BIDDING DOCUMENTS

FOR

PROCUREMENT OF

PACKAGE CP NS-01: E&M SYSTEMS AND TRACK WORKS

Volume II of IV

PART 2 Employer’s Requirements

March 2021

Employer:	**Department of Transportation**
Procuring Agent:	**Procurement Service**
Country:	**Republic of the Philippines**
Project:	**The Malolos–Clark Railway Project and the North South Railway Project-South Line (Commuter)**
JICA Loan No.:	**PH-P270**

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BIDDING DOCUMENTS

SUMMARY OF DOCUMENTS

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Employer's Requirements

a) Scope of Works (SOW)

b) **General Requirements (ERG)**

SECTION VI - EMPLOYER'S REQUIREMENTS

a) SCOPE OF WORKS (SOW)

Employer's Requirements

a) Scope of Works (SOW)

1. General

The purpose of this document is to provide the Scope of Works (SOW) for the Contractor for the E&M Systems and Track Works. A detailed description of the SOW is provided in Part 2- Employer's Requirements – Section VI – Employer's Requirements, which are subdivided into General Requirements (ERG) and Technical Requirements (ERT).

The SOW consists of both Malolos Clark Railway Project, hereinafter shown as 'MCRP' and North South Railway Project - South Line (Commuter), hereinafter shown as 'NSRP-South', connecting with North South Commuter Railway, hereinafter shown as 'NSCR' with mutual through train operation. The MCRP commences at Clark International Airport and connects to the NSCR at Malolos. The NSRP-South connects with the NSCR at 200m south of Solis Station and continues to Calamba with a connection to the Metro Manila Subway Project hereinafter shown as "MMSP" at Bicutan. The NSRP-South also includes the spurs from Blumentritt and Solis stations to Tutuban Station. At the connections with NSCR and MMSP, the E&M systems and track work shall be fully integrated to ensure full seamless interoperability between the various rail services. Depots will be located in Mabalacat on the MCRP and at Banlic on NSRP-South. The mainline runs predominantly on viaducts with the Clark International Airport and the approach tracks being in tunnels.

It should be noted that the power supply and distribution systems as well as the overhead contact line system shall be sized based on the ultimate rolling stock fleet and timetable. The sizes of the equipment, cables, and conductors, etc. stated within the ERT are for indication only and shall be supplied to suit the actual operational requirements established by detailed simulations. The power supply systems shall be designed for maximum power efficiency and economy.

2. Scope of Contract

The Contract shall include the design, supply, manufacture, delivery, integration of systems, installation, testing, and commissioning of all equipment and systems required for the efficient operation and maintenance of this project all in compliance with the outline design described in the Employer's Requirements and Drawings.

This Contract includes the following parts:

a) Track Works for the mainline and depots.

b) Signaling System for the mainline and depots.

c) Telecommunications for the mainline and depots.

d) Power Supply system at the substations.

e) Power Distribution System at the stations, between stations and depots.

f) Overhead Contact line System for the mainline and depots.

g) Automatic Fare Collection System

h) Depot & Workshop Facility at the depots.

i) Training Facility at training center

j) Platform Screen Doors at stations

k) Computerized Maintenance Management System

l) Integrated Operations Control Center.

The Employer will not provide any equipment or free issue materials to the Contractor. The Contractor shall be responsible for the provision of all equipment and materials that is required for his construction activities and the tests.

3. Outline of Track Works

The outline of track works is as follows:

a) Track works for MCRP and NSRP-South consist of mainline tracks, approach lines to the depot, and depot tracks.

b) For the viaduct sections of the mainline continuous welded rail is used. The precast sleeper with elastic fastenings is to be directly fastened on the concrete trackbed with shear connectors provided by civil contractors.

c) For the embankment sections of the mainline, the same elastic pre-cast sleepers are to be directly fastened on the concrete trackbed. There shall be drainage slope and shear connectors provided by the civil contractors.

d) For the depot area, jointed rails shall be used. The pre-cast sleeper with elastic fastenings are laid on a ballast layer for the stabling tracks. The directly fastened track on the column or wall of the pit or the embedded track on the concrete floors are to be adopted for the inspection tracks, vehicle maintenance tracks, and vehicle washing tracks. Other types of tracks will be selected according to the function in the depot area.

e) Turnouts on the mainline shall use plastic/FFU sleepers directly fastened to the concrete track. Turnouts in the depot shall be will be installed on FFU sleepers.

f) The track gauge is the standard 1435mm with 60 kg/m rail for the mainline and depot approach lines and JIS50N rail for the depot areas.

g) A operation speed of 160km/h is to be applied on some parts of the MCRP with the remainder of the mainline having an operation speed of 120km/h.

h) Track mounted maintenance vehicles.

System details are described in ERT.

