled together.
All washed aggregates and aggregates produced or handled by hydraulic methods, shall be stockpiled or binned for draining at least 12 (twelve) hours before being batched.
When mixing is done at the site of the work, aggregates shall be transported from the batching plant to the mixer in batch boxes, vehicle bodies, or other containers of adequate capacity and construction to properly carry the volume required. Partitions separating batches shall be adequate and effective to prevent spilling from one compartment to another while in transit or being dumped. When bulk cement is used, the Contractor shall use a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself for transportation to the mixer, with chute, boot or other approved device, to prevent loss of cement, and to provide positive assurance of the actual presence in each batch of the entire cement content specified.
Bulk cement shall be transported to the mixer in tight compartments carrying the full amount of cement required for the batch. However, if allowed in the Special Provisions, 4 may be transported between the fine and coarse aggregate. When cement is placed in contact with the aggregates, batches may be rejected unless mixed within 1-1/2 hours of

such contact. Cement in original shipping packages may be transported on top of the aggregates, each batch containing the number of sacks required by the job mix. The mixer shall be charged without loss of cement. Batching shall be so conducted as to result in the weight to each material required within a tolerance of one percent for the cement and two percent for aggregates.

Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not over than one percent. Unless the water is to be weighed, the water measuring equipment shall include an auxiliary tank from which the measuring tank shall be equipped with an outside tap and valve to provide for checking the setting, unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

g) Mixing Concrete

The concrete may be mixed at the site of the work, in a central-mix plant, or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time will be measured from the time all materials, except water, are in the drum. Ready-mixed concrete shall be mixed and delivered in accordance with requirements of AASHTO M 157, except that the minimum required revolutions at the mixing speed for transit-mixed concrete may be reduced to not less than that recommended by the mixer manufacturer. The number of revolutions recommended by the mixer manufacturer shall be indicated on the manufacturer's serial plate attached to the mixer. The Contractor shall furnish test data acceptable to the Engineer verifying that the make and model of the mixer will produce uniform concrete conforming to the provision of AASHTO M 157 at the reduced number of revolutions shown on the serial plate.

When mixed at the Site or in a central mixing plant, the mixing time shall not be less than 50 (fifty) seconds nor more than ninety (90) seconds, unless mixer performance tests prove adequate mixing of the concrete is a shorter time period.

Four seconds shall be added to the specified mixing time if timing starts at the instant the skip reaches its maximum raised position. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein,

The mixer shall be operated at the drum speed as shown on the manufacturer's name plate attached on the mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic meter, as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to 10 (ten) percent above the mixer's nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

The batches shall be so charged into the drum that a portion of the mixing water shall be poured in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 (fifteen) seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators or non-agitating trucks specified in **Sub-Clause 9.5.3b** Construction requirements, Equipment required for Road Works. The time elapsed from the time water is added to the mix until the concrete is deposited in place at the Site shall not exceed 45 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when hauled in truck mixers or truck agitators, except that in hot weather or under other conditions contributing to quick hardening of the concrete, the maximum allowable time may be reduced by the Engineer.

Re-tempering concrete by adding water or by other means shall not be permitted, except that when concrete is delivered in truck mixers, additional water may be added to the batch

materials and additional mixing performed to increase the slump to meet the specified requirements, if permitted by the Engineer, provided all these operations are performed within 45 minutes after the initial mixing operation and the water-cement ratio is not exceeded. Concrete that is not within the specified slump limits at the time of placement shall not be used. Admixtures for increasing the workability or for accelerating the setting of the concrete will be permitted only when specifically approved by the Engineer.

h) Limitation of Mixing

No concrete shall be mixed, placed or finished when natural light is insufficient, unless an adequate and approved artificial lighting system is operated.
During hot weather, the Engineer may require that steps be taken to prevent the temperature of mixed concrete from exceeding a specified maximum.
Concrete not in place within 90 minutes from the time the ingredients were charged into the mixing drum or that has developed initial set shall not be used. Re-tempering of concrete or mortar which has partially hardened, that is remixing with or without additional cement, aggregate, or water shall not be permitted.
In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete.

i) Placing Concrete

Concrete shall be deposited in such a manner to require minimal re-handling. Unless truck mixers or non-agitating hauling equipment are equipped with means to discharge concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and mechanically spread on the grade in such a manner as to prevent segregation. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.
When concrete is to be placed adjoining a previously constructed lane and mechanical equipment will be operated upon the existing lane, that previously constructed lane shall have attained the strength for 14 (fourteen) day concrete. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after three (3) days.
Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or side a form. In no case shall the vibrator be operated longer than 15 seconds in any one location.
Concrete shall be deposited as near as possible to the expansion and contraction joints without disturbing them, but shall not be dumped from the discharge bucket or hopper into a joint assembly unless the hopper is well centered on the joint assembly. Should any concrete material fall on or be worked into the surface of a complete slab, it shall be removed immediately.

j) Test Specimens

As work progresses, at least 1 (one) set consisting of 3 (three) concrete beam test specimens, 150 mm x 150 mm x 525 mm or 900 mm shall be taken from each 330 m^2 of pavement, 230 mm depth, or fraction thereof placed each day. Test specimens shall be made under the supervision of the Engineer, and the Contractor shall provide all concrete and other facilities necessary in making the test specimens and shall protect them from damage by construction operations.
The beams shall be made, cured and tested in accordance with AASHTO T 23 and T 97.

k) Strike-off of Concrete and Placement of Reinforcement

Following the placing of the concrete, it shall be struck off to conform to the cross-section shown on the Plans and to an elevation such that when the concrete is property consolidated and finished, the surface of the pavement will be at the elevation shown on the Plans. When reinforced concrete pavement is placed in 2 (two) layers, the bottom layer shall be struck off and consolidated to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be firmly positioned in advance of concrete placement or it may be placed at the depth shown on the Plans in plastic concrete, after spreading by mechanical or vibratory means.

Reinforcing shall be free from dirt, oil, paint, grease, mill scale and loose or thick rust which could impair bond of the steel with the concrete.

l) Joints

Joints shall be constructed of the type and dimensions, and at the locations required by the Plans or Special Provisions. All joints shall be protected from the intrusion of any detrimental foreign material until sealed.

i. Longitudinal Joint

Deformed steel tie bars of specified length, size, spacing and materials shall be placed perpendicular to the longitudinal joints, they shall be placed by approved mechanical equipment or rigidly secured by chair or other approved supports to prevent displacement. Tie bars shall not be painted or coated with asphalt or other materials or enclosed in tubes or sleeves. When shown on the Plans and when adjacent lanes of pavement are constructed separately, steel side forms shall be used which will form a keyway along the construction joint. Tie bars, except those made of rail steel, may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed, or in lieu of bent tie bars, approved two-piece connectors may be used.

Longitudinal formed joints shall consist of a groove or cleft, extending downward from and normal to, the surface of the pavement. These joints shall be effected or formed by an approved mechanically or manually operated device to the dimensions and line indicated on the Plans and while the concrete is in a plastic state. The groove or cleft shall be filled with either a pre-molded strip or poured material as required.

The longitudinal joint shall be continuous, there shall be no gaps in either transverse or longitudinal joints at the intersection of the joints.

Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width and line shown on the Plans. Suitable guide lines or devices shall be used to assure cutting the longitudinal joint on the true line. The longitudinal joint shall be sawed before the end of the curing period or shortly thereafter and before any equipment or vehicles are allowed on the pavement. The sawed area shall be thoroughly cleaned and, if required, the joint shall immediately be filled with sealer.

Longitudinal pavement insert type joints shall be formed by placing a continuous strip of plastic materials which will not react adversely with the chemical constituent of the concrete.

ii. Transverse Expansion Joint.

The expansion joint filler shall be continuous from form to form, shaped to subgrade and to the keyway along the form. Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used.
The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joint shall not deviate more than 6 mm from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

iii. Transverse Contraction Joint

When shown on the Plans, it shall consist of planes of weakness created by forming or cutting grooves in the surface of the pavement and shall include load transfer assemblies.

1. Transverse Strip Contraction Joint

   It shall be formed by installing a parting strip to be left in place as shown on the Plans.

2. Formed Groove

   It shall be made by depressing an approved tool or device into the plastic concrete. The tool or device shall remain in place at least until the concrete has attained its initial set and shall then be removed without disturbing the adjacent concrete, unless the device is designed to remain in the joint.

3. Sawed Contraction Joint

   It shall be created by sawing grooves in the surface of the pavement of the width, depth, and at the spacing and lines shown on the Plans, with an approved concrete saw. After each joint is sawed, it shall be thoroughly cleaned including the adjacent concrete surface.
   Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually 4 to 24 hours. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on during the day or night, regardless of weather conditions. The sawing of any joint shall be omitted should a crack occur at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints should be sawed in sequence. If extreme conditions exist which make it impractical to prevent erratic cracking by early sawing, the contraction joint groove shall be formed prior to initial set of concrete as provided above.

iv. Transverse Construction Joint

It shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. No transverse joint shall be constructed within 1.50 m of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has been mixed at the time of interruption to form a slab of at least 1.5 m long, the excess concrete from the last preceding joint shall be removed and disposed of as directed.

v. Load Transfer Device

Dowel, when used, shall be held in position parallel to the surface and center line of the slab by a metal device that is left in the pavement.

The portion of each dowel painted with one coat of lead or tar, in conformance with the requirements of Item 404, Reinforcing Steel, shall be thoroughly coated with approved bituminous materials, e.g., MC-70, or an approved lubricant, to prevent the concrete from binding to that portion of the dowel. The sleeves for dowels shall be metal designed to cover 50 mm plus or minus 5 mm (1/4 inch), of the dowel, with a watertight closed end and with a suitable stop to hold the end of the sleeves at least 25 mm (1 inch) from the end of the dowel.
In lieu of using dowel assemblies at contraction joints, a dowel may be placed in the full thickness of pavement by a mechanical device approved by the Engineer.

m) Final Strike-off (Consolidation and Finishing)

i. Sequence

The sequence of operations shall be the strike-off and consolidation, floating and removal of laitance, straight-edging and final surface finish. Work bridges or other devices necessary to provide access to the pavement surface for the purpose of finishing straight-edging, and make corrections as hereinafter specified, shall be provided by the Contractor.
In general, the addition of water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as fog spray by means of approved spray equipment.

ii. Finishing Joints

The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, also under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated as required in **Sub-Clause 9.5.3b** of this Technical Specification.
After the concrete has been placed and vibrated adjacent to the joints as required in **Sub-Clause 9.5.3b** of this Technical Specification the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints. If uninterrupted operation of the finishing machine, to, over and beyond the joints causes segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the front screed is approximately 20 cm (8 inches) from the joint. Segregated concrete shall be removed from in front of and off the joint. The front screed shall be lifted and set directly on top of the joint and the forward motion of the finishing machine resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screeds, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

iii. Machine Finishing

1. Non-vibratory Method

The concrete shall be distributed or spread as soon as placed. As soon as the concrete has been placed, it shall be struck off and screeded by an approved finishing machine. The machine shall go over each area of pavement as many times and at such intervals as necessary to give the proper compaction and leave a surface of uniform texture. Excessive operation over a given area shall be avoided. The tops of the forms shall be kept clean by-an effective device attached to the machine and the travel of the machine on the forms shall be maintained true without wobbling or other variation tending to affect the Precision finish.
During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed in its entire length.

2. Vibratory Method

When vibration is specified, vibrators for full width vibration of concrete paving slabs, shall meet the requirements in **Sub-Clause 9.5.3b** of this Technical Specification. If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and method which will produce pavement conforming to the Specifications. All provisions in item above not in conflict with the provisions for the vibratory method shall govern.

iv. Hand Finishing

Hand finishing methods may only be used under the following conditions:

1. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade.
2. In narrow widths or areas of irregular dimensions where operations of the mechanical equipment is impractical, hand methods may be used.

Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete if reinforcement is used.
The screed for the surface shall be at least 60 cm (2 feet) longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and constructed either of metal or other suitable material shod with metal.

Consolidation shall be attained by the use of suitable vibrator or other approved equipment.
In operation, the screed shall be moved forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross-section, and free from porous areas.

v. Floating

After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated by means of a longitudinal float, either by hand or mechanical method.

1. Hand Method

The hand-operated longitudinal float shall be not less than 365 cm (12 feet) in length and 15 cm (6 inches) in width, properly stiffened to prevent flexibility and warping. The longitudinal float, operated from foot bridges resting on the side forms and spanning but not touching the concrete, shall be worked with a sawing motion while held in a floating position parallel to the road centerline, and moving gradually from one side of the pavement to the other. Movement ahead along the center line of the pavement shall be in successive advances of not more than one-half the length of the float. Any excess water or soupy material shall be wasted over the side forms on each pass.

2. Mechanical Method

The mechanical longitudinal float shall be of a design approved by the Engineer, and shall be in good working condition. The tracks from which the float operates shall be accurately adjusted to the required crown. The float shall be accurately adjusted and coordinated with the adjustment of the transverse

finishing machine so that a small amount of mortar is carded ahead of the float at all times. The forward screed shall be adjusted so that the float will lap the distance specified by the Engineer on each transverse trip. The float shall pass over each areas of pavement at least two times, but excessive operation over a given area will not be permitted. Any excess water or soupy material shall be wasted over the side forms on each pass.

3. Alternative Mechanical Method

As an alternative, the Contractor may use a machine composed of a cutting and smoothing float or floats suspended from and guided by a rigid frame. The frame shall carted by four or more visible wheels riding on, and constantly in contact with the side forms. If necessary, following one of the preceding methods of floating, long handled floats having blades not less than 150 cm (5 feet) in length and 15 cm (6 inches) in width may be used to smooth and fill in open-textured areas in the pavement. Long-handled floats shall not be used to float the entire surface of the pavement in lieu of, or supplementing, one of the preceding methods of floating. When strike off and consolidation are done by the hand method and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the surface of the pavement by a 3-m straight-edge or more in length. Successive drags shall be lapped one-half the length of the blade.

vi. Straight-edge Testing and Surface Correction

After the floating has been completed and the excess water removed, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness with a 300 cm long straight-edge. For this purpose, the Contractor shall furnish and use an accurate 300 cm straight-edge swung from handles 100 cm (3 feet) longer than one-half the width of the slab. The straight-edge shall be held in contact with the surface in successive positions parallel to the road center line and the whole area gone over from one side of the slab to the other as necessary. Advances along the road shall be in successive stages of not more than one-half the length of the straight-edge. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straight-edge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straight-edge and the slab conforms to the required grade and cross-section.

vii. Final Finish

If the surface texture is broom finished, it shall be applied when the water sheen has practically disappeared. The broom shall be drawn from the center to the edge of the pavement with adjacent strokes slightly overlapping. The brooming operation should be so executed that the corrugations produced in the surface shall be uniform in appearance and not more than 1.5 mm in depth. Brooming shall be completed before the concrete is in such condition that the surface will be unduly roughened by the operation. The surface thus finished shall be free from rough and porous areas, irregularities, and depressions resulting from improper handling of the broom. Brooms shall be of the quality size and construction and be operated so as to produce a surface finish meeting the approval of the Engineer. Subject to satisfactory results being obtained and approval of the Engineer, the Contractor will

be permitted to substitute mechanical brooming in lieu of the manual brooming as herein described.

If the surface texture is belt finished, when straight-edging is complete and water sheen has practically disappeared and just before the concrete becomes non-plastic, the surface shall be belted with 2-ply canvass belt not less than 20 cm wide and at least 100 cm longer than the pavement width. Hand belts shall have suitable handles to permit controlled, uniform manipulation. The belt shall be operated with short strokes transverse to the center line and with a rapid advances parallel to the center line.

If the surface texture is drag finished, a drag shall be used which consists of a seamless strip of damp burlap or cotton fabric, which shall produce a uniform of gritty texture after dragging it longitudinally along the full width of pavement. For pavement 5 m or more in width, the drag shall be mounted on a bridge which travels on the forms. The dimensions of the drag shall be such that a strip of burlap or fabric at least 100 cm wide is in contact with the full width of pavement surface while the drag is used. The drag shall consist of not less than 2 layers of burlap with the bottom layer approximately 15 cm wider than the layer. The drag shall be maintained in such condition that the resultant surface is of uniform appearance and reasonably free from grooves over 1.5 mm in depth. Drag shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags be substituted.

Regardless of the method used for final finish, the hardened surface of pavement shall have a coefficient of friction of 0.25 or more. Completed pavement that is found to have a coefficient of friction less than 0.25 shall be grounded or scored by the Contractor at his expense to provide the required coefficient of friction.

viii. Edging at Forms and Joints

After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints, shall be worked with an approved tool and rounded to the radius required by the Plans. A well-defined and continuous radius shall be produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting the tool during the use.

At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. In doing this, the rounding of the comer of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed.

All joints shall be tested with a straight-edge before the concrete has set and correction made if one edge of the joint is higher than the other.

n) Surface Test

As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a 3 m straight edge or other specified device. Areas showing high spots of more than 3 mm but not exceeding 12 mm in 3 m shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of 3 mm when tested with 3 m straight-edge. Where the departure from correct cross section exceeds 12 mm, the pavement shall be removed and replaced by and at the expense of the Contractor.

Any area or section so removed shall be not less than 1.5 m in length and not less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 1.5 m in length, shall also be removed and replaced.

o) Curing

Immediately after the finishing operations have been completed and the concrete has sufficiently set, the entire surface of the newly placed concrete shall be cured in accordance with either one of the methods described herein. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour between stages of curing or during the curing period.

i. Cotton of Burlap Mats

The surface of the pavement shall be entirely covered with mats. The mats used shall be of such length (or width) that as laid they will extend at least twice the thickness of the pavement beyond the edges of the slab. The mat shall be placed so that the entire surface and the edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mat shall be so placed and weighted down so as to cause them to remain in intimate contact with the covered surface. The mats shall be maintained fully dampened and in position for 72 hours after the concrete has been placed unless otherwise specified.

ii. Waterproof Paper.

The top surface and sides of the pavement shall be entirely covered with waterproof paper, the units shall be lapped at least 45 cm. The paper shall be so placed and weighted down so as to cause it to remain in intimate contact with the surface covered. The paper shall have such dimension but each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement, or at pavement width and 60 cm strips of paper for the edges. If laid longitudinally, paper not manufactured in sizes which will provide this width shall be securely sewed or cemented together, the joints being securely sealed in such a manner that they do not open up or separate during the curing period. Unless otherwise specified, the covering shall be maintained in place for Seventy Two (72) hours after the concrete has been placed. The surface of the pavement shall be thoroughly dampened prior to the placing of the paper.

iii. Straw Curing

When this type of curing is used, the pavement shall be cured initially with burlap or cotton mats, until after final set of the concrete or, in any case, for 12 hours after placing the concrete. As soon as the mats are removed, the surface and sides of the pavement shall be thoroughly dampened and covered with at least 20 cm of straw or hay, thickness of which is to be measured after the material has been saturated with water. If the straw or hay covering becomes displaced during the curing period, it shall be replaced to the original depth and saturated. It shall be kept thoroughly saturated with water for Seventy Two (72) hours and thoroughly saturated down during the morning of the fourth day, and the cover shall remain in place until the concrete has attained the required strength.

iv Impervious Membrane Method

The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place, or if the pavement is cured initially with jute or cotton mats, it may be applied upon removal of the mass. The curing compound shall not be applied during rain. Curing compound shall be applied under pressure at the rate 4 liter (0.004 cu.m) to not more than 14 m^2 by mechanical sprayers. The spraying equipment shall be equipped with a wind guard. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly

dispersed throughout the vehicle. During application, the compound shall be stirred continuously by effective mechanical means. Hand spraying of odd widths or shapes and concrete surface exposed by the removal of forms will be permitted. Curing compound shall not be applied to the inside faces of joints to be sealed, but approved means shall be used to insure proper curing at least Seventy Two (72) hours and to prevent the intrusion of foreign material into the joint before sealing has been completed. The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film be damaged from any cause within the Seventy Two (72) hours curing period, the damaged portions shall be repaired immediately with additional compound.

v. White Polyethylene Sheet

The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units used shall be lapped at least 45 cm. The sheeting shall be so placed and weighted down so as to cause it to remain in intimate contact with the surface covered. The sheeting as prepared for use shall have such dimension that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, the covering shall be maintained in place for 72 hours after the concrete has been placed.

p) Removal of Forms

After forms for concrete shall remain in place undisturbed for not less than twenty-four (24) hours after concrete pouring. In the removal of forms, crowbars should be used in pulling out nails and pins. Care should be taken so as not to break the edges of the pavement. In case portions of the concrete are spalled, they shall be immediately repaired with fresh mortar mixed in the proportion of one part of Portland Cement and two parts fine aggregates. Major honeycombed areas will be considered as defective work and shall be removed and replaced at the expense of the Contractor. Any area or section so removed shall not be less than the distance between weakened plane joint nor less than the full width of the lane involved.

q) Sealing Joints

Joints shall be sealed soon after completion of the curing period and before the pavement is opened to traffic, including the Contractor's equipment. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign materials including membrane curing compound and the joint faces shall be clean and surface dry when the seal is applied.
The sealing material shall be applied to each joint opening to conform to the details shown on the Plans or as directed by the Engineer. Material for seal applied hot shall be stirred during heating so that localized overheating does not occur. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. The use of sand or similar material as a cover for the seal will not be permitted.
Preformed elastomeric gaskets for sealing joints shall be of the cross-sectional dimensions shown on the Plans. Seals shall be installed by suitable tools, without elongation and secured in placed with an approved lubricant adhesive which shall cover both sides of the concrete joints. The seals shall be installed in a compressive condition and shall at time of placement be below the level of the pavement surface by approximately 6 mm.
The seals shall be in one piece for the full width of each transverse joint.

r) Protection of Pavement

The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen to direct traffic and the erection of and maintenance of warning signs, lights, pavement bridges or crossovers, etc. The Plans or Special Provisions will indicate the location and type of device or facility required to protect the work and provide adequately for traffic.

Any damage to the pavement, occurring prior to final acceptance, shall be repaired or the pavement be replaced.

s) Concrete Pavement - Slip Form Method

If the Contract calls for the construction of pavement without the use of fixed forms, the following provisions shall apply:

i. Grade

After the grade or base has been placed and compacted to the required density, the areas which will support the paving machine shall be cut to the proper elevation by means of a properly designed machine. The grade on which the pavement is to be constructed shall then be brought to the proper profile by means of properly designed machine. If the density of the base is disturbed by the grading operation, it shall be corrected by additional compaction before concrete is placed. The grade should be constructed sufficiently in advance of the placing of the concrete. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placing of concrete.

ii. Placing Concrete

The concrete shall be placed with an approved slip-form paver designed to spread, consolidate, screed and float-finish the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finish will be necessary to provide a dense and homogeneous pavement in conformance with the Plans and Specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibration shall be accompanied with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The forms shall trail behind the paver for such a distance that no appreciable slumping of the concrete will occur, and that necessary final finishing can be accomplished while the concrete is still within the forms. Any edge slump of the pavement, exclusive of edge rounding, excess of 6 mm shall be corrected before the concrete has hardened.
The concrete shall be held at a uniform consistency, having a slump of not more than 40 mm (1-1/2 inches). The slip form paver shall be operated with as nearly as possible a continuous forward movement and that all operations of mixing, delivering and spreading concrete shall be coordinated so as to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

iii. Finishing

The surface smoothness and texture shall meet the requirements of **Sub-Clauses 9.5.3m and 9.5.3n** of this Technical Specification.

iv. Curing

Unless otherwise specified, curing shall be done in accordance with one of the methods included in **Sub-Clause 9.5.3o**. The curing media shall be applied at the appropriate time and shall be applied uniformly and completely to all surfaces and edges of the pavement.

v. Joints

All joints shall be constructed in accordance with Subsection.

vi. Protection Against Rain

In order that the concrete may be properly protected against rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times, materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood planks having a nominal thickness of not less than 50 mm (2 inches) and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering materials such as burlap or cotton mats, curing paper or plastic sheeting material for the protection of the surface of the pavement. Should rain appear imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

t) Acceptance of Concrete

The strength level of the concrete will be considered satisfactory if the averages of all sets of 3 (three) consecutive strength test results equal or exceed the specified strength, f_c' and no individual strength test result is deficient by more than 15% of the specified strength, f_c'.

Concrete deemed to be not acceptable using the above criteria may be rejected unless the Contractor can provide evidence, by means of core tests, that the quality of concrete represented by failed test results is acceptable in place. At least 3 (three) sample cores shall be taken from each member or area of concrete in a place that is considered deficient. The location of the cores shall be determined by the Engineer so that there will be the least impairment of strength of the structure. The obtaining and testing of drilled cores shall be in accordance with AASHTO T 24.

Concrete in the area represented by the cores will be considered adequate if the average strength of the cores is equal to at least 85% of, and if no single core is less than 75% of, the specified strength, f_c'.

If the strength of control specimens does not meet the requirements of this Subsection, and it is not feasible or not advisable to obtain cores from the structure due to structural considerations, payment of the concrete will be made at an adjusted price due to strength deficiency of concrete specimens as specified hereunder:

Deficiency in Strength of Concrete Specimens, Percent (%)	**Percent (%) of Contract Price Allowed**
Less than 5	100
5 to less than 10	80
10 to less than 15	70
15 to less than 20	60
20 to less than 25	50
25 or more	0

u) Opening to Traffic

The Engineer will decide when the pavement may be opened to traffic. The road shall not be opened to traffic until test specimens molded and cured in accordance with AASHTO T 23 have attained the minimum strength requirements in **Sub-Clause 9.5.2j**. If such tests are not conducted prior in the specified period the pavement shall not be operated to traffic until 14 (fourteen) days after the concrete was placed. Before opening to traffic, the pavement shall be cleaned and joint sealing completed.

v) Tolerance and Pavement Thickness

i. General

The thickness of the pavement will be determined by measurement of cores from the completed pavement in accordance with AASHTO T 148.

The completed pavement shall be accepted on a lot basis. A lot shall be considered as 1000 linear meters of pavement when a single traffic lane is poured or 500 linear meters when two lanes are poured concurrently. The last unit in each slab constitutes a lot in itself when its length is at least 1/2 of the normal lot length. If the length of the last unit is shorter than 1/2 of the normal lot length, it shall be included in the previous lot.

Other areas such as intersections, entrances, crossovers, ramps, etc., will be grouped together to form a lot. Small irregular areas may be included with other unit areas to form a lot. Each lot will be divided into 5 (five) equal segments and one core will be obtained from each segment in accordance with AASHTO T 24.

ii. Pavement Thickness

It is the intent of this Specification that the pavement has a uniform thickness as called for on the Plans for the average of each lot as defined. After the pavement has met all surface smoothness requirements, cores for thickness measurements will be taken.

In calculating the average thickness of the pavement, individual measurements which are in excess of the specified thickness by more than 5 mm will be considered as the specified thickness plus 5 mm and measurement which are less than the specified thickness by more than 25 mm shall not be included in the average. When the average thickness for the lot is deficient, the contract unit price will be adjusted for thickness in accordance with paragraph (iii) below.

Individual areas within a segment found deficient in thickness by more than 25 mm shall be evaluated by the Engineer, and if in their judgment, the deficient areas warrant removal, they shall be removed and replaced by the Contractor with pavement of the specified thickness at their entire expense. However, if the evaluation of the Engineer is that the deficient area should not be removed and replaced, such areas will not be paid.

When the measurement of any core is less than the specified thickness by more than 25 mm, the actual thickness of the pavement in this area will be determined by taking additional cores at no less than 5 m intervals parallel to the center line in each direction from the affected location until a core is found in each direction, which is not deficient in thickness by more than 25 mm. The area of slab for which no payment will be made shall be the product of the paving width multiplied by the distance along the center line of the road between transverse sections found not deficient in thickness by more than 25 mm. The thickness of the remainder of the segment to be used to get the average thickness of each lot shall be determined by taking the average thickness of additional cores which are not deficient by more than 25 mm.

iii. Adjustment for Thickness

When the average thickness of the pavement per lot is deficient, payment for the lot shall be adjusted as follows:

Deficiency in the Average Thickness Per Lot (mm)	**Percent of Contract Price Per Lot**
0-5	100% payment
6-10	95% payment
11-15	85% payment

16-20	70% payment
21-25	50% payment
More than 25	Remove and replace (No payment)

9.6 Curb and Gutter

9.6.1 Description

This Item shall consist of the construction of curb and gutter either Precast or Cast in place, made of concrete in accordance with this Specification at the location, and in conformity with the lines, grades, dimensions and design, shown on the Plans or as required by the Engineer.

9.6.2 Material Requirements

a) Material for Bed Course

Bed course materials as shown on the Plans shall consist of cinders, sand, slag, gravel, crushed stone, or other approved porous material of such grading that all the particles will pass through 12.5 mm (1/2 inch) sieve.

b) Concrete

Concrete shall be of the class indicated on the Plans and shall conform to the requirements of Structural Concrete.

c) Expansion Joint Filler

Expansion joint filler shall conform to the requirements of AASHTO M 153

d) Cement Mortar

Cement mortar shall consist of one part of Portland cement and two parts of fine aggregates with water added as necessary to obtain the required consistency.
The mortar shall be used within 30 minutes of preparation.

e) Bonding Compound

Where bonding compound is used, it shall conform to AASHTO M 200.

9.6.3 Construction Requirements

a) Bedding

Excavation shall be made to the required depth and the base upon which the curb and/or gutter is to be set shall be compacted to a firm and even surface. All soft and unsuitable material shall be removed and replaced with suitable material Bed course material shall be placed and compacted to form a bed of the required thickness as shown on the Plans.

b) Cast in Place Curb and Gutter

i. Placing

Metal forms shall be of an approved section.
Forms to hold the concrete shall be built and set-in-place. Forms for at least 50 m of curb and gutter shall be in place and checked for alignment and grade before concrete is placed. Curbs and gutters constructed on curves shall have forms of either wood or metal and they shall be accurately shaped to the curvature shown on the Plans.
Mixing, placing, finishing and curing of concrete shall conform to the requirements of Structural Concrete, as modified by the requirements below.
The concrete shall be placed in the forms in layers of 100 or 125 mm each, and to the depth required. It shall be tamped and spaded until mortar entirely covers the top and surfaces of the forms. The top of the concrete shall be finished to a smooth and even surface and the edges rounded to the radii shown on the Plans.

Before the concrete is given the final finishing, the surface of the gutter shall be tested with a 3-m straight-edge and any irregularities of more than 10 mm in 3 m shall be corrected.

The curb and gutter shall be constructed in uniform sections of not more than 50 m in length except where shorter sections are required to coincide with the location of weakened planes or contraction joints of the concrete pavement, or for closures, but no section shall be less than 2 m long.

The sections shall be separated by sheet templates set perpendicular to the face and top of the curb and gutter. The templates shall be approximately 5 mm in thickness and of the same width as that of the curb and/or gutter and not less than 50 mm deeper than the depth of the curb and/or gutter. Templates shall be set carefully and held firmly during the placing of the concrete and shall remain in place until the concrete has set sufficiently to hold its shape but shall be removed while the forms are still in place.

A preformed joint filler approved by the Engineer may be used in lieu of the sheet template mentioned above. In this event the fiber board shall be pre-cut to the shape of the curb so that its outer edge will be flushed with the abutting curb and/or gutter.

Expansion joints shall be formed at intervals shown on the Plans. Where a curb is placed next to a concrete pavement, expansion joints in the curb shall be located opposite expansion joints in the pavement.

The form shall be removed within 24 hours after the concrete has been placed. Minor defects shall be repaired with mortar containing one part of Portland Cement and two parts of fine aggregate.

Plastering shall not be permitted and all rejected portions shall be removed and replaced at the Contractor's expense. The exposed surface shall be finished while the concrete is still fresh by rubbing the surfaces with a dampened soft brick or wood until they are smooth. The surfaces shall be saturated thoroughly, either by dipping the brick or wood in water, or by throwing water on the surfaces with a brush. After the concrete has been rubbed smooth using water, it shall then be rubbed with a thin grout containing one part of Portland Cement and one part of fine aggregates.

Rubbing with grout shall continue until uniform color is produced. When completed, the concrete shall be covered with suitable material and kept moist for a period of 3 days, or a membrane-forming material. The concrete shall be suitably protected from the weather until thoroughly hardened.

After the concrete has set sufficiently, the spaces on the back of the curb which were excavated for placing the curb shall be refilled to the required elevation with suitable material which shall be tamped in layers of not more than 150 mm until consolidated.

c) Precast Curb and Gutter

i. Placing

The precast concrete curb and gutter shall be set in 20mm of cement mortar.

The precast curb shall not be more than 20cm in width at the top portion and not be more than 25cm at the base. The precast curb and gutter shall be 1.0 m in length and shall be put side by side consecutively with joint in between.

Joints between consecutive curb and gutter shall be filled with cement mortar to the full section of the curb and gutter. Expansion joints shall be formed at intervals shown on the Plans. Where a curb and gutter is placed next to a concrete pavement, expansion joints in the curb and gutter shall be located opposite expansion joints in the pavement.

Minor defects shall be repaired with mortar containing one part of Portland Cement and two parts of fine aggregates. Plastering shall not be permitted and all rejected portions shall be removed and replaced at the Contractor's expense.

The exposed surface shall be finished by rubbing the surfaces with a dampened soft brick or wood until they are smooth. The surfaces shall be saturated thoroughly, either by dipping the brick or wood in water, or by throwing water on the surfaces with a brush. After the concrete has been rubbed smooth using water, rubbed with a thin grout containing one part of Portland Cement and one part of fine aggregate. Rubbing with grout shall continue until uniform color is produced.

ii. Handling Precast Curb and Gutter

1. In preparation for the handling of precast curb and gutter, all fabricated curb and gutter of one (1) meter in length shall be provided or inserted with 2-1"Ø PVC pipes for fitting at their required locations. The PVC pipes shall be placed 25 mm from both edge while the fresh concrete is in plastic state.
2. Precast curb and gutter shall be lifted in upright positions and not at the points of support and shall be the same during transporting and storage.
3. Extreme care shall be exercised in handling and moving precast curb and gutter to avoid cracking.
4. No precast curb and gutter shall be used that does not reach its final strength with the required time stipulated prior to installation.

d) Pavement Markings and Signage

i. General

Where these are inside buildings, the edges of the right of way shall be clearly marked with reflective material and all access doors within these routes shall be designed to facilitate free passage of the vehicles. Walking routes under working overhead cranes shall be avoided.
A fully coordinated combination of signage, colour coding and ground markings shall be used to identify key areas of the Depot and access routes both externally and within buildings.
All hazards on or adjacent to walking routes and other accessible areas including working overhead cranes shall be specifically identified and ground markings and/or warning signs provided accordingly.
Safety signage in all buildings including without limitation marking of safe walking areas, warning signs relating to hazards from overhead crane movement and all other equipment with access to moving parts and emergency egress signage.
Other Signage as required by operational rules and procedures.

ii. Pavement Marking Description

The work shall include the furnishing of premixed reflectorized traffic paint conforming to the requirements of AASHTO M 248, sampling and packing, preparing the surface, and applying the paint to the pavement surface, all in accordance with DPWH Standard Specifications.

iii. Signage Material Requirement

Sign panels shall be manufactured from aluminum sheeting at least 3 mm thick.

All other material for signage, such as posts, frames, nuts and bolts etc. shall be in accordance with DPWH Standard Specifications.

9.7 Sidewalk

9.7.1 Description

This Item shall consist of the construction of asphalt or Portland Cement concrete sidewalk in accordance with this Specification and to the lines, grades, levels and dimensions shown on the Plans, or as required by the Engineer.

9.7.2 Material Requirements

a) Portland Cement Concrete

The cement concrete shall be Class A as specified in **Clause 4.3.2a** of this Technical Specification Cement.

b) Asphalt

Asphaltic material shall be as specified in Item 308, Bituminous Plant-Mix Surface Course, Cold-Laid, or Item 310, Bituminous Concrete Surface Course, Hot-Laid. D.P.W.H. Standard Specification

c) Expansion Joint Filler

Unless otherwise ordered, the preformed joint filler shall have a thickness of 5 mm and shall conform to the requirements of Item 311, Portland Cement Concrete Pavement. D.P.W.H. Standard Specification

d) Forms

Forms shall be of wood or metal as approved by the Engineer and shall extend to the full depth of the concrete. All forms shall be straight, free from warps and of adequate strength to resist distortion.

e) Bed Course Material

Bed course material consists of cinders, sand, slag, gravel, crushed stone or other approved permeable granular material of such grading that all particles shall pass a 12.5 mm (1/2 inch) sieve.

f) Asphalt Prime Coat

Prime coat shall be cut-back asphalt conforming to the requirements of Item 301, Bituminous Prime Coat. D.P.W.H. Standard Specification

9.7.3 Construction Requirements

a) Asphalt Sidewalk

Excavation shall be made to the depth and width required that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm and even surface conforming to the section shown on the Plans.
All materials from soft areas shall be removed and replaced with suitable materials.
The bed course shall be compacted in layers not exceeding 100 mm to the depths, lines and levels shown on the Plans.
The prepared bed course material shall receive an application of prime coat in accordance with the requirements.
The asphalt mixture shall be placed on the previously primed and prepared bed only when, in the opinion of the Engineer, the bed is sufficiently dry and weather conditions are suitable. The mixture shall be placed in one or more layers of uniform thickness to the total depth shown on the Plans.
Each layer shall be smoothed by raking or screeding and shall be thoroughly compacted by rolling with a hand operated roller of a type satisfactory to the Engineer.
After compaction, the surfacing shall be of the thickness and section shown on the Plans and shall be smooth, even and of a dense uniform texture. Forms, if used, shall be removed and the shoulders shaped and compacted to the required section.

b) Cement Concrete Sidewalk

Excavation shall be as specified above. The bed course material shall be placed in accordance with the Item 200, Aggregate Subbase Course. D.P.W.H. Standard Specification
All forms shall be staked securely in position at the correct line and level.

Preformed joint filler shall be set in position shown on the Plans before placing of the concrete is started. The top of the joint filler shall be placed 5 mm below the top surface of the finished sidewalk.

The surface shall be cut through to a depth of 10 mm with a trowel at intervals of 1 m or, were required, in straight lines perpendicular to the edge of sidewalk. The surface shall then be brushed. The edges of the sidewalk and the transverse cuts shall be shaped with a suitable tool so formed as to round the edges to a radius of 15 mm

9.8 Other Concrete Pavement Structures

9.8.1 Level Crossing

Where depot internal road across the track, Contractor shall provide the level crossing structure and pavement in Baclaran Expansion Depot and Zapote Satellite Depot. The detailed design of level crossing shall be fully coordinate with the track contractor.

The pavement design to be constructed between each level crossing shall follow the requirement of the Clause 9.0 Road and Pavement Works of this Technical Specification.

9.8.2 Train Unloading Area

At Baclaran Expansion Depot Contractor shall provide train unloading area between substation and Light Maintenance Shop. The train unloading area shall be concrete paved and the top elevation of the pavement shall be +3.47, which is same as top of rail level of Baclaran Expansion Depot. Concrete pavement shall be designed with enough strength and durability against to the new train unloading works.

9.8.3 Pavement in front of Light maintenance Shop/ Heavy Maintenance Workshop

At Baclaran Expansion Depot Contractor also shall provide pavement between Depot internal road and entrance of Light Maintenance Shop/ Heavy Maintenance Workshop for the vehicles, forklifts easy access to these buildings. The pavement design shall follow the requirement of the Clause 9.0 Road and Pavement Works of this Technical Specification.

9.8.4 Access to Light Maintenance Shop

At Zapote Satellite Depot Contractor also shall provide pavement access between Depot internal road and both side entrance of Light Maintenance Shop for the vehicles, forklifts easy access to these buildings. The pavement design shall follow the requirement of the Clause 9.0 Road and Pavement Works of this Technical Specification.

10.0 Water Supply System

This section covers the requirements of the water supply system for Depot operation usage and fire fighting.
The Contractor shall be responsible for the supply, installation, testing and commissioning of water supply system inclusive of all pipework, valves, brackets, general air and water tight fittings, sleeves and insulation to complete the required works. (Please refer to drawing #CMX-L1/DP-CV-01-0002, 0004 and 0005)

10.1 Functional Requirements

The Depot water supply system shall include cold and hot water, water supply equipment, train washing, firefighting water, floor washing and cleaning, sanitary flushing, etc.
Domestic Water System has been designed to perform the following functions:

a) To provide sufficient water storage volume to ensure continuous Depot water supply;
b) To provide adequate quality of domestic water with sufficient volume to satisfy Depot demands;
c) To conserve the use of fresh water while maintaining proper performance and cleansing of equipment and fixtures;
d) To ensure water supply facilities shall not contaminate water supply sources;
e) Pipe Materials shall be High Density Polyethylene Pipe (HDPE) Type SDR 11 and 9 and fittings, in comply with JIS Standards; and
f) Exposed Piping shall be colour painted for approval of the Engineer.