4. Outline of Signaling System

The outline of the Signaling System is as follows;

a) Signaling system is to be based on ETCS level 2 with a maximum speed of 160 km/h

b) Signaling System works together with Automatic Train Protection System (ATP), Train Detection System, Computer Based Interlocking System, Automatic Traffic Supervision System as a minimum and provision for Automatic Train Operation (ATO).

c) Onboard equipment for Commuter, Limited Express, and MMSP Rolling Stock plus maintenance vehicles.

d) All Cables, Cable Containment and supports for the system.

System details are described in ERT.

5. Outline of Telecommunications

The outline of the Telecommunications is as follows;

a) Backbone System

b) Radio System

c) Dispatcher Telecommunications

d) Voice and Data Radio System

e) CCTV System

f) Passenger Information and Flight Information Display Systems

g) Public Address

h) Time Server and Master Clock System

i) Meteorological and Seismic Monitoring System

j) All Cables, Cable Containment and supports for the system.

System details are described in ERT.

6. Outline of Power Supply System

The outline of the Power Supply Systems is as follows;

a) Substations, battery posts, and sectioning posts for the mainline and in the depots.

b) Power will be supplied from traction substation (TSS) to the train through an Overhead Contact line System (OCS) and to other facilities through a 6.6kV loop Distribution system (PDS).

c) 69kV power shall be provided by electric utility companies (MCRP).

115kV power shall be provided by MERALCO (NSRP-South) except for TSS1 which is supplied at 34.5kV.

d) SCADA System for TSS's, overhead contact line system, and electrical equipment.

e) Solar Panel power generation for selected stations and depots.

f) All Cables, Cable Containment and supports for the system.

System details are described in ERT.

7. Outline of the Power Distribution System

The outline of the Power Distribution Systems is as follows;

a) Distribution cable network installation on the mainline and in depots

b) Works at station electrical rooms and high voltage electrical room in the depots

c) Distribution of power to equipment for train operation, station equipment, etc.

d) All Cables, Cable Containment and supports for the system.

System details are described in ERT.

8. Outline of the Overhead Contact Line System

The outline of the Overhead Contact line Systems is as follows;

a) Feeder-Messenger Catenary System in mainline and Simple Catenary System at Depot

Installation of a catenary system suitable for train operation speed of 160km/h on sections of the MCRP and operational speed of 120km/h for the other areas.

b) Overhead Line Inspection Vehicles

System details are described in ERT.

9. Outline of Automatic Fare Collection System

The outline of the Automatic Fare Collection Systems is as follows;

a) The Design, Manufacture, Delivery, Installation, System Assurance, Testing and Commissioning of the AFC system.

b) The AFC system of MCRP and NSRP-South shall use a contactless IC card that is inter-operative with the existing LRT 1, LRT 2, MRT 3, and the new NSCR and MMSP lines.

c) Interface works between Level 3 AFC system with the Central Clearing House System and the Card 1st Issuer to undertake the integration of common ticketing and business rules into the AFC system.

d) The AFC system performance shall conform to the AFC National Standard and the Business Rules.

e) The AFC system shall include the ticketing system for Limited Express trains for the airport service.

f) The AFC system shall be robust, flexible, and capable for future extensions and interchanges.

g) All Cables, Cable Containment and supports for the system.

System Details are described in ERT.

10. Depot Facilities

The outline of the Depot and Workshop Facilities are;

a) Installation of equipment for Depot and Workshop shall include the following as a minimum:

i Equipment to support Preventive Maintenance activities;

ii Equipment to support Corrective Maintenance activities;

iii Equipment to support Major Overhaul activities;

b) All Cables, Cable Containment and supports for the system.

Systems details are described in ERT.

11. Outline of Training Facilities at Training Center (MCRP)

The outline of Training Facilities is as follows;

a) Train Operation Simulators

b) Track Work

   i Elastic Sleeper Directly Fastened Track

   ii Ballasted Track

   iii Simple Turnout

c) Signaling System

   i Equipment in OCC

   ii Equipment in Stations

   iii Ground equipment including radio equipment

   iv Onboard equipment including radio equipment

d) Telecommunications

   i Equipment for Network System (Miniature)

   ii Radio equipment

   iii PID equipment

   iv CCTV equipment

   v PA equipment

e) Power Supply System

   i Equipment at Substation

f) Overhead Contact line System

   i Support structure

   ii Catenary

   iii Various equipment

   iv Tool

g) AFC System

   i Automatic Gate

   ii Ticket Vending Machine

   iii Point of Sales equipment

   iv Handheld Terminal

   v Station Accounting Computer System

   vi Central Computer System

h) Pantograph and Bogie Assembly

   The CP NS-02 and CP NS-03 Contractors will prepare and supply the following equipment:

   i Pantograph for Limited Express and Commuter trains

   ii Bogie-assembly for motor-car including traction motor, gearbox, and coupling as for Limited Express and Commuter trains.

i) Platform Screen Door System

i. Automatic Sliding Door sets
ii. Fixed Screens and emergency escape doors
iii. Local control panel for driver
iv. Local control panel for the station staff
v. Power Supply Distribution panel
vi. Interface Control Panel with Signaling
vii. Workstation and display screen

j) Computerized Maintenance Management System

i. CMMS Workstation
ii. Field Devices

System details are described in ERT.

12. Outline of Platform Screen Door System

The outline of Platform Screen Door Systems is as follows;

a) Installation of Half Screen Door type and/or Full-Screen Door Type for stations on MCRP, NSRP-South, and NSCR.

b) All Cable Containment and supports for the system.

System details are described in ERT.

13. Outline of Computerized Maintenance Management System

The outline of Computerized Maintenance Management Systems (CMMS) is as follows;

a) Provision of complete CMMS systems for the whole of the NSCR line that shall capture and schedule maintenance processes including:

i. Planned Maintenance
ii. Preventative Maintenance
iii. Engineering/Maintenance Projects,
iv. Maintenance Repair Operations/Overall (MRO) parts reorder
v. MRO parts cycle count,
vi. MRO parts receiving
vii. Recording of key events

System details are described in ERT.

End of Section

b) GENERAL REQUIREMENTS (ERG)

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Employer's Requirements

b) General Requirements (ERG)

1. APPLICATION OF THE GENERAL REQUIREMENTS

1.1. General

1.1.1. These General Requirements (ERG) are part of the Employer's Requirements and form part of the Contract. The provision contained in the Technical Requirements (ERT) and the Employer's Drawings shall prevail over the provisions contained in the General Requirements. The provision contained in the General Requirements shall prevail over the provisions contained in the Republic of the Philippines standards, Japanese standards, international standards, and similar standards documents stated in the Contract.

1.1.2. These General Requirements shall be read in conjunction with the General Conditions (GC), the Particular Conditions (PC), the Technical Requirements (ERT), and the Employer's Drawings (ERD) and any other documents forming part of the Contract.

1.1.3. All of the Plant and Materials intended to form or forming part of the Permanent Works shall be new.

1.1.4. The Contractor shall always immediately seek advice from the Engineer in the event of conflicts between the provisions in the documents.

1.1.5. The Employer's Drawings assist the scope of the Works in general and clarify constraints, interface arrangements, and the conceptual nature of the finished system outline. The Contractor shall carefully check all Employer's Drawings and advise the Engineer of discrepancies, omissions, errors or ambiguities should any be found.

1.1.6. The Contractor shall note that any drawings included but marked "For information only "do not form part of the Contract. Dimensions shown on the Employer's Drawings are indicative only. The final dimensions shall be determined by the Contractor.

1.2. Definition and Abbreviations

1.2.1. In addition to the words and expressions defined in the General Conditions and the Particular Conditions, further following words and expressions shall have the meaning assigned to them except where the context otherwise requires:

"approval, approve, approved" when conveyed, given or undertaken by the Engineer or the Employer shall be deemed to mean only that the Engineer or Employer (as the case may be) has no objection to the Contractor's deliverable, submittal, request, etc., and it shall not under any circumstances constitute a waiver nor relieve the Contractor of any of its duties, responsibilities, obligations or liabilities under the Contract, since ensuring full compliance with the Employer's Requirements and the provisions of the Contract shall be deemed to be solely the responsibility of the Contractor under all and any circumstances;

"As-Built documents" means the As-Built Drawings and records submitted during completion of Construction such as inspection and test records.

"As-Built Drawings" means those drawings produced by the Contractor and endorsed by it as true records of construction of the Permanent Works and which have been agreed with the Engineer.

"Capital Spares" means those items which are expected to remain in operation and not require replacement until well beyond the end of the 2-year O&M period and which, because of the length of time it would take to get a replacement for such items, could cause a prolonged shutdown if they had to be replaced. The provision of these items is not included in the Accepted Contract Amount and, if required, shall be ordered by the Employer under separate purchase orders not forming part of the Contract. The applicable purchase rates shall nonetheless be those committed to by the Contractor under this Contract, which rates shall remain valid for a period of one year after the end of the Defects Notification Period

"Commissioning" means the process of setting to work the complete transportation system through a series of integrated tests that demonstrate the installation and performance in accordance with the specified criteria.

"Critical Path Method Network" means a networked project implementation program, usually depicted diagrammatically in bar chart form, that contains a logically connected sequence of interdependent activities each having no float, running from the planned start date through to the anticipated finish date, and which results in the longest overall duration for achieving completion of the project.

"Defect Notification Period" means the period during which the Contractor is responsible to remedy any defective work which becomes apparent during the Defect Notification Period (DNP).

"Designer" means who is responsible for the design of permanent works.