10.2 Water Supply Source

The water supply source to the Depot shall come from the city water mains for the Zapote Satellite Depot. Water supply source for the Baclaran Expansion Depot will come from the connection/tapping point within the Existing Baclaran Depot.

10.3 Scope

The Plumbing design/build contractor is required to refer to all architectural, structural, mechanical, fire protection, electrical and interior designs plus landscape plans and investigate all possible interference and conditions affecting their work including the necessary coordination with concerned parties.

All design and installation works shall comply with the pertinent provisions of the Plumbing Code of the concerned city, the Code on Sanitation of the Philippines, the National Plumbing Code of the Philippines and other agencies having jurisdiction.

Domestic and Fire Water Distribution System including pumps, fire hydrant, valves, piping and other accessories for complete and operable system.

For the Baclaran Expansion Depot the domestic and fire water supply system shall be integrated/connected to the existing Baclaran Depot water supply connection/tapping points. (Refer to drawing CMX-L1/DP-CV-01-0002)

Train washing plant requirement shall supply, install and commission a washing plant system at Zapote Satellite Depot.

Water supply and distribution system for the bogie washing machine, train parts washing machine etc. at Baclaran Expansion Depot is required.

This work shall consist of material and installation of pipes which include tee, bend, reducer, support of tee and bend, clamp saddle, fitting, fixings, hangers, necessary test etc. and “Water meter chamber”, “HDPE Tap”, “Steel Valve”, “Flange Adopter”. All works include excavation, laying, bedding, jointing, protection, backfilling, disposal and other necessary works required according to the specification and drawings.

The Contractor shall apply, liaise and coordinate with the Water Utility Company and Concessionaire for the water supply connections to the Depot and shall be responsible for the design and installation of the connection, and all costs and charges involved in such works.

The types and characteristics of water supply pipes and their attachment, chamber, tap, valve, flange adopters shown on the drawings and their estimated total quantities entered in the Bid Schedule are not to be taken as final. The Contractor has the responsibility to check and provide a shop drawings and submit for Engineers approval.

The Contractor shall perform test run and start-up of equipment, booster pumping system, fire pumping system, sump pump system, train washing system and other equipment under plumbing works.

Securing of all permits and licenses as required.

Preparation and Submittal of two (2) sets of As-Built Plans.

Furnishing of written one (1) year warranty on the Plumbing System.

10.4 Water Storage Tanks

Manual Train cleaning, Automatic Train Wash Machine, Domestic water, toilet flushing water for staff, water for the Depot and workshop equipment, kitchen water usage, and firefighting are required at the Depot. The domestic water tank and firefighting water tank can be combined storage tanks.

In Baclaran Expansion Depot water storage tank is not required because of integration of Fire/ Fresh Water Supply System with existing Baclaran Depot's new System. Water Tank is provided by the Concessionaire (LRMC) in the existing Depot.

In Baclaran Expansion Depot the Contractor is required to design and build the Fire/ Fresh Water Supply System within Expansion Depot with full coordination with the Concessionaire (LRMC) and connect these pipe lines to the tapping point at the border of existing depot and Expansion Depot. (Please refer the Bid Document Part 2, Section VI-3 "Drawings" No. CMX-L1/DP-CV-01-0002)

In Zapote Satellite Depot Water Storage Tank is required according to the following requirement.)

A conceptual schematic diagram is given in the Tender Drawings. The Contractor shall calculate the actual storage capacity of the water storage tanks in the Depot Pump Room for the whole depot operation usage to satisfy, but not limited to the following minimum requirements:

a) The designed capacity of the water storage tank at least equal to 100% of the whole depot daily consumption including all water usage and consumptions without any incoming water supply;
b) 75 litres per head of staff in each shift per day and also hand wash, shower etc.;
c) Depot and workshop equipment;
d) Flushing water for urinal and water closet;
e) Kitchen water usage;
f) Fire hydrants water supply;
g) Train washing usage; and
h) Irrigation system for landscaping

Water will be distributed to the various areas, buildings, workshops, facilities and plants in the Depot through water distribution main provided under the contract. The capacity of the water tank shall be at least one day's capacity of all water usage in the Depot. All requirements shall follow all applicable Local Code requirements.

The fire services water shall be sized to provide water supply for fire protection system in compliance with Philippine local fire code or Japanese Fire Codes, National Plumbing Code, the Code on Sanitation of the Philippines requirements.

The water tank shall be constructed of reinforced concrete and be completely waterproof, constructed to Japanese Standards and to be accepted by the Engineer.

Pipe connections and all accessories for setting into the tanks shall each comprise:

a) Tank inlet(s), including bypass section;

b) Tank outlet(s);
c) Drain;
d) Motorized Operating Valves, Isolation Valves and Pressure Gauges
e) Valves and Pressure Gauges;
f) Pressure Tank and accessories;
g) Stainless Steel Ladder;
h) Overflow(s);
i) Recirculation;
j) Level controllers;
k) Air vent; and
l) Tank access & cover.

The water tanks shall be constructed following applicable local codes, National Plumbing Code of the Philippines and MLITT-J requirements.

10.5 Water Pipe Installation

The water supply pipe-work shall include pipe lines from the connection point at the existing water mains to the water storage tank for the Zapote Satellite Depot.

And for the Baclaran Expansion Depot the water supply pipe-work shall include pipe lines from the connection point at the border of existing Depot (Please refer the Bid Document Part 2, Section VI-3 “Drawings” No. CMX-L1/DP-CV-01-0002).

The water distribution pipe-work shall include pipe lines laid from tank to the each building requiring water supply for domestic water (cold water), toilet flushing, depot cleaning and firefighting with routing provided to required locations, including irrigation system for landscape. Materials and installation of pipes, control valves complete with adequate “Open”, “Close” contacts and flow switch status etc. shall generally follow best construction specification guide of MLITT-J and applicable Local Codes and Water Utility Company requirements.

The water services shall be installed in a neat and workmanlike manner and shall, as far as practicable, follow the contours of walls and shall be graded to ensure satisfactory drainage.

The material of water pipe shall be Galvanised Steel Pipe with internal poly vinyl chloride pipe (JIS-K-6742(AW) lining and fittings to comply with MLITT-J Requirements or equivalent.

Contractor shall pay special attention to the steel materials which to be installed under or near the track against to stray current. In case of material has possibility to be badly affected by the stray current in the future, Contractor shall arrange appropriate protection measure for the Engineer approval.

Wherever water pipes enter into a building/structure/facility of the Depot, special attention shall be paid to the ground movement/differential settlement to avoid breakage of the installed pipe. Measures such as expansion joint shall be proposed for approval by the Engineer.

All valves and drain cocks shall be located for ease of maintenance. Valves located behind panels within toilets or other areas shall be clearly identified via appropriate marking on the external face of the panel.

Where urinal cisterns are installed, they shall be complete with hydraulic flow control devices, installed within the supply pipework preceding the cistern.

10.6 Valves

All valves used on the water supply system shall be in accordance with the requirements of the local water supply authority. The Contractor shall be responsible to ensure that the requirements of the water authority are fully complied with. All valves shall be non-dezincifiable.

Valves used on water services for isolation purposes shall be gate valves to Local Code and MLITT-J with JIS and/or equivalent.

Drain valves for use on water services shall be screw down cock type to relevant international standards or equivalent.

Ball valves (less than 50mm pipe diameter) shall be high pressure equilibrium pattern complete with arm and copper ball float.

The mains water pipes shall be divided into sections by provision of valves so that water may be shut off for repairs. Isolation valves shall be provided for repairs at specified location on the reference drawing and motorized operating valves to all domestic gate valves entering the building facilities in order to automatically shut off in case of fire occur.

Air Release Valves and Blow off Valves shall be provided where required.

All single and double non-return valves shall be with screwed ends.

Valve material and construction materials as specified below shall conform to the following standards: bronze, high tensile brass, cast iron to; zinc-free bronze, stainless steel to JIS standards or equivalent.

Type of Valve Size (mm) Body Material Disc & Seat Material; in comply with MLITT-J requirements or equivalent;

Gate & Globe 15 - 50 Bronze Bronze 65 and above Cast Iron Bronze

Butterfly 50 and above Ductile iron steel/ PVC encapped ductile Stainless Steel

Swing Check 15 – 50 Bronze Bronze 65 and above Cast Iron Bronze

Silent Seat Check 65 and above Cast Iron Bronze/Stainless Steel

Lubricated Plug 50 and above Cast Iron Bronze/Stainless Steel

Ball Float 15 – 50 Bronze Bronze 65 and above Cast Iron Bronze

10.7 Material

Both the “HDPE pipes” and “Steel pipes” shall conform to the requirement of the following Standard or equivalent.
HDPE pipe: PNS-ISO4427
Steel pipe: JIS G 3452

10.8 Domestic Water Heater

Electric instantaneous type water heater shall be provided in area/room that requires hot water supply. Low flow cut-out, high temperature cut-out and other safety precaution shall be included in the heaters. The instantaneous type water heater shall comply with relevant Japanese Standard and/or international standard.

10.9 Water Pump Requirements

In Baclaran Expansion Depot Water Pump is not required because of integration of Fire/ Fresh Water Supply System with existing Depot’s new System. Water Pump/ Pump Room are provided by the Concessionaire (LRMC) in the existing Depot.

In Zapote Satellite Depot Water Pump is required according to the following requirement.

Pressurized booster pump set Duplex Type (one duty and one standby) parallel and alternate operation with pressure vessel shall be installed to supply water from the main water storage tank to the various areas and water points in the Depot.

The system unit shall be to MLITT-J requirements and be an approved type packaged unit.

Pneumatic cold water booster pump sets (pressurized booster pump unit) shall comprise of duplicated pumps, complete with pressure vessel, motor starter panel and control unit.

The pump set shall be of the package type, being designed and manufactured by a reputable pump manufacturer. The pump sets shall be complete with inter-connection pipework, isolating and non-return valves, flexible connectors, with flanged connections ready for affixing to the pipework system. Locally assembled pump sets shall not be accepted.

One or more pressure vessels shall be provided and installed on the same mounting. The vessels shall be constructed of steel plate built to JIS standards for Unfired Pressure Vessel. The vessels shall be of adequate capacity to accommodate a considerable fluctuation in water demand by the system and shall minimize the start/stop cycles of the pumps.

Pump start/stop frequency shall not be more than 6 times per hour at rated output. If the pressure in the system drops to the pre-determined level, the duty pumps shall cut in automatically via a pressure switch installed on the pressure vessel so as to maintain the water pressure set point in the water supply system.

Automatic control shall be electrode type or float type switches in fresh water tanks whilst float type switches shall be used in flushing water tank. Automatic and manual change-over facilities shall be provided for the pumps. The standby pump shall automatically start upon failure of the duty pump. A lead/lag selection and an automatic alternation facility shall be provided for the duplicated pump sets. After one pump has finished one operation, the other pump shall act as a duty pump for next cycle.

The pump head as shown in the equipment schedule is indicative only and serves as the minimum provision. The pump head calculation shall be carried out via well-established methodology to determine the exact pressure head serving for the system.

Pump shall be type-tested in accordance with the requirement of MLITT-J and JIS standards.

The pumps selected shall have a relatively flat characteristic suitable for both of the combined parallel operation and single-pump operation. Curve indicating excessive shut-off head shall not be permitted. Impeller size shall be sized at 80%-85% of the casing diameter.

Capacities of each pump and motor shall be designed for all conditions of parallel operation. Each motor shall be of sufficient capacity to operate over the entire head capacity range of its respective pump without exceeding nameplate power rating.

Pump motor shall be energy efficient type totally enclosed fan cooled class-F insulation with speed not exceeding 1450 r.p.m unless otherwise specified. All pumps and motors shall be so designed and completed with vibration isolator to attain minimum vibration and noise level during operation.

Automatic priming equipment/tank shall be provided if the position/level of the pump suction inlet is higher than the normal water level of the corresponding water tanks.

Water pumps shall be of horizontal/vertical multi-stage centrifugal type. Impeller shall be of bronze mechanically balanced and keyed to shaft. Pump shaft shall be fabricated from 316 stainless steel, statically and dynamically balanced after assembly. Bearing shall be of ball or roller type protected against ingress of water, dirt and other matter. Shaft sleeves shall be of 316 stainless steel and shaft seal shall be of mechanical seal. Pump casings shall be of close-grained cast iron accurately machined and assembled with metal-to-metal joints.

All pumps pairs shall be so arranged that one pump respectively is the duty pump and the other is the standby pump, with duty/standby selection being effected at the local pump control panel.

If the duty pump does not start within 15 seconds when is called upon to do so (as sensed by pressure switch in the discharge header), then the standby pump shall start automatically.

High/low level float switches shall be provided at each of the water tanks for the control of the respective pumps. Indicator lights and buzzer shall be provided on the control panel to indicate low and high water level of tanks. High water level alarm and pump fail signal shall to alert the Depot staff.

10.10 External Fire Fighting System

10.10.1 Fire Pump

In Baclaran Expansion Depot Fire Pump is not required because of integration of Fire/ Fresh Water Supply System with existing Depot's new System. Fire Pump/ Pump Room are provided by the Concessionaire (LRMC) in the existing Depot.

In Zapote Satellite Depot Fire Pump is required according to the following requirement.

Fire pump sets including one duty and one standby pump shall be installed as part of the firefighting system. The capacity of the main fire pump shall be designed to comply with local requirement or Japan standard. The main fire pump is Diesel Driven Fire Pump (nominal pressure: 110 psi (7.58 bar) automatic / manually). The operation can be controlled by a signal from smoke / heat detectors and provide motorized operated valves to all the domestic gate valves going to building facilities in order to automatically shut off in case of fire occur. The main fire pump shall be driven by a diesel engine for two hours. The Contractor shall submit a fire protection proposal for acceptance by Local Fire Services Department.
The capacity of the fire pump shall be determined as required by Local Fire Codes or Japan Standard

10.10.2 Fire Hydrant

The Contractor shall design and install sufficient fire hydrants with twin-hydrant outlets or two single-hydrant outlets in accordance with local codes, NFPA standard or Japanese standard to ensure that every part of the depot can be reached by a length of not more than 50 m of Fire Services hose in accordance with the requirements of Local Fire Service Department.

The hydrants shall have not less than 6 inch diameter connection with the water mains. A valve shall be installed in the hydrant connection.

Wherever possible, they should be strategically fixed within 50 m as far as possible but not less than 6 m from the designated emergency entrance of the depot they are intended to protect.

The Contractor shall install the fire hydrant assemblies in accordance with local fire codes and the manufacturer's recommendations. The interior components of the fire hydrant shall be cleaned of all foreign matter prior to installation.

Guard posts shall be installed where subject to mechanical damage or directed by the Engineer in accordance with the requirements of Local Fire Service Department. The posts shall be arranged in a manner that will not interface with the connection to, or operation of, hydrants.

10.11 Testing of the System

The testing of the system shall be as per relevant MLITT-J construction requirements and the requirements of the Water Utility Company. The entire pipe line system shall be hydraulically tested to a pressure of 0.5N/mm or twice the working pressure in accordance with MLITT-J whichever is greater for a specified period after a steady state is reached.
Piping Test Conditions for Project

Table 10.11-1 Piping Test Condition

Description	Condition of Pipe	Test Specification	Remarks
Primary Water Pipes	As per Water Authority Requirements or 2 times of max working pressure	Water pressure test for 30 minutes duration	Branch water from City Main
Water Pipes	2 times of max working pressure (1568Kpa=16kg/cm2)	Water Pressure Test of 120 minutes duration	Any pipes except primary ones
All Waste and Soil Pipes	3 meter water static pressure (30Kpa=0.3kgf/cm2)	Water Pressure Test 60 minutes duration	
Vent Pipes	Same as waste pipes above	Watertight Test or Smoke Test 30 minutes duration	

Notes

a) This piping tests shall be based on the MLIT-J construction requirement and HASS-010-2000 of Japan

b) The Contractor shall submit the testing information to the Engineer for Approval:

c) All pipe work shall be tested before covering, insulating, and backfilling, in accordance with the Test procedure shown in the above table.

d) Disinfection of the water supply and distribution system in accordance to National Plumbing Code of the Philippines, the Code on Sanitation of the Philippines and other agencies having jurisdiction.

11.0 Domestic and Industrial Waste Treatment System

11.1 General

This section covers the requirements of the waste water treatment system for Depot operation usage.

The Contractor shall be responsible for the design, supply, installation, testing and commissioning of the system inclusive earthwork, structure work, all pipework, valves, brackets, general air and water tight fittings, sleeves and insulation to complete the installation. All materials shall be suitable for installation. All materials shall be halogen free.

The Contractor shall be responsible for the detail design for the system including but not limited to pipe sizing, adequate supports, storage requirements, sump sizes, pumping arrangements and submit calculations and drawings for the consent. The Contractor shall also confirm the general adequacy of the space requirements within voids or services ducts, openings, main routes etc.

In Baclaran Expansion Depot Waste Water Treatment Plant is not required because of integration of Waste Water Treatment System with existing Depot. Baclaran Expansion Depot waste water will be connected to the Maynilad Lift Station (to be constructed soon in existing depot), then finally going to the Maynilad Waste Water Treatment Plant.

In Baclaran Expansion Depot the Contractor is required to design and build the Domestic and Industrial Waste Water Drainage System which include oil/ grease separators within Expansion Depot in full coordination with the Concessionaire (LRMC), and connect these drainage pipe lines to the connection manhole at the border of Existing Depot and Expansion Depot.

At the connection manhole which is to be constructed by the Concessionaire (LRMC), the Baclaran Expansion Depot side connecting pipe size shall be ϕ 200mm PVC. (Please refer to Bid Document Part 2, Section VI-3 “Drawings” No. CMX-L1/DP-CV-01-0006 & 0007)

11.2 Functional Requirements

11.2.1 Facility Requirements

The number and types of the plumbing and drainage facilities shall be designed and selected based on the anticipated building occupant loads, both transient and permanent, and classifications of the occupancy.

11.2.2 Drainage System

a) Drainage system consists of foul water drainage, including waste water treatment plant, storm water drainage and waste water drainage system; and

b) Sewer drainage and wastewater drainage system shall be designed to perform the following functions:

   i. To provide drainage system that is free from fouling, clogging, and deposit of solids with adequate provisions for maintenance;

   ii. To provide drainage systems with proper separation, isolation and venting of drainage systems to prevent the potential siphonage, aspiration, mixing, and backflow; and

   iii. To provide drainage system piping arrangement, drainage pipe sizes, and facility requirements shall be in compliance with National Plumbing Code of the Philippines, the Code on Sanitation of the Philippines or MLITT-J requirements.

c) Sewer drainage System shall be designed to collect foul water from the staff toilets of the Depot.

d) Waste water drainage system shall be designed to collect waste water from the Depot offices and workshop, depot and track waste water and firefighting water.

e) Storm water drainage system shall be designed to collect rain water from all the above-ground buildings, structures, facilities and plants and discharge into nearest storm water drainage line or existing body of water in accordance to the National plumbing Code of the Philippines or Local code in the area and shall be carried out under the Architectural Building Works.

11.2.3 Waste Water Treatment Plant - General

This work shall consist of the designing, furnishing and installation of Domestic Waste Water Treatment Plant and Industrial Waste Water Treatment Plant. All works shall be done in strict accordance with the Requirements and these Specifications and as directed by the Engineer.

Water demand shall be designed by considering the all the consumption by the staff who are working in the Depot in 1 (one) day, also by the industrial requirement of washing and cleaning cars and spare parts etc. and required fire regulation.

Location and planned work force of each Depot for the assuming of water demand of each Depot is shown in the following table.

Table 11.2.3-1 Planned Work Force

Location	Planned Work Force (persons)	
	Admin and Other Staff	Maintenance Staff
Baclaran Expansion Depot	167	65
Existing Baclaran Depot LRTA Administration Building	150	0
Zapote Satellite Depot	36	89

Water quality of Influent (Assumed) and Effluent (Required) shall be as follows;

Table 11.2.3-2 Assumed Water Quality of Influent and Required Quality of Effluent

Item	Influent		Effluent
	Domestic	Industrial	
pH	6-10	6-10	6.5-9.0
COD (Chemical Oxygen Demand) (mg/lit)	300	400	100
5-days 20℃ BOD (mg/lit)	250	300	50
Total Suspended Solids (mg /lit)	300	400	70
Oil / Grease (mg/lit)	100	200	20

The Contractor shall strictly follow Philippines regulations, R. A. 9275, "The Philippine Clean Water Act of 2004", and R. A. 6969 "Toxic Substances and Hazardous Waste Control Act of 1990" and its corresponding Implementing Rules and Regulations.

The details shown on the Employer's Drawing in the Bid Documents is for reference only. The Contractor shall take all the surrounding condition into account and design Waste Water Treatment Plants in Zapote Satellite Depot including mechanical and electrical works based on the requirement and submit them to the Engineer for approval. Special tools for maintenance shall be also included in the scope of work.

The Contractor shall provide the training to the Employer and Concessionaire staff about the operation and maintenance of Waste Water Treatment Plant, and also provide handling and dispose procedure of waste material together with the operation and maintenance manual for the Treatment Plant.

The water tanks shall be constructed following applicable local codes and MLITT-J requirements.

Notes:

a) This piping tests shall be based on the MLIT-J construction requirement and HASS-010-2000 of Japan;
b) The Contractor shall submit the testing information to the Engineer for Approval;
c) All pipe work shall be tested before covering, insulating, and backfilling, in accordance with the Test procedure shown in the above table; and
d) All sewage collected from the Zapote Satellite Depot and Baclaran Expansion Depot shall comply with the influent sewage characteristics set out by DENR administrative order no. 35, series of 1990.

11.2.4 Waste Water Treatment System in Baclaran Expansion Depot

The Contractor is not required to construct Waste Water Treatment Plant in Baclaran Expansion Depot. The Contractor is required to design and build the Domestic and Industrial Waste Water Drainage System.

The Domestic Waste Water pipe line shall collect domestic waste water from Gate House, Light Maintenance Shop, Heavy Maintenance Workshop, Motor Pool and other buildings and connect to the existing depot new waste water drainage pipe line.

The Industrial Waste Water pipe line will collect industrial waste water from Light Maintenance Shop and Heavy Maintenance Workshop, then after passing through the oil/ grease interceptor connect to the domestic/ industrial waste water drainage manhole at the border of Existing Depot and Expansion Depot.

11.2.5 Waste Water Treatment Plant in Zapote Satellite Depot

The Contractor shall construct one Waste Water Treatment Plant in Zapote Satellite Depot.

The Waste Water Treatment Plant shall treat both domestic and industrial waste water. The domestic waste water shall be collected from Gate House, and Light Maintenance Shop etc. The industrial waste water shall be collected from Light Maintenance Shop. The waste water from

Train Washing Plant shall be separately treated and recycled by the Washing Plant itself prior to disposal to any receiving waterway.

11.3 Storm Water, Sewer Water Drainage and Waste Water Drainage System

The Contractor shall be responsible for the detail design to suit his equipment. They shall design and provide the foul water, waste water and storm water drainage systems to suit the individual requirements at each area and building of the whole Depot.

11.3.1 Rain Water Drainage

Refer to Section 12. Rain Water Drainage.

11.3.2 Waste Water Drainage

Floor drains shall be provided in plant rooms, workshops, equipment rooms and other areas requiring drainage. Waste water shall then be drained by gravity via a system of floor drains and down pipes leading to a waste water manhole at the ground level of the building or structure. Separate floor drains, down pipes and wastewater manhole shall be provided for waste drainages in kitchens and workshop areas.

Grease interceptor and vent pipes shall be provided for waste from kitchen and food preparation facility before discharge to the Depot main waste water system through the waste water/foul water terminal manhole of each individual building/structure.

An oil interceptor shall be provided for the waste from the workshop and maintenance areas before discharge to the Depot main waste water system through the waste water/foul water terminal manhole of each individual building/structure.

11.3.3 Sewer Water Drainage

Sewer water drainage shall be provided to collect and dispose of sewer water generated within the buildings, workshops and facilities of the Depot from sanitary fixtures.

Gravity drainage system for all toilets located at or above ground level shall be provided to collect the foul water directly into the foul water manhole. The foul water shall be discharged to the depot main waste water system through the foul water treatment plant and the waste/foul water terminal manhole of each individual building, structure and facility in the Depot.

11.3.4 Depot Waste Water Drainage System

Besides the waste and sewer water drainage in each individual building, structure and facility of the Depot, the Contractor is also required to provide a main waste water drainage system for the whole Depot.

The Contractor shall ensure that the detail design and provision of storm water, waste water and foul water drainage systems for individual building, workshops, structures and facilities are compatible to the main systems of the Depot, and adjust the detail design where necessary to accommodate for his equipment/systems.

11.3.5 Pipe and fitting for Drainage/Venting

All materials shall be galvanised steel pipes and fittings complying with MLITT-J requirement. Vent pipes shall be PVC pipe and fittings in accordance with MLIT-J requirement.

11.3.6 Sewer Drainage, Waste and Ventilating Pipes Installation

All pipe runs shall be arranged to present a neat appearance and where practicable be parallel with one another and with the building structure. All vertical pipes shall be plumb and identical in their installation method.

The Pipe work shall follow the lines of walls vertically and horizontally and shall be graded as necessary for draining and venting. The minimum clearance between a pipe and any adjacent finished building surface, fixing or pipe shall be 35mm. All pipes shall be securely fixed to walls and under structure slabs with brackets or pipe hangers.

Pipework runs shall in all cases be installed with a view to coordination with other services, whether provided by the Contractor or not.

All pipes passing through the building expansion joints shall be fixed with pipe expansion joints, to cope with movement.

Where plastic pipes pass through structural walls, floors or fire-rated separations, fire stops shall be provided to maintain the fire resistance of the wall, floor or other building element to the satisfaction and acceptance of local Fire Authority and/or the Engineer.

Careful consideration must be given to the low flow rates experienced within the Depot when designing suspended drainage schemes. Self-cleansing velocities must be achieved, minimizing potential blockages etc., therefore a normal minimum installation gradient of 1:60 should be achieved. Any flatter gradient than 1:60 must be proven by the Contractor prior to receiving approval by the Engineer.

Waste pipes shall discharge into open gullies with back inlets, connected to manholes constructed of highly impervious materials properly formed to withstand contamination from mild acids. Allowance shall be made for proper venting and rodding of the drainage system.

Manhole covers within the Depot shall be medium duty double cover, made of cast iron, with screwed down recessed type to accommodate finished floor.

11.3.7 Traps

All traps to soil and waste fittings shall be of suitable heavy duty metal fittings. All traps shall have a minimum of 50mm deep water seal.

All exposed traps within public toilets and staff rooms shall have a chromium plated finish cover with appropriate perforations. All other exposed traps shall have natural copper or painted finish.

11.3.8 Sanitary Fittings

a) Wash Hand Basins : 35 mm diameter deep seal
b) Sinks : 42 mm diameter deep seal
c) Sanitary Disposal Units : 54 mm waste to connect to (integral) 75 mm deep seal trap
d) Water Closets : 100mm soil pipe, trap incorporated within sanitary fitting

11.3.9 Waste Water Pump

Waste water drainage pumps are required to pump out the waste water collected at one point from all sources in case the waste water cannot be discharged by gravity.

All drainage pumps shall be submersible units. Two submersible pumps shall be installed to provide with 100% spare capacity. The pumps shall be mounted on guide rails for ease of maintenance. Each pump shall have an isolating valve and non-return valve. A local control panel shall be provided.

The Pump shall start when water rises just above the high level electrode and stops when the water drops just below the low level electrode.

A lifting system shall be provided for each installation together with an access hatch.

Discharge pipe work shall be in heavy duty galvanized steel. The water shall discharge to the local surface water system via a “goose neck” bend with invert above flood level to prevent back flow.

For the purpose of operation, a normal start level and an emergency start level has been defined for monitoring and control through a set of liquid level controllers or electrodes. In addition, a standby mechanical indicating gauge shall be provided for counter checking of the liquid level controllers. A pump stop level shall be provided for the normal sump level. The pumps shall be capable of pumping the normal daily collection in a period of three to four hours. The other pump shall be available as standby. In case the water level rises above the high level, all the two pumps shall work simultaneously.

The Drainage sump pumps shall be of the centrifugal submersible type. The pump shall be so designed that it can be removed from the sump without the need to drain the sump or enter the sump to disconnect the pipework. Facilities shall be provided for raising and lowering the pump, and the discharge pipe connection shall be automatic. Galvanised steel guide rails and chains shall be provided for raising and lowering the sump pumps.

A coupling shall be provided between the pump and motor, and shall be semi-flexible, of the steel pin/rubber bush type, accurately aligned. Coupling between the pump and motor shall be by means of double mechanical seal. The seal shall be enclosed in an oil filled chamber for dissipation of heat. The Pump impeller and water chute shall be of the non-clog type and so designed that it can pump out soil or waste water containing solids up to 65mm diameter and high viscosity sludge.

The Pump motor rating shall be greater than 3.7kW and shall incorporate thermo protection devices to protect the motor from overheating. The pump and motor shall comply with MLIT-J requirements /JIS

The pump shall be provided with integrated submersible power cable of adequate length to connect to the power supply point for the pump when in place in the sump. No intermediate junction/jointing/connection of this cable is permitted. The cable entry sealing arrangement shall be designed to ensure watertight sealing without the use of epoxies, silicones or the like. The Pump motor cable shall be suitable for submersible pump service and shall conform to JIS specification for pump motors and shall be of adequate size for the transmission of the required motor current.

The pumps shall be so constructed to meet the maximum required working conditions, water temperature, test pressure and nature of the liquid to be passed. All pumps and motors shall meet the minimum vibration and noise levels during operation. Bearing shall be of the silent type. The pump motor shall be provided with an adequately designed cooling system. Where cooling jackets are used, the circulation system shall be designed with minimum liquid exchange and shall be non-clogging and prevent the entrance of large particles and sludge by virtue of design and dimensions.

Pump casing shall be to MLIT-J requirement or close grained cast iron, with impeller of stainless steel grade 316. Shaft sleeves shall be of zinc free bronze, and shaft of stainless steel grade 316. External surfaces coming into contact with sewage shall be protected by an epoxy based coating of minimum 150μm thickness. All exposed bolts and nuts shall be of stainless steel grade 316.

All pump pairs shall be so arranged that one pump respectively is the duty pump and the other is the standby pump, with duty/standby selection being effected at the local pump control panel.

The typical pump control shall be:

a) When the water level in the sump pit reaches the first pre-determined high level, the duty pump shall be started and continue to run until the water level drops back to the low level;
b) If the water level continues to rise to the second pre-determined level, the standby pump shall also be called to operate in parallel with the duty pump. The pump shall only be stopped when the water level drops back to the low level. If the duty pump does not start within 15 seconds when called upon to do so (as sensed by level switch in the sump), then the standby pump shall start automatically;
c) An extra high level alarm shall be provided at the vicinity of the pit and on the panel in management control rooms, when the water raises up to the level, an audible and visual alarm shall be raised. A high water level alarm and pump fail signal s hall also be sent to alert the duty staff;
d) Automatic and manual change-over facilities shall be provided for the pumps; and
e) A lead/lag selection and an automatic alternation facility shall be provided for the duplicated pump sets. After one pump has finished one operation, the other pump shall act as a duty pump for the next cycle.

11.3.10 Waste Water Drainage Pumps

The Waste water disposal pump shall pump out the wastewater collected at one point from all sources by gravity.
The basis for the pumping set selection shall be (in accordance with MLITT-J requirements) and shall be capable of the following:

a) Head loss;
b) Discharge based on four hours of operation;
c) Pump efficiency to be not less than three to five per cent of the maximum possible for the particular type of pump chosen;
d) Pumps shall be selected considering maximum life span based on corrosion analysis of the water or content of solids to be pumped;
e) The motor shall have overload margins of at least 25% and meet MLITT-J requirements and/or international standards;
f) The pump shall be capable of trouble free and maintenance free operation with liquid level controlled automatic operation and capable of remote interface and monitoring;
g) The motor shall be H class insulated with casing rated to withstand the splash of water on the equipment;
h) The pumps shall be submersible type noise and vibration free;
i) The centrifugal pumps shall be of self-priming type with net positive suction head;
j) The pumps shall be generally rated for 2900 or 3000rpm;
k) The main and standby pump shall be identical;
l) The Net Positive Suction Head (NPSH) pump shall always be lower than the atmospheric NPSH to avoid cavitation due to vaporization;
m) Capacitor banks shall be provided for power factor improvement in case the power factor is lower than 0.85;
n) Normally 100% standby shall be provided for each installation; and
o) Other specified shall be followed as waste water pump

11.3.11 Operational Requirements of Waste Water Pump:

a) The pump shall be rated for continuous operation under all conditions;
b) The motor shall have DOL starters for rating less than 3.75 kW and suitable star delta starters for higher ratings. Wherever feasible, electronic type of soft starters shall be provided;
c) Starters shall incorporate systems for protecting the motor from over load, short circuit, earth fault, under voltage and single phasing;
d) Operation shall be possible by remote control based on liquid level controllers fitted in various tanks with adequate redundancy. There will be provision of manual or remote operation for testing or emergency operation;
e) The pumping system shall be provided with lifting tackle at roof level for lifting the pump;
f) Submersible pumps shall have inbuilt protection against dry running, reverse rotation, and the pump failure;
g) The minimum design period required for dewatering shall be 4 hours;
h) The sump capacity must take into account the dead storage of water and the free space required at the top of sump;
i) The pumps shall be chosen to operate on a cyclical basis for alternate operation;
j) Stand-by pumps shall be of similar type and identical design; and
k) The pump installation shall maintain sufficient clearance between the wall and the equipment and that between the two pumps. The installation shall maintain adequate vertical clearance between the pump and the sump floor.

11.3.12 Grease Interceptor

A Grease interceptor shall be provided for the waste water from the kitchen and food preparation facility of the Depot. This is to separate kitchen waste before the waste is discharged to depot main waste water system through the terminal manhole of each individual building and structure. The

design and construction of the grease interceptor shall follow the Japanese standard and comply with local codes and regulations.

The interceptor shall be constructed of epoxy coated fabricated steel. Accessories of the interceptor shall include multi-weir baffle assembly, integral deep seal trap, removable integral flow control and sediment bucket. The cover shall be made of steel with epoxy coast, non-skid with gasket and recessed for floor finish. Securing handle and enzyme injection port shall be provided.

11.3.13 Oil Interceptor

An Oil interceptors shall be provided for the waste water from Heavy Maintenance Workshop, Light Maintenance Shed and other workshop areas of the Depot to separate the oil waste before the waste is discharged to depot main waste water system through the terminal manhole of each individual building and workshop. The design and construction of the oil interceptor shall follow the Japanese standard and comply with the National Plumbing Code of the Philippines and local regulations.

The oil interceptor shall be constructed of epoxy coated fabricated steel.

Accessories of the interceptor shall include integral deep seal trap, removable integral flow control, adjustable draw-off assembly and sediment bucket. The cover shall be made of steel with epoxy coat, non-skid with gasket and recessed for floor finish. Securing handle and enzyme injection port shall be provided.

11.3.14 Testing Requirements

The Contractor shall submit their test regime to establish the adequacy and efficiency of the pumping set and other operational requirements. The Contractor shall furnish the acceptance criterion for the consent of Engineer based on the system requirement. The criteria shall also state the rejection limits. And shall comply with the pertinent provisions of the National Plumbing Code of the Philippines and the Code of Sanitation of the Philippines.

12.0 Rain Water Drainage

12.1 Scope

This work shall consist of the construction of drainage pipes, manholes, catch basin, junction box and other drainage facilities in accordance with these Specifications and the specifications for other work items involved, in conformity with the lines, grades and dimensions instructed by the Engineer.

The design of rain water drainage shall consider extreme rainfall experience during recent decade and the climate change scenarios for Metro Manila stated in PAGASA 2020 and 2050 as well as hazard map index of Metro Manila.

The cost of working in, or dealing with all ground water encountered in executing the work of this section shall be deemed to be included in the unit price for the pay item being installed or constructed.

The Engineer reserves the right to inspect and test all pre-cast concrete, PVC pipe and other items described on the drawings or instruction by the Engineer before their delivery to the site and at any time prior to and during laying.

The two (2) rain water drainage out fall shall be provided with backflow preventer device to stop the backflow of water in case of High Tide and/ or Storm Surge.

Minimum covering for all drainage pipes shall be in accordance with DPWH Specifications.

12.2 General

The types and characteristics of the drainage pipes, manholes, catch pits and other drainage structures shown on the Drawings and their estimated total quantities entered in the Bid Schedule are not to be taken as final.

To assist the Engineer in their review of the contract drawings, the Contractor shall undertake a survey of all sites to determine the location, pipe, culvert or channel size, invert level and estimated discharge of all storm water, foul sewer or irrigation flows entering the Site.

On the basis of the results of this survey the final types, lines, characteristics and quantities shall be decided by the Engineer, who shall inform the Contractor of them in writing in due time in relation to the approved schedule of work submitted by the Contractor. Responsibility for accurately locating all existing flows shall rest with the Contractor and the cost of this survey shall be deemed to be included in the various pay items of this Section.

Any procedures shown on the Drawings for the temporary drainage is only for reference. The Contractor must select their own working methods based on their consideration of the prevailing conditions and other factors.

12.3 Sequence of Work

In areas where significant settlement is expected below new embankments, the Engineer may instruct that work on the permanent drainage below such embankments be delayed until the settlement is substantially completed. This delay shall be considered by the Contractor when preparing their schedule of site works and temporary drains shall be provided as necessary. Any additional or special conditions relating to this matter will be given in the Special Specifications. The Contractor shall at all times so schedule the construction of drainage works that the discharge of runoff from rain or other sources, both during and after construction, is suitably provided. To avoid damage to works in course of construction the Contractor shall provide in due time adequate means of protection, including all necessary temporary outlet ditches, dams, or diversion channels.

Culverts or other drainage works for the discharge of runoff water either during or after construction shall not be built until adequate facilities for the inflow and outflow of the water have been completed, and they shall be kept clear of all obstructions that might impede the flow of water. All culverts, ditches and other drainage works shall be fully operative before work is commenced on the construction of sub-grade, sub-base or shoulders.

These requirements shall be fulfilled without additional payment and all costs thereof shall be included in the respective milestone payment for the completed drainage work.

12.4 Drainage Pipes

12.4.1 Description

The work shall consist of reinforced concrete drainage pipes and perforated PVC pipes furnished and installed in accordance with these Specifications and in conformity with the lines, levels and other details decided by the Engineer as a result of the Contractor's survey mentioned in Clause 6.2. The relevant requirements of Clauses 6.2 and 6.3 shall be read into and considered part of this clause.

For RC Pipe and PVC Pipe (accepting perforated PVC pipe), a water leak test shall be performed from manhole to manhole not exceeding 100m after backfilling. The Water level shall be not less than 1.2m head of water above the pipe soffit. The pipe line including manhole shall be filled with water and a minimum period of two (2) hours shall be allowed for absorption, after which water shall be added from a measuring vessel at interval 5 minutes and the quantity required to maintain the original water level noted. Unless otherwise stated, the length of pipeline shall be accepted if the quantity of water added over a 30 minutes period is less than 0.5 litre/linear metre/metre of nominal size.

12.4.2 Materials

All drainage pipes shall be factory manufactured and before the Contractor places any orders for the supply of pipes, the factory must be inspected and approved in writing by the Engineer. In cases where the supply of factory made pipes is not possible then pipe details shall be as shown on the Drawings and the Contractor shall submit for the Engineer's approval, full details

of his proposed arrangements for the manufacture, curing and handling of reinforced concrete pipes and perforated PVC pipes. Form-work used in the manufacturing reinforced concrete pipes shall be steel and of rigid construction.

All PVC pipes shall conform to the requirement of JIS K6741 or equivalent.

RC pipes shall be confirm to the requirement of DPWH standard or equivalent

Geotextile which wrap around the gravel drain in Track Yard shall conform to this Specification 4.8 Geotextile. Gravel around the perforated PVC pipes for underground drain shall be crushed stone, free of silt and clay material and conform to this Specification 5.3 Permeable backfill.

12.4.3 Construction

12.4.3.1 Excavation

Prior to starting excavation the Contractor shall take all necessary measures to keep the excavation free from free-surface water or surface water run-off.

Except as otherwise instructed by the Engineer, in areas of fill, filling shall be completed at least to a depth of one pipe diameter above the top of the pipe, before excavation begins. All excavation shall be carried out so as to minimize damage to existing surfaces. The sides of pits and trenches shall be adequately supported at all times. Except where otherwise described in the Contract, they shall not be battered. The supports shall be left in pits or trenches only where described in the Contract. Excavated material not required for back-filling shall be dealt with in accordance with Section 4 of the Specifications. Soft spots in the base of the drainage excavation shall be removed and the resulting void immediately back-filled with Granular Backfill in accordance with Clause 5.2 of this specification. Should the Engineer instruct this additional treatment it shall be paid for under the relevant clauses of the Specifications. Where the Engineer considers that soft spots are due to the Contractor's failure to fulfil his obligations under any clause of these Specifications then the Contractor shall, at their own expense, undertake the additional excavation and replacement with Granular Backfill to the satisfaction of the Engineer. Any suitable material below the level of the pipe bed which is removed unnecessarily shall be replaced at the Contractor's expense with Granular Backfill in accordance with Clause 5.2 of this Specification.

12.4.3.2 Bedding, Laying and Surrounding of Pipes

All pipes shall be laid, using cradles if necessary, to the true line and level as directed by the Engineer. Joints for reinforced concrete pipes shall be sealed with 1:2 cement mortar and/or bituminous material, except where otherwise specified, so that water will not leak. The inside of the joint shall be wiped and finished smooth and the outside shall be protected for two days or as otherwise directed by the Engineer to prevent cracking. The external face of the joint shall then be treated / sealed as shown on the Drawings or instructed by the Engineer.

Joints for perforated PVC pipes shall be accordance with the manufacture’s instruction.

12.4.3.3 Backfilling and Reinstatement

Backfilling for reinforced concrete pipes shall not commence until in the opinion of the Engineer, the concrete has achieved sufficient strength. Backfilling shall be carried out in accordance with the requirements of the drawing. On completion of backfilling, the area excavated shall be reinstated to its original condition but the Engineer may waive or modify this requirement if the area is to be overlaid or reconstructed under other Clauses of this Contract.

For perforated PVC pipes, the geotextile shall be laid on the excavated trench after inspected by the Engineer. First layer of gravel shall be placed on the geotextile, perforated PVC pipe shall be laid according to previous clause then rest of the gravel shall be laid by layer by layer, maximum thickness of layer shall be 20cm. Gravel drains shall be wrapped by the geotextile, geotextile shall overlap on the top of gravel drain, minimum overlapping shall be 50cm and properly sewn. Perforated PVC pipes including clean-out and geotextile shall be protected from the damages throughout the construction.

12.5 Inlet, Catch Basin and Manhole

12.5.1 Description

This item shall consist of all work in connection with the construction of inlets, catch basin and manholes where shown on the Drawings or where instructed by the Engineer.

All work shall be done in accordance with these Specifications and in conformity with the lines, levels, grades and dimensions shown on the Drawings or as directed by the Engineer. The applicable provisions of Clauses 6.1, 6.2 and 6.3 shall apply and be relevant to of this clause. If the work required is not covered by these Specifications then the relevant Local standards shall be adopted.

12.5.2 Materials

Materials shall be as shown on the Drawings and comply with the relevant clauses of the Specifications.

12.5.3 Construction

All work on inlets, catch basins and manholes shall be carefully set out and constructed with due recognition being taken of the fact that the upper surfaces must be incorporated exactly into curbs, foot paths and asphalt, etc. The Engineer may reject any item of work under this Clause when the upper surfaces do not meet the tolerances for curb and foot paths given in these Specifications.

Unless otherwise specified, joints of pre-cast blocks shall be carefully constructed using cement mortar of 1 part cement and 2 parts sand so as to prevent leakage.

To ensure uniformity in the horizontal and vertical alignment of the curb, the Engineer may instruct that work on the upper sections of inlets, catch pits, manholes and ditches be deferred and carried out immediately before or during work on the adjacent curb. Any additional expense incurred in complying with this instruction shall be deemed to be already included in the unit price for this work.

Backfill shall be performed in accordance with the requirements of Clause 5.1 of this Specification. Backfill shall be carefully implemented as to obtain a bearing capacity equal to the adjacent sub-grade. In compacting the sub-base or base course in contact with drainage structures, rammers or small compactors shall be used and care taken to prevent damage to the adjacent structures. On completion of backfilling, the area excavated shall be reinstated to its original condition, but the Engineer may waive or modify this requirement if the area is to be overlaid or reconstructed under other Clauses of this Contract.

12.6 Grating Ditch

12.6.1 Description

Contractor shall provide grating ditch at the entrance of Light Maintenance Shop, Heavy Maintenance Workshop where outside of the entrance is concrete paved and same level as inside floor to prevent rain water enter into the building.

The grating cover shall have the frame which is fixed into concrete ditch firmly to protect the concrete edge and also require locking device to fix the grating cover tightly onto frame. Grating also shall be designed to bear the folk lift working load.

12.6.2 Material

Grating shall be galvanized and conform to ASTM A36 and/ or the requirement of Clause 8.0 Structural Steel of this Technical Specification.

Concrete ditch shall follow the requirement of Clause 4.0 Concrete works of this Technical Specification.

12.6.3 Construction

All the construction works of grating ditch shall conform to the requirement of this Specification and to be carefully done so that the upper surfaces of grating and concrete ditch must be exactly fit with the top surface of building floor and outside concrete pavement.

13.0 Incidental Structures

The following incidental structures shall be designed and constructed in accordance with conceptual plan shown on the Drawings.

13.1 Retaining Wall

13.1.1 Retaining Wall in Baclaran Expansion Depot

The Reinforced concrete retaining wall shall be constructed along the service road where the track level is higher than the road in Baclaran Expansion Depot Area. The Contractor shall identify the location and depth of the existing box culvert and take this into account for their design of the wall.

13.1.2 Retaining Wall in Zapote Satellite Depot

The river wall and perimeter wall shall be constructed in Zapote Satellite Depot Area. The Contractor shall take into consideration the effect of consolidation settlement caused by embankment fill for their design and working sequence of the wall.

13.1.2.1 River Retaining Wall

The River retaining wall shall be constructed along a section of the Depot Area located adjacent to the river as shown on the Drawings. The wall shall be of reinforced concrete, sheet pile wall or pipe pile wall. A Tie back structure to hold the wall will not be allowed for the design.

13.1.2.2 Perimeter Retaining Wall

A Reinforced concrete perimeter retaining wall shall be constructed along the ROW of Depot Area as shown the Drawings.

13.2 Perimeter Fence and light

The perimeter fence and light shall be constructed along the ROW of Depot Area as shown on the Drawings.
At Zapote Satellite Depot it shall be made by and required height of the fence is H=2.5m.
At Baclaran Expansion Depot structure and height of the fence shall be same as existing type.
In Baclaran Expansion Depot the Perimeter fence and light shall be provided in the place where the fence and light are not existing now, and after the expansion.

13.3 Height Limit Gantry

The Steel height limit gantry shall be constructed at the location shown on the Drawings in order to restrict entry of vehicle where overhead catenary line is running. The beam bottom elevation of Height Limit Gantry shall be a minimum of 50cm lower than the level of overhead catenary line of the area. This beam bottom elevation should be coordinated with the OCS to ensure the clearance is sufficient.

13.4 Cable Trough and Cable Duct for Electrical Cables

Reinforced concrete cable trough/ duct, pit and plinth shall be constructed as shown on the Drawings or required by The Employer and/ or Engineer. Minimum soil cover of cable trough/ duct to the top of sub-ballast of track or sub-grade of road shall be 0.7 meter. (Please refer to drawing #CMX-L1/DP-EM-01-0001 to 0007)

13.5 Utilities and Services Crossings for At Grade Track

Where any utility or service crosses beneath the tracks which are on ballasted formation, a culvert or sleeve shall be provided around the utility or service in order to prevent erosion of the

railway formation due to leakage or pipe bursts and the like. The culvert or sleeve shall extend for a sufficient distance on either side of the railway reserve, so that any excavation to expose the utility or service will not result in loss of stability of the railway formation. The top of the culvert or sleeve shall be located below the maximum depth specified for the railway drainage.

13.6 Car Park

A car parking facility for staff and visitors shall be provided, which can be readily accessed from the main Depot entrance, in an area which is not taken up by designated accommodation.

Sufficient car spaces shall be provided in accordance with the staff estimates.

A central covered car parking facility shall be provided in Zapote Satellite Depot Area as shown on the Drawings.

An uncovered car parking area shall be provided nearby train unloading area in Baclaran Expansion Depot Area as shown on the Drawings.

The following are standard space requirements of typical vehicles. These may be used as the basic minimum requirements for the car park area.

Car 2.4 meter x 4.8 meter

Light Vans 2.4 meter x 5.5 meter

These dimension refer to standing space only and do not take into account of access, manoeuvring space or space required for loading/unloading.

Motorcycle Parking facility will be assessed on demand and also take into account the requirement of users and recognise that they are vulnerable in a tight or enclosed space. An additional security can be afforded through the provision of security bollards or in ground motorcycle clamps to which motorcycles can be chained.

13.7 Working Deck

A Working Deck shall be provided with a width of 1.5m, and a height of 0.9m from top of rail and a length of 116m at the Siding Track in Zapote Satellite Depot for train cleaning works.

These tracks shall have water hose tapping points and power points at every 30 m to make easy access to water and electrical source.

A hand rail also shall be provided at the opposite of Siding Track side for safety.

13.8 OCS Foundation

Overhead Catenary System (OCS) Foundation shall be designed and constructed at Baclaran Expansion Depot and Zapote Satellite Depot by The Contractor.

Required specification relating to the design and construction of OCS and Anchor Foundation shall follow this Technical Specification and General Specification.

The location, number and loading data for each type of OCS and Anchor Foundation is attached in the Bid Document Part 2 Section VI-4 Supplemental Information VI-4-4 OCS and Anchor Foundation

The Contractor shall be responsible for review of the OCS and Anchor Foundation layout design to avoid the interface problem with his drainages, duct and other depot structures to be constructed inside of Depot.

Material and installation of Anchor Bolt, Anchor and other necessary associated accessories shall be the scope of EPC Contractor.

The demarcation of the scope of works shall follow **Table 13.8.1 Demarcation of OCS Foundation Work**.

Table 13.8.1 Demarcation of OCS Foundation Work

Description	SCOPE	
	EPC (LRMC)	Depot Contractor
A. Design Work		
・Location/ number and type of foundation	○	
・Loading on foundation	○	
・Anchor bolt, anchoring material etc.	○	
・Grounding provision	○	
・Design of OCS and Anchor Foundation		○
B. Material Supply		
・Anchor bolt, Anchor material and other necessary associated material	○	
・Grounding material	○	
・Grouting (if necessary)	○	
・OCS and Anchor Foundation		○
C. Construction, Installation		
・Anchor bolt, Anchor material and other necessary associated material	○	
・Grounding material	○	
・Grouting (if necessary)	○	
・OCS and Anchor Foundation		○

14.0 Track works

14.1 Scope of Work

The depot track works for both the Baclaran Expansion Depot and Zapote Satellite Depot comprises of the civil works portions and interfacing activities with the concessionaires. These include the ground preparation up to the sub-ballast level of the track structure for ballasted tracks, concrete slabs for concrete tracks or the embedded tracks and foundations for pedestal tracks supports in the maintenance shop or workshops.
The Works shall comprise, but not be limited to;-

a) Design, supply, constructing, integration with other contracts, field testing of track related civil works in the stabling yard, depot access line track and workshops. All track works and ballast layer in the depot stabling will be furnished by the Concessionaire;
b) The Contractor shall be responsible for the installation of sub-ballast in the stabling yards, depot access and on other locations where ballasted tracks will be constructed;
c) The Contractor shall be responsible for the design and installation of reinforced concrete pavement tracks base with concrete opening for rail installation where embedded track will be installed by the concessionaire. The size of concrete opening shall be coordinate with concessionaire.
d) The Contractor shall be responsible for the design and installation of track substructure where pedestal tracks inside the workshops are to be constructed;
e) The Contractor shall be responsible for the design and installation of drainage system for the collection and discharge of surface water run-off; and
f) The Contractor shall be responsible for the design and installation of transition slab where there is a change in the type of track structure.

14.2 Performance Requirements

Ballasted tracks will be constructed by the Concessionaire, including the spreading and compaction of ballast level and all rail installation inside the workshop and maintenance buildings.

The track civil work application required is mainly the formation and compaction of the sub-ballast, placed on a prepared track bed to accommodate the loads that will be imposed during depot operations.

In paved work areas and level crossings where the rails shall be embedded, the Contractor shall prepare the concrete slabs in a setting for a pourable resilient base and the top of rail flushed with the paved areas.

In workshops with pedestal tracks, the Contractor shall design and provide the column supports in close coordination with other Systems requirements.

The track substructure at the Baclaran Expansion Depot and Zapote Satellite Depot shall be designed and constructed to suit for train operation at speeds up to 5 km/hr, and shall have a low maintenance requirement.

The track drainage system shall effectively drain surface water run off to prevent flooding or ponding of water in the stabling yard.

14.3 Design Requirements

The track substructure must be designed so that the subgrade, sub-ballast and track ballast provide uniform support and distribution of superstructure loadings. The subgrade strength will dictate the combined depth of ballast and sub-ballast materials.

A transition slab shall be designed and installed on locations where the rolling stock passes from one type of track to another. The contractor shall design the transition slab to adequately carry the dynamic load and to properly cushion load impact.

14.3.1 Sub-Ballast

The following conditions should be considered in the design of the sub-ballast section:

a) Engineering properties of subgrade soil;
b) Support capability of subgrade;
c) Unit load applied to the ballast at the base of tie;
d) Total thickness (track ballast + sub-ballast);
e) Sub-ballast properties;
f) Gradation of sub-ballast; and
g) Installation and compaction.

The distribution of loads to depth is approximately the same regardless of the granular material. The combined depth of sub-ballast and ballast is calculated as a single unit to develop the pressure on the subgrade.

14.3.2 Sub-Grade Soils

The minimum data needed to evaluate the subgrade soils should be classification (which requires Atterberg limits and gradation as appropriate) and strength (lowest expected). The following current ASTM test designations may be used in developing the necessary data where appropriate for design:

a) Plastic Limit and Plasticity Index D4318
b) Grain Size Analysis . . . . . D421 (Sample Preparation)
D422 (Test Procedure)
c) Compaction Test D698
D1557
d) Unconfined Compression Test D2166

Where cohesive soils exist in the subgrade, resulting of an unconfined compression test of the compacted cohesive material (saturated) will give cohesion or shear strength for use in design. It may not be necessary to develop shear values from tests for some non-cohesive soils but where necessary standard tests may be performed.

The level of stress in the subgrade should not exceed an allowable bearing pressure that includes a safety factor. A minimum factor safety of a least 2 and as much as 5 or more should be provided to prevent bearing capacity failure or undue creep under the loaded area. When subgrade support is marginal and/or where the liquid limit of the subgrade soil exceeds a value of 30 or the plasticity index exceeds 12, special attention should be given to that soil. A change of subgrade soil or stabilization of the subgrade material may be considered to obtain a more reliable support for the sub-ballast.

14.4 Sub-Ballast

14.4.1 Description

This section of the specification covers the design, materials requirement and construction of sub-ballast section including the spreading as well as the compacting of crushed aggregates base or sub-ballast for the construction of new tracks.

The Contractor shall submit the necessary procedures required in this section for the Engineer's approval. He shall also submit initial material acceptance test report.

14.4.2 Material Requirement

The sub-ballast shall be a granular material so graded as to prevent penetration into the subgrade and penetration of track ballast particles into the sub-ballast zone. Applying the filter principle used in drainage to the grading of the subgrade material will determine the grain size distribution of the sub-ballast.

The sub-ballast shall conform to the applicable requirement of Section 9.3 of this Specification.

14.4.3 Construction Requirements

The sub-ballast shall be spread and compacted in conformance with the requirement of Section 9.3.3 of this Specification.

14.5 Sub-Grade Preparation

This item shall consist of the preparation of the subgrade for the support of overlying Sub-Ballast layers. It shall extend to full width of the track bed and constructed in conformance with the requirement of Section 9.2 of this Specification.

14.6 Transition Slab

Where concrete track change to ballast track Contractor shall provide transition slab in order to mitigate adverse effect caused by differential settlement. The design and construction work of the transition slab require well coordination with EPC and their contractor

C. Architectural Works and Finishes

1.0 Zapote Satellite Depot Architectural Works

The scope of Zapote Satellite Depot Architectural Works include but not limited to:

a) Study of the Employer's Requirements;
b) Study of Concession Agreement;
c) Necessary survey and investigation works of design and construction;
d) Verifications of bid drawings;
e) Design of Depot Architectural Works and production of construction drawings;
f) Necessary temporary works for the construction of Zapote Satellite Depot Architectural Works;
g) Necessary Interface works with EPC contractors; and
h) All Contractors designed architectural work shall be approved by the Employer, by the Engineer and accepted by the Concessionaire or their Independent Consultant

1.1 Light Maintenance Shop

Zapote Satellite Depot shall provide approximately 126m x 15.5m x 7m minimum high clear dimensions steel structure and roof with blockwork rendered and steel sheet external walls of Light Maintenance Shop which includes two (2) light maintenance tracks equipped with overhead catenary system, one (1) light maintenance pit with depth 1.7m at the center and both sides and 2-floors platforms. (Please refer to drawing #CMX-L1/DP-AR-01-0006 and 0007)

One is at train floor level and the other is at roof level. The floor level platform shall be provided at both sides of each track with the height of 0.9m from the top of rail, and roof level platform shall be at one side of each track.

Each track pit shall provide compressed air and electricity tapping points at a maximum of 30m interval so that 20m length cable and air hose can easily cover all of the train parts.

The Stairs to the roof level platforms shall be access controlled on the respective track to ensure that access to roof level is only possible with the overhead catenary retracted and unpowered with an appropriate safety interlocking with traction power supply inside of workshop.

The roof level platform and opposite side of train roof level shall provide safety facilities to prevent staff of falling down from the roof level platform or train roof.

Emergency exit shall be provided at the opposite end of the roof level platform. Also the platform shall be designed to prevent material and tools from falling down.

The drainage system shall be provided in the pit. This shall be linked to the network of industrial waste water treatment system.

All necessary expansion joints to be provided in the structure.

The facility is to be open at each end without doors with induced ventilation provided by appropriate fan system to ensure a comfortable environment for workers.

The both end opening portion shall be provided with enough size of canopy and grating pit so that even during storm minimize the rain fall to enter inside of the building.

Supporting rooms and facilities within the shop shall include the following:

1.1.1 Offices

The Light Maintenance shop shall include the following offices for maintenance work management staff

a) Engineering Director 15 sq.m.;
b) Executive Room 20 sq.m.;
c) Executive Room 15sq.m.;
d) Infrastructure Head 15 sq.m.; and

e) Rolling Stock Head 15 sq.m

All rooms shall provide an air conditioned environment and appropriate lighting, socket outlets and service provisions.

1.1.2 Meeting Rooms

The Light Maintenance shop shall include a meeting room the size of 35 sq.m which can be divided into 3 rooms with separations. The room shall provide appropriate service requirements and pantry space for refrigerator, sink and water dispenser etc.

All rooms shall have an air conditioned environment and appropriate lighting and socket outlets

1.1.3 Staff Rooms and Cleaners Room

The Light Maintenance shop shall include the following staff rooms for their work,

a) Light maintenance Staff room 30 sq.m.;
b) Infrastructure maintenance Staff room 30 sq.m.; and
c) Cleaners Room 30 sq.m.

All rooms are to have an air conditioned environment and appropriate lighting, socket outlets and service provisions.

1.1.4 Additional Rooms

The Light Maintenance shop shall include the following material/ tools storage rooms for staff and cleaners works,

a) Cleaner's material room 30 sq.m.

The Cleaner's materials room shall be located adjacent to the stabling sidings and next to the cleaners room so that every days cleaning works of trains can be proceeded smoothly. This store shall be lockable and contain sufficient cleaning materials for three (3) days work without needing replenishing.
Cleaning materials shall be specified to be non-flammable to the maximum practicable extent. Where flammable materials are unavoidable, these shall be stored and used in accordance with manufacturers' recommendations.

b) Light maintenance Storage 30 sq.m.

The contractor shall provide a Light Maintenance storage facility 30 sq.m. in size. The area must be secure and provide access routes wide enough to enable delivery, sorting and storage of materials. In addition it must provide adequate ventilation and lighting to enable satisfactory working environment of personnel and all other necessary provisions.

c) Kitchen 14 sq.m.

The Kitchen shall comprise of a Sink, Water supply and discharge plumbing with worktops and tiled upstands around worktops, exhaust fan and electrical points etc.

d) Compressor Room

A Compressor Room 6.8m x 3.5m x 3.5m high shall be located adjacent to the Battery Charging Room. The Compressor Room shall be adequately ventilated and provided with a roller shutter door 3m wide x 2.7m high and a personnel door of standard dimension.

e) Battery Charging Room 6 sq.m.

Battery Room shall be designed following the standard EN 50272-2 for rooms to charge batteries. The main door shall be double leaf with clear dimensions of 2500 (W) mm. The door shall be fitted with a panic bar.

1.1.5 Locker Room/Toilet/Showers

The Light Maintenance shop shall include appropriate numbers of lockers room, WC and showers in accordance with the local regulations.

Locker room shall provide toilet, washing, shower, changing and locker facilities for all light maintenance shop using staff on all shifts.

Locker rooms shall be conveniently located relative to the main areas which they serve.

Separate facilities shall be provided for both males and females.

Each set of facilities shall be accessed by one main entrance for security reasons. Alternative exits will be controlled and used only in case of emergency.

The room is expected to be heavily used at certain peak periods such as change of shift and so the space standards must be adequate.

Circulation must be direct and must facilitate the easy movement of staff in, around and out.

The design shall facilitate cleaning and the finishes are to be durable, impermeable and easily cleaned. There are to be no sharp corners or edges.

The services installation shall provide a clean, fresh, odour-free environment. The general appearance is to be bright and cheerful.

1.1.6 Medical Room

The Light Maintenance shop shall include medical room with the size of approx. 10 sq.m Room shall provide one (1) bed separated with other space with curtain, chairs and desk for simple first aid activity and first aid kit, telephone for emergency call, air conditioned environment and appropriate lighting, socket outlets and service provisions.

1.1.7 Telecommunication Room

The Contractor shall provide a dust free windowless room 20 sq.m. with an air conditioned environment and can accommodate the surveillance/CCTV monitors and control equipment with partition.

1.2 Substation

Zapote Satellite Depot shall provide approximately 35m x 10m dimension of substation with fire suppression equipment and includes all necessary fire and access doors for maintenance including lay-by road access. There shall be a provision for a 10000mm x 2000mm metering vault within the substation. (Please refer to drawing #CMX-L1/DP-AR-01-0008)

The substation shall be adequately provided to accommodate the traction rectifier unit, AC HV Switchgear and LV Switchgear.

The incoming outdoor step down transformer and rectifier transformer shall be installed in the Transformer Bay that is abutting the substation.

Ventilation is by natural circulation of ambient air. Ventilation fans of the transformers shall be activated when the temperature had exceeded the ambient by 30 OC.

Since the substation is located next to the water tank, it has to be adequately water-proof from outfall up to 150 mm high.

The main door shall be double leaf with clear dimensions of 2000 (W) X 3200 (H) mm and an equipment door and escape door in opposite direction. The escape door shall be fitted with a panic bar. The clear ceiling height shall be minimum 4500 mm. (Confirmation required to LRMC at design stage)

1.3 Switch Room

The low voltage switch room shall be 9m x 6m and adequately ventilated by appropriately sized heat extract fan/s. The maximum ambient room temperature shall not exceed 30^{O} C. The LV switchgear's ventilation fan/s shall operate to extract heat inside the LV switchboard panel, in particular incoming air circuit breaker section and busbar compartment once the room ambient temperature had reached 35^{O} C.

The room layout shall include front and rear access clearance of 1000 mm and 1500 mm respectively to facilitate routine test that shall include front and rear access.

The main door shall be double leaf with clear dimensions of 2500 (W) X 3000 (H) mm. The clear ceiling height shall be minimum 4000 mm to facilitate installation of suspended light fittings below cable containment that shall be suspended from the ceiling.

1.4 Material Storage

Zapote Satellite Depot shall provide approximately 6m x 10m internal dimension material storage with all necessary security doors and windows which is located roadside near light maintenance shop for convenient access of light maintenance staff.

a) The Contractor shall provide storage facilities for all appropriate spares, parts, tools, consumables etc.;
b) Accommodation for the complete range of spares and supplies for the maintenance and operation of the Railway Systems equipment shall be provided. Selected stock (specific to particular activities) may be distributed to sub-stores where necessary;
c) Stores shall be equipped with shelving, bins, racking and cupboards from floor to roof in sufficient quantity to house spares and consumables. Security of these stores shall be a high priority;
d) There shall be circulation aisles, to enable mobile equipment to access the goods held in the racks;
e) The stores facilities shall provide controlled conditions of even temperature and be free from condensation as necessary;
f) The stores shall be in two sections, a heavy store and an air-conditioned light store.
g) There shall be an air conditioned internal office located in the stores for clerical activities associated with the stores function;
h) Goods will be delivered by road, therefore two way road access from outside the depot shall be provided; and
i) All access points shall have a minimum clear height of 3.6m.

1.5 Gate House including Entrance Gate

Zapote Satellite Depot shall be provided with approximately 4m x 5m size gate house which adjoins the entrance gate. Gate house shall be suitable to accommodate 2 persons with all necessary services and provisions including toilet and lockers facilities.

The gatehouse shall be equipped with facilities to operate the Security Camera System. This shall comprise of video display monitors and PTZ control facilities for the selection and display of camera images. The gatehouse shall be equipped with security cameras and barrier for car inspection.

1.6 Hazardous Material Storage

Zapote Satellite Depot shall provide approximately 5m x 8m internal dimension hazardous material storage which is located at a roadside and conform to regulations regarding storage of Hazardous Materials

To comply with legislation regarding the storage of dangerous goods, a dedicated Hazardous Materials Store shall be provided in each Depot.

The Hazardous Materials Store shall make provisions for all categories of dangerous goods with different categories of dangerous goods being physically separated.

Hazardous materials shall include but not be limited to the following:

a) Oil;
b) Solvents;
c) Acids / Alkalis;
d) Paint;
e) Batteries;
f) Fluorescent Tubes;
g) Gas Bottles; and
h) Cement.

The Contractor shall provide an adequately sized and constructed bund around or within any liquid chemical storage facilities, providing a retention volume equal to the storage capacity.

1.7 Waste Material Storage

Zapote Satellite Depot shall be provided with approximately 3m x 15m internal dimension of waste material storage and waste disposal facilities for temporary storage of waste materials to account for all waste generated in the Depot area, including:

a) From Vehicle internal cleaning;
b) Domestic waste from working areas;
c) Domestic waste from offices and personnel amenities;
d) From cleaning of roadways and walkways;
e) From track cleaning;
f) Swarf from machine area, tool room, track maintenance and wheel shop;
g) Maintenance waste from working areas;
h) From oil separators; and
i) From the Waste Water Treatment Plant.

1.8 Oil Storage

Zapote Satellite Depot shall be provided with approximately 3m x 3m x3m height structure for oil storage. It shall be concrete structure with roof, secure door and natural ventilation.

1.9 Pump Room for Water Tank

Zapote Satellite Depot shall provide approximately 3m x 6m internal dimension of pump room for water tank.

There shall be a water point at the corner of the water pump room for general washing. This water point shall be installed between 1200 mm to 1500 mm from the finish floor level. The wash point area shall be 1500 mm (L) X 1500 mm (B) and shall be surrounded by a wall of minimum height of 150 mm with either a floor waste (FW) or floor trap (FT) that shall expediently discharge the effluent through the waste water pipe system.

This room shall be adequately water proof to the height of 150 mm.

2.0 Baclaran Expansion Depot Architectural Works

The scope of Baclaran Expansion Depot Architectural Works include but not limited to:

a) Study of the Employer's Requirements;
b) Study of Concession Agreement;
c) Necessary survey and investigation works of design and construction;
d) Verifications of bid drawings;
e) Design of Depot Architectural Works and production of construction drawings;
f) Necessary temporary works for the construction of Baclaran Expansion Depot Architectural Works;
g) Necessary Interface works with EPC contractors; and
h) All contractors designed architectural work shall be approved by the Employer, by the Engineer and accepted by the Concessionaire or their Independent Consultant

2.1 Light Maintenance Shop

Baclaran Expansion Depot light maintenance shop shall be approximately 126m x 22m with 7m clear height underside of overhead gantry and steel roof above with all necessary insulation, walls to be masonry and profiled steel sheet containing the following accommodation of Light Maintenance Shop which includes three (3) light maintenance tracks. Two (2) maintenance tracks provide pit with depth of 1.7m at the center and both side and 2-floors platforms. One (1) maintenance track provide only center pit with depth of 1.7m (Please refer to drawing #CMX-L1/DP-AR-01-0001 to 0003)

As of platforms to be provided for two maintenance tracks, one is at train floor level and the other is at roof level. Floor level platform shall be provided at both sides of each track with the height of 0.9m from the top of rail, and roof level platform shall be at one side of each track.

Roller shutter doors and personnel door at one end. The other end (train enter side) to be open. The roof level platform shall be of steel framing and steel plates. Ventilation facility shall be provided by appropriate fan system to ensure a comfortable environment for the workers.

Each track pit shall provide compressed air and electricity tapping points at the maximum of 30m interval so that 20m length cable and air hose can easily cover all part of the trains.

The Stairs to the roof level platforms shall be access controlled on the respective track to ensure that access to roof level is only possible with the overhead catenary retracted and unpowered with an appropriate safety interlocking with traction power supply inside of workshop.

The roof level platform and opposite side of train roof level shall provide safety facilities to prevent staff of falling down from the roof level platform or train roof.

Emergency exit shall be provided at the opposite end of the roof level platform. Also the platform shall be designed to prevent material and tools from falling down.

The drainage system shall be provided in the pit. This shall be linked to the network of industrial waste water drainage and treatment system of Baclaran Expansion Depot.

The open end portion (track entrance) shall be provided with enough size of canopy and grating pit so that even during storm minimize the rain fall enter inside of the building.

All necessary expansion joints to be provided in the structure.

Supporting rooms and facilities within the shop include the following:

2.1.1 Offices

Light Maintenance shop shall include offices for maintenance work management staff.

The Light Maintenance Supervisor Head Room 15 sq.m.

The room shall be provided with an air conditioned environment and appropriate lighting, socket outlets and service provisions with external windows for the offices wherever permitting.

2.1.2 Meeting Rooms

The Light Maintenance shop shall include meeting room the size of 35 sq.m which can be divided into 3 rooms with separations. The room provide appropriate service provisions and pantry space for refrigerator, sink and water dispenser etc.

All rooms shall have an air conditioned environment and appropriate lighting and socket outlets

2.1.3 Staff Rooms and Cleaners Room

Light Maintenance shop shall include the following staff rooms:

a) Light maintenance Staff room 30 sq.m.;
b) Infrastructure maintenance Staff room 30 sq.m.; and
c) Cleaners Room 30 sq.m.

All rooms to have an air conditioned environment and appropriate lighting, socket outlets and service provisions.

2.1.4 Additional Rooms

The Light Maintenance shop shall include following material/ tools storage rooms for staff and cleaners works,

a) Cleaner's material room 30 sq.m.

The cleaner's materials room shall be located adjacent to the stabling sidings and next to the cleaners room so that every days cleaning works of trains can be proceeded smoothly. This room shall be lockable and contain sufficient cleaning materials for three (3) days work without needing replenishing.
Cleaning materials shall be specified to be non-flammable to the maximum practicable extent. Where flammable materials are unavoidable, these shall be stored and used in accordance with manufacturers' recommendations.

b) Light maintenance Storage 30 sq.m.

The contractor shall provide a Light Maintenance storage 30 sqm. The area must be secure and provide access routes wide enough to enable delivery, sorting and storage of materials. In addition it must provide adequate ventilation and lighting to enable satisfactory working environment of personnel and all other necessary provisions.

c) Kitchen 14 sq.m.

The Kitchen shall comprise of Sink, Water supply and discharge plumbing with worktops and tiled upstands around worktops, exhaust fan and electrical points etc.

d) Battery Charging Room 6 sq.m.

Battery Charging Room shall be designed following the standard EN 50272-2 for rooms to charge batteries. The main door shall be double leaf with clear dimensions of 2500 (W) mm. The door shall be fitted with a panic bar.

2.1.5 Male/ Female Locker/Room/Toilet/Showers

The Light Maintenance shop shall include appropriate numbers of lockers room, WC and showers in accordance with the local regulations.

The locker room shall provide toilet, washing, shower, changing and locker facilities for all light maintenance shop using staff on all shifts.

Locker rooms shall be conveniently located relative to the main areas which they serve.

Separate facilities shall be provided for each gender.

Each set of facilities shall be accessed by one main entrance for security reasons. Alternative exits will be controlled and used only in case of emergency.

The room is expected to be heavily used at certain peak periods such as change of shift and so the space standards must be adequate.

Circulation must be direct and must facilitate the easy movement of staff in, around and out.

The design shall facilitate cleaning and the finishes are to be durable, impermeable and easily cleaned. There are to be no sharp corners or edges.

The services installation shall provide a clean, fresh, odour-free environment. The general appearance is to be bright and cheerful.

2.1.6 Telecommunication Room

The Contractor shall provide a dust free windowless room 20 sq.m. with an air conditioned environment and can accommodate the surveillance/CCTV monitors and control equipment with partition.

2.2 Heavy Maintenance Workshop

Baclaran Expansion Depot shall include approximately 126m x 25m overall dimension with steel roof and necessary insulation. Heavy Maintenance Workshop which includes three (3) heavy maintenance tracks. Within three (3) tracks two (2) tracks has each one (1) center pit with depth 1.7m, length approximately 32m including both end stairs. One (1) track doesn't provide center pit, only for floor level track with enough length of good for one (1) car mover's shunting. (Please refer to drawing #CMX-L1/DP-AR-01-0001 to 0003)

Each track pit provide compressed air and electricity tapping points at both side of center pits for electric and compressed air supply. The drainage system shall be provided in the pit. This shall be linked to the network of industrial waste water drainage and treatment system of Baclaran Expansion Depot. All necessary expansion joints to be provided in the structure.

At the track entrance provide roll up doors and grating pit to prevent from rain water to enter from outside. Supporting rooms and facilities include floor tracks and turntables for moving bogies within the workshop.

2.2.1 Offices (Mezzanine)

Heavy Maintenance Workshop shall include following offices for maintenance work management staff:

a) Heavy Maintenance Head Room 55 sq.m.; and
b) Supervisors Room 51 sq.m.

All rooms shall provide an air conditioned environment and appropriate lighting, socket outlets and service provisions.

2.2.2 Meeting Rooms (Mezzanine)

Heavy Maintenance Workshop shall include meeting room at Mezzanine of 100 sq.m which can be divided into 3 rooms with separations. All rooms shall have air conditioned environment and appropriate lighting and socket outlets and service provisions.

2.2.3 Pantry (Mezzanine)

A room of 31 sqm Pantry space shall be provided for refrigerator, sink and water dispenser, shelf, cupboard, table and chairs etc.

2.2.4 Male and Female Toilets, Shower and Locker Rooms (Mezzanine)

Male and Female Toilets, shower and locker rooms also shall be provided at Mezzanine level to serve the office, meeting room and staff room.

2.2.5 Staff Room (Mezzanine)

Heavy Maintenance Workshop shall include maintenance staff room with the size of 105 sq.m.

The room shall provide table, chairs and necessary facilities for staff work.

All staff rooms to have an air conditioned environment and appropriate lighting, socket outlets and service provisions.

2.2.6 Other Rooms

Heavy Maintenance Workshop shall include the following rooms for various works:

a) Compressor Room 45 sq.m.;
b) Test Room 42 sq.m.;
c) Electrical Room 169 sq.m with Roller Shutter of 2m width;
d) Electronic Room 203 sq.m with raised floor approx. 400mm and Roller shutter of 2m width;
e) Air Brake Compressor Room 156 sq.m with Roller Shutter of 2m width; and
f) Tool Room 63sqm with Roller Shutter of 2m width
g) Battery Charging Room 6 sq.m. According to standard EN 50272-2.

All rooms to have an air conditioned environment and appropriate lighting, socket outlets and service provisions except for compressor room and tool room. These two rooms does not require air conditioning environment. Service elevator of sufficient size and capacity shall be provided to facilitate transportation of equipment/components for repair to the Electronic Room at the Mezzanine Level of the Workshop.

2.2.7 Locker Room/ Toilet / Showers

The Heavy Maintenance Workshop shall include appropriate numbers of lockers room, WC and showers in accordance with the local regulations.

Locker rooms shall provide toilet, washing, shower, changing and locker facilities for all light maintenance shop using staff on all shifts.

Locker rooms shall be conveniently located relative to the main areas which they serve.

Separate facilities shall be provided for each gender.

Each set of facilities shall be accessed by one main entrance for security reasons. Alternative exits will be controlled and used only in case of emergency.

The room is expected to be heavily used at certain peak periods such as change of shift and so the space standards must be adequate.

Circulation must be direct and must facilitate the easy movement of staff in, around and out.

The design shall facilitate cleaning and the finishes are to be durable, impermeable and easily cleaned. There are to be no sharp corners or edges.

The services installation shall provide a clean, fresh, odour-free environment. The general appearance is to be bright and cheerful.

2.2.8 Medical Room

The Heavy Maintenance Workshop shall include medical room with the size of approx. 10 sq.m.

Room shall provide one (1) bed separated with other space with curtain, chairs and desk for simple first aid activity and first aid kit, telephone for emergency call, air conditioned environment and appropriate lighting, socket outlets and service provisions.

2.3 Substation

Baclaran Expansion Depot shall provide a Substation building of approximately 31m x 10m dimension which include all necessary Fire and access doors for maintenance including lay-by road access. (Please refer to drawing #CMX-L1/DP-AR-01-0005)

The substation shall be adequately provided to accommodate the traction rectifier unit, AC HV Switchgear and LV Switchgear.

The incoming outdoor step down transformer and rectifier transformer shall be installed in the Transformer Bay that is abutting the substation.

Ventilation is by natural circulation of ambient air. Ventilation fans of the transformers shall be activated when the temperature had exceeded the ambient by 30 ^{O}C.

Since the substation is located near the water tank, it has to be adequately water-proof from outfall up to 150 mm high.

The main door shall be double leaf with clear dimensions of 2000 (W) X 3200 (H) mm and an equipment door and escape door in opposite direction. The escape door shall be fitted with a panic bar. The clear ceiling height shall be minimum 4500 mm. (Confirmation required from LRMC at design stage) There shall be a provision for a 2000mm x 2500mm metering vault within the substation.

2.4 Motor Pool

The existing Motor Pool is to be demolished for the construction of expansion Depot tracks. Motor Pool facility is to be re-provided with the size of 30m x 15m, with at least similar facilities as the existing. The Contractor is to finalize the layout and provide toilet facilities approx. 19sqm. and space for lockers with 2 WC's 2 Showers and 2 wash hand basins and 2 urinals all in accordance with local Regulations. An office of approx. 17sqm, and storeroom approx. 27 sqm should also be provided. The Motor Pool should also provide the compressed air supply and several tapping points in workshop area and 2 pits with approx. 1.2m depth and be designed to avoid the Box Culvert in the vicinity of the Motor Pool.

2.5 Material Storage

The Baclaran Expansion Depot shall provide approximately 20m x 15m size of material storage.

Material Storage shall be located roadside near maintenance shop and workshop for convenient access with all necessary security doors and windows.

a) The Contractor shall provide storage facilities for all appropriate spares, parts, tools, consumables etc.;
b) Accommodation for the complete range of spares and supplies for the maintenance and operation of the Railway Systems equipment shall be provided. Selected stock (specific to particular activities) may be distributed to sub-stores where necessary;
c) Stores shall be equipped with shelving, bins, racking and cupboards from floor to roof in sufficient quantity to house spares and consumables. Security of these stores shall be a high priority;
d) There shall be circulation aisles, to enable mobile equipment to access the goods held in the racks;
e) The stores facilities shall provide controlled conditions of even temperature and be free from condensation as necessary;
f) The stores shall be in two sections, a heavy store and an air conditioned light store. Both stores shall be located in the Main Depot Building;
g) There shall be an air conditioned internal office located in the stores for clerical activities associated with the stores function;
h) Goods will be delivered by road, therefore two way road access from outside the depot shall be provided; and
i) All access points shall have a minimum clear height of 3.6m.

2.6 Gate House including Entrance Gate

Baclaran Expansion Depot shall provide approximately 4m x 5m size gate house which adjoins entrance gate. Gate house shall be suitable to accommodate 2 persons with all necessary services and provisions including toilet and lockers facilities.