"Design Package" means the drawings, documents, structural analysis, simulation and calculation, test reports, etc. prepared by the Contractor.

"External Interfacing Parties" means those parties with whom it is the Contractor's responsibility to co-ordinate the design of the Contract Works with; and includes all relevant bodies and entities, in particular government authorities, departments and regulatory bodies utility companies, and the consultants, Project Management Units and contractors of adjacent Projects whether ongoing or planned. The Contractor shall identify such interfacing parties in his Interface Management Plan (IMP).

"Execution of the Works" means the manufacture, supply, transportation, delivery to Site, construction, erection, installation, testing, commissioning, performance testing, completion, and training in the use of the Works in accordance with the Contract; the preparation and/or delivery (as appropriate) of all information, drawings and manuals in respect of the Works required by the Contract, the provision of such spare parts, consumables, tools, and spare materials as are required by the Contract to be provided by the Contractor for the performance of its Defects Liability obligations, and the management of all such matters.

"Factory Acceptance Tests" means the tests to be performed at the Contractor's factories prior to delivery to the Site to verify compliance with the Technical Requirements and quality standards.

"Final Design" means the design developed to the stage where all manufacturing drawings are fully defined and specified.

"Installation Tests" means the tests to be performed to verify the conformity of completion of an installation/assembly to the design documents previously given a Notice of No Objection by the Engineer prior to the start of Commissioning. Installation Tests do not form part of the Tests on Completion to be performed by the Contractor in order to achieve Employer's Taking Over of the Works or any

Section however they must be successfully completed before the Tests on Completion can commence.

"Integrated Testing and Commissioning" means those tests that demonstrate the integration of the complete transport system meeting the requirements of the Technical Requirements in an operating environment. Integrated Testing and Commissioning form part of the Tests on Completion to be performed by the Contractor in order to achieve Employer's Taking Over of the Works or any Section. Test Running is part of the Integrated Testing and Commissioning (ITC) following completion of Partial Acceptance Test and System Acceptance testing etc. The O&M Concessioner can join the Employer in witnessing these tests.

"Interface Contractor" means a Contractor, engaged by the Employer, which are undertaking works on the other NSCR-Ex Contract Packages. The Contractor shall identify all such Interface Contractors in the Interface Management Plan.

"Key Personnel" means individuals who are considered by the Engineer to be critical for the Execution and completion of the Works in accordance with the Contract and as listed as such in the Contractor's Organization.

"O&M Spares" means all those items that the Contractor has advised the Employer will need to be replaced during the O&M period since they do not have longevity beyond two years. The cost of all such items shall be deemed to be included in the Accepted Contract Amount. If any items not included in the list of "O&M Spares" fail during the O&M period and are not capable of being satisfactorily repaired, they shall be treated as defects and must be replaced by the Contractor as soon as reasonably possible, all at no extra cost to the Employer.

"Railway System": is a general name showing the system consisting of sub-systems; in Track Works, Signaling System, Telecommunications, Power Supply System, Power Distribution System, Overhead Contact line System, Depot facility, and AFC.

"Rolling Stock Gauge" means the maximum profile within which the rolling stock may be constructed or loaded.

"Software maintenance" means activities on debugging, improvement, modification, or replace of software.

"Spare Parts" means those items with a known short operational life that are required to be replaced during the O&M period in order to ensure that there will be no interruption whatsoever due to the failure of such items in the operation of the Permanent Works after handover to the Employer.

"Structure Gauge" means the profile related to the designated normal coordinated axis of the track into which no part of any structure or fixed equipment may penetrate.

"Technical Requirements" mean the requirements set out in Part 2, Employer's Requirements, Section VI, Technical Requirements (ERT).

"Taking Over" means the point where the Contract Works or any part thereof has passed all relevant tests and can be Taken-Over by the Employer in accordance with Contract Conditions notwithstanding the Contract Works may have certain outstanding works to be completed but nonetheless such will not affect the Employer's beneficial use of the Contract Works or part as intended by this Contract.

"Temporary Facilities" means the facilities constructed by the Contractor for his own use or for the use of the Employer or the Engineer during the Construction period which are not intended to become part of the permanent works.

"Temporary Works" means all temporary works of every kind (including, without limitation, false-work, temporary structures, temporary earthworks, and other things), and the goods, materials, and other constituent parts forming or intended to form a part thereof, required for the Execution of the Works but does not include Contractor's Equipment.

"Testing and Commissioning Spares" means all those spares that may be required to ensure that, after all, testing and commissioning work has been completed (including all "Integrated Testing and Commissioning" work), and prior to taking over by the Employer, the work to be taken over is in full compliance with the Employer's Requirements and is ready to go into operation. The cost of all such items shall be deemed to be included in the Accepted Contract Amount.