The gatehouse shall be equipped with facilities to operate the Security Camera System. This shall comprise of video display monitors and PTZ control facilities for the selection and display

of camera images. The gatehouse shall be equipped with security cameras and barrier for car inspection.

2.7 Hazardous Material Storage

Baclaran Expansion Depot shall provide approximately 5m x 8m internal dimension hazardous material storage which is located at a roadside and conform to regulations regarding storage of Hazardous Materials

To comply with legislation regarding the storage of dangerous goods, a dedicated Hazardous Materials Store shall be provided in each Depot.

The Hazardous Materials Store shall make provisions for all categories of dangerous goods with different categories of dangerous goods being physically separated.

Hazardous materials shall include but not be limited to the following:

a) Oil;
b) Solvents;
c) Acids / Alkalis;
d) Paint;
e) Batteries;
f) Fluorescent Tubes;
g) Gas Bottles; and
h) Cement.

The Contractor shall provide an adequately sized and constructed bund around or within any liquid chemical storage facilities, providing a retention volume equal to the storage capacity.

2.8 Waste Material Storage

Baclaran Expansion Depot shall be provided with approximately 3m x 15m internal dimension of waste material storage and waste disposal facilities for temporary storage of waste materials to account for all waste generated in the Depot area, including:

a) From Vehicle internal cleaning;
b) Domestic waste from working areas;
c) Domestic waste from offices and personnel amenities;
d) From cleaning of roadways and walkways;
e) From track cleaning;
f) Swarf from machine area, tool room, track maintenance and wheel shop;
g) Maintenance waste from working areas; and
h) From oil separators.

2.9 Not Used

2.10 Switch Room

Baclaran Expansion Depot shall provide an approximately 10m x 6m dimension low voltage switch room.

The low voltage switch room shall be adequately ventilated by appropriately sized heat extract fan/s.

The maximum ambient room temperature shall not exceed 30 ^{O}C. The LV switchgear's ventilation fan/s shall operate to extract heat inside the LV switchboard panel, in particular incoming air circuit breaker section and busbar compartment once the room ambient temperature had reached 35 ^{O}C.

The room layout shall include front and rear access clearance of 1000 mm and 1500 mm respectively to facilitate routine test that shall include front and rear access.

The main door shall be double leaf with clear dimensions of 2500 (W) X 3000 (H) mm. The clear ceiling height shall be minimum 4000 mm to facilitate installation of suspended light fittings below cable containment that shall be suspended from the ceiling.

2.11 Infrastructure Maintenance Equipment Storage

Beside of lead track near the river a 25m × 5m size Infrastructure Maintenance Equipment Storage shall be provided. Storage Rooms shall be separated for Track Maintenance, Power and OCS Maintenance, Telecommunication Maintenance, Signalling Maintenance and Building Maintenance Room..

Access road/ level crossing with 4m width shall be provided for vehicle access. The area between the lead track and the storage rooms shall be paved for easy transportation of tools and equipment.

Each room shall be provided with light, power outlet and ventilation. At the outside of the storage building a water supply which include slop sink and drainage shall be provided.

The Contractor also shall provide storage facilities for maintenance equipment, tools, test kits etc. in each room.

2.12 Renovation of Existing Administration Building/ Structures

The Existing Administration Building at Baclaran Depot is to be re furbished. The Contractor will be responsible for defining the extent of required refurbishment by inspection and production of a detailed scope of works. The enclosed Key Plans and schedules are for guidance only. (Please refer to drawing #CMX-L1/DP-AR-01-0009 and 0010)

In addition the Contractor will highlight other works which requires attention to bring the building into a habitable and safe condition satisfying all the current Legislations where appropriate and deliver the Building as "Fit for Purpose".

Detailed Schedules of these works will be required to be submitted for approval to the client and his representative. The contractor will determine and give reasons for replacement or making good of existing works in accordance with relevant Codes of Practice and /or Method statements where appropriate. The Contractor will outline how the Building works and will be co-ordinated with required M&E refurbishment works and show the phasing of each element of Work.

As the refurbishment will be carried whilst maintaining a degree of occupancy for the LRTA personnel, the Phasing and Co-ordination of work will be of paramount importance. The Contractor is to ensure the working efficiency and Safety of LRTA personnel and workers and will be required to submit acceptable proposals as to how this will be achieved throughout the construction of the works.

The Administration Building will be used as the Office of the LRTA personnel who will monitor all the Operations and Maintenance activities during the Concession Period. Aside from this, a designated area particularly at the ground floor will be used for railway personnel training and testing facilities complete with diagnostic equipment.

Brief Outline of the Building Renovation Works.

a) Demolishing existing and provide new partitions in accordance with the issued" Layout as Proposed."

b) Supply and installation of modular partitions including desks, chairs and cabinets

c) Replacing Doors and Windows where defective

d) Taking up existing Floor tiles and providing new suitable flooring throughout.

e) Provide new ceilings where appropriate.

f) Provide new fitments in Toilets and re- tile floors walls and provide new ceilings as necessary.

g) Remove and replace of all roof.

h) Provide all necessary items to update the Building to accord with Local legislation which may apply.

i) Co-ordinate building works with Mechanical and Electrical works for re wiring and fitting air conditioners and other M&E works as necessary.

j) Co-ordinate all works with the client including removal and temporary storage of equipment and reinstalling.

k) Compile and propose a Finishing Schedule describing suitable materials to be used throughout the works with samples of these materials.

l) Removal and replacement of all electrical wirings, materials, fixtures and protective devices.

m) Construction of new comfort room at the 2nd level including electro-mechanical works.

n) Removal and replacement of all plumbing fixtures.

o) Removal and replacement of all existing piping and fittings (water supply line, sewers and vent lines, storm drainage and down spouts. Sewer pipe line shall connect to Maynilad Lift Station which is planned to be constructed near the LRTA Administration Building parking area.

p) Replacement of catch basins and concrete drain pipes (external of building) and de-clogging of existing main storm drainage line.

q) Removal and replacement of existing roof drain strainers and balcony drains.

r) Removal and replacement of existing fire hose cabinets and provide new fire lines in the building.

s) Installation of new fire water pipe line, pump house, fire pump and fire water supply system for the Administration Building.

t) Provide perforated pipe on the planter box including water supply line and planters drain at 2nd floor perimeter of Administration Building.

u) Removal of existing septic tank.

v) Landscaping

w) Installation of Telephone Service Entrance with Structured Cabling and Equipment

x) Installation of Fully Addressable Fire Detection and Alarm System

y) Installation of surveillance/CCTV System

z) Installation of Security and Access System

The Contractor must satisfy himself by careful Inspection of the Building that his proposals cover all the requirements, detailed above, are carried out correctly, on programme and all in accordance with the relevant American, Japanese and Philippine standards in addition to the latest Legislative Laws appropriate to this building.

All works shall also conform to the various relevant and applicable provisions and requirements mentioned within the Technical Specification and General Specification of the Project.

2.12.1 Structural Works

The Contractor shall conduct an assessment of the structural condition and integrity of the existing LRTA Administration Building and perform necessary repairs or replacement of any damaged structural members.

Evaluation of the structural adequacy of all existing structural members shall be based on the current National Structural Code of the Philippines (NSCP 2010 Volume I, 6th Edition) and retrofitting or strengthening of the non-conformant members. Evaluation by analysis is recommended.

All existing steel structural members, including trusses, purlins, sagrods and base plates shall be cleaned and painted in accordance with the various applicable provisions mentioned in the Technical Specification of the Project. All new concrete and structural steel elements shall also be in conformance with the Technical Specification of the Project.

2.12.2 Sanitary/Plumbing Works

The basic design of the Sanitary/Plumbing system shall be carried out based on the findings of the site investigation to be conducted and in consideration of the project design requirements for the Renovation of Baclaran Administration Building at LRT Line – 1, as described below:

a) Design the Sanitary/Plumbing Systems based on the requirements of the new structure and its facilities'

b) Low operating costs of application focused on efficient energy used and maintenance;

c) Flexible physical layout of the system to consider the phased construction and to accommodate future system's improvements of the building; and

d) Compliance with the requirements of applicable codes and standards and other relevant government agencies.

2.12.2.1 Scope of Work

a) The Plumbing Design/Build Contractor is required to refer to all architectural, structural, mechanical, fire protection, electrical and interior designs plus landscape plans and investigate all possible interference and conditions affecting his work.

b) All design and installation works shall comply with the pertinent provisions of the Plumbing Code of the concerned city, the Code on Sanitation of the Philippines, the National Plumbing Code of the Philippines and other agencies having jurisdiction.

c) Remove and replace all the existing water distribution line. The water supply line of the Administration building is connected from Maynilad Water District independently near gate– 1. Provision of booster pump and pressure tank to be considered in order to boost water pressure to the system.

d) Remove and replace fire hose cabinets including fire water distribution line and installation of new fire water pipe line, pump house, fire pump and construction of new cistern for domestic and fire water use of the Administration Building

e) Provide perforated pipe drain and water supply for planter's box at First floor perimeter of the building.

f) Remove and replace the sewer piping layout, sanitary drains, waste and venting systems including floor drains, shower drains and other required accessories to make the systems complete and operable. Sewer pipe line shall connect to Maynilad Lift Station which is planned to construct near the parking area.

g) Remove the existing Septic Tank.

h) Remove and replace the Sewage collection and disposal system including ground cleanouts, sewer service connections, and other required appurtenances which are essential to the proper function of the system.

i) Remove and replace all the downspout for the storm drainage system including roof drains strainer, canopy drains, and planter's drains.

j) Remove and replace the under-drains at external perimeter of the building, catch basin drains, junction boxes and collection system including peripheral collector line into nearest existing storm drain line within the vicinity.

k) Remove and replace all plumbing fixtures, fittings, trims and accessories. And provide flush valve with sensor type for water closet, urinals and lavatory faucet. Heavy duty type toilet fixture and accessory shall be used.

l) Testing for leakage of all water supply and distribution system, drains, waste, sewer and venting system plus pressure testing and disinfection of the water supply and distribution system.

m) Securing of all permits and licenses as required.

n) Excavation and backfilling in connection with the work shall be included.

o) Preparation and submittal of two (2) sets of as built-plans.

p) Furnishing of written one (1) year warranty on the plumbing system.

2.12.2.2 Materials Outline Specification

a) Exterior Underground Water Distribution Lines shall be High Density polyethylene Pipe (HDPE) Type SDR 11 & 9 conforming to AWWA C900, Pressure Class 150 with cast-iron pipe equivalent OD.

b) Exterior Exposed Water Supply and Distribution Lines shall be hot dipped galvanized iron pipe conforming to ASTM A53, schedule 40.

c) Exterior Gravity Sewer Lines hall be Polyvinyl Chloride (PVC) plastic pipe and fittings and shall be in accordance with ASTM D3034, Type PSM with a maximum SDR of 35.

d) Interior Cold and Hot Water Lines shall be Polypropylene Random (Type 3), high resistance to pressure and temperature, conforming to EN ISO 15874

e) Interior Soil, Waste Pipes and Downspouts shall be un-plasticized polyvinyl chloride (uPVC) pipe class DWV conforming to ASTM D2729, Series 1000.

f) Interior Vent Stacks and Vent Lines shall be un-plasticized polyvinyl chloride (uPVC) pipe class DWV conforming to ASTM D2729, Series 1000.

g) Vertical Drain Pipe (Downspout) shall be un-plasticized polyvinyl chloride (uPVC) pipe class DWV conforming to ASTM D2729, Series 1000.

h) Valves shall have flanged end connections, except sizes smaller than 65mm may have threaded end connections with a union on one side of the valve, or solder end connections between bronze valves and copper tubing. Copper alloy and bronze valve body shall be ASTM B61 or ASTM B62 copper alloy. Provide valves suitable for minimum of 125 psig and minimum of 180 degrees F hot water.

i) Drains shall be cast-iron drains and clamping rings for use with membrane water proofing, conforming to ANSI A112.21.1.

j) Pipe Hangers and Supports shall be MSS SP-58 and MSS SP-69, Type 1 or 6, of the adjustable cast-iron drains and clamping rings for use with membrane water proofing, conforming to ANSI A112.21.1.

k) Hose Bibbs shall be size 13mm (½ in.) male inlet and 19mm (¾ in.) hose bib thread connection, bronze body conforming to ASTM Specifications B62 suitable for cold water pressure up to 150 psi.

l) Plumbing Fixtures and accessories shall be standard lines of first quality to be specified by the architect.

2.12.3 Power Supply and Electrical Works

Existing power supply to the LRTA Administration Building coming from the existing rectifier substation shall be disconnected. And a new power supply line shall be installed from the Meralco distribution line along Aurora Boulevard. Power requirements for the Administration Building

shall be 480/240VAC system to accommodate the building loads. Combination of 480 and 240 VAC power outlets shall be provided for the ground floor training area and testing facility area. The Contractor shall also be responsible for the supply, installation and testing & commissioning of a new generator, automatic transfer switch and transformer including the renovation of the existing generator room.

2.12.3.1 Equipment and Materials General Specification

a) Generator / Automatic Transfer Switch (ATS)

The Contractor shall provide a 480VAC Diesel engine generator for the Administration Building. The Contractor will compute for the final KVA load essential to the 100% continuous operation that would determine the appropriate KVA rating of the generator.

The generator is a complete stand- alone generating set. The alternator and engine should be in the same skid base. The generator and the electrical components are fully enclosed in weather-proof canopy.

The generator should be self-ventilated, drip-proof, synchronous alternator designed for minimum reactance, low voltage-waveform distortion and maximum efficiency.

The exciter must be brushless rotating or static with silicone rectifier for maximum motor starting capacity. Maximum temperature at 100°C. Insulation Class F.

The generator should have the lowest possible TIF (Telephone Influence Factor), THD (Total Harmonic Distortion), and WFD (Waveform Deviation).

Voltage Regulation must be within ±1.0% from no load to full load using a solid state Automatic Voltage Regulator (AVR). Frequency regulation should be within ± 4.5% through no-load to full-load.

The Insulation Resistance of the alternator should be higher than 2 Mega-ohms between armature windings and earth, field winding and earth, and control circuit and earth.

The Dielectric Strength for winding insulation should withstand 1500 to 1800 volts at 60 Hz for one minute.

Should comply with a desirable Noise level of not more than 65 decibels, 7 meters away from the generator.

The generator shall automatically run if a loss of power is detected.

The Contractor shall match the Automatic Transfer Switch (ATS) control system with the Generator's controls to ensure reliability and dependability. The scheme and parameters for the integration shall be presented and approved by the Engineer.

The Generator and Automatic Transfer Switch (ATS) Equipment shall also comply with the requirements of the Technical Specification of the Project.

The Contractor shall provide Training to operators and maintenance crew with complete Training Materials, Operating Manuals, and Electrical/Mechanical Diagrams.

The ATS must be designed to provide ample time for the generator to warm up before carrying the Load.

b) Transformers

Transformer shall comply, as regards to rating, temperature rise and overload, with the appropriate requirements of the load. The rating of the transformer of the system shall be determined by the Contractor to meet his designed loads.

Transformers shall be general purpose dry-type 480 volts primary,240 volts secondary, 3 phase, 60 hertz, Delta-Wye connection with solid neutral. The transformers shall be provided with 1-2.5% tap above normal and 3-2.5% tap below normal.

Maximum temperature shall not exceed + 48 °C and the average temperature during any 24-hour period shall not exceed + 30 °C. Type Tested.

i. Phases and Frequency

Number of Phases : Three (3)

Rated Frequency : 60Hz

ii. Rated Voltage Line to Line and Connection

Primary : 480V, delta

Secondary (no load) : 240V Wye with solid neutral

The admissible tolerances for no-load current component and total losses, voltage ratio and impedance voltage shall be as given in IEC Standards.

Suitable earthing terminals shall be provided at diagonally opposite corners of the case and these shall be connected internally to the transformer earth termination.

Transformer shall be designed with adequate self-cooling (AN) to enable the full specified rating to be obtained continuously under the maximum specified site ambient temperature and altitude conditions.

2.12.4 Telephone (PABX) System Specification

2.12.4.1 General Requirement

The telephone system is required to be a fully electronic digital time switching Private Automatic Branch Exchange (PABX) of the latest design, including all required devices, components, supplements and auxiliary equipment.
Initial capacity of 75 trunk and local lines expandable to 150 lines complete with telephone sets.
A Telephone System will be provided for internal and external communication through telephone outlets mounted on walls and floors. Direct lines and trunk lines will be used.
An Intermediate Distribution Frame (IDF) will be located in a Telecom Room serving a given floor or facility. Through Main Distribution Frame (MDF) where lines are connected directly from the Local Telephone/ Network provider e.g. PLDT, Digitel etc, it will be distributed to offices at every facility. Redundancy is recommended for a non-interruption operation, source coming from two (2) different location of service entrance.
A PABX shall be in accordance with the local telephone company requirements and applicable codes and regulations. The requirement of PABX will be determined by the area size, type of clients, location, call traffic and grade of service and limitation of local exchange. The number of exterior/interior lines and level of restriction will be included during the design development stage. PABX capacity is expandable and its features are upgradeable.
A back up UPS (Uninterruptible Power Supply) system shall be provided to maintain the operation during power failure. Provision of PABX shall be in accordance with the following:

a) as a rule of thumb, a voice and/or data outlet per 10sqm or 3m spacing for an office building shall be provided;
b) minimum of 30% provision for future expansion;
c) provision of one (1) spare conduit for maintenance purpose to avoid interruption; and
d) maximum of 70% conduit fill is allowed for easy pulling of cable to prevent losses.

Voice and Data Outlets

A 4-pair Cat6 Twisted cable may be housed in 20 to 32mm diameter conduit. Size of conduit will based on the number of cables in a particular circuit. PVC schedule 40 shall be used for installations embedded in wall or floor slab and IMC for exposed installations. Location of outlets shall be based on the furniture arrangement of the facility.

The minimum number of outlets to be provided will be as follows:
e) offices (room type) ----- duplex type outlet (1-voice, 1-data); and

f) offices (open space) ---- 1 outlet every 10sqm or every 3m distance

The PABX will need to be based on an office platform and the Vendor / Supplier will need to give the following;

g) Detail of the current platform and how long it has been on the Market. The Vendor/ Supplier should be an accredited distributor of the proposed brand of PABX System for a minimum of 5 years. The Vendor/Supplier shall provide minimum 5 to 10 client base / installations in the office industry with the same model for the proposed PABX system. Please include detailed description of the installation including all interfaces with other System.

h) The new IP PABX system shall be capable of processing calls to/from any point in the PABX system. Any PABX telephone users shall be able to go off-hook and dial any local number, regardless of location serve by the PABX, and the system shall automatically complete the call to a system telephone set or route it over primary rate lines for switching between the existing PABX and new IP PABX, whichever is applicable.

i) The PABX shall provide 20% wired spare capacity.

j) The System shall also have dialling facilities in the maintenance application software for 24/7 customer care and after sales services.

2.12.5 Structured Cabling

2.12.5.1 General Requirement

This Section specifies the basic requirements for furnishing, installing, certification, testing, and guarantee of a complete and operating Structured Cabling Network to cater to the requirements of Telephone and Data distribution in the Administration Building

The contractor shall allow for cabling to Cat-6 standard for both data and voice distribution. Data and voice outlets shall be distributed in the entire building, offices, service/residential apartments, lounges.

The structured cabling network shall include but not limited to RJ45 telephone and data outlets, horizontal cabling, RJ45 patch panels for data, Krone type IDC blocks for telephone, backbone fibre optic cable for data and telephone, and all associated labeling, testing and commissioning of the system.

2.12.5.2 Overview

The structured cabling network specified under this section includes all passive components excluding switches, routers, and etc. for the implementation of Local Area Network (LAN) for data and Telephone Network for voice within the building. The network shall provide end-to-end connectivity from a network PC to IDF/MDF patch panel.

Cabling for both sections shall be identical with Cat 5E/6 cables and twin or quad TIA/EIA T-568-B outlets for Data. Locations of data and/or VOIP outlets are as indicated in the lay out drawings. However, contractor shall allow for a few additional data outlets if required, as an outcome of detailed engineering of other low current systems by the proposed specialists' vendors. Horizontal cables shall be terminated at patch panels and Intermediate Distribution Frames.

Patch panels shall be housed in floor mounted 19" equipment cabinet complete with cable management and power distribution. These cabinets shall be sized to allow space for accommodating the switches to be supplied. All equipment cabinets shall be of standard size, 42U height. Additional cabinets shall be provided if found necessary to accommodate all the equipment as above. Patch panels and IDF's shall be sized with an allowance of 20-30% spare capacity for any future additions of outlets.

Backbone cable shall be multimode fibre optic (FO) and shall originate from the MDF in the Telecom Room. Fibre optic cables shall be terminated at both ends by suitably sized fibre optic patch panels, All FO connectors used shall be SC type. FO patch panels shall be housed in the

same equipment cabinet as RJ45 patch panels. Farther end of telephone backbone cables shall be terminated at the MDF in the PABX room.

Contractor shall ensure that no horizontal cable run from patch panel to outlet exceeds 90m. being the CAT5e/Cat6 limits. In the event of any outlets exceeding the limit contractor shall relocate to adhere to this limit.

2.12.5.3 Equipment Identification

a) IO Ports
b) Patch Panels – RJ45
c) Patch Cords - Copper
d) UTP Cable
e) Fibre Optic Cables
f) Fiber Optic Patch panels
g) Fibre Patch Cords
h) Intermediate Distribution Frame (IDF) – (for ground floor only)
i) Equipment Cabinet

2.12.6 CCTV/SURVEILLANCE SYSTEM

2.12.6.1 General Requirements

The surveillance system shall consist of IP CCTV cameras combination of fixed and equipped with Pan/Tilt/Zoom Lens System (PTZ) located at the lobbies and entrances and exits of Ground and Second floors. CCTV monitors and remote control units shall be located at the Security Room. A master controller shall be provided wherein a CCTV video monitor and video tape recorder shall be connected to record the display of a preselected camera view. Video inputs to the multiplexer and sequential switcher shall come from the video outputs of CCTV cameras. The master controller shall function as a bridging auto alarming switch.

Under normal condition, the operator has the option to either manually or automatically sequence the cameras. The 24 CCTV cameras can be viewed on the two (2) monitors using multiplexer and sequential switchers.

When an alarm occurs, the auto alarming sequence goes into effect. The video signal from the camera covering the alarmed area is displayed on monitor , an audible signal notifies the operator of an alarm, a video tape recorder is automatically switched on to record the video from the second monitor and a LED illuminates the “confirm alarm” button until acknowledged by the operator. Should multiple alarms occur, each is automatically sequenced until confirmed by the operator.

2.12.6.2 General Specification

Fixed IP Camera:

The camera shall be 1.3 megapixels utilizing a 1/2” CMOS sensor.
Surround Video IP Camera
The camera shall utilize four high sensitivity 2 Megapixel CMOS sensors each with 1/2” optical format
Network Video:

Supports up to 64 megapixel camera
Supports live, recording and playback triple video function simultaneously on multiple megapixel cameras
Control PTZ function with 4 axis joystick keyboard allows megapixel camera to pan, tilt, zoom in/out the image
LCD Color Monitors:

Monitors shall be color, 4:3 formats with steel housing operating on 240VAC. The units shall have controls for the following: contrast, brightness, and other facilities including separate synchronizing of signal inputs, alternative video input and data processing input (VGA socket).

2.12.7 Security/Access Control System

2.12.7.1 General Requirement

Access control system products shall meet or exceed the following specifications. It is the responsibility of the specialist contractor to add any product for which specifications are not provided but require for the smooth operation of the system

The management software shall allow control and monitor of access and security to the proposed facility and remote facilities. The software shall allow centralized alarming, card holder management etc. and shall have comprehensive reporting capabilities – standard and customized.

The management system shall use a Client Server architecture bases around a modular PC network, utilizing industry standard operating system, networks and protocols.

The system shall store security related cardholder/pass holder information in a relational database such as Microsoft SQL Server.

The cardholder database shall support at least 10000 cardholders. The cardholder database shall be delivered with at least 40 user definable fields for storing data specific to the requirements of different systems, it shall be possible to increase or decrease this number of user definable fields. Systems without the ability to increase the number of user definable fields shall not be accepted.

It shall be possible to assign a single cardholder multiple cards for use in the system. Multiple cards assigned to a single cardholder shall be able to be in different states. For example, it shall be possible for a single cardholder to have both an "active" card assigned and an "inactive", "lost" or "stolen" card assigned.

2.12.7.2 System Components

a) Door Interface Unit
b) Card Readers
c) Biometric Reader
d) Magnetic Door Contact
e) Electromagnetic Lock
f) Break Glass Unit
g) ID Cards
h) PC Hardware
i) Server

2.12.8 Fire Detection and Alarm System

2.12.8.1 General Requirements

The system shall be programmable, fully addressable closed circuit, electronically-supervised, non-coded, Fire Detection and Alarm System capable of control and monitoring 1500 minimum addressable points.

The system shall include but not limited to Fire Alarm Control Panel (FACP) with trouble buzzer and lights, manual stations, alarm speaker with strobe light, automatic detectors, interface addressable modules, stand-by batteries, telephone and emergency voice evacuation system.

The system shall be wired as Class “A” System throughout. Wiring between Automatic Detectors, Manual Station and FACP shall be zone addressable via a Class A loop wiring with two (2) pairs of wires.

The system shall comply with the applicable provisions of NFPA, local building codes and meet all the requirements of the local enforcing authorities. The system shall be listed, labelled or approved by Underwriter’s Laboratories, Inc.

Installation of the system shall be governed by the provisions of the latest edition of the Philippine Electrical Code and existing rules and regulations of the locality and other governing agencies.

All materials and equipment to be furnished shall be essentially the standard products of a single manufacturer regularly engaged in the production of such equipment. This shall cover total system functionality, capabilities and efficiency of the over-all operation.

All signal initiating circuits, signal indicating circuits and trouble signal circuits shall operate on 24 VDC. The main operating power shall be 220 volts AC from building supply mains transformed through a two-winding isolation type transformer and rectified to 24 volts DC. An auxiliary power supply for operation of the system in the event of failure of the AC shall be provided. The auxiliary power supply consists of rechargeable storage batteries and battery charger. The batteries shall re-charge automatically upon restoration of the AC power supply. Transfer from normal to emergency to normal power. Transfer from automatic shall not cause transmission of a false alarm.

2.12.9 Air-Conditioning and Ventilation System

The scope of work shall include the supply, installation and commissioning of all air-conditioning and ventilation system. The air-conditioning and ventilation system for the Administration Building shall conform to the relevant and applicable provisions mentioned in the Technical Specification.

2.12.9.1 Air Conditioning System

The Administration Building shall be provided with new Air Conditioning system which shall meet the requirements of this section. The air conditioning system proposed shall be DX Inverter type VRF/VRV (Variable refrigerant flow/volume) units for the large areas with individual evaporator controls and DX Inverter Split type units for the small conditioned areas. The type of refrigerant that shall be use shall be in accordance with the present environmental requirement subject to acceptance by the Engineer.

The Contractor shall make proposal demonstrating the air flows of the units to be installed to show evenly distributions of conditioned air inside the air-conditioned areas.

Capacity and functionality of the air-conditioning system shall be proven by qualification test. Acceptable capacity qualification test shall be in accordance with the air/enthalphy method as defined in the ASHRAE Standard 37 or acceptable equivalent.

The system shall maintain a room comfortable conditions not greater than 24 0C (75 0F) dry bulb and 60 % relative humidity under the ambient condition of Manila environmental climate. These condition together with the anticipated heat loads from: local summer solar radiation falling on the roof; on opaque glazed surfaces of windows; interior lightings, electric and electronic equipment; air leaks from doors; forced air ventilation supply; sensible and latent heat gains shall be included in determining the cooling load capacity. For calculation purposes body heat gains shall be evaluated at 270 Btu/Hr sensible and 240 Btu/Hr latent heat gains respectively.

The cooling system shall not induce condensation on metal and other surfaces.

Manual control device shall be permitted to maintain uniformity of the interior temperature. It shall be placed in conspicuous accessible location. The Air conditioning units shall demonstrate normal automatic functions to economically maintain the comfortable temperature condition of the conditioned space.

2.12.9.2 Ventilation System

The Contractor shall propose and submit a complete design of fresh air feed system to the conditioned areas. Contractor shall propose ducting and diffusing of air and blower sizing to match the required fresh air feed to the conditioned areas. For reference purposes; fresh air ventilation shall be provided at the rate of at least 15 m3 per hour (9 cfm) per person or 25% of the total air flow, whichever is greater.

3.0 Outline Schedule of Internal Finish

All workshops and structures:

a) Walls

   i. CMU Walls with Plain Cement Plaster finish /steel sheet plastic coated or both (Toilet Walls- Granite Tiles or Glazed Ceramic Tiles wherever applicable)

b) Concrete Columns – Reinforced Concrete rendered (Painted)

c) Steel Columns – Painted as per approve Colour Scheme with suitable paint system.

d) Floors

   i. Offices /Lobbies – Granite Tiles or Unglazed Ceramic Tiles (wherever applicable) Work Spaces;
   ii. Store Rooms – Plain Cement Trowelled Finish with epoxy coating/sealer where applicable, dust proof and suitably hard wearing;
   iii. Dust proof and suitably hard wearing to handle heavy use; and
   iv. Toilets – Unglazed Ceramic Tiles or Granite Tiles wherever applicable.

e) Ceiling

   i. Offices/ Lobbies – Acoustical Ceiling Boards on Metal T- Runners Workshops; and
   ii. Store Rooms – Exposed underside of second floor slab, or underside of roofing system to be painted with approved paint system.

f) Doors

   i. Offices – Custom made UPVC frame with double glazing;
   ii. Workshop/Storerooms – Flush Steel Door with fixed glass (painted);
   iii. Roll-up Metal Shutter (painted) verify location on drawing; and
   iv. Emergency Exit/Escape Doors – Approved Steel Doors (painted) as per International fire code with panic bar.

g) Windows

   i. Offices - Sliding custom made UPVC frame windows with tinted glass and screens; and
   ii. Workshops/Store Rooms – Fixed Steel Louver painted or anodized factory finished

h) Roofing/Sidings – Pre-Formed, Pre – Painted/Plastic coated/anodized long span metal roofing and sidings

i) Roof Sky Lights – Pre-Formed, Pre-Painted/pre finished long span fiberglass skylights from Same supplier of metal roof

j) Steel Shelves – Approved factory brand with paint for store rooms

k) Wood Cabinets/ Marine plywood, highly laminated (where ever Applicable)

l) Kitchen Sink / Counters (where ever Applicable) – Glazed Ceramic tiles

m) Toilet Fixture – Approved Brands with manufacturer's standards colour

n) Gates, Balusters, Handrails – Tubular Steel painted combination of square and flat bars for guardrails

o) Perimeter Fence – Combination of CMU Walls with plain cement plaster finish and Horizontal tubular steel fencing with paint (ref.to drawing)

p) Door Locks, HINGES And Door Closer – Shall be of approved brand and stainless steel. Material fixing and installation as per manufactures standard.

4.0 External Finishing

External Architectural finishes walls and Roofs to be proposed by the Contractor with materials deemed "Fit for Purpose" including all finishes ,Thermal Insulation, Water Proofing in relation to Roof Lights windows doors and Louvres and adequate Ventilation with Specifications and details submitted for approvals under the section of Further Submittals including prevention from ingress of water.

5.0 Landscaping

5.1 General

The Contractor shall prepare Landscaping plans that shall provide the following:

a) Location of areas to be landscaped
b) Site preparation
c) Location and type of plants and shrubs
d) Irrigation requirements
e) Special features

Landscaping works shall generally be limited only to approximately 1000 square meters of area per Depot (Baclaran Expansion Depot and the Zapote Satellite Depot)

5.2 Reference Standard

Landscaping shall be in accordance with applicable local codes and urban design guidelines. Landscape design shall be guided by the recommendation of a Filipino publication:

a) Philippine Ornamental Plants , by Mona Lisa Steiner, P.H.D. latest edition

5.3 Objectives

To provide shade, screening opportunities, comfort and sense of scale and attractiveness to the LRT1 Depot Facilities.

To achieve landscape design that is compatible with local climatic conditions and minimal maintenance.

5.4 Design Considerations

Based on the above objective and in consideration of unique environmental conditions, the following landscaping design criteria have been developed to ensure harmony of design within the LRT1 Depot (Baclaran Expansion and Zapote Satellite):

a) Adequate clearance must be provided and maintained between trees and the OCS structures and conductors;

b) Plants should be located at sufficient distance away from the tracks ballast to minimize the deposit of plant litter and to avoid damage to plants from herbicides used within the ballast areas;

c) The longitudinal spacing of trees shall be adjusted to accommodate existing sub-surface utilities, ducts and vaults, and special conditions such as existing poles, walkways, canopies awnings and shelters;

d) When combined with lighting and signage, planting shall not interfere with access to any maintenance facilities. Plant material selection and location shall be coordinated with lighting and signage to avoid obstruction of either;

e) Plant materials shall not obstruct the train operators view of approaches to maintenance facilities, curves and grade crossings;

f) Vegetation shall not obscure or obstruct road vehicle drivers or pedestrian visibility of approaching trains at grade crossings;

g) Plant material shall be selected and located so as not to restrict access to or use of hydrants;

h) Plant materials shall be selected and placed to avoid conflicts with all utility installation, including overhead utility lines;

i) Planting and other landscape elements shall allow for positive, easily maintained drainage;

j) No thorny plants shall be planted; and

k) Planting areas shall be designed without permanent irrigation system if special care is taken to select plant materials that are adaptable to natural rainfall conditions in Manila. Water requirements shall be considered in the selection of all plant materials and the design should focus on long-term low water usage. The designer shall locate irrigation components to minimize vandalism but ensure easy access to maintenance personnel.

5.5 Selection of Plant Materials

Consideration for the selection of plant materials shall include:

a) Initial cost
b) Availability
c) Attractiveness or design intent
d) Growth rate
e) Drought tolerance
f) Tolerance to wind, pollutants and abuse
g) Sun/shade preference
h) Soil and drainage condition
i) Minimum plant droppings or litter production
j) Potential damage to adjacent paved areas by roots
k) Attraction of rodents or insects
l) Maintenance requirements

D. Building E&M Work

This section describes the E&M Building Services. The scope includes design, supply, installation, testing and commissioning of all related equipment.

The concepts and major components to be provided in the Baclaran Expansion Depot Area and the Zapote Satellite Depot areas are:

a) Mechanical Works

   i. Fire Suppression System;

   ii. Environmental Control Systems for facilities under section C; and

   iii. Compressed Air System.

b) Electrical Works

   i. Low Voltage distribution for facilities under section C incl. Earthmats, Lightning Protection for facilities under section C. Power supply shall be connected at the main distribution feeders;

   ii. Fire Protection Services for facilities under section C;

   iii. Security Camera System, Stand-alone systems, shall allow to supervise perimeter from the Gatehouse.

   iv. Lighting Towers.

Note:

The following works are excluded from this scope of E&M Building services and it is expected that it will be provided by EPC:

a) HV/MV Supply Power;
b) Facility Supervisory Control and Data Acquisition (SCADA) System;
c) All Track Work;
d) All Signalling;
e) Telecommunications;
f) Automatic Fare Collection;
g) 750 VDC Traction Power, and interlocking's (access to work area on roof top); and
h) Overhead Catenary System

D-1. Electrical Works

1.0 Low Voltage Power Supply System and Electrical

1.1 Introduction

1.1.1 General

This Specification, for the power supply and distribution, for the LRT Line 1 Extension shall be read in conjunction with the Conditions of Contract, the General Specification for Electrical and Mechanical Works and the other documents forming part of the Contract.

The Contractor shall comply with the standards and design criteria a part of this Specification. Where materials or equipment are specified to be constructed or tested or both, the Contractor shall submit proof that the items furnished under this section of the Specification conform to such requirements.

1.1.2 Standards

The relevant International Standards are generally acceptable and shall form a part of this Specification. Where materials or equipment are specified to be constructed or tested or both, the Contractor shall submit proof that the items furnished under this section of the Specification conform to such requirements.

The following IEC codes shall be complied with:

Table 1.1.2 Standards

Railway Applications - fixed installations - Electrical Safety, Earthing and the return circuit - part 1: protective provisions against electric shock	EN-50122-1
Insulation co-ordination - part 1: definitions, principles and rules	IEC 60071-1
Electrical insulation. Thermal evaluation and designation	IEC 60085
Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials	IEC 60093
AC insulation - enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 38 kV	IEC 60466
AC. insulation - enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 38 kV	IEC 60694
Low-voltage switchgear and control gear - part 1: general rules	IEC 60947-1
Low-voltage control gear, part 1: contactors	IEC 60158
Dimensions of low-voltage switchgear and control gear standardized mounting on rails for mechanical support of electrical devices in switchgear and control gear installations	IEC 60715
low-voltage switchgear and control gear assemblies - part 1: type-tested and partially type-tested assemblies	IEC 60439-1
Direct acting indicating analogue electrical measuring instruments and their accessories - part 1. definitions and general requirements common to all parts	IEC 60051
Direct acting recording electrical measuring instruments and their accessories	IEC 60258
Dimensions for panel-mounted indicating and recording electrical measuring instruments	IEC 60473
Electrical measuring instruments - x-t recorders - part 1: definitions and requirements	61143
Conductors of insulated cables	IEC 60228
Tests on electric and optical fiber cables under fire conditions part 1-1 test for vertical flame propagation for a single insulated wire or cable. Test apparatus Tests on electric and optical fiber cables under fire conditions. Part 1-2. Test for vertical flame propagation for a single insulated wire or cable. Procedure for 1 kw pre-mixed flame Tests on electric and optical fiber cables under fire conditions. Part 1-3 test for vertical flame propagation for a single insulated wire or cable. Procedure for determination of flaming droplets/particles	IEC 60332
Basic and safety principles for man-machine interface, marking and identification - identification of conductors by colors	IEC 60446

Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV - part 1: cables for rated voltages of 1 kV and 3 kV	IEC 60502
General test methods for insulating and sheathing materials of electric and optical cables. Measurements of thickness and overall dimensions. Tests for determining the mechanical properties	IEC 60811
Tests of materials from cables during combustion determination of the amount of evolved halogen acid gases	IEC 60754
Measurement of smoke density of cables burning under defined conditions - part 1: test apparatus	IEC 61034
Electric cables - calculation of the current rating - part 1-3: current rating equations (100 % load factor) and calculation of losses - current sharing between parallel single-core cables and calculation of circulating current losses	IEC 60287
Diagrams, charts, tables	IEC 60113
General principles for the creation of graphical symbols for use on equipment	IEC 60416
Graphical symbols for use on equipment - part 1: overview and application Graphical symbols for use on equipment - part 2: symbol originals	IEC 60417
Graphical symbols for diagrams	BS EN- 60617
Philippines electrical code, part 1 and part 2	
Standard for fixed guide way transit and passenger rail systems	NFPA 130
Life safety code	NFPA 101
National fire alarm and signaling code	NFPA 72
National electrical code	NFPA 70
Luminous egress path marking systems	UL 1994
Standard specification for photo luminescent (phosphorescent) safety markings	ASTM E-2072
Earthing	BS - CP 1013
The protection of structures against lightning	CP 326
Regulations for Electrical Installations, Institution of Electrical Engineers Wiring Regulations 17th edition	
Cathodic protection of underground structures	UIC 605

1.1.3 Contractor Responsible for the Design

The Contractor shall design, supply, provide installation, commissioning and testing of the LV Distribution as specified under this Section. The overall concept for Earthing shall be responsibility of the EPC.

This scope includes labour force, supervision and equipment necessary for the proper completion and execution of the electrical work within the described demarcation.

1.1.4 Scope of Work

The work, inclusive of all calculations and details design effort, under this Section shall include furnishing of all tools, labour, supervision, equipment, fixtures and all necessary materials, each complete and in proper working condition unless one or the other is specifically excluded or stated otherwise in this Specification

The Contractor shall provide, but not limited to the following items:

a) All Local Control Panels (LCPs) complete with circuit breakers and programmable controller equipped with a data interface TCP/IP for future use for Lighting Towers, Water supply System, Water Treatment Plant, Train Wash Plant, Building M & E Services and Maintenance Workshops;
b) All works and materials for complete lighting and small power supply systems including all distribution equipment, feeder cables and conduits, branch circuits, circuit breakers, panel boards, and connection to the load side, supports and accessories;
c) All LED lighting fixtures including portable LED emergency lighting kits, control gears, wirings, conduits, switches, supports and accessories, for the facilities according section C;
d) Complete lightning protection and earth mesh system with adequate number of appropriate sized cable risers in accordance with relevant Codes and Standards;
e) All other items incidental to and or required for the proper completion of the installation such as painting of boxes, conduits, etc.; and
f) Earthing and Lightning Protection System in Depot and all ancillary buildings for the facilities according section C.

1.1.4.1 Engineering Documents

The Contractor shall be responsible to consistently update the final combined services drawings (CSDs) for the depot area and the facilities under the scope of this contract to reflect any changes due to site and or engineering development. An up to date marked-up copy shall be available and kept in the Site office for construction purpose. All updates shall be documented and captured in soft copy.

The Contractor shall ensure that all changes and updates and or engineering changes are consistently and that a valid As-Built revision is being issued at the end of the project.

1.1.4.2 Testing

The Contractor shall organize First Article Inspection and all required Tests as mentioned in **Sub-Clause 1.7.1**.

1.1.5 Interface Activities

All interface activities shall follow the overall interface management plan. The following items are particular for LV Distribution.

The Contractor shall coordinate all permits including inspection fees and associated paper works, as built plans as required by the approving Authorities.

The Contractor shall provide all required calculations, customized installation details and materials equipment, if required for the satisfactory co-operation, at the interfaces between this Section of the works and other Sections of works, including works provided by other System Contractors.

The Contractor shall be responsible to co-ordinate their equipment's delivery with the Civil Contractor and Other Contractors so as to be able to use the given access openings and timing.

Encasement of pipe sleeves, cable trays supported on vertical wall of cable trough or trench along the cable route shall be part of the entire cable containment.

The Contractor shall be responsible for testing and commissioning of all interfaces with the existing electrical system.

The most important disciplines with which this Specification will interface are given below but not limited to:

a) Low voltage Main Switchboard. (by Depot Contractor);
b) Earthing mat and Pigtails (by Depot Contractor);
c) Lightning Protection of OCS masts (by EPC);
d) Environmental Control System (Ventilation & Air-conditioning) (by Depot Contractor); and
e) Depot Equipment (by Depot Contractor)

1.2 LV Distribution Description

1.2.1 Demarcation Line

The demarcation line shall be at the terminals after the Main Switch Gear (output) at the substation. All Services and Equipment including the Main Switch Gear upstream this demarcation line shall be by the EPC contractor.

1.2.2 Power Supply Voltages for LRT 1 Extension

The source of electrical power supply for the LRT 1 Extension System shall be taken from the outgoing feeder residing in the Low Voltage Main Switchboard. The 3-Phase power supply is expected to be 480V, 60 Hz, 3 Phase. The Earthing System shall be coordinated with EPC, who provides the Earthing concept.

1.2.3 Connected Loads

The type tested LV Main Switchboard shall have ample capacity to deliver electrical power to but not limited:

a) Lighting in Facilities according to Section C;
b) Lighting Towers (motorised mast/platform) with high intensity LED Flood luminaires;
c) Security Camera System;
d) Water Treatment Plant;
e) Water Supply System including booster and transfer pump;
f) Building's M & E Services (ACMV, Small Power, Lightning Protection and Earthing);
g) Maintenance Shops;
h) Compressor;
i) Cranes;
j) LV Distribution Panel at Heavy Maintenance Workshop;
k) LV Distribution Panel at Light Maintenance Shop; and
l) Other Depot Equipment
m) Perimeter Light

Security Camera System equipment located on or adjacent to the Illumination Towers shall be fed from the power supply serving the Illumination Lights.

1.3 Technical Requirements

1.3.1 Standards of Protection

All items of the project covered by this Specification shall be designed to conform to the climate conditions prevailing in Manila.

The protection within the Depot and ancillary buildings to equipment and personnel shall be with Earth Fault Relay in Local Control Panel

Unless otherwise specified, all Local Control Panels (LCPs) shall be protected by a flush mount programmable overcurrent and earth fault relay.

All incoming circuit breaker inside the Local Control Panel shall be fitted with a programmable flush mount overcurrent and earth relay (DTL and IDMTL).

1.3.2 Environment and Noise Pollution

The noise level from any equipment shall not exceed the sound pressure levels, as defined by IEC Standards and Philippines Act of Republic, Decree 1151 and 1152.

1.3.3 Programmable Controller

Unless otherwise specified, all controls and local control panels shall be equipped programmable logic controller (PLC) having serial link TCP/IP enabled.

1.3.4 Cable Routes/Power Supply Homerun

Cable routes for Power Supply, Telecommunications and signalling cables in the Depot shall follow the approved coordinating drawings showing cables transit from cable trench and service duct with intermediate service manhole.

Power Supply homeruns for 480V AC cables in the Depot and ancillary buildings shall be taken off from the outgoing feeder circuit breakers of the Low Voltage Main Switchboard. These 480V AC cables shall run in prefabricated cable trenches with heavy duty hinged cover on ground or through pipes sleeves inside the concrete service duct at all access road crossing.

The 480V AC cables shall be designed and layout according to its application. The Engineer shall approve the design for such provision.

Low Voltage 230V AC cable routes shall be designed and layout according to its application. The Engineer shall approve the design for such provision.

The route of telecommunications cables shall provide physical segregation from other electrical services in accordance with EN standards and shall be mechanically protected throughout the route using suitable cable trough, duct, cable trunking, or conduit.

For armoured cables these may be routed via cable trays subject to the approval of the Engineer.

1.3.5 Penetrations in Walls and Floors

The Contractor shall utilize the existing designed penetrations.

The Contractor shall request the Engineer for additional necessary penetrations through walls and floors to obtain approval.

The Contractor shall do all patching necessary using approved fire stopped materials.

The Contractor shall provide all necessary backfill to all excavation work of his doing. All unused openings shall be grouted in using approved high strength grout materials.

1.3.6 Low Voltage Distribution Panel in Switch Room

The Depot Contractor shall provide the distribution panel in switch room which feeds the principal loads of Depot equipment and facilities.

1.4 General Technical Specification for Electrical Equipment and Materials

1.4.1 General

These requirements shall be taken to be generally applicable in accordance with good practice. Compliance to these requirements shall not relieve the Contractor from ensuring that all materials and equipment incorporated in the Works are suitable for their intended purposes and environments.

1.4.2 Local Control Panels and Boxes

All cubicles, panels, and junction boxes necessary for the accommodation and termination of all electrical apparatus and equipment, cabling and wiring provided under the Contract shall be of solid construction designed for a minimum lifetime of 15 years and uniform in appearance, powder coated with colour RAL 9003 (to be agreed on) throughout the Works.
The degree of protection shall meet the requirements in IEC 529.

a) IP 31 shall be applicable for indoor cubicles;
b) IP 54 for outdoor cubicles and junction boxes; and
c) Unless otherwise specified, non-metallic junction boxes shall not be used.

Unless otherwise approved, access to type tested panels and cubicles shall be from the rear. The polarity of all apparatus shall meet the IEC specification.

Anti-condensation heaters shall be provided according to 60 W/m^3 controlled by means of thermostat.

1.4.3 LED Lights, LED Emergency Lighting Kit/Illumination/EXIT SIGNS

The Contractor shall provide adequate light fixtures to achieve the desired illumination level as follow:

Table 1.4.3 Desired Illumination Level

S/No	Rooms/ Area to be illuminated	Lux Level	Working Plane	Day/Warm
1	Gate/Guard House	300	600 mm	5000 K
2	Substation	300	Floor	4000 K
3	Workshop	500	Floor	5000 K
4	Toilet	200	Floor	5000 K
5	Maintenance Shop	500	Floor	5000 K
6	All Storage Areas	300	Floor	4000 K
7	Hazardous Store	300	Floor	4000 K
8	Office	300	600 mm	5000 K
9	Tower Light	100 (min)	Floor	4000 K
10	Motor Pool	150	Floor	4000 K

The Contractor shall provide and install all LED lighting fixtures including the control gear of the size and type as required and or indicated in the drawings. All fixtures shall be wired and installed completely including LED luminaires, light controllers, supports, brackets, and other parts necessary for the complete installation and wirings.

The use of LED light sources is the preferred light source for calculation of the illumination level required by the area to be lighted depending upon the application to determine the number of luminaires. The lighting plan (isolux distribution) showing the maximum, minimum and average illumination level shall be presented to the Engineer for review and approval.

LED High Intensity Luminaires shall be used wherever practicable, in particular for outdoor lighting tower. LED High Bay High Intensity light fittings shall be used in Workshop maintenance bay. All LED luminaires shall comply with requirements with the relevant IEC Standards

Outdoor and floor flushed units shall satisfy the requirements in relevant IEC 60598 Standard. These units shall be rated at IP 65 or IP 66 and having a Class 1, Electrical Insulation.

LED emergency lighting including EXIT SIGNS shall be adequately provided inside the Facilities provided under the scope of this contract. The emergency lighting plan (isolux distribution) showing the minimum illumination level shall be presented to the Engineer for approval.

The EXIT SIGN shall be self-illuminating and high performance strontium aluminate type. The Contractor shall provide test certificates from the manufacturer in accordance with following the standards:

a) UL 1994;
b) NFPA 101; and
c) ASTM E 2072.

Water, shock, dust and moisture proof luminaires shall be used for the inspection pit or areas of similar conditions. There shall be a wire guard to prevent mechanical damage.
Indoor recessed or suspended diffused LED luminaires with mirror optic suitable for modular or non-modular system shall be used in Depot and ancillary buildings.

1.4.4 Wiring Devices

Convenience outlets for general purpose shall be duplex 15 A, 2 Pole, 3 Wire, 230 V, grounding type with parallel and tandem slots with stainless plate cover.

Switches of light box shall be 10 A, 230 V with stainless cover.

Industrial plugs and sockets with contact tubes and pins made of brass shall be used for 480V AC 3 Phase and 230 V AC Single Phase supply outlets at the inspection pit or wherever applicable.

All wiring devices should comply with relevant Philippine - and International Standards.

1.4.5 Cabling and Wiring

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 and appropriately rated IP terminal box mounted directly upon and immediately adjacent to each item involving such interconnection.

Cable entry shall in all cases, except where otherwise specifically approved, be at the base of all enclosures. Cables, armored and non-armored type shall be halogen-free and shall have reduced fire-propagation characteristics unless otherwise approved.

These cables shall conform generally to IEC 60331 and IEC 60332-3 and these cables shall be adequately rated according to IEC 60287 for their duty and loads.

1.4.6 Conductors

Conductors shall be stranded electrical-grade annealed high-conductivity copper. Stranded copper conductors shall comply with the requirements of IEC Recommendation No. 228 or whichever is applicable.

Conductors shall be smooth, uniform in quality, free from scale, inequalities, spills, splits and other defects. There shall be no joints in individual strands.

LV for 480VAC Cables shall be single multi-core comprising of 4 conductors wires and a shielded drain wire/s.

a) Up to 15 A shall not be less than 2.5 mm^2 cross section for wiring connecting items. Wiring within the equipment shall be to manufacturers factory requirements and shall be subject to Engineer's approval;
b) Greater than 15 A shall be subject to Engineer's approval; and

Unless otherwise specified, the Contractor shall be responsible for:

c) Provision of approved non-ferrous glands with Earthing lug and suitable for each type of cable entering the equipment,
d) Provision of adequate gland plates and for drilling and mounting them within the equipment,

The Contractor shall provide, install and terminate all internal wiring within cubicles, panels, and junction boxes or other enclosures supplied under this Specification.

Unless otherwise approved, all internal wirings shall use halogen-free and fire-retardant wire.

Electrical devices placed inside the battery room shall follow the requirements according to ICE 60079

Bus-wires shall be fully insulated. Bus-wire terminals shall be located below cubicle top covers and fully accessible from the point of entry to each enclosure.

Fuses and links shall be provided to enable all circuits within a cubicle, except in the case of lighting and heating, to be isolated from the bus-wires.

Rigid Steel Conduits (RSC) or Electro-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.

Insulated flexible metal conduit shall be used for connection from ceiling to LED lighting fixtures and where RSC is impractical, such as where equipment is prone to vibration or thermal expansion. Insulated flexible metal conduits shall be liquid tight, with a flexible steel core and extruded liquid tight overall neoprene jacket.

1.4.7 Diagrams

In the case of special items of the project, diagrams of the circuits shall be provided as requested by the relevant section of this Specification.

Each panel, cubicle, or enclosure shall be provided with a laminated wiring diagram/circuit and terminals assignment suitably treated to prevent deterioration from dirt or age.

1.4.8 Analog and Digital Type Instruments

All instruments mounted on cubicles or panels shall be subject to approval of Engineer. Instruments shall be similar in appearance (suitable for 100 X 100 mm knock-out for indicating instruments) throughout the system

1.4.9 Power Monitoring Device

The Contractor shall provide a power-monitoring device to be placed in the Low Voltage Main Switchboard (LVMSB) that shall store and collect electrical data such as current, voltage and Power Consumption.

This meter shall be designed with integral TCP/IP data link.

1.4.10 Insulation and Sheathing

The constituents used in the manufacture of the material for insulation and sheathing shall be mixed together in such quantities and processed in such manner as to ensure a stable product with the required physical and electrical characteristics and suitable for use in the specified operating conditions without deterioration.
The minimum insulation level shall be according IEC 60364-6, > 10Mohm / 1000VAC.

1.5 Installation of LV Cables, Accessories and Auxiliary Equipment

The installation and handling of cables shall be undertaken at all times by suitably trained staff, adequately equipped with all the necessary plant, equipment tools and lighting. The arrangement of the cables and all methods of laying shall be approved by Engineer, and shall be along planned routes.
Every precaution shall be taken to ensure that cables and accessories are not installed in a manner or under conditions likely to cause electrolytic or other corrosive action or damage to the cables, or be detrimental to the performance of the cables during operation.

1.6 Local Control Panel (LCP)

The Contractor shall supply, where required local control panels (LCPs). The LCP shall be standalone, comprising the necessary MCCBs and or MCBs equipped with a programmable controller for each of the following:

a) Illumination Tower Light;
b) Water Treatment Plant;

c) Water Supply System;
d) Train Wash Plant;
e) Depot Building Services;
f) Maintenance Workshop; and
g) Perimeter Lights.

The number of outgoing feeders shall suit the application for that particular location including the provision for one spare MCCB or MCB. The Contractor shall provide all terminal assignments, circuitry and single line diagram.
A TCP/IP interface shall be provided to allow future interface with a control system and the functionality shall be documented for future use.

1.7 Testing and Commissioning

Tests shall be done to verify that the equipment and materials comply with the Specifications. All tests, static and dynamic shall be done under working conditions.
All tests shall be done as required by the specifications and the national standards or by equivalent requirements of international standards.
The Contractor shall present a test plan to the Engineer to prove the following:

a) Specified functionality;
b) Performance test;
c) Interface performance;
d) Continuity test;
e) Ground and Insulation test; and
f) Phase sequence.

1.7.1 Test Plan

The Contractor shall be responsible for all the following tests. For this purpose the contractor shall provide under the regime of the quality control a test plan for the following Test:

a) Factory Routine Tests for Quality control;
b) Site acceptance test during and after construction;
c) In-line Tests; These special tests that are done to the first or/and to the subsequent (if agreed) units of combined equipment;
d) Insulated Power Cable Tests; Type Tests; and
e) Insulated Power Cable Tests; Routine Tests.

2.0 Fire Detection, Alarm and Control System

2.1 Introduction

This specification, for the Fire Detection, Alarm and Control System for the LRT Line 1 Extension shall be read in conjunction with the Conditions of Contract, the General Specification for Electrical and Mechanical Works and the other documents forming part of the Contract. (Please refer to drawing #CMX-L1/DP-EM-01-0008)

Fire Detection, Alarm and Control System shall comply with required Philippine Code (Fire Code of the Philippines and applicable Local Government fire regulations and requirements), and also shall comply with the requirement of Safety Integrity Level (SIL 2).

2.1.1 Work in General

The work to be done, in accordance with the following specifications includes design, supply of materials, installation, commissioning, parameterization, testing, supervision, including all labour and equipment necessary to the proper completion and execution of the Fire Detection Alarm and Control Works except those clearly defined to be done by others.

The work inclusive of calculations and design effort under this Section shall include

furnishing of all tools, labour, supervision, equipment, fixtures and all necessary materials, each complete and in proper working condition unless one or the other is specifically excluded or stated otherwise in this Specification.

2.1.2 Interface Activities

The Contractor shall perform all design duties and provide the materials' equipment and installation necessary for the satisfactory co-operation, at the interfaces between this section of the works, other sections of works, including both existing works and work provided by other Contractors.

The Contractor shall be responsible for testing and commissioning of all interfaces with the existing electrical system.

The Contractor shall coordinate and or secure at his expense all permits including inspection fees and associated paper works, as built plans as required by the approving authorities.

The most important disciplines with which interfacing is needed are:

a) Civil Engineering including location for Outdoor Manual Call Points; and
b) Environmental Control System (Ventilation & Air-conditioning).

At the Baclaran Expansion Depot integration of Fire Detection and Alarm System is required between existing depot and Expansion Depot (Refer to Drawing No. CMX-L1/DP-EM-0001 for connection point). Therefore the Contractor is required to fully coordinate with the Concessionaire (LRMC) for the design and construction of the System.

2.2 System Description

2.2.1 Fire Detection, Alarm System

The proposed Fire Alarm and Detection System shall be a customized, maintenance free system, consistently monitoring the protected areas in real time. It shall be manufactured using programmable; state of art technology having a minimum of 20% capacity for future upgrades.

The following shall be the minimum areas to be protected:

a) Substation;
b) Gate house;
c) Technical equipment Room;
d) Low Voltage Switch Room;
e) Light and Heavy Maintenance Workshop and rooms;

f) Offices in Maintenance Workshop; and
g) Hazardous Material Storage.

2.2.2 Main Fire and Alarm Control Panel (FACP)

The Main Fire Alarm Panel with annunciator and digital (text) display shall be wall mounted at the gate houses in Zapote Satellite Depot and the gates in Baclaran Expansion Depot to be built under this scope.
The fire alarm system shall comply with requirements of NFPA Standard No. 72 for protected premises signalling systems except as modified and supplemented by this specification.

The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analogue information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

The Initiating Device Circuits shall be individually programmable as conventional two-wire smoke detector circuits, as well as any dry contact input device. Examples of dry contact input devices include four-wire smoke detectors, manual pull stations, abort switches, heat detectors, pressure switches, and water flow switches. The Initiating Device Circuits shall support conventional two-wire smoke detectors as well as conventional smoke detectors capable of generating a maintenance signal when the detector becomes dirty.

The outputs (minimum 4) shall be individually programmable. The output relays shall be fail-safe.

The main system display shall be an integral Display with a keypad. The keypad shall have full programming capability.

Interface shall be available to make use of a laptop computer for programming.

The CPU shall communicate and control the following types of equipment used to make up the system: connection of optional annunciators and remote LCD displays

Intelligent addressable smoke (photo and ionize) and thermal (heat) detectors, Smoke detector shall be a photoelectric smoke detector, listed to UL 268 for Fire Protection Signalling Systems. The detector shall be a combination photoelectric/thermal with thermal sensor rated at 57.2°C.

and/or:

Conventional Ionization Type Area Smoke Detectors - conventional ionization plug-in smoke detector, listed to UL 268 for Fire Protection Signalling Systems - Ionization type smoke detectors shall be a two wire, 24 VDC type using a dual unipolar chamber. Each detector shall contain a remote LED output and a built-in test switch. It shall be possible to perform a calibration sensitivity and performance test on the detector without the need for the generation of smoke.

and/or:

Duct Smoke Detectors

Heat Detector,

Conventional or Linear type with Monitoring Modules

The detector shall be either a single-circuit or a dual-circuit type, normally open. The detector shall be rated for activation at either 57°C or 90°C, and shall activate by means of a a combination fixed temperature/rate-of-rise thermal sensor. The rate-of-rise element shall be activated by a rapid rise in temperature, approximately 8.3°C per minute.

Addressable modules, Printer, Annunciators, and All Horns, Strobes, and Horn/Strobes shall be addressable and be synchronized without the need for additional synchronization hardware or modules.

Manual Fire Alarm system controlled devices.

Manual stations shall be constructed of red coloured polycarbonate or equivalent

2.2.3 System Capacity and General Operation

The FACP shall be capable of communicating on Local Area Net-work (LAN) regenerative communication format and protocol. The network shall support TCP/IP Protocol.

The FACP shall be capable to provide the following features:

a) Drift compensation including a smoothing feature that allows transient noise signals to be filtered out to extend detector accuracy over life;
b) Detector sensitivity test, meeting requirements of NFPA 72;
c) Two (2) levels of maintenance alert (alert and urgent) to warn of excessive smoke detector dirt or dust accumulation;
d) Ability to display and or print system reports; and
e) Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times

2.2.4 Standards of Protection

All items of the project covered by this Specification shall be designed to conform with the climatic conditions prevailing in Manila in general and within the Depot and ancillary buildings to give protection to equipment during its service life.

2.2.5 Standards

The relevant International Standards shall form a part of the specification. Where materials or equipment are specified to be constructed or tested or both, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements.

The following are the applicable Codes and Standards:

a)	National Electric Code	:	NFPA 70
b)	National Fire Alarm Code	:	NFPA 72
c)	Air Conditioning Systems	:	NFPA 90 A
d)	Smoke Control Systems and Management Systems	:	NFPA 92 A and B
e)	Life Safety Code	:	NFPA 101
f)	Smoke Detectors for Fire Protective Signalling Systems	:	UL 268
g)	Smoke Detector, Single or Multiple Station	:	UL 217
h)	Heat Detectors for Fire Protective Signalling Systems	:	UL 521
i)	Audible Signalling Appliances	:	UL 464
j)	Manually Activated Signalling Boxes	:	UL 38
k)	Power Supplies for Fire Protective Signalling Systems	:	UL 1481
l)	Visual Notification Appliances	:	UL 1971
m)	Safety of Information Technology	:	UL 60950

2.3 General Technical Requirements

2.3.1 Cabling and Wiring

All cables and control wires shall not be concealed and shall be adequately protected in a dedicated red coloured cable containment. These cable containments shall be physically separated from other containments by at least 300 mm.

Red coloured rigid electro-galvanized conduits (RSC) or electro-galvanized cable tray shall be used throughout for surface wiring.

2.3.2 Cable Route and Heat Detector Cable Route

All screened and sheathed wirings between detectors and or peripherals routing towards the Fire Detection, Alarm and Control Panel shall be contained in a separate cable containment. The Contractor, at all times shall maintain the physical separation distance of 300 mm from other cable containments.

2.3.3 Earthing of Fire Detection, Alarm and Control Panel

The housing of the Fire Detection, Alarm and Control Panel shall be adequately earthed

2.3.4 Installation of Fire Alarm Cables, Accessories and Auxiliary Equipment

The installation and handling of cables shall be undertaken at all times by suitably trained staff, adequately equipped with all the necessary plant, equipment tools and lighting.

2.4 Testing and Commissioning

Tests shall be done to verify that the equipment and materials comply with the Specifications. Tests, static and dynamic shall be done under working conditions.
All tests shall be done as required by the specification and the relevant national Specifications, if applicable or by equivalent requirements NFPA, unless otherwise defined.

2.4.1 Test Plan

The Contractor shall be responsible for the all the following tests. For this purpose the contractor shall provide under the regime of the quality control a test plan for the following:

a) Factory Routine Tests for Quality control;

b) Site acceptance test during and after construction; and

c) Tests should be done to verify if the system, equipment, programming and materials conform to the specifications. All tests, shall be done under working and or operational conditions.

The Engineer shall be notified at least ten days in advance for execution of every test. The Contractor shall apply for work permit before the execution of any test involving the main line. Tests shall generally be performed in the presence of the Engineer and in accordance to an agreed program. After each test, the Contractor shall provide the Engineer with copies of reports for test and measurements.

3 .0 Earthing and Lightning Protection

3.1 General

This Section defines the requirements for the Earthing and Bonding of the electrical power system for the depot area in Baclaran Expansion and Zapote Satellite Depot requirements necessary for any other electrical systems to ensure:

a) The safety of workers for maintenance and the operating personnel in the depot to prevent from electrical shock,

b) Minimal electrical interference between electrical systems.

Earthing is to be carried out to the requirements of the relevant earthing standards applicable for the railway construction and operation. Principles of Earthing and Bonding shall follow National and International Standards:

i. EN 50122 Railway Application – Fixed Installation – Electrical Safety – Earthing and Return Circuit

ii. International Union of Railways Standards (UIC) 605-1 and 605-2

iii. CP 326 The Protection of Structures from Lightning and CP 1013 - Earthing

3.2 Scope of Work

The EPC is responsible for the power supply system for Auxiliary Power and for Traction Power. The concept of the Earthing in the Baclaran Expansion Depot Area and Zapote Satellite Depot area is under the full responsibility of EPC.

The scope of this contract includes only the Earthing elements needed for the facilities being provided under this contract in the Zapote Satellite and Baclaran Expansion Depot area. This earthing provision includes pigtails (risers for protection earth and clean earth) from the earth grids. In the substation, additionally the earth grid for the traction power earth shall be provided

Signalling earth is under the full responsibility of EPC

The scope of work for the earthing system shall include the Security Camera System (Lightning Hazard) but shall exclude other telecommunications facilities which may be installed within the Depot by other parties such as telephone, radio and public address systems, etc.

3.3 Responsibility for Implementation

The Contractor shall liaise with the EPC for the incorporation and co-ordination of the various requirements of Earthing and Bonding.

3.4 Principles

Earthing can be classified as the provisions included in the design of electric (or electronic) systems to ensure that dangerous potentials do not occur on any metallic structure surface and on the enclosures/frames of equipment forming the system and that relevant faults are detected.

Under normal operating conditions, the apparatus does not carry current.

The earthing provisions on an electrified railway are similar to those on a power distribution system, but the effects of traction current return system must be taken into account

Bonding can be classified, for the purposes of this Section as:

Connections for non-current carrying parts of substation electrical apparatus and equipment and other electrical equipment within the system, to ensure that dangerous potentials do not occur and to maintain earth continuity throughout and,Classes of Earthing

For the purposes of this Section, seven (7) classes of earthing are defined as follows:

Class 1 : Connection to earth at one or more nominally equipotential points of each section of the power supply system to ensure that the voltage at any point in the system relative to earth will be

within definite limits and provide a low impedance path for earth fault return current (e.g., the neutral point of a transformer).

Class 2: Connections to the Structure Earth system at one or more points of the non-current carrying part of the electrical equipment, to ensure that in the event of failure of the insulation or other inadvertent connection between current and non-current carrying parts, no dangerous potential difference occurs between the non-current carrying parts of the equipment and earth, (e.g. the frame, housing or cubicle containing electrical equipment).

Class 3: Connection to the Structure Earth system of metallic structures which are not part of the electrical equipment, but are in the proximity of the electrical system, and which can be touched by the general public or staff or to which faults could occur (e.g. columns, piers and fences).

Class 4: Traction system earthing (Track Earth), in which the rails forming the return current path, are insulated from earth by a nominal resistance.

Class 5: Unearthed systems, where the current carrying conductors are fully insulated from earth at all points. No part of such a system need be automatically disconnected immediately on the occurrence of a single earth fault in that part (e.g. telecommunications systems; no provisions under this scope).

Class 6: The protection of buildings, structures and electrical equipment from lightning, by the provision of lightning conductors and earth electrodes.

Class 7: At certain locations the Structure Earth system will be connected to earth electrodes and will therefore include two or more of the above classes.

3.5 Earthing Requirements

This Section requires the provision of an earth system at every traction and auxiliary substation, for the purposes of earthing AC power supply systems under Class 1 and metallic enclosures and structures under Classes 2 and 3.

Earth conductors shall interconnect the earth system at each location, earth bonding connections, cable sheaths and/or armoring to adjacent location earth systems, to form an all-embracing earth for the whole LRT system.

This Section includes provisions for separating Classes 1 to 4 from 6 and 7 and ensuring the minimum effects of corrosion by not providing purposely stray current paths having overall low impedance.

Transformers (By Others)

It is expected that the Transformers provided by others have an earth screen connected to the transformer earth terminal shall be provided between the primary and secondary windings

3.5.1 Earthing Mesh and Cable Risers

There shall be an embedded earth grid/mesh following the relevant Standards in the Depot substation. The value of the embedded earth grid/mesh resistance shall be 1 Ω (ohm) or less.

There shall be two earthing schemes. The Clean Earth shall be used for grounding all non-linear loads such as telecoms, signalling, UPS and electronic equipment while the Protection Earth shall be used as earth point for all loads such as transformer's start-point, armour or sheath of cables, electrical power for pumps and machines.

The Protection Earth shall also be used for earthing equipment cabinets, exposed metal works and racks (equi-potential bonding). Lightning discharge shall be designed according to the LRMC concept and EN 50122.

The clean earth shall be used for COM and DATA (IT) and shall be derived from a independent Pigtail.

All earth connections, in particular between each cable riser and embedded bared earth mesh conductor, shall be exothermically welded (cad weld).

All magnetic conduit, equipment, cabinets and the like shall be properly grounded and bonded by means of copper straps of appropriate size.

All metallic structure not forming part of the earthing system shall be adequately connected to the nearby earth connection to maintain the same potential (equi-potential bonding) with the System Earth to ensure operation of the protection device when a fault current flows.

3.5.2 Earthing of All Depot and Ancillary Buildings' Equipment

All metal parts, other than those forming part of any electrical circuit, shall be effectively connected in an approved manner to the main Earthing system

Unless otherwise specified, all single cubicles shall be provided with an earth stud of appropriate size.

The quality of copper shall be medium drawn strip of conductivity not less than 97 % as per International Standards.

All earth conductors shall be Low smoke, Flame Retardant Halogen free, multi-strand, insulated and coloured green or yellow/green single core XLPE cable. The earth conductor for the main earth system shall not be less than 95 mm^2 and for branch circuits shall not less than half the cross sectional area of the phase conductor, for 50 mm^2 and above. For phase conductor of cross sectional area below 50 mm^2, the size of the earth conductor shall be the same as the phase conductor.

3.6 Lightning and Surge Protection

Lightning conductors for protection of structures and buildings shall be connected to a dedicated earth electrode which does not make contact with any part of the structures or buildings. Reinforcing bars used as part of a structure shall not be used as lightning conductors.

Depending on the architecture layout, there shall be a vertical down conductor at every span of 20 taut meter or less from the horizontal conductor that acts as the lightning arrester in the overall lightning protection scheme. Active lightning protection system shall be considered.

All habitable structures constructed from metallic materials for the purpose of storage and having metallic roof shall be adequately protected by bonding all discontinuities.

The Gate House at the Entrances shall be adequately protected with a combination of horizontal, vertical down conductors, electrode rod and commercially available heavy duty earth pit or chamber.

3.7 Depot Equipment

The main frame of any travelling cranes shall be earthed via the structures on which they run or an earth connection in the supply arrangements.

Cranes required to lift equipment on or off trains standing on electrified tracks shall be fitted with two insulated links close to the hook, or preferably shall use a non-metallic sling.

Power outlets for small portable electrical equipment used on or near trains on electrified tracks shall have double insulation or have their earth pins isolated from earth and connected to the running rails.

The supply arrangements shall take into account of high earth loop impedance resulting from this arrangement by the provision of suitable protection, e.g. earth-leakage-circuit-breakers and detection.

Heavy mobile plant used on or near trains on electrified tracks shall incorporate suitable measures to prevent inadvertent connection to the trains or tracks to earth. The Contractor shall

provide adequate fixed and insulated connection points/receptacle for any equipment requiring air supplies with matching connection.

Metallic pipes, conduits, light fittings etc., located close to the tracks in the maintenance sheds shall be kept to an absolute minimum. Where necessary, these shall be insulated and in such a position as to minimise the risk of accidental contact with the rails by dropped tools etc. The minimum suggested distance shall be 2.5 metre from the track.

3.8 Incoming Services

All services entering or passing through the Depot tracks shall be fitted with insulated joints or sections to separate external services and utilities from the earth system.

4.0 Illumination Tower Light

4.1 Scope of Works

The Scope of Works for the Illumination tower light work includes engineering of the tower light foundation, procurement lighting tower post, LED flood light, cabling and control panel etc., commissioning and testing.

4.2 General

There shall be a minimum of 4 (four) lighting towers, each 12 meters high installed in Zapote Satellite Depot and a minimum 5 (five) lighting towers, each 12 meter high in Baclaran Expansion Depot. These lighting towers shall be suitably located in the Depot to provide adequate and efficient illumination

These lighting towers complete with mounting plate constructed with alloy steel shall be robust to resist the wind velocity of 160 km/h and also satisfying the requirements as specified in the Institute of Lighting Engineers document, in particular installation of Security Camera System.

High intensity LED flood lights assembly in each direction, one light fitting tilted to illuminate 50 metre and two light fittings to illuminate 100 metre away from the lighting tower shall be capable of uniform illumination over a distance of 100 metre. Additional quantity of LED high intensity flood lights shall be added, if required in each direction.

A dedicated platform shall be provided at a height of 4500 mm from the base of the lighting tower for the installation of cameras associated with the Security Camera System to provide full omni-directional area coverage.

The cross bar attachment to which the light fittings are secured shall be attached to the motorised system that shall move up and down vertically and centrally along the axis of the lighting tower. The operating voltage of the motorised unit shall be 230 V AC, 60 Hz.

The IP 65 control panel shall be installed beside the lighting tower to facilitate lowering, raising of the cross bar attachment. The cables attached to all the light fittings that are mounted onto cross bar attachment shall be neatly arranged in pigtails during lowering or raising operation within the hollow of the lighting pole.

4.3 Minimum Requirements for Lighting Tower

4.3.1 Pole Shaft, Base Plate, Access Hole/Cover

The pole shall be a one section design fabricated from 5 mm thick steel.
The base plate telescopes the pole shaft and shall be circumferential welded top and bottom. The base plate shall have adequate number of round bolt holes.
A reinforced access hole 80 X 130 mm shall be foreseen 450 mm above the base plate. An access hole cover shall be included.

4.3.2 Finish

All poles, mounting brackets and platforms shall be furnished with a coating of either red oxide/zinc primer, factory painted, powder coated or hot-dip galvanized to ASTM A-123. Exterior anodised finish coatings shall be available by request.

5.0 Security Camera System

5.1 Introduction

5.1.1 This specification outlines the requirements for the Security Cameras to be installed within the Zapote Satellite Depot and Baclaran Expansion Depot of the LRT Line 1. (Please refer to drawing #CMX-L1/DP-EM-01-0010)

5.1.2 The general scope of this specification is to provide:

A Security Camera installation at the new Zapote Satellite Depot aiming to supervise the perimeter; and
A Security Camera installation covering only the areas applicable to the expansion of Baclaran Expansion Depot aiming to supervise the perimeter, at the expansion area;

5.1.3 The Contractor shall offer cameras, equipment, housings cables and materials which meet the requirements detailed in the specifications and which have gained wide acceptance in the railway industry, or are close to gaining such acceptance.

5.1.4 The following layout drawings provide outline details of each depot site:

Document	Title
DWG: CMX-L1/DP-C1-01-0005	Zapote Satellite Depot Layout
DWG: CMX-L1/DP-C1-01-0003	Baclaran Expansion Depot Layout

5.2 Abbreviation

Acronym	Definition
AC	Alternating Current
ASTM	American Society for Testing and Materials
BS	British Standard
CCD	Charge Coupled Device
CMOS	Complementary Metal-Oxide Semiconductor
COTS	Commercially off the Shelf
dB	Decibel
DDF	Digital Distribution Frame
EMC	Electromagnetic Compatibility
EN	Euro Norm
ES	ETSI Standard
ETSI	European Telecommunications Standards Institute
G.652	Characteristics of a single-mode optical fibre and cable
GPS	Global Positioning System
GUI	Graphical User Interface
HMI	Human Machine Interface
HV	High Voltage
Hz	Hertz
I &TP	Inspection and Test Plan
IEC	International Electro technical Commission
IEEE	Institute of Electrical and Electronic Engineers
IP	Internet Protocol or Internal Protection (Depending on Context)
ISO	International Organization for Standardization
ITU-T	International Telecommunications Union, Telecommunications
km	kilometre
kV	Kilo Volt
LAN	Local Area Network

Acronym	Definition
LED	Light Emitting Diode
EPC	Light Rail Manila Corporation
LRT	Light Rail Transit
LV	Low Voltage
Mbps	Megabits per second
MCB	Miniature Circuit Breaker
MP	Megapixel
MPEG	Motion Picture Experts Group
N/A	Not Applicable
NMS	Network Management System
NTP	Network Termination Point or Network Time Protocol (Depending on Context)
NTSC	National Television System Committee
NVR	Network Video Recorder
OCC	Operations Control Centre
ODF	Optical Distribution Frame
OFDF	Optical Fibre Distribution Frame
PAL	Phase Alternating Line
PDB	Power Distribution Board
PoE	Power over Ethernet
PTZ	Pan, Tilt and Zoom
QoS	Quality of Service
RAMS	Reliability, Availability, Maintainability And Safety
S/N	Signal to Noise
SCADA	Supervisory Control and Data Acquisition
SDH	Synchronous Digital Hierarchy
SIF	Source Input Format
TBA	To Be Advised
TCP/IP	Transport Control Protocol/Internet Protocol
TER	Telecommunications Equipment Room
TIA	Telecommunications Industry Association
TS	Technical Specification
TV	Television
UPS	Uninterruptible Power Supply
UTC	Coordinated Universal Time

5.3 Standard

Document	Title
ASTM D6386	Standard practice for preparation of zinc (hot-dip galvanized) coated iron and steel product and hardware surfaces for painting
BS 4800	Schedule of paint colours for building purposes
BS 7958	Closed Circuit Television (CCTV) - Management and Operation, Code of Practice
BS 8418	Installation and Remote Monitoring of Detector Activated Security CCTV Systems, Code of Practice
BS 8495	Code of practice for digital CCTV recording systems for the purpose of image export to be used as evidence.

Document	Title
BS3692	ISO metric precision hexagon bolts, screws and nuts. Specification
BS4190	ISO metric black hexagon bolts, screws and nuts. Specification
EN 10025 (Series)	Hot rolled products of structural steels
EN 1011-1	Welding. Recommendations for welding of metallic materials. General guidance for arc welding
EN 1011-2	Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels
EN 10210-1	Hot finished structural hollow sections of non-alloy and fine grain steels. Technical delivery requirements
EN 10210-2	Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties
EN 10219-1	Cold formed welded structural hollow sections of non-alloy and fine grain steels. Technical delivery requirements
EN 10219-2	Cold formed welded structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties
EN 1990	Eurocode. Basis of structural design
EN 1991-1-4	Eurocode 1. Actions on structures. General actions. Wind actions
EN 1993-1-8	Eurocode 3. Design of steel structures. Design of joints
EN 50121	Railway Applications. Electromagnetic Compatibility
EN 50125	Railway Applications, Environmental Conditions for Equipment
EN 50126-1	Railway applications. The specification and demonstration of reliability, availability, maintainability and safety (RAMS). Basic requirements and generic process
EN 50132-7	Alarm Systems, CCTV Surveillance Systems for use in Security Applications - Part 7: Application Guidelines
EN 60529	Specification for Degrees of Protection Provided by Enclosures
EN 60896-21	Stationary lead-acid batteries. Valve regulated types. Methods of test
EN 60896-22	Stationary lead-acid batteries. Valve regulated types. Requirements
EN 61000-2-2	Electromagnetic compatibility (EMC). Environment. Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems
EN 62040-1	Uninterruptible power systems (UPS). General and safety requirements for UPS
EN 62040-2	Uninterruptible power systems (UPS). Electromagnetic compatibility (EMC) requirements
EN 62040-3	Uninterruptible power systems (UPS). Method of specifying the performance and test requirements
EN 62040-4	Uninterruptible power systems (UPS). Environmental aspects. Requirements and reporting
EN 62305 (Series)	Protection against lightning

Document	Title
EN 62676 (Series)	Video Surveillance Systems for use in Security Applications
EN ISO 11064 (Series)	Ergonomic design of control centres
EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods
ETSI ETS 300 019-1-1 Storage as per Class 1.2	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Classification of environmental conditions : Storage
ETSI ETS 300 019-1-2 Transport as per Class 2-3	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Classification of environmental conditions: Transportation
ETSI ETS 300 019-1-3 In Use as per Class 3-1	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Classification of environmental conditions: Stationary use at weather protected locations
ETSI TR 102 446 V1.1.1	Technical Report Environmental Engineering (EE); General Requirements for UPS for use in Telecommunication Environment
ETSI TS 102 121 V1.3.1	Technical Specification Environmental Engineering (EE); Power distribution to telecommunications and datacom (ICT) equipment
IEC 60793	Optical fibres
IEC 60794 (Series)	Optical fibre cables: Generic specification
IEC 61000-4-2	Electromagnetic compatibility (EMC) - part 4-2: testing and measurement techniques - electrostatic discharge immunity test
IEC 61000-4-4	Electromagnetic compatibility (EMC) - part 4-4: testing and measurement techniques - electrical fast transient/burst immunity test
IEC 61000-4-5	Electromagnetic Compatibility (EMC) - Part 4-5: Testing And Measurement Techniques - Surge Immunity Test
IEEE 802.3	IEEE Standard for Ethernet
IEEE 802.3af	IEEE Standard for Data Terminal Equipment (DTE) Power Via Media Dependent Interface (MDI)
IEEE 802.3at	IEEE Standard for Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements
ISO 14443	Identification Cards, Contactless Integrated Circuit(s) Cards - Proximity Cards
ISO 15693	Identification Cards, Contactless Integrated Circuit Cards - Vicinity Cards
ISO/IEC 11801	Information technology - generic cabling for customer premises
ISO/IEC 90003	Guidelines for the Application of ISO 9001: 2000 to Computer Software
MIL-STD-704F	Department of Defense Interface Standard - Aircraft Electric Power Characteristics

Document	Title
Philippine Electrical Code	Part 1 (PEC-1) and Part 2 (PEC-2)
TIA 568-C	Generic Telecommunications Cabling For Customer Premises

5.4 System Outline

5.4.1 The design shall incorporate the latest proven technology and shall provide to users of the system high quality video images.