"Tests on Completion" means the tests which are specified in the Contract or agreed by both Parties which are carried out before the Works or a Section (as the case may be) are taken over by the Employer.

"Works Program" means the Contractor's Works program, showing the sequence, design, manufacture, delivery to Site, erection, construction, installation, testing, commissioning of the Contract Works and related activities in the form and content prescribed by the General Requirements (ERG) and Technical Requirements (ERT), or any amended or varied version thereof, as submitted by the Contractor and approved by the Engineer in accordance with the Works Requirements.

1.2.2. A common abbreviation used in the ERG and the ERT are set out in alphabetical order in Appendix 1 attached hereto.

1.2.3. Further abbreviation may be defined within the body of the ERG or the ERT where there is only local applicability.

2. MOBILIZATION

2.1. Contractor's Mobilization Program

No more than 28 calendar days after the Commencement Date the Contractor shall submit a mobilization program to the Engineer for his review.

The program shall include a schedule noting the anticipated arrival of all Railway System construction equipment and facilities as well as the arrival of all-key Contractor's Personnel and Subcontractors.

The mobilization program shall include a layout plan noting the location, size, and arrangement of all Temporary Facilities for the Contractor, including site office, stores, security fencing, entrance and exit gates, sewage and water lines systems, electrical supply, access, and facility roads.

The program shall clearly list all activities requiring the Engineer's input and reflect any agreements regarding responses outside the standard response time.
The program shall include but not be limited to mobilization of staff, procurement of facilities, information required from the Engineer and deliverables to be submitted.

A narrative that clearly states any assumptions made by the Contractor, any items that the Contractor identifies as being at risk, and any action required to be undertaken by the

Engineer shall support the Mobilization Program.

2.2. Mobilization Requirements

Mobilization shall consist of preparatory and execution works and operations, including but not necessarily limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to the work site; for the establishment of offices, buildings, and other facilities necessary to commence work on the Project; and for other work and operations which must be performed, or costs incurred prior to beginning work on the various contract items on the project site.

Mobilization shall include providing submittals as detailed in Appendix 4 and elsewhere in this document. This will include the proposed Organization Chart that shall be submitted for approval by the Engineer.

The Contractor shall complete construction of all Temporary Facilities for the Contractor and mobilization of all Key Personnel, equipment, and plant in such a time frame that the start and progress of works is not delayed due to late mobilization.

3. TEMPORARY FACILITIES FOR THE CONTRACTOR

3.1. General

3.1.1. This section describes the minimum Temporary Facilities with required infrastructure that will need to be provided by the Contractor for the Works. These include, but are not necessarily limited to the provision and maintenance (including all reasonable operating costs) of:

(1) Site offices, huts, workshops, warehouses, and stores;

(2) Temporary utilities such as water, electricity, and sewage connections;

(3) mobile and fixed; Telephones, internet access,

(4) sanitary, and medical facilities;

(5) Enclosures, access roads, and fencing;

(6) Safety procedures for the Contractor's rail traffic and compliance with requirements of the Particular Conditions;

(7) Provision of an operation and control system for vehicle movements within the site of rail-mounted equipment;

(8) All necessary police, highway, and utility approvals or authorizations necessary for the Temporary Facilities and controls;

(9) Material transportation facilities inside the Contractor's site facilities, like cranes, lifting plant and machinery, with their foundations, rooms, etc. as required;

(10) Other facilities related to site transportation;

(11) Road vehicles for material transportation, site transportation, and Work vehicles;

(12) All equipment to be assigned to the Temporary Works including requirements for ladders, planks, hoists, scaffolding, and similar items;

(13) Security for the whole of the worksite from access to the commencement of Trial Running.

The Contractor shall use all means necessary to maintain the Temporary Facilities and control in proper and safe condition throughout the progress of the Works, moving as required during the construction of the Works and remove the same from the Site on completion of the Works and ensure that the area is left free of debris, excess materials, and obstructions.

The minimum major Temporary Facilities for the Contractor are described below.

3.2. The Contractor's Site Offices

The Contractor's site office shall be provided within or in the vicinity of the work site with all necessary facilities including furniture, office equipment, office supply, utilities services, sanitary systems, etc.

Adequate parking space for the vehicles shall be provided at the site offices.

3.3. Contractor's Labor Accommodation and Camps

The Contractor shall supply, equip and maintain for the Contract period all his own living accommodation, sheds, and stores necessary for the execution of the Work, and shall make his own arrangements with the owners of any land required and, if necessary, pay for its use.

The accommodation shall comply with the appropriate Government Regulations, and standards like the National Building Code, Republic of the Philippines. No dwelling shall be constructed with non-insulated metal walls, Thatch will not be permitted. Married Quarters as necessary shall be provided in the Contractor's camp. All hutments and buildings shall be adequately equipped furnished. The Contractor shall also construct and maintain adequate roads or paths to all hutments and buildings.