5.4.2 The Security Camera system shall normally operate in colour and shall use IP surveillance to monitor and record video over an IP transmission media.

5.4.3 The Security video monitors (HMI) including the controls of the cameras shall be provided within the new Gatehouse in Zapote Satellite Depot to enable the operator to view live and recorded images of the perimeter of the depot in particular of personnel and vehicles entering and departing the depot.

The Security video monitors (HMI) including the controls of the cameras shall be provided within the new Gatehouse 3 in the Baclaran Expansion Depot to enable the operator to view live and recorded images of the entire depot but in particular of personnel and vehicles entering and departing the depot.

The HMI facilities shall enable video images from the locally installed security cameras to be selected by the operator or viewed by the operator when specific camera views are automatically presented on detection of a specified alarm condition.

5.4.4 The System shall be installed within the Telecommunication Room in Zapote Satellite Depot and Baclaran Expansion Depot of the LRT Line 1.
Both depots shall be equipped with Network Video Recording NVR facilities located in the Telecommunication Room.
On playback the quality of recorded images shall be of evidential quality acceptable to a court of law in the Philippines.

5.4.5 No inter-site transmission network is foreseen under the scope of this contract

5.5 Scope of Supply

5.5.1 Contractor's Scope of Supply and Services

The Contractor's scope shall include the following:

a) The Contractor shall design, supply, install, test and commission all of the equipment (hardware, software and licenses), cables, materials and interfaces required to complete the Works for the Security Camera System.

b) The Contractor shall be responsible for:

   i. Support the design of the Telecommunication Room and part of the Gatehouses. HVAC and lighting, etc. shall be provided by others.

   ii. Design and provision of all minor cable routes, assume a maximum length of 5 metres per cable run, interconnecting the Contractor's equipment to main cable routes provided by the Depot Civil Contractor.

   iii. Installation, testing and labelling of all equipment and cables within the Contractor's scope of supply up to designated interface connection points.

5.6 System Architecture

5.6.1 Main System Elements

The Security Camera System to be provided by the Contractor shall, as a minimum, consist of the following main elements;

a) Central equipment cabinets installed in the Zapote Satellite Depot Telecommunication Room and within the Telecommunication Room in Baclaran Expansion Depot which shall house, as appropriate, the video server, camera power supplies, video recorders, alarm functions and interfaces to external equipment, etc.

b) Network Video Recording (NVR) shall be provided within the Telecommunication Room cabinet to provide a continuous recording of all cameras within a moving time window covering the previous 31 days.

c) Security cameras installed in and around the Depot.

d) Suitable structures and towers for the mounting of cameras. It should be noted that the Illumination Towers, provided by the Depot Contractor, for Depot lighting shall be used to the extent possible for the mounting of the cameras and associated equipment. Where additional camera locations are required these shall be mounted externally on buildings or on Tilt Down Towers as described in the specification.

e) Security Monitors (HMI) facilities within the gatehouses in Baclaran Expansion Depot and Zapote Satellite Depot for the selection and viewing of the images and associated system data, alarms and video streams.

f) A distributed IP Transmission Network linking the cameras, central equipment, including external interfaces.

g) UPS Power Supply installed in the Telecommunication Room at each Depot and UPS power shall be available for each camera to provide a 15 mins battery back-up power.

h) A Master Clock for time and date information and system synchronization will be provided by others.

i) Cables, cable glands, connectors, junction boxes, earthing, labelling and all associated installation materials required to complete the work.

j) Zapote Satellite Depot

k) The Contractor shall provide within Zapote Satellite Depot a complete installation of Security Camera facilities to supervise the perimeter.

c) Baclaran Expansion Depot

The Contractor shall provide within the Baclaran Expansion Depot a complete installation of Security Camera facilities to supervise the perimeter of the new area. The existing Baclaran Depot is already equipped with a video supervision Installation which is to remain operational. To enable the existing security camera installation to be replaced at a later date, the design of the Security Camera facilities to be provided by the Contractor for the depot extension shall be capable of being readily upgraded to accommodate the entire depot to provide a uniform and complete installation.
There is no direct interface required between both systems

5.7 Functional Requirement

5.7.1 Security Camera System

a) Colour IP cameras shall be provided and installed at strategic locations within the site to provide efficient monitoring and surveillance of the required site areas.

b) The cameras shall be designed to provide high definition and high quality video images under normal daylight, at night and under emergency lighting conditions.

c) Supplementary lighting, such as Infra-Red, may be required at night to provide the necessary picture quality. In such installations the camera lens type shall allow both the colour and infrared wavelengths to be focused correctly on the camera sensor.

d) Pan/tilt cameras shall be equipped with zoom lens.

e) The TV standard to be employed shall be ITU-T, PAL, 625 scan lines per frame, 25 frames per second with progressive scan.

f) Advanced video compression techniques, such as MPEG-4 and H.264, shall be employed to minimize transmission bandwidth and recorder storage capacity without compromising the subjective quality of the displayed video images.

5.7.2 Camera Coverage

a) Cameras shall be installed throughout each depot area primarily to provide security surveillance.

b) Pan and tilt cameras shall be installed to view the open depot areas up to and including the entire perimeter fence.

c) The pan and tilt cameras shall be installed on a dedicated platform mounted on each Illumination Tower, provided by the Electrical Contractor. These towers are constructed from hollow metallic tube sections; nominally 12metres in height.

Illumination Towers will be provided as follows:

i. Zapote Satellite Depot: Four (4) towers;
ii. Baclaran Expansion Depot: Five (5) towers covering only the extended depot area

d) Cameras shall be installed throughout all other depot locations which shall include cameras to view barriers for vehicle and pedestrian access to the depot.

Security surveillance coverage shall be provided as follows:

i. Within Zapote Satellite Depot: All depot perimeter areas;
ii. Within Baclaran Expansion Depot: All perimeter areas which form an extension to the existing depot.

e) The required number and locations of the security cameras to achieve adequate coverage of the site facilities, plant and equipment shall be designed by the Contractor to meet the requirements of this specification.

5.7.3 Camera View Requirements

a) Two categories of views shall be employed as defined below:

i. Observe: Not less than 25% R. Some characteristic details of the individual, such as distinctive clothing, can be seen, whilst the view remains sufficiently wide to allow some activity surrounding an incident to be monitored.
ii. Recognize: Not less than 50% R. A viewer is able to state with a high degree of certainty whether or not the individual shown is the same as someone they have seen before.
iii. Complete camera coverage shall be provided to cover the following areas in accordance with the following fields of view:

Table 5.7.3 Camera View Requirement

Depot Locations		Camera Field of View	
Area	Sub-Area	>=25% R	>=50%R
Buildings and Site Perimeter	Open areas up to the perimeter fence enclosing the site.	Yes	N/A
	Train exit and entrance road	Yes	N/A
	All Access Controlled Barriers For Vehicles and Pedestrians to access the Depot	N/A	Yes

5.7.4 Video Management Facilities

Video Management Software shall be provided which shall operate in conjunction with the HMI Monitors and shall, as a minimum, include the management of the display, recording, playback and processing of life feed images, system fault management and control of camera pan/tilt functions.
Video Management software shall enable the following facilities to be provided, as a minimum:

a) Capability to manage the security camera equipment;
b) Flexibility to locate the facilities at any point on the transmission network;
c) Capability to access live and recorded video from anywhere on the network;
d) Management of the display of live camera feeds from the network including video image recording by Network Video Recorders (NVRs); and
e) Management of NVR video playback facilities.

5.7.5 Network Video Recording (NVR)

Network Video Recorders (NVRs) shall be provided which shall be equipped with mirrored, hard disk storage facilities to enable all camera images to be recorded continuously in a moving time window covering the previous 31 days.

5.7.6 Not Use

5.7.7 Operator Playback of NVR Recordings

a) Within the Depot Gatehouse the security shall be able to view and playback recorded images.
b) To aid incident analyses the display of still images (thumbnails) from video recordings made over a set time period.

5.7.8 Operator HMIs, Monitors and PTZ Control

5.7.8.1 Security Control (HMI) Locations

Each HMI shall provide:

a) High quality colour presentation with clear and crisp images;
b) Minimum diagonal display dimension of 27 inches;
c) 16:9 aspect ratio (proposed);
d) Control for tilt, swivel, pivot and height along (brightness, contrast and colour control shall be automatic); and
e) Control for PTZ Cameras.

The following HMI facilities shall, as a minimum, be provided for Operator control, display and monitoring of the Security System.s

Table 5.7.8.1 Security Control (HMI) Locations

Depot Locations	Number of Operator HMIs	Number of Playback Workstations	Video Display Monitors
Zapote Satellite Depot Gatehouse	One, Control PTZ	Nil	Two (Note 1)
Zapote Satellite Depot Telecom Room	One	One	One (Note 2)
Baclaran Expansion Depot Gatehouse	One, Control PTZ	Nil	Two (Note 1)
Baclaran Expansion Depot Telecom Room	One	One	One (Note 2)
Notes:			

Depot Locations	Number of Operator HMIs	Number of Playback Workstations	Video Display Monitors
The Gatehouse Operator HMI shall be able to select and present live and recorded video images. The Telecom Room facilities shall be rack mounted and shall be provided on a retractable roller mechanism for ease of Operator use. It shall include access to all relevant functions including system set-up, testing, operation and playback. The NVR shall be installed in the Telecom Room			

5.7.8.2 Operator Functions (HMI)

The HMI (Human Machine Interface) shall provide the Operator interface to:

a) Security System functions controlled by the Video Management software; and
b) System fault alarm and event management.

5.7.9 Network

a) The Contractor shall provide a fibre optic based IP Transmission Network, in full compliance to IEEE 802.3 requirements offering 10/100/1000Mbps port speeds.
b) The network shall be suitable for video transmission.

c) The Contractor shall provide all equipment, cables and software required to complete the installation including all Ethernet switches, routers, transmission equipment, network management equipment, patch panels, termination and splicing facilities, etc.

d) The transmission network shall utilise industrial grade equipment which is readily configurable, highly reliable, providing high circuit quality and alternate path routing with suitable protection switching to provide path restoration within 50ms.

5.7.10 Power over Ethernet (PoE)

All Ethernet switches in the network shall have Power over Ethernet (PoE) functionality for connection of external devices such as cameras and other equipment:

5.8 UPS and Earthing System

a) The Security System equipment shall at each Depot operate from Uninterruptible Power Supplies (UPSs) providing a stabilised 230V, 60 Hz, single phase AC power supply.
b) The Contractor shall supply all Power Distribution Boards (PDBs) and power supply sub-distribution facilities required.
c) Electrical protection shall be provided for all main and sub-circuits against excess current, residual current and earth faults.

5.9 Lighting

a) Suitable lighting is expected throughout the site areas to ensure that the illumination levels are sufficient for high image quality The Contractor shall assume the following minimum lighting levels at night as follows:

   i. Normal lighting: 100 Lux; and
   ii. Emergency lighting: 10 Lux.

b) Suitable infra-red lighting shall be provided by the Contractor, such as cameras fitted with night vision, to enhance the image quality for outdoor surveillance during poor lighting conditions.

5.10 Earthing and Lightning Protection

a) The Contractor's earthing policy and transient protection requirements shall be in conformity with the Earthing concept provided by EPC and with internationally recognised

railway standards along with national guidelines and requirements including applicable ITU-T recommendations, such as the K series.

b) The Contractor shall incorporate in the telecommunication installation design and associated support structures suitable protective measures against lightning in accordance with internationally recognised standards such as EN 62305 (Parts 1 to 4): Protection Against Lightning.

c) All electrically operated equipment shall be equipped with solid-state Line Protection devices on the input and output circuits.

5.11 Structural Mounting Facilities

a) The Contractor shall provide suitable supporting structures and mounting frames for the installation of all equipment within rooms and at field locations.

c) This shall include the provision of interface steelwork on the lighting Illumination Towers and on the walls of Depot buildings for equipment mounting.

5.12 Cabling and Installation Materials

The scope of work shall include the supply, installation and testing of all cabling, selected cable routes and installation materials required to complete the Works.

5.13 Equipment Construction

5.13.1 General Requirements for Equipment Construction

All equipment and cable housings shall be of sound construction and uniform appearance, manufactured from steel sheet, or equivalent non –corrosive materials, at least 1.5 mm in thickness and fully proofed against vermin and insects.

The minimum protection required shall be as follows:

a) IP 55 for equipment which is located within covered areas and not exposed to the external environment; and

b) IP 65 for equipment, which is fully exposed to the elements.

5.13.2 Glanding of Cables

Each enclosure supplied, whether located within Equipment Rooms, Control Rooms or site field locations, shall be furnished with metallic gland plates sufficient in quantity, strength and size to accommodate all cables entering and terminating within the enclosure.

5.13.3 Labelling of Equipment and Cables

The Contractor shall be responsible for the labelling of all cables and equipment including signage and safety labelling, in accordance with the requirements of the Engineer.

5.14 Design Life

a) Except as otherwise stated herein all equipment and materials shall have a minimum of 10 years of service life, operating continuously.

b) The service life of all cables shall be a minimum of 15 years.

5.15 Inspection, Testing and Commissioning

The Contractor shall be responsible for:

a) Providing a programme which details the inspection and testing timescales;

b) Providing Test and Inspection Procedures, which detail the inspections and tests to be performed;

c) Undertaking all tests and inspections at the factory and at site; and

d) Providing all Inspection and Test Result documentation:

i. The Engineer shall be invited, and shall be given notice in advance, to witness all the inspections and tests to be performed.

ii. The Contractor shall be responsible to rectify the outstanding Works in accordance within a timescale to be agreed with the Engineer.

The Contractor shall perform Site Acceptance Testing on completion of the installation Works. The site testing requirements shall include the following categories:

a) Electrical testing of cables;
b) Overall end to end system testing; and
c) 28 day stability testing;

5.15.1 Documentation and Manuals

a) The Contractor shall provide all of the necessary documentation, drawings and calculations to present coverage and lighting situation to the engineer for approval
b) Drawings and documentation to illustrate the proposed installation details.

5.16 Maintainability and Safety Requirements

All cabinet and console mounted equipment shall be easily maintainable with adequate space provided for the removal and replacement of equipment, cards and sub-units together with their associated cables.

5.17 Spare Parts

The Contractor shall recommend and supply for 2 years for acceptance by the Engineer a complement of spare parts for equipment, cables, materials and back-up software.

5.18 Special Tools and Test Equipment

The Contractor shall recommend and supply for acceptance by the Engineer a complement of special tools.

5.19 Training

The Contractor shall provide comprehensive training to the Employer’s and Concessionaire’s staff for acceptance by the Engineer

D-2. Mechanical Works

1.0 Environmental Control System

1.1 Air – Conditioning

1.1.1 General

This Section specifies–the procurement and installation of the Air Conditioning Units (FCU/PCU) to be installed in selected rooms in the facilities provided by this contract.

Depending on the ceiling layout, fan coil units (FCU) shall be selected for an elegant match using cassette or ceiling or ducted or high wall mount or a combination of these.

Special attention must be given to the selection of the cooling units Package Condensing Unit (PCU), using environmental friendly (ozone depletion layer coefficient zero) refrigerant fed R 410A.

Mission critical areas shall be cooled by a redundant set of FCU/PCU, each shall be capable of delivering 100% cooling load. These two PCUs shall operate and alternate to maintain the room temperature not higher than 22º C when the outdoor ambient temperature is 35º C.

Non-essential rooms shall be cooled by a FCU/PCU, capable of delivering 100% cooling load. It shall be capable to maintain the room temperature not higher than 22º C when the outdoor ambient temperature is 35º C

A remote wall mount controller with LCD display shall be provided to allow the User to set the preferred room temperature for Manual or program operation.

The rooms where it is necessary to install the air conditioner are listed in this specification section C Architectural Works and Finishes.

1.1.2 Work in General

The work shall consist of the design and calculation of the necessary capacity of the Air Conditioning Units, providing all materials, operations or methods listed, implied, mentioned or scheduled on the drawings and/or herein, including all labour and equipment necessary to the proper completion and execution and supervision of the works.

1.1.3 Work Included

Installation of Eco-friendly Packaged Condensing Units in Depot area and Window Unit, if applicable in Guard House and ancillary buildings. Forced air ventilation, if required shall be provided in the ancillary buildings with at least 15 air change per hour.

Depending on the architecture layout and size and types of equipment inside the electrical substation, either forced air ventilation or air-conditioning shall be provided to maintain the room temperature around outside ambient temperature with tolerance of +/- 3º C. Suitable measure shall provide that the maximum temperature in working areas shall remain below 30ºC. Specific rooms, where lubricants, batteries, electronic parts among others are stored the temperature may not exceed 22ºC.

1.1.4 Air-conditioning Units (Package Condensing Unit)

Work Description

This section describes the technical requirements for the supply and installation of Air cooled, split-type air-conditioning units consisting of an indoor evaporator unit, filter section and outdoor air cooled condensing unit and interconnection wiring, piping and accessories, at the areas shown on the drawings.

The following conditions shall be used in the design of air-conditioning of package condensing unit:

a)	Ambient Temperature	:	15º to 40º C (shade)
b)	Ambient Relative Humidity	:	60% to 100% (non-condensing)

Requirement:

c)	Room Temperature	:	22 +/- 3ºC
d)	Relative Humidity	:	50 + 5% RH

For Telecommunications Equipment Rooms the environment shall be maintained in accordance with the following:

e)	Room Temperature	:	20 to 25 Deg C, nominally 22 Deg C
f)	Relative Humidity	:	40 to 55% RH, nominally 45% RH

1.2 References

ARI 210	:	Packaged Air Conditioning Equipment
ARI 260	:	Standard for Application, Installation & Servicing of Unitary System
ANSI B 16.22	:	Wrought Copper & Bronze Solder - Joint Pressure Fittings
ASHRAE 158	:	Cooling and Heating Load Manual
ASHRAE 16.22	:	Wrought Copper & Bronze Solder, Joint Pressure
ASHRAE 16	:	1983
ASTM B	:	117 Salt Spray (Fog) Testing

1.3 Safety Measures

All movable parts of air-conditioning units shall be properly guarded (belts, pulleys, chains, gears and other rotating parts) so that any person can safely come in close proximity thereto.

All air-conditioning units of any type shall have all acoustical and thermal insulation, which shall be fire-resistant and conform to the requirements of NFPA and the Local Philippines Fire Department.

1.4 Equipment

The precision Air Conditioning unit shall be self-contained, factory assembled and tested, arranged for floor mounted free blow top discharge, front air delivery.

The unit shall be designed and constructed with automatic monitoring and control of cooling, heating, dehumidifying and air filtration functions.

1.5 Materials – Packaged Condenser Unit (PCU)

1.5.1 Cabinet Construction - Heavy Anti-Corrosion Protected

Self-contained Units shall be constructed from 1.3 mm or heavier electro-galvanized sheet steel.

All necessary intake and return air grilles shall be assembled so that they can be removed for cleaning. There shall be an insulated condensate drain pan. The interior of the casing shall be coated with minimum, 25 mm fiberglass for protection against moisture, vermin and outdoor corrosion.

1.5.2 DC Twin Rotary Compressor

Only inverter driven, eco-friendly and energy efficient DC twin rotary compressor shall be used. This compressor shall operate at high efficiency, not only under energy efficiency rating (EER), but also during partial load, which shall predominate the actual operating conditions.

The Contractor shall consider the latest development using larger rotor magnet with a slit that offers quiet operation at enhanced efficiency.

Vector controlled inverter DC rotary compressor shall be selected for all outdoor units. The waveform of the motor current is consistently maintained to a smooth sinewave. This shall

reduce the noise emanating from the drive. Wide flow grille shall be incorporated together with high efficiency DC fan motor to optimise the ventilation performance and contribute to higher efficiency in operating conditions.

1.5.3 Packaged Condensing Unit – Components

1.5.3.1 Evaporator Coil

Evaporator coil shall be of direct expansion type and fabricated using seamless copper tubing with aluminium fins that are mechanically bonded to tubing. The minimum fin spacing shall be determined by design.

Cooling capacity selection shall be based on the conditions derived from the cooling load calculations as well as on entering wet bulb temperature at the evaporator and on entering ambient temperature at the condenser coil.

Factory installed thermal expansion valve for refrigerant control shall be provided. A leak test at minimum 2500 KPa gas pressure shall be carried out with all devices isolated.

1.5.3.2 Air Cooled Type Condenser Coil

The coil shall be of similar construction as evaporator coil with the exception that the minimum fin spacing shall be determined by design with a capacity based upon the condensing and ambient temperature. The same leak test as in evaporator coil shall be applicable.

1.5.3.3 Evaporator Fan

Prevailing technology employing energy efficient design fan driven by eco-friendly inverter DC controller shall be used to efficiently cooled the compressor while in operation quietly.
Fan and DC motor shall have permanently lubricated type ball bearings or better with different technology shall have an average life expectancy of at least 50,000 hours.

1.5.3.4 Condenser Fan

Prevailing technology employing large bat wing fan driven by inverter DC controller shall be used to efficiently cool the compressor while in operation quietly. Removable (removing four SS 316 L stainless steel screws) and front accessed wide flow grille panel shall be incorporated aesthetically as the intake for the compressor cooling fan.

1.5.3.5 Condensate Drain Pan

Drain pans shall be constructed of electro-galvanized steel sheets with minimum thickness of 1.5 mm. Inner and outer shall sandwich a continuous layer of glass fibre insulation with a minimum thickness of 25 mm. This glass fibre insulation shall be laced with an aluminium foil that shall act as a barrier to vapour.

Both internal and external pan surfaces and joints shall be coated with corrosion resistant elastomeric base material. Joints shall be brazed watertight.

Drain coupling shall be 25 mm diameter (minimum). Drain pan shall be installed in a pitch position towards the drain coupling.

1.5.4 Fan Coil Unit – Requirements

FCUs shall be compact and designed for simple and easy for installation and maintenance.

There shall be a complete range of indoor units for selection. These are cassette, duct, ceiling or high-wall FCU that can elegantly cool the rooms quietly at 45 dB (A). All FCUs shall be equipped with a built-in condensate drain pipe and or heater.

Ceiling type FCU shall be suitable for surface mount. This type of FCU shall have a wide flap to handle large air volume. The air flow angle shall be adjustable and the automatic swing shall enable airflow to reach all areas of the room to create a comfortable ambience. There shall be an anti-bacterial drain pump kit to reduce the formation of mould.

Alternatively High Wall type FCU shall be used for surface mount. There shall be automatic air control and swing louvre to enable airflow to reach all areas of the room to create a comfortable ambience. A self-cleaning feature shall operate the fan for a pre-determined time after the shutdown to dry up the moist air around the heat exchanger.

1.5.4.1 Refrigerant (Ozone free and eco-friendly R 410 A) Circuit

As a minimum, the refrigerant circuit shall comprise of the following:

a) Thermostatic expansion valve (Remote bulb and equalizer shall be provided for direct expansion coil);
b) Refrigerant filter at expansion valve input;
c) Dryer-filter for refrigerant;
d) Sight-glass covered opening and moisture indicators at inlet of dryer-filter;
e) Sight-glass covered indicator in liquid line close to receiver;
f) Solenoid valve for each evaporator coil;
g) Valves in liquid and hot gas lines for maintenance reasons;
h) Charging valve at suction side and; and
i) Low and High pressure cut-out switches.

1.5.5 Remote Controller

Factory built wired controller shall be provided and installed in a conspicuous location position at eye level. It shall have the following minimum features:

a) LCD/LED Display;
b) Individual unit operation that shall provide pass coded access restriction;
c) Weekly scheduled operation;
d) Operating Status output; and
e) Control input (Temperature).

1.6 Provision for Essential Loads Operation

1.6.1 Types of Fan Coil Units

1.6.1.1 High Wall Mount

This arrangement shall be selected when the wall mounted FCUs shall be elegantly blended into the room setting.

In Auto-Louvre mode, the outlet grilles shall automatically move to fill every corner of the room with cool or warm air. The quality of the indoor air shall be improved through the introduction of proprietary filtration system that shall deodorise, purify and adding anti-oxidant to the cool air.

The Inverter driven DC fan shall automatically regulate and reduce the fan speed quietly after the room temperature had been attained.

1.6.1.2 Ceiling Mount

FCU shall be suspended from the ceiling using factory assembled mounting plate and or integral attachment within the FCU. Depending on the room layout, in rectangular or square layout, FCU shall be mounted at least 1 metre away from the wall.

In the automatic swing mode, the airflow angle at the grille side shall be automatically set to enables airflow to reach all areas of the room to create a comfortable and dehumidified ambience.

Depending on the difference between the room temperature and the set-point, the energy efficient and quiet air volume control shall switch between High, Low and Very Low while maintaining the room temperature to the set point. Built-in and withdrawable long life filter shall be incorporated into the construction design.

1.7 Provision for Non-Essential Loads Operation

The requirement is identical to provision for essential loads except that there shall be only one set of PCU operating without any backup set.

1.8 Split Unit with Single FCU

1.8.1 Insulation Finishes

The Contractor shall ensure the provision of aluminium jackets on all exposed piping. The Contractor shall allow a maximum water vapour permeance of 0.05 perm per ASTM E 96 in the installation.

1.8.2 Installation

The Contractor shall ensure proper and adequate provision for foundation, platform, hanger and supports prior to installation and to the satisfaction of the Engineer. The air-conditioning units shall be fitted into the space provided and make readily serviceable for inspection and maintenance.

Insulated and halogen free drain pipes and accessories of suitable size shall be installed from drain pan to nearest floor drain with adequate fall to facilitate the flow of condensate.

1.9 Ventilation System

The following areas shall be adequately ventilated and the number of air change shall be 15 times per hour:

a) Sheds;
b) Heavy maintenance Shed, Baclaran Expansion Depot;
c) Light Maintenance Shed in Baclaran Expansion and Zapote Satellite Depot;
d) Designated Storage areas in in Baclaran Expansion and Zapote Satellite Depot;
e) Designated work areas;
f) Toilets;
g) Substations;
h) Electronic Workshops.
i) Switch Room; and
j) Pump Room.

1.9.1 Toilets

The main purpose of ventilating the toilets is to avoid potential hazards arising from wet and sometimes slippery toilet floor due to heavy usage. Wall or ceiling mount ventilation fan/s capable of 20 air change per hour shall be provided to dry up the wet floor quickly.

The ventilation fan and lighting circuit shall be interlocked such that the fan shall be energised whenever the lights are turned "ON". The ventilation fan will continue to run for a pre-determined time.

1.9.2 Metal-roof Shop

The contractor shall calculate the necessary size and number of fans, preferably wall mounted ventilation fan/s capable of 20 air change per hour installed with damper. This outdoor solenoid operated damper with IP 54 rating shall be fire rated for 1 hour.

Single phase ventilation fan shall be used for all selected ventilation fan having electrical rating 3 KW and below. This single phase ventilation fan can be started using direct on line.

When two fans are used, one shall be configured for drawing in fresh air into the shed and the other for exhausting air to the outside of the shed. The ventilation fans selected shall be capable of at least 20 air change per hour.

A local control panel with selector switch, LED indication lights and illuminated Start/Stop pushbuttons shall be provided and installed inside the shed in a conspicuous location. A wall

mounted thermostat switch with an adjustable turning knob shall be provided to monitor the room temperature.

1.9.3 Substations

The Contractor shall coordinate with EPC to establish the total heat load from the equipment and rectifiers for sizing the ventilation fan/s. The contractor shall calculate the necessary size and number of fans, Solenoid operated fire rated dampers, wherever required shall be provided.

2.0 Fire Suppression System

2.1 Scope of Works

This section covers the requirements of the Fire Suppression and Protection System for the Zapote Satellite Depot, and for the Baclaran Expansion Depot.

The Contractor shall be responsible for the design of the entire Fire Suppression System including the Fire Water Tank and Fire Pump. Furthermore they shall be responsible for the supply, installation and testing and commissioning of the entire system and gaining approval from the relevant Authorities for such works.

A complete set of fire protection calculation shall be provided. The calculation shall cover all aspects of design of fire protection systems and shall include but not limited to hydraulic calculations, system capacity calculation, pressure loss, pumping capacity and equipment selections. Computer based calculations shall be encouraged and selected programme shall be submitted to the Engineer for approval.

The capacity of the fire storage tank shall meet the applicable local code of practice. Water storage shall be provided for suitable size as per approval of the local fire services authority/department.

The water supply to hose reels shall be such that hose reels can be in use simultaneously, without affecting the water pressure and water throw.

The Heavy Maintenance Workshop, Light Maintenance Workshop, Substations, Material Storage and all other areas/workshops and associated ancillary building/structures shall include but not be limited to the following fire protection system:

a) Portable Fire Extinguishers;
b) Hydrants and Hose Reels;
c) External Fire Hydrants inside the Depot area (stabling area).

The Contractor shall initially provide a study on Fire Regulations which rule in Manila and in the district of Parañaque, Pasay and Cavite as well as of the international Standard NFPA 130 and how these requirements are to be applied in the 2 Depots as a single solution. The study shall also demonstrate the assumptions of the expected fires/fire load expected in the depot area Baclaran Expansion and Zapote Satellite Depot.

The Contractor shall be encouraged to try to replace the conventional firefighting system with High Pressure Water Fire Fighting where possible to become less dependent from water supply and other agents.

The Contractor shall be responsible for the supply, installation and testing and commission of fire suppression and protection system inclusive of all equipment and accessories such as pipe work, valves, brackets, fittings and sleeves. All materials shall be suitable for installation. All materials shall be halogen free.

The Contractor shall be responsible for complete design of fire suppression and protection system including but not limited to the hydraulic calculation, water tank size, pump size and arrangement, pipe sizing and submit calculation for consent. The Contractor shall also confirm the general adequacy of the space requirements within voids or services ducts, openings, main routes etc.

The fire provision of the Depot shall follow the relevant international Standard NFPA 130 and any applicable local codes and regulations introduced by the authorities (Fire Marshall).

2.2 Interface

Fire Alarm/Push Button Station for starting operation of Fire Pump shall be furnished at the following facilities, to be integrated in the Fire Alarm System:

a) Maintenance Shop, Gate Houses, Switch Room, Substation; and
b) Motor-Pool, Material Storage.

The Contractor shall interface with the Fire Alarm Provider to secure the correct wiring of the Fire Alarm Stations with the Fire Alarm provided under the same contract. The Fire Alarm System is specified in the document D2_Electrical Works_5_Fire Detection and Alarm.

At the Baclaran Expansion Depot integration of Fire Alarm and Detection System is required between existing depot and Expansion Depot. Therefore the Contractor is required to fully coordinate with the Concessionaire (LRMC) for the design and construction of the System.

2.3 Pipework and Fittings

All pipework, expansion joint and all pipe fittings within the buildings in the Depot shall be heavy quality galvanized steel and shall follow the relevant Philippine standard and international Standard including NFPA 130.

Earth continuity across each coupling and valve shall be installed either by purpose made earth clips or 16 mm^2 green/yellow cable bolted to each side of pipework via brass fittings.

Wherever pipes entering into a building/structure/facility of the Depot, special attention shall be paid to the ground movement/differential settlement to avoid breakage of installed pipe.

2.4 Hydrant and Hose Reel

Hose reels should be installed in prominent and accessible positions at the work deck and adjacent to exits or exit routes of the buildings. The hose and nozzle should be capable of directing a jet of water into any recess area.

An isolating valve shall be installed to control the hydrant main. The valve shall be both lockable and addressable.

Internal fire hydrants shall be mounted within equipment cabinets. The internal fire hydrant system shall be designed and provided to protect the whole Depot in accordance with the standards issued, Philippine Standard and international Standards including NFPA 130.

One hose reel should be provided to cover every 30 meters distance in compliance with the relevant Philippine Fire Code.

2.5 Wet Fire Main

The coverage of wet main shall be for the whole Depot. The wet main shall consist of Pipework and High pressure regulating valves, to enable a uniform firefighting pressure.

2.6 Portable Fire Extinguishers

CO^2 and or Foam extinguishers shall be installed indoors in all the facilities provided under this contract, particularly in the maintenance sheds in the working areas, electrical equipment rooms, sub-stations, working Deck, cabinets, material storage and Oil Storage.
Extinguishers shall be mounted securely on purpose made brackets. All extinguishers shall be installed in location and manufactured according to the relevant Local Fire Code and to the requirements of relevant international Standards including NFPA 130.
Three types of portable extinguishers or equivalent shall be used:

a) 4 kg CO^2 extinguisher (carbon dioxide) - Substation and Electrical Supply Room.
b) 2 kg CO^2 extinguisher (carbon dioxide) - other electrical rooms.
c) litres foam extinguisher - water based.

A location sign shall be provided directly above the extinguisher to indicate the presence of an extinguisher. An identification label/sign, specifying the contents and types of fire on which the extinguisher is to be used, shall also be placed above the extinguisher below the location sign.

2.7 Testing and Commissioning

The following fire protection systems shall be tested and commissioned:

a) Interface to Fire Alarm Panel; and
b) Fire mains, Fire hydrant and hose reels.

All Portable Fire Extinguisher shall be type tested.
The Contractor shall produce test procedures and test certificates for the Fire Marshall consent prior to commissioning.
Commissioning shall comprise the full integration and connection of the fire detection and fire protection system as an integrated safety system.

3.0 Compressed Air System

3.1 Scope of Works

This section covers the requirements of the Compressed Air System to be installed in the Zapote Satellite Depot, to be provided in the inspection Pits in the Light maintenance Shed and in the inspection Track and in the Baclaran Expansion Depot where the provision include the Light Maintenance Inspection Pits, the Heavy Maintenance work area.

The Contractor shall be responsible for design, supply, installation and testing and commissioning of the compressed air systems inclusive of all equipment and accessories such as pipe work, valves, brackets, fittings and sleeves in the Main Workshop and Infrastructure Workshop.

The compressed air system and equipment shall comply with relevant International standards.

3.2 System Requirement

An independent compressed air systems shall be provided in each other two depots.

The compressed air systems are required to provide air supplies for selected pneumatic equipment and hand tools in the Heavy Maintenance and Light Maintenance Workshops and Inspection tracks.

Redundant air cooled packaged compressor units including air intake filter, screw compressor, electric motor, after cooler, moisture separator and trap, coolant system, control and monitoring system and accessories etc. shall be provided as an integral unit house inside acoustic cabinet.

The air compressor shall be capable of automatic start-stop with modulating control to maintain pre-set system pressure during normal operation. If the receiver pressure still falls to set point (adjustable) after the lead compressor, the standby compressor will start. Should the system pressure keeps on falling, a low pressure alarms need to be actuated.

Similarly, if the pressure keeps on building up beyond set point (adjustable) after actuation the lead compressor, a high pressure alarm needs to actuate and stop the equipment.

The equipment shall be equipped with a suitable interface to enable a future integration in to a supervision system.

Each receiver vessel shall be designed, constructed and hydrostatically tested in accordance with the relevant Philippine Standard or an applicable International standard. It shall be complete with pressure relief valves, tested and bear legible and clear indications.

Each compressed air take off point shall be terminated with gauging station comprising filters, pressure regulators and auto-drain. Automatic drain trap needs to be considered at reservoir and the lowest points along the distribution pipe.

Drain should be led to the nearest floor drain for discharge.

3.3 Compressed Air Pipe and Pipe Fitting

Galvanised steel pipe complying with relevant standard shall be used for the compressed air system distribution piping. Threaded or welded joint and steel welding type fittings complying with relevant standard shall be provided.

The distance in between outlets in the considered workspace shall be chosen, having in mind that the operator will use hoses no longer than 15 meters.

3.4 Compressed Air Valves

The gate valves, ball valves, swing check valves and air outlet in the compressed air system shall be in accordance with relevant International standards.

3.5 Air Compressor

The air compressor used in the compressed air system shall be in accordance with relevant International standards.
Rotary Screw type air compressor shall be provided and shall comply with the following:

a) Unit: Air compressor shall be rotary screw and lubricated type with control panel;
b) Features: Differential pressure oil pump, oil separator and filter, oil charging valves, compressor bearing;
c) Motor: Open dip proof flange squirrel cage induction, close coupled to compressor;
d) Control panel: factory mounted panel with starters, controls and indications; and
e) Automatic capacity reduction: Continuously viable slide valve with infinitely variable control to 25 percent full load.

The pressure of the compressed air system at the point of end users shall be 7 Bar

3.6 Refrigerated Air Dryer

The air dryer in accordance with relevant International standards shall be provided in the compressed air system.

3.7 Air Receiver

The fittings of the receivers shall include adjustable pressure regulators, safety valve, pressure gauge, drain valve and automatic float actuated condensate trap.

3.8 Air Filter

The pre-filter and after-filter shall be provided for each air compressor installation suitable for the compressed air system application.

Pre-filter shall have a non-woven type and disposable polypropylene filter. After-filter shall have an epoxy impregnated cellulose filter and activated carbon medium suitable for system working pressure.

3.9 Filter, Regulator and Lubricator

Portable filter, regulator and lubricators shall be provided for the use with equipment that requires oil mist air. The unit shall be capable of being fitted in line throughout the compressed air network for use with appropriate air tooling.

4.0 Testing and Commissioning

The following fire protection systems shall be tested and commissioned:

a) Compressor;
b) Piping; and
c) Control.

The Contractor shall produce test procedures and test certificates for the Engineers consent prior to commissioning.
Commissioning shall comprise the full integration and integrity of the system.

E. Depot Maintenance Equipment

The general environmental conditions to be applied to Depot Maintenance Equipment are as follows:
Ambient temperature: Min. +15℃, Max. +40℃
Relative humidity: Min. 60%, Max. 100%

RAM operational mission availability of each piece of Major Depot Maintenance Equipment shall achieve 99.5% outside of scheduled maintenance.
Each Depot Equipment indicative laydown area is shown in Appendix A and Appendix B at the last page of Technical Specification"

1.0 Rolling Stock Maintenance Equipment

1.1 Light Maintenance Equipment

The maintenance equipment to be prepared by this Project is for the 3rd and 4th generation trains. The locations are Baclaran Expansion Depot (3 tracks) and Zapote Satellite Depot (2 tracks). Accordingly, 5 tracks are available for this purpose. The light maintenance track of the existing Baclaran Depot is 5, and the maintenance works of 40 trains (1st, 2nd and 3rd generation trains) are executed. The number of 4th generation trains prepared for this project is 30 and 61 trains will be available when the Project is completed. The light maintenance of 61 trains shall be done in 10 light maintenance tracks, and the new section shall have about half volume of the light maintenance, that is to say 30 trains.

The maintenance schedule of these trains are assumed as follows:

Table 1.1 Schedule of Light maintenance

Train		3rd Generation	4th Generation
Daily Maintenance			
Light maintenance	15 day maintenance	○	○
	30 day maintenance	○	
	45 day maintenance	○	
	3 month maintenance	○	○
	6 month maintenance	○	
	12 month maintenance	○	

The schedule may seem to have a big difference, but the schedule of both trains are almost same at the point that every 15 days "light maintenance of Level 1" is undertaken and every 3 months "light maintenance level 2" is performed. The difference is the contents of light maintenance works. For 30 trains, a total of 720 "light maintenance level 1"/year and 120 "light maintenance level 2"/year will be necessary. At present light maintenance work is done every day in Baclaran Depot as day work, and 720 maintenance/year, 2 light maintenance level 1/day, and 120 light maintenance or 10 light maintenance level 2/month. If the necessary work time for light maintenance level 1 is 3 hours, 2 light maintenance will be done using 1 track. If the necessary time for light maintenance level 2 is 2 days, 1 track for the work can be executed on 1 track (in 20 days).

Additional maintenance works are done on the light maintenance tracks, such as daily preventive maintenance and cleaning of the trains (exterior and interior, every 3days). For these works, the remaining 3 tracks at Baclaran and Zapote Depot will be used.

At the detail design of Depot Light Maintenance Equipment, Contractor shall consider current 3rd generation LRV maintenance activity, schedule, task and other necessary requirement. Then shall coordinate with 4th generation LRV contractor for planned maintenance activity, schedule, task and other necessary requirement and propose for The Engineers approval

1.1.1 Baclaran Expansion Depot

In the light maintenance building of Baclaran Expansion Depot there are 3 tracks. One of the tracks shall be used for battery check and preparation of heavy maintenance when a train is divided to cars and cars are composed into a train.

Light maintenance works comprise of inspection of the functions of the train and the majority of the work is visual checking. Accordingly, special equipment is not necessary. The tracks shall be provided with a platform, boardwalk at roof level and pits (center and both sides). On one track some space for de-coupling work of the semi-permanent couplers between the two cars.

The necessary equipment for light maintenance are as follows:

a) Motor truck; and
b) Battery charger/ tester.

The specifications of this equipment is the same as those used in heavy maintenance area as indicated in Clause 1.5.18 and 1.5.19 inclusive of quantities.

1.1.2. Zapote Satellite Depot

In the light maintenance building of Zapote Satellite Depot, there are 2 tracks. The tracks shall be provided with a platform, board walk at roof level and pits (center and both sides).
The necessary equipment for light maintenance are as follows:

a) Motor truck; and
b) Battery charger/ tester.

The specifications of this equipment is the same as that used in the heavy maintenance area as indicated in Clause 1.5.18 and 1.5.19 inclusive of quantities.

1.2 Heavy Maintenance Equipment

The Heavy maintenance workshop that will be provided in Baclaran Expansion Depot, shall provide 2 tracks in which each track is capable of stabling 2 cars in one time. Therefore, heavy maintenance of one train set is possible at one time. Before heavy maintenance, the function of the train shall be checked in detail at the light maintenance track. Then the train is divided to cars at that particular track. After the heavy maintenance of a car, it will be sent to the light maintenance track and the total function of a train is checked.

As stated before, the heavy maintenance of 3rd and 4th generation trains will be done at this workshop. The schedule of the trains are assumed as follows:

Table 1.2 Schedule of Heavy maintenance

Maintenance schedule	3rd generation	Maintenance schedule	4th generation
R3 (every 3 years)	○	R4 (every 4 years)	○
R5 (every 5 years)	○	R8 (every 8 years)	○
R8 (every 8 years)	○	----	----
R12(every 12 years)	○	----	----

The heavy maintenance cycle of “3rd generation train” is about 3 years, the “4th generation train” is expected to be 4 years. The cycle for the heavy maintenance of the 30 “4th generation” trains is 7.5 times/year. If the work schedule of the train is one month, it can be executed in this building. In the case of “3rd generation trains” the number goes up to 10 times/year. Even in such case, heavy maintenance can be possible if the work schedule is one month. At present, the heavy maintenance of “3rd generation train” is done within 28 days.

At the detail design of Depot Heavy Maintenance Equipment, Contractor shall consider current 3rd generation LRV maintenance activity, schedule, task and other necessary requirement. Then shall coordinate with 4th generation LRV contractor for planned maintenance activity, schedule, task and other necessary requirement and propose for The Engineers approval

1.2.1 Heavy Maintenance Equipment List

The necessary equipment for heavy maintenance is as follows:

a) Overhead crane;
b) Lifting Jack;
c) Bogie turn table;
d) Wheel lathe;
e) Hydraulic press machine (to be supplied by Rolling Stock manufacturer);
f) Bogie washing booth;
g) Pneumatic valve tester;
h) Air compressor tester;
i) Bogie stand (to be supplied by Rolling Stock manufacturer);
j) Universal machine;
k) Pantograph Working stand;
l) Brake tester (to be supplied by Rolling Stock manufacturer);
m) Parts wash machine;
n) Electric relay tester;
o) Car Mover (Shunting Locomotive);
p) Jib crane;
q) Battery charger;
r) Motor truck;
s) Forklift (1.0 t);
t) Forklift (1.5 t);
u) Dummy Bogie;
v) Table Lifter;
w) Table lifter on pit;
x) Access Platform;
y) High Speed Breaker Tester
z) Arrester Tester
aa) Jet Cleaning Machine
bb) Levelling Valve Tester
cc) Bearing removal and Pressing-in device;
dd) Induction Heater;
ee) Universal Press Machine;
ff) Re-railing Equipment;
gg) Truck for Air Conditioner Unit;
hh) Other Equipment to be supplied by Rolling Stock manufacturer; and
ii) Tools and Furnishings for Rolling Stock Maintenance

The quantity and technical specifications are shown in Clause 1.5 “Detail Description of Heavy Maintenance Equipment” of this section.

The Contractor shall provide a back-up software for the equipment wherein software program is required.

1.3 Not Used

1.4 Automatic Train Wash Plant

The Contractor shall provide a new Automatic train wash plant at Zapote Satellite Depot for every 3days regular washing work which comprises of wash slab and buried tanks for installation of wash equipment and drainage arrangement for waste water, including waste water treatment and recycling system.

The recycle system of waste water shall be recycled to at least 70% of the used water. Excess water after passing through the water treatment system can connect to the newly constructed rain water drainage on the condition effluent water quality complies with the required Philippine regulations.

1.4.1 Quantity: One (1) Set

1.4.2 Functional Requirement

The train wash plant shall be a one-way wash system. The side body of a car is washed with water containing chemical detergent using vertical brushes.

Technical requirements for the wash plant are:

a) Train speed through the wash plant: 3 to 5 km/h
b) Train exterior wash range: +700 to +3400 mm from the top of rail
c) Side brushes: 4×2 rows (8 pcs)
d) Power source: 480 V AC, 3φ 60 Hz
e) 220 V AC, 1φ60 Hz
f) Track gauge: 1435 mm

1.4.3 Performance

The wash plant detects a train automatically and starts washing

a) Control system

The plant shall consist of a local control panel and a central control room that shall control the washing system automatically by a track switch or manually controlled by an operator at the local panel.

b) Composition
The automatic train wash plant shall be composed of the following;

i. Pre-wet station with one set of vertical spray pipes;
ii. Detergent station with 2 (two) pairs of vertical brushes;
iii. Water brushing station with 2 (two) pairs of vertical brushes;
iv. Final rinse station with one set of vertical pipes;
v. Recycling water system;
vi. Train detection device: track switches; and
vii. Maintenance walkways and access ladder fitted with safety handrail which will allow access to the top structure

c) Function

i. The plant room will house recycled water tank and associated pumps, detergent tank with metering pump, fresh water tank with pump and electrical control console. The fresh water tank will be fitted with a low level switch connected to an alarm within the control console. The fresh water tank is fitted with a ball float valve and water level kept constant. The recycling tank is fitted with low level sensor for activating the top-up transfer pump, sending water from the recycling sump.

ii. A recycling sump and water reclamation system constructed within the train wash plant will collect detergent, water and final rinse run-off from the wash apron and recycle it for use in the detergent and water wash applications.

The recycle sump is constructed with weirs and overflow drainage. Solution used for the washing and rinsing cycle will drain to the collection sump, where debris is removed prior to the solution being pumped via filter to the recycling tank in the plant room, for re-use.
Water from the recycling tank will be used for the detergent washing and water washing applications. Final rinse will use the water from the fresh water (city water) tank.

The side brush main structures are constructed from standard hollow steel sections fully welded and sealed against ingress of moisture. Fitted to the main structures are brush support frames that support the brush shafts top and bottom in sealed bearings and are driven by top mounted gear motors.

Jet spray pipes made of stainless steel are fitted to the brush modules, pre-wet, and final rinse stanchions. The pipes are fitted with spray nozzles, arranged to give full coverage of spray pattern to the car body sides.

Waste water which comes from the train wash plant shall be treated physically, biologically or chemically prior to disposal to any natural/artificial waterway.

All control equipment, pumps, storage facilities will be installed in the plant room adjacent to the wash area. The control panel will incorporate all necessary control and protection devices, pushbuttons, indicator lamps, emergency stop buttons and so on to allow automatic or manual operation of the train wash.

d) The following controls and indicators shall be provided:

i. Automatic/manual mode and off switch;
ii. Main power "On" indicating light;
iii. Motor running indicating light;
iv. Emergency stop activated light; and
v. Detergent tank low level indicator.
vi. The control voltage of the equipment is 110 V AC, internally produced from the general supply voltage of 480 V AC, 3φ 60 Hz.

e) Environment condition

The equipment shall be operated under the following conditions

i.	Ambient temperature	: +40 ℃ to +15 ℃
ii.	Ambient relative humidity	: 100 % to 60 %
iii.	Maximum rainfall	: 60 min rating, 120 mm/h 30 min rating, 180 mm/h 10 min rating, 270 mm/h

f) Operation mode

i. Automatic mode

A track switch (interlocked to prevent the operation when a train passes through in reverse direction) starts the wash operation when it is in the automatic mode. A signboard fitted to the wash plant will indicate to the train driver to proceed or wait to proceed. When the system is activated by the track switches, the plant starts automatically the wash process and the signboard indicates proceed. The wash process are:

1. Pre-wet the car body from one (1) pair of vertical spray pipes
2. Detergent solution brushing both sides of the car body by two (2) pairs of brushes
3. Water brushing both sides of the car by two (2) pairs of brushes
4. Spray rinse the car from one (1) pair of vertical spray pipes
5. When the wheelset of the last bogie of the train passes the track switch, the wash plant will shut down after pre-determined time, allowing the last section of the train to be washed.

ii. Manual mode

In the manual mode, the motors and pumps can be operated individually for maintenance or set-up purposes.

1.5 Detailed Description of Heavy Maintenance Equipment

1.5.1 Overhead Crane (10 t/3 t)

1.5.1.1 Quantity: Two (2) Sets

1.5.1.2 Functional Requirement

The overhead crane shall be used to transport components and parts of cars in the heavy maintenance area.

1.5.1.3 Performance

The overhead crane shall be capable of hoisting loads and run in both lateral and longitudinal directions, driven by independent motors through manipulation of the control pendant suspended from the crane by a staff at ground level. The pendant shall be capable of being moved over the entire span of the crane via a festoon carriage. All controls shall be of "dead man" type, i.e. crane will stop if the control buttons are released.

a) Performance

i. Hoist type: Overhead type, double girder
ii. Operation method: A push button pendant control
iii. Span of the crane: 23.2 m (approximately)
iv. Power source voltage: 3Φ AC 480 V 60HZ
v. Power supply for running: Insulated trolley wires
vi. Capacity: 10/3 ton
vii. Lift: around 7.0 m
viii. Hoisting speed: 0.6 m/min～6.0 m/min (Main hook), 0.75 m/min～7.5 m/min (Auxiliary hook)
ix. Lateral travelling speed: 2.5 m/min～12.5 m/min
x. Longitudinal travelling speed: 5～25 m/min
xi. Control method: Hoisting 2 speed, direct control
xii. Lateral travelling Inverter
xiii. Longitudinal run Inverter

b) Components

i. Running system: The overhead crane shall be driven by motors installed on the saddles on both sides, each attached with a brake system. A collision prevention system shall be installed at each saddle.
ii. Lighting system: The overhead crane shall be equipped with lighting system which will provide enough visibility.

1.5.2 Lifting Jack

1.5.2.1 Quantity: Sixteen (16) Sets

1.5.2.2 Functional Requirement

When a 4-car train enters to heavy maintenance building, it is divided into cars each composed of two articulate bodies. These two bodies of a car shall be lifted up by 8 lifting jacks positioned at the supporting point of bogies. And bogies are disconnected from the car. Car bodies are supported by lifting jacks while the dummy bogies are transported and installed under the car. At the Heavy maintenance shop, two (2) position for lifting car bodies are prepared with center pits. Therefore, 16 sets of lifting jacks are required. Movement of jacks into lifting position shall be done manually on workshop floor, assisted by hydraulically raised wheels. Wheels shall retract when lifting.

1.5.2.3 Performance

Four jacks on each side (8 jacks per a car) shall work in synchronously and shall be able to travel independently of others to keep the articulated body flat. When connecting bogies to car body, car body pin shall be adjusted correctly at the bogie pivot. For this purpose, the mating two lifting jacks on the left and right side of the track shall have the function to move the supporting point perpendicularly to the rail and in unison up to 3.0 mm.

a) Principal functions

i. Lifter Lifting load: 10 ton/set
ii. Lifting stroke: 1.25 m (0.70 to 1.95 m)
iii. Supporting point is 700 mm above top of the rail
iv. Car body supporting claw Supporting load: 7.5 ton/jack

b) Unit composition

i. Main unit Lifting unit: 8 sets (8 sets/car)
ii. Power controller Centralized control panel: 1 set
Independent operation panel: 8 sets
iii. Approximate Dimension of a Lifter: 1.3 m (L)×1.0 m (W)×2.5 m(H).
iv. Special requirement: Power supply shall be 480 V AC, 3φ 60 Hz

1.5.3 Bogie Turn Table

1.5.3.1 Quantity: Four (4) Sets

1.5.3.2 Functional Requirement

The turn table shall be used to change easily the direction of movement of a bogie being moved in heavy maintenance building. The turn table mounted on the track shall be turned by a motor to the specified direction.

1.5.3.3 Performance

At first the bogie is moved manually on the turn table and secured with a stopper. After that the turn table is turned 90 degrees through manipulation of a push button and stops correctly at one of the two 90-degree spaced positions. Then the bogie is removed.
The following performance requirement shall be provided:

a) Outer diameter of turn table : 3.2 m
b) Rail gauge : 1,435 mm
c) Approximate Outside dimension : 4.4 m (L)×4.4 m (W)×0.57 m (H)
d) Turning angle of the table : 90 degrees (two stopping position of 0 degree and 90 degree)
e) Turning time of the table : 15 sec/90 degree
f) Bogie stopper : ratchet
g) Power supply : 480 V AC, 3φ 60 Hz
h) Minimum load capacity : 15 tonne

1.5.4 Wheel Lathe

1.5.4.1 Quantity: One (1) Set

1.5.4.2 Functional Requirement

This wheel lathe is used to re-profile the wheel tread of a wheel. A wheel or the rim of a wheel can be turned which is attached to the lathe by 4 inside chucks.

1.5.4.3 Performance

a) Turning machine

i. Cutting method: CNC method
ii. Wheel diameter: 600 to 960 mm
iii. Wheel width: 110 to 140 mm
iv. Cutting precision: 0.1 mm or less (difference of diameter between right and left wheels) 0.1 mm or less (tread run-out)
v. Quantity of cut wheel: 1 wheel
vi. Cutting time : 20min. or less

b) Chip cutter
c) Chip conveyor

i. Capacity: 300 kg/h

d) Approximate Outside dimension: 5.0 m (W)×2.4 m (D)×2.4 m (H),
e) Power supply: 480 V AC, 3φ 60 Hz

1.5.5 Hydraulic Press Machine (To be supplied by Rolling Stock Manufacturer)

1.5.5.1 Quantity: One (1) Set

1.5.6 Bogie Washing Booth

1.5.6.1 Quantity: One (1) Set

1.5.6.2 Functional Requirement

The bogie washing booth is used to wash a bogie or the bogie frame using high pressure steam nozzle. Inside the booth, there is a turn table, track to move the bogie to/from the turn table, steam supplying unit, exhauster, air blower and drainage & sludge treatment system. Bogie washing work shall be done manually.

1.5.6.3 Performance

a) Principal specifications

i. Approximate Outside dimension: 5.4 m (W)×6.0 m (D)×3.1 m (H).
ii. Weight: 7.0 ton, App
iii. Power supply: 480 V AC, 3φ 60 Hz, and 220 V AC 1φ, 60 Hz

iv. Component

i. Main booth
Approximate Dimension 5.4 m (W) ×5.0 m (D) ×3.1 m (H).
ii. Hot water tank
iii. Outside dimension: 0.5 mφ×1 m (H)
iv. Capacity: 200 ℓ, App

v. Operation panel

i. Operation panel: 1 set (self-standing)
ii. Hand-held operation panel: 1 set

vi. Exhauster

i. Ventilation fan: Displacement 200 m3/min

vii. Sludge treatment

i. The equipment shall be composed of separator, thickener, mesh screen and floating oil treatment system.

1.5.7 Pneumatic Valve Tester

1.5.7.1 Quantity: One (1) Set

1.5.7.2 Functional Requirement

The magnetic valve testing machine shall be used to perform the operation and performance tests of electromagnetic valves dismounted from a car.

1.5.7.3 Performance

a) Test method

Tests can be performed in semi-automatic and manual modes to follow a pre-determined procedure.
In semi-manual mode, selection of object valve type and test items shall be done through a switch, and semi-automatic tests will be taken place.

In manual mode, the object valve can be tested manually, comparing their on/off position and the pressure of test air circuit.

b) Test item

i. Measurement of coil resistance
ii. Leak test
iii. Operation test (minimum operation voltage, return voltage)
iv. No pressure release test
v. Capacity test (supply, exhaust)
vi. Insulation test (resistance, dielectric strength)

c) Component

i. Table top fixing bench
Valve fixing bench
Operation panel
ii. Table bottom fixing bench
Air controller

d) Approximate Dimension: 1.3 m (L)×0.85 m (W)×1.85 m (H).

1.5.8 Air Compressor Tester

1.5.8.1 Quantity: One (1) Set

1.5.8.2 Functional Requirement

The air compressor tester shall be used to check the function and performance of air compressor dismounted from a car.

1.5.8.3 Performance

The unit is automatically tested.

a) Test item

i. Preparatory test (manual)
ii. Volume efficiency
iii. Temperature rise test/pressure rise test
iv. Temperature switch test
v. Leak test
vi. Starting test
vii. Insulation test

b) Component

i. Control panel
ii. Power source panel
iii. Tank unit
iv. Test bench

c) Principal specifications

i. Control panel
Pressure measurement: 1.2 MPa (maximum)
Approximate Area dimension: 5.0 m (L) ×5.0 m (W).
ii. Power supply: 480 V AC, 3φ 60 Hz and 220 V AC 1φ, 60 Hz

1.5.9 Bogie Stand (To be supplied by Rolling Stock Manufacturer)

1.5.9.1 Quantity: One (1) Set

1.5.10 Universal Machine

1.5.10.1 Quantity: One (1) Set

1.5.10.2 Functional Requirement

This universal machine shall have the function of a lathe, drilling machine, and milling machine.

1.5.10.3 Performance

The machine shall be protected with various safety measures to make the lathing function effective with other functions simultaneously.

a) Lathing function

Swing over the bed: 420 mm
Swing over the carriage: 240 mm
Center to center distance: 580 to 2,000 mm
Spindle speed: six-stage, 20 to 640 rpm

b) Drilling function

Maximum drilling capacity: 38 mm
Swing: 430 mm
Spindle speed: 3-stage, 125 to 500 rpm

c) Milling function

Cutter shaft diameter: 25.4 mm
Spindle speed: 3-stage, 32 to 128 rpm
(In case this function is not available the contractor shall provide a separate milling machine for the required function)

d) Approximate Dimension: 2.6 m (L)×1.0 m (W)×1.7 m(H).
e) Power supply: 480 V AC, 3φ 60 Hz

1.5.11 Pantograph Working Stand

1.5.11.1 Quantity: Two (2) Sets

1.5.11.2 Functional Requirement

The pantograph working stand shall be a carrier to transport and store the pantograph dismantled from a car.

1.5.11.3 Performance

After being dismantled from cars, pantographs can be piled up to four layers with an attachment inserted in between.

a) Principal specifications

i. Allowable weight of pantograph: 130 kg/set
ii. Wheel diameter of the carrier: 150φ
iii. Allowable load: 520 kg
iv. Approximate Outside dimension: 1.4 m (L)×1.25m (W)×1.6 m(H).

1.5.12 Not Use

1.5.13 Brake Tester (To be Supplied by Rolling Stock Manufacturer)

1.5.13.1 Quantity: One (1) Set

1.5.14 Parts Wash Machine

1.5.14.1 Quantity: One (1) Set

1.5.14.2 Functional Requirement

The parts washing machine shall be used to wash car parts efficiently with a combination of high pressure, high temperature water, a rotating table and a high pressure oscillating nozzle.

1.5.14.3 Performance

a) Capacity of washing liquid tank: App. 200 ℓ
b) Power source: 480 V AC, 3φ 60 Hz
c) Wash object maximum size: 1.0 mφ×0.7 m (H)
d) Approximate Dimension: 1.6 m (L)×1.3 m (W)×1.7 m (H).

1.5.15 Electric Relay Tester

1.5.15.1 Quantity: One (1) Set

1.5.15.2 Functional Requirement

The electric relay test machine shall be designed to be movable and individually perform the operation and performance test of relay unit, such as those of main converters, breakers, distributing panels, those in breaker boxes, which are mounted in a car.

1.5.15.3 Performance

a) Test method

The relay test machine automatically tests the relays installed on it or those connected with cables for external relays.

b) Test item

i. Measurement of coil resistance: resistance of the coil of each relay
ii. Measurement of minimum operational voltage: minimum value of each relay
iii. Measurement of the release voltage
iv. Measurement of contact resistance
v. Measurement of time element: measure the delay time and time element of slow operating relays

c) Approximate Dimension: 1.6 m (L)×0.9m (W)×1.5 m (H).

1.5.16 Car Mover (Shunting Locomotive)

1.5.16.1 Quantity: One (1) Set

1.5.16.2 Functional Requirement

The car mover shall be driven by AC motors or diesel engine type to move a car/train or a bogie in the heavy maintenance area and/or wheel re-profiling plant area. The provisions for being hoisted up by overhead crane shall be provided.

1.5.16.3 Performance

The car mover shall be operated in manned and unmanned mode through remote control and to be able to run on track or road.

a) Principal specifications

i. Tractive force: 24 kN
ii. Speed: 0 to 3 km/h (remote control mode) and 0 to 5 km/h (manual operation mode)
iii. Brake system which can stop the car mover and a car shall be provided.
iv. Dimension: max. 2.6m(W), 3.6m(H)
v. Approximate Tare weight: 7 ton
vi. Track gauge: 1435 mm
vii. Back gauge of wheel set: 1380mm
viii. Wheel diameter: 350 mm App. (guide wheel), and 660 mm App. (Road wheel)
ix. Coupler: tow bar which can connect with an end car or an intermediate car, shall be used.
x. Coupler height: 780 mm

b) Component

i. Driving system: The car mover shall be driven by AC motor powered by battery or by diesel engine. The driving axles shall have parking brake systems.
ii. Car body: The frame shall be made from welded steel sections and plates. It shall be robust and durable structure to withstand the shock in hauling or pushing of a car/ train.
iii. Control system of running: The car mover shall be able to move forward, backward or stop through the manipulation of a control handle. The running speed shall be controlled continuously in proportion with the tilting angle of the handle.
iv. Alarm: An electric alarm device shall be installed and emit a big enough sound.
v. Head lamp and tail lamp: The locomotive shall have a head lamp and a tail lamp at both sides.

1.5.16.4 Data Concerning the Train to be Connected

a) Lateral displacement of car body in curve section

i. Single articulated body car (a car with 3 bogies)

Length of a body: 13.0 m
Distance between bogie centers: 10.0 m
Distance from bogie center to coupler center: 2.35 m
Wheel base of a bogie: 1.9 m (depend on the proposal of tenderer)

ii. Minimum radius of curve: 25.0 m
iii. Coupling plane of a car body: 0.25 m from the end of body

b) Data of coupler

i. Height of tow bar connector : 780 mm above top of rail

1.5.16.5 Accessories

a) Toe bar

i. Short tow bar
The short tow bar is used to pull/push a car at a straight section, and the length will be around 1.0 m.
ii. Long tow bar
The long tow bar is used to pull/push a car at a steep curve section, and the length shall be the same as that of existing train, approximately 3.08 m.

iii. Carrier for tow bar

Long tow bar is very heavy and some carrier for transportation of the bar shall be provided. The carrier shall be designed for the long tow bar.

1.5.17 Jib Crane

1.5.17.1 Quantity: Three (3) Sets

1.5.17.2 Functional Requirement

One jib crane is used for wheel lathe and universal machine. One jib crane is used for air conditioner maintenance area. Another jib crane is used in motor maintenance area.

1.5.17.3 Performance

a) Jib crane for wheel lathe

i. Capacity: 2.0 ton
ii. Jib length: 5.0 m
iii. Lift height: 3.5 m
iv. Swing angle: 360 degree

v. Power source: 480 V AC, 3φ 60 Hz

b) Jib crane for motor maintenance area

i. Capacity: 1.0 ton
ii. Jib length: 6 m
iii. Lift height: 3.0 m
iv. Swing angle: 360 degree
v. Power source: 480 V AC, 3φ 60 Hz

c) Jib crane for air conditioner maintenance area

i. Capacity: 1.0 ton
ii. Jib length: 6 m
iii. Lift height: 3.0 m
iv. Swing angle: 360 degree
v. Power source: 480 V AC, 3φ 60 Hz

1.5.18 Battery Charger

1.5.18.1 Quantity: Three (3) Sets

1.5.18.2 Functional Requirement

The battery charge/discharge unit is used to perform the constant-current charge/discharge of the batteries dismounted from a car.

1.5.18.3 Performance

a) Test method

Tests can be performed automatically to follow a pre-determined procedure, and the test results are registered in a storage medium such as a hard disk and displayed graphically.

b) Test item

i. Measurement of voltage and current of assembled/mono-block battery
ii. Estimated capacity of the battery.

1.5.19 Motor Truck

1.5.19.1 Quantity: Four (4) Sets

1.5.19.2 Functional Requirement

The motor truck is a small 3 wheel truck to transport car spare parts to respective inspection/repair shop and shall be powered by battery.

1.5.19.3 Performance

a) Principal specifications

i. Maximum load: 1,000 kg
ii. Running speed: 10 km/h (with standard load), 15 km/h or more (with no load)
iii. Climbing gradient: 1/10
iv. Minimum turning radius: 1.94 m
v. Power transmission: belt + reduction gear
vi. Seat: 2 (two)

b) Tire

i. Front wheel: white tire 1 piece
ii. Rear wheel: white tire 2 pieces

c) Battery: DC 48 V
d) Load carrying platform Approximate dimension: 1.34 m (L)×1.15 m (W).
e) Approximate Outside dimension: 2.6 m (L)×1.15 m (W)× 1.26 m (H).

1.5.20 Forklift (1 ton)

1.5.20.1 Quantity: Two (2) Sets

1.5.20.2 Functional Requirement

This forklift is used for multipurpose.

1.5.20.3 Performance

a) Rated load: 1,000 kg
b) Standard lift: 3.0 m
c) Maximum lift: 3.9 m
d) Driving power source: battery
e) Approximate Outside dimension: 3.0 m (L)×1.1 m (W)× 3.9 m (H).
f) Weight: 2.25 ton

1.5.21 Forklift (1.5 ton)

1.5.21.1 Quantity: Two (2) sets

1.5.21.2 Functional Requirement

This forklift is used for multipurpose.

1.5.21.3 Performance

a) Rated load: 1,500 kg
b) Standard lift: 3.0
c) Maximum lift: 3.9 m
d) Driving power source: battery
e) Approximate Outside dimension: 3.0 m (L)×1.1 m (W)× 3.9 m (H).
f) Weight: 2.9 ton

1.5.22 Dummy Bogie

1.5.22.1 Quantity: Six (6) Sets

1.5.22.2 Functional Requirement

The dummy bogies are used to support the car bodies when the bogies of the car is removed for inspection and repair. One car has 3 bogies and 6 dummy bogies are necessary for 2 cars. Other 2 cars are supported on 16 lifting jacks.
The dummy bogie shall have the function that the height of supporting point can be changed by some devices to provide easy maintenance work of the body. By the use of these bogies, removal or installation of under floor equipment can be executed in the flat floor area (no center pit) using the conventional table lifters. The provision for hoisted up by overhead crane shall be provided.
Two dummy bogies out of the six bogies shall have self-mobile function and can move the car without the assistance of the car mover

1.5.22.3 Performance

a) Track gauge: 1435 mm
b) Back gauge of wheel set: 1380mm
c) Lifting stroke: 0.5 m
d) Lifting device: motor or oil cylinder. In case of oil cylinder is used, some safety
e) Device for oil leak and descending the body shall be prepared.
f) Wheel diameter: the near size of LRT (660 mmφ) is preferable.
g) Wheelbase of the bogie: the near size of LRT (1.9 m) is preferable.
h) The dummy bogie shall be able to be used for 4th generation car and 3rd generation car.

1.5.23 Table Lifter

Table lifter is used to facilitate the disassemble/assemble work of under floor equipment on flat floor area.

1.5.23.1 Quantity: Four (4) Sets

1.5.23.2 Functional Requirement

The lifter shall have the following characteristic:

a) Lifting capacity: 2 ton
b) Approximate Table size: 1.2 m (L)×0.8 m (W).
c) Lift table design: scissors type mechanism, electro-hydraulic operation, table height when fully raised 1.0 m, lowered position 0.4 m. Table lifter is mobile with 4 heavy duty casters, of which 2 swiveling type and remaining 2 fixed type. Casters shall have foot operated stoppers to keep it stopping.

1.5.24. Table Lifter on Pit

1.5.24.1 Quantity: Two (2) Sets

1.5.24.2 Functional Requirement

The table lifter is used on center pit area and it shall be able to move longitudinal direction of the track. The lifter shall have the following characteristic:

a) Lifting capacity: 2 ton
b) Approximate Table size: 1.2 m (L)×0.8 m (W).
c) Lift table design: scissors type mechanism, electro-hydraulic operation, table height when fully raised 1.0 m, lowered position 0.4 m. The lifter is mobile with 4 wheels on the rails.

1.5.25 Access Platform (low type)

1.5.25.1 Quantity: Four (4) Sets

1.5.25.2 Functional Requirement

This mobile platform is used for the access to the car interior and the floor height of a car is 1.1 m above the floor level (when the car is raised about 0.2 m by dummy bogies). The Mobile platform shall be made of aluminum alloy for easy handling by hand. On the top of the mobile platform, the landing space of 0.8 m (L) ×0.8 m (W) ×1.1 m (H) shall be provided for the convenient access to the car interior. The permissible load for the ladder and landing space shall be more than 200 kg, and the platform shall be equipped with lockable rollers and guard rails.

Approximate Outside dimension: 1.8 m (L)×0.8 m (W)× 1.9 m (H).

1.5.26 Access Platform (high type)

1.5.26.1 Quantity: Four (4) Sets

1.5.26.2 Functional Requirement

This mobile platform is used for the access to the car roof or high position of a car (height of a car roof is 3.385 m above the floor level (when the car is lowered by dummy bogies). Mobile platform shall be made of aluminum alloy for easy handling by hand. On the top of the mobile platform, the landing space of 0.8 m (L) ×0.8 m (W) ×3.3 m (H) shall be provided for the convenient access to the car roof. The permissible load for the ladder and landing space shall be more than 200 kg, and the platform shall be equipped with lockable rollers and guard rails.

Approximate Outside dimension: 3.5 m (L)×1.0 m (W)× 3.9 m (H).

1.5.27 Overhead Crane

1.5.27.1 Quantity: One (1) Set

1.5.27.2 Functional Requirement

This overhead crane is used in air brake system repair shop. The heaviest item in the shop is air compressor. Therefore, capacity and lift height is not so big.

1.5.27.3 Performance

a) Hoist type: Overhead type, single girder
b) Operation method: A push button pendant control
c) Span of the crane: 9.0 m (approximately)
d) Power source voltage: 3Φ AC 480 V 60HZ
e) Power supply for running: Insulated trolley wires
f) Capacity: 1.5 ton
g) Lift: around 3.0 m
h) Hoisting speed: 0.6 m/min～6.0 m/min
i) Lateral travelling speed: 2.5 m/min～7.5 m/min
j) Longitudinal travelling speed: 5～10 m/min
k) Control method: Hoisting 2 speed, direct control

1.5.28 High Speed Breaker Tester

1.5.28.1 Quantity: One (1) Set

1.5.28.2 Functional Requirement

The high speed breaker tester shall be used to check the operation and performance of high speed breakers (HB) dismounted from a car by feeding a large-current. It also measures the resistance of cylindrical fuses of the main circuit. Four high speed Breakers or four cylindrical fuse for main circuit shall be tested simultaneously.

1.5.28.3 Performance

a) Test of High speed Breaker: Large–current generator sends the circuit the high current, and measure the trip (cut-out) time and trip value of current. During the test of the circuit, some means shall be provided to prevent unauthorized person to enter within 1 m of the testing machine.

b) Test of Main circuit fuse: The resistance is measured in large current.

1.5.28.4 Components

a) Large-current generation unit: Generates a large current
b) Variable power source: Outputs DC 110 V.
c) Fuse measuring unit: Measure the resistance of the fuse
d) Control implementation unit: Controls the large-current generating unit, variable power source and fuse measurement unit.

1.5.29 Arrester Tester

1.5.29.1 Quantity: One (1) set

1.5.29.2 Functional Requirement

The arrester tester shall be a DC arrester tester to measure easily the operation performance of arresters dismounted from a car.

1.5.29.3 Performance

a) Test method: Apply a high DC voltage between the poles of the test arrester and gradually increase the value, and measure the voltage to start operation. The test is carried out manually.

1.5.30 Jet Cleaning Machine

1.5.30.1 Quantity: One (1) set

1.5.30.2 Functional Requirement

The jet cleaning machine washes the parts of air conditioner and traction motor components with high pressure hot water.

1.5.30.3 Performance

a) Discharge pressure: 9 MPa
b) Discharge volume: 750 ℓ/h
c) Hot water temperature: 30 to 80 ℃ variable
d) Approximate Outside dimension: 600 mm (W) ×950 mm (D)×750 mm (H).

1.5.31 Levelling Valve Tester

1.5.31.1 Quantity: One (1) Set

1.5.31.2 Functional Requirement

The levelling valve tester is used to perform manually unit performance test of levelling valves (LV) and differential pressure valves (DPV) used for air suspension.

1.5.31.3 Performance

a) Levelling valve test:
   i. Check of operation
   ii. Blind zone test
   iii. Operation delay time test
   iv. Leak test
b) Differential pressure test
   i. Differential pressure operation test
   ii. Flow test
   iii. Leak test

c) Performance
   i. LV lever stroke measurement range: 0 to 200 mm
   ii. LV pressure measurement range: 0 to 1 MPa
   iii. LV operation delay time range: 0 to 60 sec
   iv. DPV pressure measurement range: 0 to 1 MP
d) Spares
   i. Leveling valve: 2 sets

1.5.32 Bearing Removal and Pressing-in Device

1.5.32.1 Quantity: Two (2) Sets

1.5.32.2 Functional Requirement

Devices shall be used for removal and pressing in the axle and motor bearings.

1.5.32.3 Performance

a) The equipment shall be suitable for removal and pressing in of axle bearings of 3rd and 4th generation trains.
b) Devices shall be equipped with manually operated hydraulic pump for bearing removal and fitting.
c) Bearing sizes and particular requirements for handling and removal and installation process shall be coordinated with rolling stock manufacturers.

1.5.33 Induction Heater

1.5.33.1 Quantity: One (1) Set

1.5.33.2 Functional Requirement

The induction heater shall be used to quickly heat air compressor bearings and fix them intact.

1.5.33.3 Performance

a) Components
   i. Bearing heater
   ii. Carrier

b) Specifications
   i. Magnetizing power source
   ii. Object bearing size: Inside diameter is more than 35 mmφ
   iii. Approximate Outside dimension: 710 mm (L)×500 mm (W)×500 mm (H).
   iv. Weight: 75 kg

c) Accessories
   i. I type core Inside diameter 35φto 50φ: 1 set
   ii. Inside diameter 50φto 80φ: 1 set
   iii. Inside diameter 80φand over: 1 set
   iv. Temperature sensor: 1 set

1.5.34 Universal Press Machine

1.5.34.1 Quantity: One (1) Set

1.5.34.2 Functional Requirement

The hydraulic press machine shall be used for general use and for various vehicle parts in assembling and disassembling works.

1.5.34.3 Design and Performance

a)	Press Capacity	:	50 Ton
b)	Type of Cylinder		Double-Acting
c)	Stroke	:	300 mm
d)	Pressing Speed	:	38 mm/min
e)	Advance Speed	:	551 mm/min
f)	Valve Type		4-way
g)	Control	:	Electrical (Pendant type)
h)	Pump Electrical Specs		220V, 60Hz, 1Ø ; 0.50 ~ 1.0 kW App.
i)	Approximate Table Size		600 mm x 300 mm.
j)	Approximate Outside Dimension:		965 mm (W) x 1,285 mm (D) x 2,000 mm (H).
k)	Weight	:	600 kg App.

l) Equipped with high accuracy pressure gauge.

m) Equipment shall be of robust and self-contained frame construction. Floor mounted hydraulic press type.

1.5.35 Re-railing Equipment

1.5.35.1 Quantity: One (1) Set

1.5.35.2 Functional Requirement

Re-railing Equipment of derailed passenger light rail vehicles either in the mainline or in depot area shall be supplied.

1.5.35.3 Design and Performance

All components of the re-railing equipment shall be portable and shall be designed and manufactured with the following features:

a) Complete set of equipment, hydraulically operated for lifting and traverse movement of derailed vehicles and setting-down on rails.
   The list of components but not limited to the following;
   i. Control unit
   ii. Motor pump
   iii. Telescopic ram
   iv. Traversing unit
   v. Lifting jacks (set of big and small)
   vi. Mechanical accessories, such as re-railing bridge, roller carriage and distance bars.
   vii. Pulling device
   viii. Long stroke jack and accessories for uprighting overturned rail vehicles
   ix. Generator set (total rating shall include capacity for flood light requirement)
b) Equipment complement shall be self-contained, complete with electric driven engine and hydraulic system to operate the re-railing system.
c) Components shall be sized for manual handling and capable to handle by no more than two to three persons per component at derailment sites.

Note: Final specifications subject to Engineer's review.

1.5.36 Truck for Air Conditioning Unit

1.5.36.1 Quantity: Two (2) Sets

1.5.36.2 Functional Requirement

The trolley truck shall be used to carry and transport car air-conditioning unit dismounted from a car to the inspection and repair area.

1.5.36.3 Performance

a) Rectangular carriage truck with lever
b) Approximate Outside dimension: 4000mm (L) x 1800mm (W) x 500mm (H)
c) Truck shall be mobile with four (4) heavy duty caster wheels: Two fixed direction type and two swivelling type. Caster wheels shall have locking mechanism to keep the truck immovable.
d) Load capacity: One (1) ton
e) Material: Manufactured from structural rectangular steel pipe
f) Finish: Suitably protected against corrosion

1.5.37 Equipment to be Supplied by Rolling Stock Manufacturer

1.5.37.1 Items to be Delivered to Depot for Maintenance

a) Hydraulic press machine: as described in Clause 1.5.5.
b) Bogie stand: as described in Clause 1.5.9.
c) Air conditioner test bench
   Maintenance works of air conditioner shall be executed on this stand.
d) Brake tester: as described in Clause 1.5.13.

1.5.37.2 Test Equipment of Rolling Stock Subsystem for Maintenance

a) Train management system (include computer and additional back up soft)
   Train operation & maintenance data are accumulated and recorded in this system. The records of the train can be down-loaded by a computer, and used for its maintenance.
b) Traction controller (include computer and additional back up soft)
   The function of traction control system can be tested by this system. The test results can be down-loaded by a computer.
c) Auxiliary Power Supply Equipment (APSE) (include computer and additional back up soft)
   The function of the auxiliary invertor unit can be tested and the results can be down-loaded by a computer.
d) Air Conditioning Unit (ACU) (include computer and additional back up soft)

The control system of air conditioner can be tested by a computer on every function.

e) Brake Control Unit (BCU)
This system can execute the functional test of air brake system of the train.

f) Door
This system can execute the functional test of door control system.

1.5.38 Tools and Furnishings for Rolling Stock Maintenance

1.5.38.1 Quantities: One (1) Lot

1.5.38.2 Functional Requirements

The tools and furnishings shall be used for general use in depot and workshop.