All hutments and buildings must at all times be open to inspection by the Engineer and officers of the public health authorities and any instruction given for the proper cleaning, disinfecting and general maintenance in a building must forthwith be carried out by the Contractor.

Temporary living accommodation for the use of watchmen and a limited number of workers and emergency personnel may be provided by the Contractor within the Site. The accommodation shall be kept clean and hygienic at all times.

The Contractor shall supply, equip and maintain facilities as necessary for the living accommodation such as providing separate living quarters and toilet facilities for men and women personnel, feeding and welfare of its employees by providing, servicing, and maintaining a camp at the Contractor's Main Site Office or other sites as necessary.

3.4. Warehouse/ Store

The Contractor shall have on the Site a suitable workshop, adequately equipped and provided with utilities, to allow for repairs of the equipment employed to carry out the Works. He shall also provide a warehouse for spare parts for his equipment mainly for the parts that frequently fail or are difficult to procure. A chief foreman qualified for mechanical repairs, with an adequate labor force must manage the workshop.

The Contractor shall provide, erect, construct and equip all offices, workshops, stores, sheds, loading and unloading facilities and the like required by him, complete with all machines and equipment and all services, access roads, rail tracks and the like, required by him for the site depot, in consultation with the Engineer.

3.5. Vehicles

The Contractor shall provide all necessary road vehicles for material transportation at the site depots like trucks (with cranes), trailers, and cars. Vehicles shall also be provided by the Contractor for site transportation of labor where necessary.

Furthermore, the Contractor may also provide road-rail vehicles such as track-type (with cranes), etc. where required for cable laying, material transportation at the sites, etc.

Competent licensed drivers shall be appointed for all the vehicles and the vehicles shall be well maintained throughout the Contract including during the Defect Notification Period.

3.6. Utilities for Temporary Facilities

3.6.1. Water

All water required for and in connection with the equipment and plants, devices, dust control, for settling of backfill material, or for any other use as may be required for proper completion of the Works, shall be provided by and at the expense of the Contractor. No separate payment for water used.

3.6.2. Temporary Power and Lighting

(1) Temporary power shall consist of temporary power for construction operations and temporary lighting.

(2) The Contractor shall provide all power for operation of his plant and equipment, or any other use, including cooling and lighting of buildings for use by the Engineer.

(3) The Contractor shall arrange with the utility company to provide and pay for the service required for power and lighting.

(4) The Contractor shall provide temporary lighting for all work areas and buildings, to protect the Works and maintain suitable working conditions. Temporary lighting shall be maintained in all areas under the control of the Contractor.

(5) The Contractor shall provide and install circuit and branch wiring, with area distribution boxes located so that power and lighting are available throughout the construction site.

(6) Standby Generators with a suitable capacity shall be furnished by the Contractor to cope with the cases of power supply cut-off.

3.6.3. Air Conditioning

The temporary facilities shall be equipped with air conditioning units to provide climate control to the temporary facilities.

3.6.4. Telephone

The Contractor shall make all necessary arrangements and pay all costs for operation and installation and usage charges of telephone service to the Contractor's offices at the site.

3.6.5. Internet

The Contractor shall provide the necessary arrangement and pay all costs for operation and installation and usage charges of the internet service to the Contractor`s offices at the site.

3.6.6. Sanitation

The Contractor shall furnish temporary sanitary facilities at the Site, as provided herein, for the needs of all construction workers and others performing work or furnishing services on the Project. Sanitary facilities shall be of sufficient capacity, properly maintained throughout the construction period, and obscured from public view to the greatest practical extent. The Contractor shall enforce the use of such sanitary facilities by all personnel at the Site.

Separate sanitary facilities for male and female personnel shall be of sufficient capacity, properly maintained throughout the construction period, and obscured from public view to the greatest practical extent. The Contractor shall provide separate sanitary facilities accessible to male and female workers. The Contractor shall ensure that the ratio of fixtures for male and female sanitary facilities is 1:2.

3.6.7. Drainage

(1) The Contractor shall construct and maintain at his own cost a system of surface drainage and waste disposal. Sanitary conveniences for the use of persons employed on the Project shall be provided and maintained by the Contractor in accordance with the appropriate laws and regulations in force in the Republic of the Philippines. All persons connected with the Project shall be obliged to use them.

(2) For any sudden floods that may occur, pumping and dewatering shall be carried out by the Contractor.

3.6.8. Fire

(1) The Contractor shall construct, equip and administer at his own cost fire control points in such positions and of such size as will provide an adequate service for the protection against fires on work areas and buildings, stores, and properties on the Site.

(2) He shall provide and maintain a proper warning system to ensure that fire-fighting equipment can be concentrated on a fire before it has had time to spread.

3.7. Maintenance of Temporary Facilities

The Contractor shall keep all offices, stores, and other areas set up during the Contract clean and litter-free. The Contractor shall be responsible for dealing with all forms of vermin at the Site during the Contract to the satisfaction of the Engineer and in accordance with local authority requirements. The Contractor shall be responsible for maintenance costs and charges arising from the facilities provided or used by him and the Engineer site supervision staff until completion of the Contract.

3.8. Damage to Existing Property

The Contractor will be held responsible for any damage to existing structures, works, materials, or equipment because of his operations or the operations of any of his

Subcontractors. The Contractor shall repair or replace any damaged structures, works, materials, or equipment to the satisfaction of the Engineer, and at no additional cost to the Employer.

The Contractor shall be responsible for all damage to streets, roads, railroads, curbs, sidewalks, highways, shoulders, ditches, embankment, culverts, bridges or other public or private property, which may be caused by the transport of equipment, materials or people to or from the Works.

3.9. Access to Temporary Facilities Sites

The Contractor shall construct entry and exit roads to/from and around all Temporary Facilities. Entry and exit points should be accessible to all personnel, including those with disabilities and those who might find themselves handicapped at any point in the project's development.

Security fencing shall be constructed around all Temporary Facilities. Fencing shall be provided with lockable gates at each entry and exit point.

Suitable external lighting shall be provided at the entrance to all buildings.

3.10. Additional land for Construction Purposes, Detours, Plant and Other Uses

The Contractor shall acquire, if needed, additional working areas in the vicinity of the Works or elsewhere for his camp, yard, for the storage of equipment, for his own office buildings, housing, quarters, stores, plant yard, workshops, offices, and any additional areas required for construction purposes and access or other uses.

Before entering the working site, the Contractor shall give written notice to the Engineer. The Contractor shall give separate notices for each owner and occupier or authority having charge over the working sites.

Before entering any additional working areas, the Contractor shall obtain, and forward to the Engineer, a copy of the written consent of the owner and occupier or authority having charge over the land and stating the purposes for which such land is to be used. The Contractor shall define the extent and periods of occupation for which such consent is granted.

The Contractor shall select, arrange for, and if necessary, pay for the use of sites for construction purposes, detours, plant, and other uses necessary for the execution of the Works.

Before any land belonging to the Government or a private landowner is used for any purposes in connection with the execution of the Work, the Engineer's approval shall be obtained.

Prior to placing the facilities in any area, all clearing and grubbing operations shall be to the satisfaction of the Engineer. The ground elevation of all temporary facilities shall be a minimum of 20 cm above the adjacent existing ground. The surface shall be adequately sloped to allow rainwater to adequately drain.

If any utility for water, electricity, drainage, etc., passing through the temporary site will be affected by the Works, the Contractor shall, at his own expense, provide a satisfactory re-alignment or alternative in full working order to the satisfaction of the owner of the utility and the Engineer, before the cutting or removal or relocation of the existing utility.

On completion of the Contract, or earlier if so directed by the Engineer, all plant, Temporary Facilities, and any other encumbrances shall be removed, the site and land use areas shall be properly cleaned, all damage made good, and, if necessary, the land-owner paid for the use of the land.

4. PROJECT MANAGEMENT BY THE CONTRACTOR

4.1. Contractor's Management Plans

4.1.1. In order to ensure satisfactory execution of the Contract, completion of the Works within specified time, and quality in design, manufacturing, and execution of work, a series of Contractor's Management Plans shall be developed.

4.1.2. 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 Employer's Requirement - Technical Requirements (ERT) in respect of the subjects listed.

4.1.3. The respective Plans shall be submitted for the Engineer's Approval as per the submission schedule furnished in Table 4-1 of Appendix 4 attached hereto.

4.1.4. All Plans shall be updated and resubmitted at an interval of between 6 to 12 months as approved by the Engineer.

4.2. Project Management Plan

4.2.1. The Contractor shall submit a Project Management Plan, which 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.

4.2.2. The Contractor shall submit the Project Management Plan for the Engineer's Approval as per schedule of Table 4-1 of Appendix 4 attached to hereto. The Engineer will review the Contractor's Project Management Plan and will have the right to require the Contractor to make amendments as deemed necessary. The Contractor shall submit a detailed revised plan within 15 days of the review of the Engineer. The Project Management Plan shall include;

(1) A diagram showing the organizational structure for the management of the Contract, with locations, names, and position titles of Key Personnel 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 Engineer. All Key Personnel and those holding senior positions, as designated by the Engineer, shall be given a Notice of No Objection prior to their engagement and mobilization. Approval may be withdrawn at any time in the event of incompetence, non-performance, or misconduct. Any person so removed shall be replaced without delay by a substitute given a Notice of No Objection by the Engineer. The Contractor shall not be entitled to any claim for any expenses whatsoever incurred by him in respect of any direction given by the Engineer under this Clause nor any claim for extension

of time arising from this Clause. All Key Personnel shall be employed on a full-time basis until the issuance of the final Taking Over Certificate or such other time as the Engineer may instruct.