1.5.38.3 Items and Specifications

a) Measuring Instrument

The Contractor shall provide the latest type of the following:

Name of Parts/Equipment	Quantity	Specification
Digital Inside Micrometer	3	Range 5-30mm; Min 0.001 mm; 305 gr
Digital Inside Micrometer	3	Range 25-50mm; Min 0.001 mm; 310 gr
Outside Micrometer	3	Range: 0 - 150 mm Min:1/100 mm
Outside Micrometer	3	Range: 0 - 300 mm Min:1/100 mm
Caliper	7	Range: 200 mm Min:1/100 mm
Dial Gauge	2	Range: 0 - 100 mm Min:1/100 mm
Straight Rules	10	Max:150 mm
Straight Rules	10	Max:200 mm
Digital Multi-meter	1	600V ; 400 mA
Digital Weight Scale	3	140 g
AC/DC Digital Clamp Current Meter	4	Range:100 -1000 A
Leak Current Meter	4	Range;10 mA – 200 A
Insulation Resistance Meter (Digital)	4	Max.1000V/4000MΩ, Min:125V/40MΩ
Insulation Resistance Meter (Analog)	4	500V/100MΩ
Phase Detector	4	Range: AC 70-600V, 45-60Hz
High Voltage Probe	2	AC 80-7000
Digital Vibration Meter	1	ACC 5Hz-5kHz
Digital Temp & Humidity Meter	3	Range: 0 -50 Degree/25 -90%Rh
Thermo-Meter	2	Range:-40 - 200 degree
Electromagnetic Field Radiation Tester	1	30Hz - 400Hz
luminance Meter	1	Max: 999000 lx
pH Meter	1	Range: 0.00 - 14.00 pH
Bench Dial Scale	1	Max:100 kg Min.:200 g
Portable Scale	1	Max:80 kg Min.:50 g
Weight Checker	1	50 kg, min 0.05 kg
Torque Wrench Checker	5	Max:200Nm Min.:5 Nm
Gauge for measuring contact force of pantograph	2	Range: 0 – 100 N
Measuring Tape	8	Max: 5 m

Measuring Tape	8	Max: 3 m
Laser Distance Meter	2	Max: 60 m, in-door type

b) Tools

The Contractor shall provide the latest type of the following:

Name of parts/equipment	**Quantity**	**Specification**
Straight Drill Set	10	6.0 -10.0 mm, 40 drills
Engine pump	1	30 m, 550 l/min
Hose	1	52 mm
Precision Level	2	200 mm, Accuracy:0.02 mm
Inverter Welding machine	4	220 V, 11.4 kVA
Digital Pulse TIG Welder	1	3 Phase 220 V
Welding Stick Holder	5	400 - 500 A
Holder Cover	5	
Work Cable with Clamp	5	10 m, 170 – 240 A with holder
Work Cable with Clamp	5	10 m, 170 – 240 A with earth crip
Air Plasma Cutter	2	3 Phase 220 V, 6.9 kVA
Welding Helmet	5	With filter
Welding Mask	2	
Welding Glove	5	For welding work
Welding Foot Cover	5	For welding work
Welding Screen	5	1000 mm (W)×2000 mm (H)
Welding Screen	5	2000 mm (W)×2000 mm (H)
Engine Generator	2	3 Phase 220 V, 5 kVA
Engine Generator Cell	2	Battery
Battery Charger	2	7.2 V – 24.0 V
220 V Extension Cord	2	20 m, 19 A
Torque Driver	1	Max:120 cN・m, Min:20 cN・m
Torque Driver	1	Max:260 cN・m, Min:60 cN・m
Torque Meter	1	Range: 0.15 - 10.00 Nm
Torque Reels	8	50 N, Weight 4.5 kg
Impact Driver	2	With Case and Battery Charger
Impact Wrench	4	127.4 N・m
Portable Power Light	2	400 W Lamp
Strong Handy Light	10	3 W LED Bulb with Aluminum Body
LED Head Light	4	LED Lamp
Handy light	3	520 g
Air Duster Gun	10	1.0 MPa
Screw air hose air duster gun set	6	8.0 m
Nozzle for Air Dust Gun	4	100 mm, Nozzle 2 mm
Nozzle for Air Dust Gun	4	200 mm, Nozzle 2 mm
Impact Wrench	20	12mm
1/2" Impact Wrench	20	14mm 16mm
Tool Set	2	21 items
Tool Set (Mechanic)	2	Tool box
Tool Set (Electric)	3	Tool Bag
Ratchet Handle	20	250 mm (L), Inset angle 9.5mm
Socket Adapter	20	8 mm, 10 mm, 12 mm, 14 mm, 17 mm, 19 mm, 21 mm

Socket & Wrench Set	20	Full set
Flat Ratchet Wrench	4	170 mm (L), 8 -13 mm
Flat Ratchet Wrench	4	170 mm (L), 10 -14 mm
Flat Ratchet Wrench	4	170 mm (L), 13 -17 mm
Flat Ratchet Wrench	4	170 mm (L), 13 -21 mm
Plier	5	250 mm (L) with Fiber grip
Long Nose Plier	5	150 mm (L) for electric works
Screw Driver	11	75 mm (L) 5.5mm (-)
Screw Driver	11	100 mm (L) 6 mm (-)
Screw Driver	11	150 mm (L) 6 mm (-)
Screw Driver	11	150 mm (L) 8 mm (-)
Screw Driver	11	75 mm (L) (+)
Screw Driver	11	100 mm (L) (+)
Screw Driver	11	150 mm (L) (+)
Screw Driver	11	150 mm (L) (+)
Impact Screwdriver	8	Full set
Hand Hammer	16	300 mm (L)
Test Hammer	11	380 mm (L) for Checking
Flat Cart	16	400kg
2 Flat Cart	4	400kg, 2 decker
Medium Duty Work Bench	24	1800×900×740
Heavy Duty Work *Bench*	10	1800×750×740
Step to a car floor	8	1200×600×700
Soldering Iron complete with accessories	4 sets	Power source: 220 V AC, 75 watts

c) Material Storage and Tool Room Equipment (Baclaran Expansion Depot)
The Contractor shall provide the latest type of the following:

Name of parts/equipment	**Quantity**	**Specification**
Garage Jack	1	3 ton
Chain Hoist	1	1000 kg, 2.5 m (lift)
Portable Gate crane	1	1000 kg, 2.73 m (W)×3.2 m (H), 3 m (lift)
Compact crane	1	150 – 500 kg, 2.4 m (lift)
Plastic Pallet	10	
Foldable Container	10	
Container (1)	10	
Container (2)	100	
Medium Duty Shelving	15	
Heavy Duty Shelving	8	
Cabinet with door	6	
Heavy Duty Rack	3	
File Rack	1	
Tool Wagon	3	

Storage Cabinet	17	
Tool Cabinet	2	
Heavy Duty Cabinet	1	
Work Bench	1	
Work Bench with Drawer	1	
Work Stool	6	
Wheel Barrow	6	
Plywood Dolly	6	

d) Material Storage (Zapote Satellite Depot)
The Contractor shall provide the latest type of the following

Chain Hoist	1	1000 kg, 2.5 m (lift)
Container	10	
Medium Duty Shelving	2	
File Rack	1	
Storage Cabinet	2	
Wheel Barrow	1	
Work Bench with Drawer	1	

2.0 Non – Rolling Stock Maintenance Equipment

All rail born maintenance equipment minimum curve radius shall be 27m, and if maximum height of these rail borne maintenance equipment is over 3.6m it is subject for the review and approval by the Engineer.

2.1 Track Maintenance Equipment

The track maintenance equipment shall be prepared for track and infrastructure work on the main line and depot. Existing length of Line1 is 20.0km and extending length is 11.7km. Then after expansion Line1 total length will be 31.7km. The total length of track will be 63.4km, total length of rail is 126.8km.
Main track maintenance being considered are replacement of materials, rail grinding, tamping, re- alignment etc. Materials to be replaced are rails, rail fastenings, sleepers, ballast etc. The maintenance items and work speed of track works are assumed as follows:

Table 2.1 Track Maintenance Equipment

No	Maintenance	Length/day	Maintenance vehicles
1	rail grinding	300m/track	Motor car, rail grind car
2	rail replacement	100m/track	Motor car, flat wagon, covered wagon
3	ballast replacement	50m/track	Motor car, covered wagon
4	replacement of sleepers	50m/track	Motor car, covered wagon
5	measuring Track	25km/track	Motor car, track geometry measuring machine
6	Tamping	100m/track	Motor car, covered wagon
7	re-alignment	200m/track	Motor car, covered wagon

Track works length per day are assumed and written in the table. Degradation of the track depends on train gross tonnage. Actual track works frequency, maintenance work length per day are planned by track works department based on track observation.
The Contractor shall provide a back-up software for the equipment wherein software program is required.
Track maintenance equipment needed to be supplied for Line1 are described as follows.

2.1.1 Track Maintenance Vehicle

2.1.1.1 Quantity: One (1) Set

2.1.1.2 Functional Requirements

A self-propelled, multi-purpose track and infrastructure maintenance vehicle (Rail Car) shall be supplied.

2.1.1.3 Design and Performance

The track and infrastructure maintenance vehicle shall be a multi-purpose. Diesel-powered vehicle to be used as single vehicle as well as automotive power for flat cars and wagons along the entire Line1, elevated structures and depot. The Track Maintenance Vehicle (Rail Car) shall consist of crew cab, and hydraulic crane. Maintenance work may involve:

a) Track works - Transport and replacement of rails, sleepers and ballast;
b) Civil structure - General maintenance; and
c) Transport of equipment to and from stations.

d) Performance

i. Traction from depot to main line : total 120 tons freight wagon on rail;
ii. Full hauling velocity 10 km/h at 4% gradient from depot to main line;
iii. Full hauling velocity 30 km/h on main line;
iv. Self-running forward velocity 45 km/h, backward velocity 30km/h on main line;
v. Running minimum radius 27 m in depot;
vi. Equal operation in forward and reverse directions; and
vii. Possible to change the direction of the cab on track.

e) Vehicle dimensions and features

i. Vehicle length approximately 10 m, max. width 2.6m, max height 3.8m
ii. Gauge on rail 1435mm
iii. Back gauge of wheel set: 1380mm
iv. Minimum curve radius 27 m in depot area
v. Max axle load 10.5 ton
vi. Loading platform with slip-resistant surface, accessible from ground level via steps
vii. Platform load capacity 3ton
viii. If maximum height of the equipment is over 3.6m, it is subject for the review and approval by the Engineer
ix. Connector for pneumatic and electrical control of hauling procedure shall be equipped with needs.
x. All attachments should not influence to the signalling axle counting system.

2.1.1.4 Drive Power

a) Self-propelled, diesel powered, emission-optimized; and
b) Running velocity is variable by multi gear;

2.1.1.5 Cab

a) The cab shall be include space for 3-person crew;
b) Large window for visibility, windshield wipers and washer, sun visors/blinds, access to cab each side door from ground level; and
c) Adequate lighting shall be provided for night work.

2.1.1.6 Operating Equipment

a) Couplers shall be provided for hauling flat open wagon and covered wagon;
b) Decelerating hydraulic brakes are applied at track running and road traveling;
c) Mechanical parking brake is applied at track working;
d) Two chocks are attached to wheel tread at track working;
e) Capacity of the fuel shall be adequate for eight hours operation;
f) Head and tail lights, work lights (both ends);
g) Equipped with effective illumination for night work;
h) Air horn; and
i) Tool kit, fire extinguisher, first aid kit.

2.1.1.7 Hydraulic Crane

a) Hydraulic crane, lifting capacity approximately 6 tons
b) Outriggers for crane operation

2.1.2 Flat Open Wagon

2.1.2.1 Quantity: Four (4) Sets

2.1.2.2 Functional Requirements

Flat open car hauled by motor car, transporting materials of track and infrastructure maintenance shall be supplied.

2.1.2.3 Design and Performance

The flat open car shall be universally used transporting materials of track and infrastructure maintenance as follows:

a) Tools and materials to and from work sites;
b) Track works materials, mainly new and old rails;
c) Re-railing and rescue equipment;
d) Vehicle dimensions and features

   i. Track gauge 1435mm;
   ii. Back gauge of wheel set: 1380mm;
   iii. Vehicle width maximum 2.6m;
   iv. Vehicle overall length approximately 3.0m;
   v. Floor level match to station platform (0.69 m) from TOR;
   vi. Weight of empty car under 10 tons;
   vii. 2 Axles
   viii. Couplers shall be identical to couplers on motor car
   ix. Coupler between flat wagon vehicle shall be provided with sufficient length
   x. Wheels monobloc type, with same profile as passenger car wheels
   xi. Mechanical parking brake shall be provided, applied via hand from either side of wheel;
   xii. Fully Load capacity 6 ton;
   xiii. Hauling speed on main line 30 km/h; and
   xiv. Minimum curve radius 27m in depot area.

e) Operating equipment

   i. Loading platform with slip-resistant surface
   ii. All sides of the wagon shall have no side cover
   iii. Motorized crane maximum capacity 1ton, shall be erected at floor Side
   iv. Two chocks are attached to wheel tread at track working

2.1.3 Side Covered Wagon

2.1.3.1 Quantity: Two (2) Sets

2.1.3.2 Functional Requirements

Side covered wagon hauled by motor car, transporting materials of track and infrastructure maintenance shall be supplied.

2.1.3.3 Design and Performance

The side covered wagon shall be universally used for transporting materials of track and infrastructure maintenance as follows:

a) Tools and materials to and from work sites:

   i. Track works materials, e.g. sleepers, ballast, equipment etc.;

b) Vehicle dimensions and features:

   i. Track gauge 1435mm;
   ii. Back gauge of wheel set: 1380mm;
   iii. Vehicle width maximum 2.6 m;
   iv. Vehicle overall length approximately 6.0m;
   v. Floor level match to station platform (0.69 m) from TOR;

vi. Weight of empty car under 15 ton;
vii. 2 Axles;
viii. Couplers shall be identical to couplers on motor car;
ix. Wheels monobloc type, with same profile as passenger car wheels;
x. Mechanical parking brake shall be provided, applied via hand from either side of wheel;
xi. Fully Load capacity 10 tons;
xii. Hauling speed on main line 30 km/h; and
xiii. Minimum curve radius 27m in depot area.

c) Operating equipment

i. Loading platform with slip-resistant surface;
ii. All sides of the wagon shall have hinged boards (approximately 400 mm high fold down type) around periphery of vehicle; and
iii. Two chocks are attached to wheel tread at track working.

2.1.4 Rail Profile Grinding Car

2.1.4.1 Quantity: One (1) Set

2.1.4.2 Functional Requirements

Car is self-propelled, for grinding rail profile shall be supplied.

2.1.4.3 Design and Performance

The Rail profile grinding car shall be equipped for maintenance of rail profile on the mainline. Grinding stone under the floor shall also be equipped for:

a) Grinding top of rail;
b) Grinding gauge corner of rail;
c) Vehicle dimensions and features;

i. Track gauge 1435mm;
ii. Back gauge of wheel set: 1380mm;
iii. Vehicle width maximum 2.6 m;
iv. Axle load under 10.5 ton;
v. Totally 12 Grinding Stones (6 Grinding stones Car×2 sets);
vi. Couplers shall be identical to couplers on motor car;
vii. Wheels monoblock type, with same profile as passenger car wheels;
viii. Mechanical parking brake shall be provided, applied via hand from either side of wheel; and
ix. Grindstone under the floor rotation speed approximately 30m/s.
x. If maximum height of the equipment is over 3.6m, it is subject for the review and approval by the Engineer.

d) Operating equipment.

i. Traveling speed on main line 30 km/h;
ii. Minimum curve radius 30 m in depot area;
iii. Rail grinding velocity approximately 0.7～0.8 km/h or more;
iv. Grinding depth 0.05mm/pass; and
v. Two chocks are attached to wheel tread at track working.

2.1.5 Rail Grinding Machine (Hand Operation)

2.1.5.1 Unit Quantities: Three (3) Sets

2.1.5.2 Functional Requirements

Machine equipment operated by track workers for grinding rail profile shall be supplied.

2.1.5.3 Design and Performance

The Rail grinding machine is handled by track workers for grinding rail profile. The surface of rail is ground by the equipment and small scratches are removed, corrugation is changed flat. Grinding the rail profile is effective for extending rail life cycle. And the operation is effective for declining noise as well as vibration. The rail grinding shall be equipped for:

a) Grinding top of rail;
b) Grinding gauge corner of rail;
c) Grinding inner side of rail; and
d) Machine dimensions and features:

   i. Track gauge 1435mm;
   ii. Back gauge of wheel set: 1380mm;
   iii. Machine width maximum 2.6 m
   iv. Machine overall length approximately 2.0m
   v. Max weight of 120kgf can be carried by workers
   vi. Operating performance
   vii. Grinding depth 0.02mm/pass or more
   viii. Grinding time is 30min for one welding point on rail joint

2.1.6 Track Geometry Measuring Equipment

2.1.6.1 Quantities: One (1) Set

2.1.6.2 Functional Requirements

Measuring equipment hauled by Track Maintenance Vehicle for measuring track irregularity shall be supplied.

2.1.6.3 Design and Performance

Track geometry measuring equipment shall be packaged in suitable module(s).
That equipment shall display the real time geometry information on a monitor placed on the frame of the equipment, and retain inspection records as digital data in computer or other data storage device.
Measuring items are follows:

a) Gauge;
b) Cross level;
c) Longitudinal level;
d) Alignment;
e) Twist; and
f) Equipment dimensions and features

   i. Track gauge 1435mm;
   ii. Back gauge of wheel set: 1380mm;
   iii. Machine width maximum 1.7 m
   iv. Machine overall length approximately 3.0m
   v. Maximum weight of 200 kg can be carried by workers

g) Operating performance

   i. Measure work at hauling velocity 15 km/h
   ii. Measure accuracy all items 0.5 mm

2.1.7 Tie Tampers with Generator Set

2.1.7.1 Quantity: Eight (8) Sets

2.1.7.2 Functional Requirements

Equipment for hand tamping of track ballast shall be supplied.

2.1.7.3 Design and Performance

Tamping of track ballast is taken by track workers for smoothing track surface.
Tie tampers with generator set for spot tamping comprising:

a) Two (2) – Electric power generator to power tampers.
b) Eight (8) – Hand-held power tampers;

2.1.8 Surveying Equipment

2.1.8.1 Quantity: Two (2) Sets

2.1.8.2 Functional Requirements

Equipment for track surveying instrument shall be supplied.

2.1.8.3 Design and Performance

High performance surveying equipment is used for checking long range track irregularity.
Surveying items on track are:

a) Longitudinal level at long wave;
b) Alignment at long wave;
c) Curvature in circular section;
d) Required accuracy of surveying items are;
   i. Horizontal angle 3";
   ii. Vertical angle 2";

2.1.9 Ultrasonic Rail Inspection Equipment

2.1.9.1 Quantity: One (1) Set

2.1.9.2 Functional Requirements

Ultrasonic rail inspection equipment for the detection of surface or subsurface material defects with the aim of finding out flaws, shall be supplied.

2.1.9.3 Design and Performance

The rail inspection equipment shall be either, equipment installed on towed vehicle, or equipment module(s) mounted on another maintenance vehicle.

a) The rail inspection equipment shall detect surface or subsurface defects in rails, including welding part.
b) Flaw shall be detected by ultrasonic technology.
c) The equipment shall have a sufficient number of probes to detect head and web of rail defects, at single-pass operation.
d) The rail inspection equipment shall display on monitor(s) and records inspection data to electronic media of personal computer.
e) Recording data shall identify track location in accordance with travelling direction.
f) Hauled vehicle shall have Couplers identical to couplers on motor car for push-pull operation;
g) Equipment module(s) shall have Self-contained equipment module(s) that attach to other track maintenance vehicles solidly.

2.1.10 Field Welding Hardware Sets and Welding Kits

2.1.10.1 Quantity: One (1) Set

2.1.10.2 Functional Requirements

Field welding hardware Sets and welding kits shall be supplied.

2.1.10.3 Design and Performance

Field welding hardware Sets and welding kits shall include the following:

a) Two (2) – Hardware sets for alumino-thermic welding applicable to EB50T rail and UIC54 rail; and
b) Ten (10) – Field welding kits.

2.1.11 Rail Heater

2.1.11.1 Quantity: Two (2) Sets

2.1.11.2 Functional Requirements

Rail heaters for field welding shall be supplied.

2.1.11.3 Design and Performance

a) Suitable for pre-heating of rail by gas-fired.
b) Include gas containers for preparation for field welding.

2.1.12 Rail Tensor

2.1.12.1 Quantity: One (1) Set

2.1.12.2 Functional Requirements

Rail tensor for field welding shall be supplied.

2.1.12.3 Design and Performance

a) Stressing is operated hydraulically with hand pump.
b) Required pulling force 70 ton, pushing force 40 ton.
c) Suitable EB50T rail, or equivalent rail.

2.1.13 Weld Shear

2.1.13.1 Quantity: One (1) Set

2.1.13.2 Functional Requirements

Weld shear for field welding shall be supplied.

2.1.13.3 Design and Performance

a) Trimming of field welding unnecessary material.
b) Suitable for EB50T rail and UIC54 rail.

2.1.14 Track Work Tools, Human Powered

2.1.14.1 Quantity: One (1) Set: noted including follows

2.1.14.2 Functional Requirements

Track work tools operated by human power shall be supplied as follows:

2.1.14.3 Design and Performance

a) Six (6) – Rail lifting chain jack with standing rack bar, minimum500 mm lifting height;
b) Six (6) – Hydraulic bottled track jack, 3ton lifting capacity;
c) Six (6) – Rail carrying tongs by lifting jack, 3ton lifting capacity;
d) Four (4) – Rail carrying tongs for human power;
e) Two (2) – Sleeper carrying tongs for human power;
f) Ten (10) – Rail pulling rollers;
g) Three (3) – "T" type wrench for rail fastenings;
h) Two (2) – Manual rail turner;
i) Five (5) – Pinch bar, 1.5 m long;
j) Ten (10) – Ballast work fork; and
k) Two (2) – Warning devices (Barricade) for personnel working on rails

2.1.15 Tools and Equipment for Track Maintenance

The Contractor shall provide the latest type of the following:

Table 2.1.15 Tools and Equipment for Track Maintenance

Name of parts/equipment	Quantity	Specification
Rail Sawing Machine	2 sets	3000 rpm. EB50Trail is cut within 3 min.
Boring Machine for Rail	2 sets	300 rpm. Max travel 100 mm, Max core φ 40 mm
Coach Screwing Machine	1 set	Socket speed 100 rpm. Max torque 12 kN・m
Lighting equipment	10 sets	100 lx 10 m from light origin
Emergency Rail Clamps	5 sets	interpose "C" type clamp for emergency
Portable generator	2 sets	3 phase AC, 220 V, 4 kVA
Rail Top and Side Roughness Measuring Instrument	2 sets	Measuring Stretch: 1000mm Phase (Top and Inner Side) Measuring Range: ±1.5mm Measuring Scale Ratio: 10 times

2.2 Power and OCS Maintenance

2.2.1 General

It is expected that a light maintenance frequency as appended below will be applied to OCS and Power Supply Equipment.
All tools and equipment shall be included to maintain the Power Systems necessary for the operation of the LRT Line 1 System. It is not foreseen to include tools for specialized works, such as SF6 Switch gear maintenance and Regeneration of Transformer Oil.

Table 2.2 Power and OCS Maintenance

Activity	OCS EQUIPMENT	POWER EQUIPMENT	FREQUENCY
Visual Check Equipment, Disconnector, Panels	Yes	Yes	Bi-monthly
Integrity of OCS Assemblies	Yes		Monthly
Gap/Clearance of Section Insulator	Yes		Monthly
Greasing Counter weight mechanism	Yes		Annually
Insulation Test on Feeder Cables	Yes		Bi - Annually
Measurement of Earth Impedance	Yes	Yes	Bi - Annually

Maintenance work shall be carried out in Zapote Satellite Depot. The tools and equipment for effective light maintenance work for OCS and Power Maintenance Equipment are listed below. The Contractor shall provide a back-up software for the equipment wherein software program is required.

2.2.2 OCS Maintenance Equipment

The OCS Maintenance Equipment will normally be used for routine maintenance to confirm all outdoor installations; contact wire, tensors, feeder cables and breakers are in good working condition. Scheduled routine tests shall be carried out.

2.2.2.1 Quantity: One (1) set

2.2.2.2 Components:

a) Set of Basic Electrical Tools
b) PC for Diagnostic Software Manuals, Reports etc.
c) OCS Maintenance Vehicle (Rail Car): Model with scissors or hydraulic working platform, Track gauge: 1435 mm, Back gauge of wheel set: 1380mm, self- propelled type, traction from Depot to mainline the Lorry of Cable Drum, Minimum Curve Radius 27m
d) Contact wire video capture data evaluation and storage unit
e) Lorry of Cable Drum
f) Digital CW Height and Stagger Measuring Device, mounted on the Rail Car
g) Clamp meters AC respectively DC
h) Non-contact High Voltage Detector
i) Digital Insulation Resistance Tester, 5 kV
j) Tools for heavy Electrical works
k) Grounding Cluster, Snap-On with complete rail clamp
l) Tools for Mechanical works (OCS)
m) Hydraulic powered tool (cutter, press, wrench)
n) Torque Wrench
o) Job Site Lighting, including Generator

The OCS Maintenance Vehicle (Rail Car) shall be equipped with a video capture and data evaluation unit. The video capture unit shall be on the roof of OCS Maintenance Vehicle (Rail Car) and the data capture, evaluation and storage computer shall be in the same vehicle.

2.2.3 Power Works Maintenance Equipment

2.2.3.1 Quantity: Two (2) Sets

2.2.3.2 Functional Requirement

The Power Maintenance Equipment shall normally be used for general maintenance and routine test to confirm all power supply equipment, indoor and outdoor installations, feeder cables, disconnector panels etc. are in good working conditions, in particular the insulation of outdoor cables
Maintenance on Switchgear
Verification of earthing condition
Daily visual and monthly routine tests shall be carried out on schedule. As such and to effectively facilitate execution of work, the following equipment including measuring instruments shall be required:

2.2.3.3 Components

a) Set of Basic Electrical Tools
b) PC for Diagnostic Software Manuals, Reports etc.
c) Non-contact High Voltage Detector

Light weight non-contact voltage detector that shall operate from 80V to maximum 50 KV and shall issue an audible note and a visual Designed for use with hot sticks incorporating a universal spline adaptor

d) Portable Hi-Pot Tester

This Hi-Pot tester shall be light weight and suitable for outdoor operation to test the OCS feeder's insulation.
Test voltage up to 2.5 KV for 10 minutes continuously and rise from 0 to 2.5 kV in 1 minutes

e) Digital Earth Resistance Tester

Portable digital earth resistance tester that shall be suitable for the measuring of the earth resistance up to 2000 ohms. Shall withstand Voltages of 3.7 KV for 1 minute

f) Portable Single Phase Power Generator

Light weight outdoor generator that could be either hand start and or electric start. 5000 W at 120/240 V, 50/60 Hz
Variable control switch to vary output voltage from 0 – 120V

g) Digital Multi-meter
h) Cable Fault Finder
i) Grounding set with Socket Clamp
j) Electrical High Voltage Safety Gear

2.2.4 Tools and Equipment for Power and OCS Maintenance

The Contractor shall provide the latest type of the following:

Table 2.2.4 Tools and equipment for Power and OCS Maintenance

Name of parts/equipment	Quantity	Specification
Cable splicing tool	2 Sets	Hydraulic type for power cables up to 500 mm2
Cable cutting and crimping tool	2 Sets	Hydraulic type for power cables up to 500 mm2
Portable digital multi-tester	2 Sets	AA battery, AC/DC Voltmeter/Ammeter and Ohm meter 0 to 100/1000/5000 Ohms
Thermal Scanner or Thermal Imaging Gun	2 Sets	Temperature measurement range : 0℃ to 200℃, accuracy : ±5℃ Display LCD : min. 3.5 inches
Standard electrician hand tools	3 Sets	Local standard issue for all electrician
Heavy safety gloves	2 Sets	Insulated up to 50 kV
Portable hand light	2 Sets	100 lux 10 m from light origin

2.3 Telecommunications Maintenance Works Tools and Test Kits

All tools and equipment shall be included for the maintenance of all the Telecommunication Systems used for the operation of the LRT Line 1 System.
Diagnostic computer, which is loaded with proprietary software of the system contractors shall be in the scope of the EPC and be provided by the system contractor.
Two sets of tools, special tools, test equipment, fixtures required to carry out all functions described in the Maintenance Instructions or as required by the Technical Specifications shall be delivered and shall not be less than the list of equipment provided by the Contractor, along with their Bid. The Contractor may add any additional equipment required, but, at no extra cost to the Employer. The extent of supply shall include protective or carrying cases, as may be appropriate for the storage and use of each item.
The Contractor shall provide a back-up software for the equipment wherein software program is required.
Two test kits shall be provided comprising the following equipment which shall be of a make with good reputation represented in the Philippines to assure Service and Calibration. The equipment shall be software based where applicable

2.3.1 Test Kits

Table 2.3.1 Telecommunications Maintenance Works Test Kits

No.	Name of Test Kits	Quantity
1	Diagnostic computer for the COM systems system - TEL - PIS - PA - Radio - SDH Multiplexer - CCTV	to be provided by COM contractor
2	General Test Equipment Cable Tester for CU com cable - Tone Tester - Cable continuity - Defective Insulation (short / long distance) - Pulse Echo Tester - Megger and Loop Resistance	2 Sets
3	General Test Equipment for Fibre Optic cable - Optical Time Domain Reflectometers (OTDRs) to support both Singlemode and Multimode MPO fiber testing - Fiber Optic Cleaning Kits - OTN Testing - Ethernet Testing	2 Sets
4	General Test Equipment PA including sound pressure meter, test tone generator - Audio Signal Generator - Audio Line Tester - Analog Audio Analyzer - Measurement Microphone	2 Sets
5	General Test Equipment CCTV, maintenance display, pattern generator - PTZ Tester Camera Testing Monitor CCTV system installation Tester Equipment - Handheld Camera Focus Indicator - Light (Lux) Meter - Pattern Generator	2 Sets
6	General Test Equipment Radio incl. SWR Measurement, Analyser, Generator - Set of attenuators / Terminations - RF Maintenance Spectrum Analyser - RF Maintenance Generator - SWR Analyser	2 Sets

2.3.2 Man Lift

Table 2.3.2 Telecommunications Maintenance Works Man Lift

No.	Description	Quantity
1	Man lift (Scissors working Platform, Ladders etc.) for works in 6 meters, and weights up to 120kg, the stand shall be such that the platform can be used in the area of uneven floor or stairs	2 Sets

2.3.3 Tool Set

Table 2.3.3 Telecommunications Maintenance Works Tool Set

No.	Name of Tool Set	Quantity
1	Set of Basic Electronic Tools - Electronic tools - Electrical Tools (Light works) - Mechanical Tools (Light works)	2 Sets
2	Set of Basic Test Equipment - Multimeter General Use - Clamp meters (AC/DC min 1 mA - max 10A)	2 Sets
3	PC for Diagnostic Software - Window based - Laptop - incl. Office Standard Version	2 Sets

Note:

a) It is assumed that splicing of fibre optic cable will be outsourced.
b) Any special mechanical tools and software shall be under the scope of the particular system provider from EPC

2.4 Signalling Maintenance Works Tools and Test Kits

All tools and equipment shall be included for the maintenance of the new Signalling and Train detection system used for the operation of the LRT Line 1 System. It is foreseen that this will be ERTMS/ETCS L1 compatible.
A diagnostic computer, which is loaded with proprietary software of the system contractors shall be in the scope EPC and be provided by system contractor.
Two sets of tools and test equipment to carry out all functions described in the Maintenance Instructions or as required by the Technical Specifications shall be delivered and shall not be less than the list of equipment provided by the Contractor, along with their Bid. The Contractor may add any additional equipment required, but, at no extra cost to the Employer. The extent of supply shall include protective or carrying cases, as may be appropriate for the storage and use of each item.
The Contractor shall provide a back-up software for the equipment wherein software program is required.
Tools for SIG needed to perform the following maintenance works:

a) Signalling System
b) Train Detection System
c) Eurobalise
d) Signals
e) Switch Machines
f) Interlocking-
g) On board equipment incl. Radar, Odometer, DMI, Antennas

The two test kits shall comprise the following equipment which shall be of a make with good reputation represented in the Philippines to assure Service and Calibration, shall be state of the art and where applicable software based

2.4.1 Test Kits

Table 2.4.1 Signalling Maintenance Works Test Kits

No.	Name of Test Kits	Quantity
1	Diagnostic computer for the Signalling system	to be provided by SIG contractor
2	Diagnostic Equipment for Eurobalise	to be provided by SIG contractor
3	Diagnostic Equipment for on board systems	to be provided by SIG contractor
4	Diagnostic Equipment for Interlocking systems	to be provided by SIG contractor

2.4.2 Tools to work on Sites

Table 2.4.2 Signalling Maintenance Tools to Work on Site

No.	Name of Tools	Quantity
1	Tools for Mechanical works (switches, switch machine, points))	2 Sets
2	Hydraulic powered tool (wrench), Torque Wrench	2 Sets
3	Job Site Lighting, including Generator	2 Lots

2.4.3 Tool Set

Table 2.4.3 Signalling Maintenance Works Tool Set

No.	Name of Tool Set	Quantity
1	Set of Basic Electronic Tools - Electronic tools - Electrical Tools (Light works) - Mechanical Tools (Light works)	2 Sets
2	Set of Basic Test Equipment - Multimeter - Clamp meters (AC/DC min 1 mA - max 10A)	2 Sets
3	PC for Diagnostic Software - Window based - Laptop - incl. Office Standard Version	2 Sets

2.5 Building Facilities Maintenance Equipment

A working platform for light maintenance work and a set of ladders shall be provided to do maintenance works in the buildings
The platform shall allow works in 12 m heights and carry a weight of 150kg. .

2.5.1 Working Platform and Ladders

Table 2.5.1 Building Facilities Maintenance Equipment

No.	Name of Maintenance Equipment	Quantity
1	Man lift (Scissors working Platform, Ladders for works in 12 meters, and weights up to 150kg, The stand shall be such that the platform can be used in the area of uneven floor or stairs	2 Sets
2	Isolated Ladders extendable ladders (2m; 5m) for works in height from 1,5m to 4m	2 each
3	Safety Harness	4 Sets

APPENDIX A - Heavy Maintenance Equipment Indicative Laydown Area

Item	Equipment	No	Approximate Size	Indicative Laydown Area
A	Overhead Crane	2		Heavy Maintenance Workshop
B	Lifting Jacks	16		Heavy Maintenance Pit Track Area
C	Bogie Turn Table	4	4.4L×4.4W×0.57H	Heavy Maintenance Track
D	Wheel Lathe	1	5.0L×2.4W×2.4H	Wheel and Axle Work Area
E	Wheel Lathe Wheel Set Laydown area	-		Beside the Wheel Lathe
G	Universal Press Machine	1	0.965L×1.285W×2.0H	Motor Work Area
H	Hydraulic Press Machine	1	Rolling Stock Manufacturer supply	Wheel and Axle Work Area
I	Bogie Wash Booth	1	5.4L×6.0W×3.1H	Bogie Work Area
J	Pneumatic Valve Tester	1	1.3L×0.85W×1.85H	Brake Tester Area
K	Air Compressor Tester	1	5.0L×5.0W	Air Brake Compressor Room
L	Bogie Stand	3	Rolling Stock Manufacturer supply	Bogie Work Area
M	Universal machine	1	2.6L×1.0W×1.7H	Wheel and Axle Work Area
N	Pantograph Stand	2	1.4L×1.25W×1.6H	Pantograph Work Space
O	Compressor tester	0	already in the item K : Air Compressor Tester	
P	Brake Tester	1	Rolling Stock Manufacturer supply	Brake Tester Area
Q	Parts Wash Machine	1	1.6L×1.3W×1.7H	Bogie Work Area
R	Elec Relay Tester	1	1.6L×0.9W×1.5H	Electrical Room
S	Car Mover	1	4.1L×2.0W×1.5H	Light/ Heavy Maintenance Track
T	Jib Crane	3		Air-con/ Motor/ Wheel and Axle Work Area
U	Battery Charger	3		Battery Charging Room
V	Motor Truck	4	2.6L×1.15W×1.26H	Near floor track, beyond the bogie turn table
W	Fork lift (1.0t)	2	3.0L×1.1W×3.9H	Near the battery charging room or material storage
X	Fork lift (1.5t)	2	3.0L×1.1W×3.9H	Near the battery charging room or material storage
Y	Dummy Bogie	6		Heavy Maintenance Floor Track
Z	Spare Bogie	?		Heavy Maintenance Floor Track (Equipment will be supplied by RS contractor)
AA	Table lifter on Pit	2	1.2L×0.8W	Heavy Maintenance Pit Track Area
BB	Table Lifter	4	1.2L×0.8W	Near floor track, beyond the bogie turn table

Item	Equipment	No	Approximate Size	Indicative Laydown Area
CC	Re-railing Equipment	1		On the existing re-railing road/rail vehicle
DD	Access Platform (low type)	4	1.8L×0.8W×1.9H	Side of flat floor track
	Access Platform (high type)	4	3.5L×1.0W×3.9H	Side of flat floor track
EE	HSB Tester	1		Electrical Room
FF	Arrester Tester	1		Electrical Room
GG	Jet Cleaning M/c	1	0.6L×0.95W×0.75H	Bogie Wash Booth
HH	Leveling Valve Tester	1		Air brake compressor room
II	Bearing Removal and Press	2		Motor and door machine area
JJ	Bearing Laydown area	-		Motor and door machine area
KK	Induction Heater	1		Motor and door machine area
LL	Portable Arc Set	1		Tool Room
MM	Truck for HVAC Transport	2	4.0L×1.8W×0.5H	Air-con Space Area
NN	HVAC Laydown area	-		Air-con Space Area
OO	Rolling Stock Equipment	1		Electrical Room
PP	Rolling Stock Tools	1		Tool Room
QQ	Consumable Stores	-		Material Storage/ Light Maintenance Storage
RR	Sub-system Stores e.g. Traction Motors,Windows, Seats etc.	-		Material Storage
SS	Staff Lockers	-		Toilet, Shower and Locker room

APPENDIX B - Non- Rolling Stock Equipment and Vehicles Indicative Laydown Area

Item	Equipment	No	Approximate Size	Indicative laydown Area
2.1 Track Maintenance Equipment				
a)	Track Maintenance Vehicle	1	10.0L×2.6W×3.8H	Unloading Track
b)	Flat Open Wagon	4	3.0L×2.6W×0.69H	Lead Track
c)	Side Covered Wagon	2	6.0L×2.6W×0.69H	Lead Track
d)	Rail Profile Grinding Car	1	10.0L×2.6W×3.6H	Lead Track
e)	Rail Grinding Machine (Hand Operation)	3	2.0L×2.6W	Infrastructure Equipment Storage (Track Room)
f)	Track Geometry Measuring Equipment	1	3.0L×1.7W	
g)	Tie Tampers with Generator set	8	Tie Tamper-8 Generator-2	
h)	Surveying Equipment	2		
i)	Ultrasonic Rail Inspection Equipment	1		
j)	Field Welding Hardware Sets and Welding Kits	1		
k)	Rail Heater	2		
l)	Rail Tensor	1		
m)	Weld Shear	1		
n)	Track work Tools, Human Powered	1set		
o)	Tools and Equipment for Track Maintenance			
2.2 Power and OCS Maintenance Equipment				
a)	OCS Maintenance Equipment			
	OCS Maintenance Vehicle	1	10.0L×2.6W×3.8H	Unloading Track
	Lorry of Cable Drum	1		Lead Track
	Other OCS Maintenance Equipment	1sets		Infrastructure Equipment Storage (Power/ OCS Room)
b)	Power Works Maintenance Equipment	2sets		

Item	Equipment	No	Approximate Size	Indicative laydown Area
c)	Tools and equipment for Power and OCS Maintenance	2-3sets		
2.3	**Telecommunication Maintenance Works Tools and Test Kits**			
a)	Test kit for electrical and electronic works	2sets		Infrastructure Equipment Storage (Telecom Room)
b)	Tool sets for electrical and electronic works	2sets		
c)	Man Lift to facilitate a working height of 6m	2		Motor Pool
d)	Special tools and test equipment, to be recommended by the Contractor, as required by the Technical Specification			Infrastructure Equipment Storage (Telecom Room)
2.4	**Signaling Maintenance Works Tools and Test Kits**			
a)	Test kit for electrical and electronic works		To be supplied by Signaling Contractor	Infrastructure Equipment Storage (Signal Room)
b)	Tools for electrical and electronic works	2set		
c)	Special tools and test equipment, to be recommended by the Contractor, as required by the Technical Specification			
2.5	**Building Facilities Maintenance Equipment**			
a)	Man lift to facilitate a working height of 12m	2		Motor Pool
b)	Insulated and extendable ladders	4	2m-2 5m-2	Infrastructure Equipment Storage (Building Room)
c)	Safety Harness	4sets		