(2) 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.

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

(4) The Deputy Project Manager shall coordinate activities of the design offices and manufacturing works. The Deputy Project Manager shall be responsible to the Project Manager for all works executed outside the Republic of the Philippines and in the Republic of the Philippines for ensuring that effective coordination is maintained with the various manufacturing units of the Contractor, Subcontractors, and Interface Contractors and that contract delivery schedules are met.

(5) The Project Manager shall, be on-site in the Republic of the Philippines and devote himself full-time to the Project, commencing not later than 30 days after the Commencement Date.

(6) To fulfill the Contractor's obligations during the Testing and Commissioning and the Defect Notification Period, the Contractor shall nominate experienced engineers and organize deployment after obtaining the Engineer's Approval before undertaking testing and commissioning in depot and track.

(7) The contractor shall engage staff with the requisite professional licenses and certification to undertake the duties to which they have been assigned.

(8) The Key Personnel and those holding senior positions, as designated by the Engineer, shall be employed on a full-time basis until the issuance of the Taking Over Certificate (or such other time as the Engineer may instruct).

4.3. Interface Management Plan

4.3.1. In order to ensure seamless railway systems, the Contractor shall prepare an Interface Management Plan detailing their approach to interface management and coordination with interfacing contractors and third parties e.g., utility providers.

4.3.2. Interfacing Contractors shall include but not be limited to the following:

(1) Package CP N-01: Viaduct Structure and 2 Stations
(Bridge Works, Calumpit and Apalit Stations Works: 34KM+749 to 51KM+670)

(2) Package CP N-02: Viaduct Structure and 1 Station
(San Fernand Stations Works: 51KM+670 to 67KM+440)

(3) Package CP N-03: Viaduct Structure and 2 Stations
(Angeles and Clark Stations Works: 67KM+440 to 79KM+560)

(4) Package CP N-04: Railway Structure and CIA Station
(Viaduct/At Grade/ Tunnel/ CIA Stations Works: 79KM+560 to 86KM+177)

(5) Package CP N-05: Depot Building and Civil Works

(6) Package CP NS-03: Rolling Stock – Limited Express Trainsets

(7) Package CP NS-02: Rolling Stock – Commuter Trainsets

(8) Package CP S-01: Viaduct Structure and 1 Stations

(9) Package CP S-02: Railway Structure and 4 Stations
(10) Package CP S-03a: Railway Structure and 3 Stations
(11) Package CP S-03b: Railway Structure and 1 Stations
(12) Package CP S-03c: Railway Structure and 2 Stations
(13) Package CP S-04: Viaduct Structure and 2 Stations
(14) Package CP S-05: Viaduct Structure and 4 Stations
(15) Package CP S-06: Viaduct Structure and 3 Stations
(16) Package CP S-07: Depot Building and Civil Works
(17) Independent Safety Assessor (ISA)
(18) Package CP01: Elevated Structures, 7 Stations and Depot;
(19) Package CP02: Elevated Structures, 3 Stations
(20) Package CP03: Rolling Stock;
(21) Package CP04: E&M Systems and Track Works
(22) Package CP05: Elevated Structures, 1 station.
(23) Package CP107: Rolling Stock for MMSP;
(24) Package CP106: E&M System and Track Works for MMSP;
(25) Package CP101: Civil work and Depot for MMSP;
(26) Packages CP102,103,104,105 and 108 Civil work for MMSP
(27) O&M Concessionaires.
(28) 3rd Party Interfacing parties such as authorities, utility companies, and other Stakeholders.

4.3.3. The Contractor shall develop and submit for the Engineer's Approval as per the schedule of Table 4-1 of Appendix 4 attached hereto, an Interface Management Plan, The Interface Management Plan shall include:

(1) Scope

Interface management and coordination arising from this contract, with interfacing contractors and third parties.

(2) Interface Management Organization

The contractor shall be responsible for all aspects (Liaise, Interface Identification, Technical Solution, Complementary studies, Implementation planning) of interfacing with third parties.

The Contractors organization shall be such to guarantee timely integration and coordination with other systems and civil works.

(3) Deliverables

a. Interface Matrix

The Contractor shall systematically identify all interfaces and list these interfaces with a brief description and naming of the interface counterparts in an Interface Matrix regardless of the contractual relationship. This Interface Matrix is a live document and shall be update regularly.

b. Interface Agreement

Each Interface must be described with an Interface Agreement which shall define the authority and responsibility of the Contractor and Interface Contractors (and any relevant subcontractors) staff involved in the interface management and development;

Define the information to be exchanged, precise division of responsibility between the Contractor and Interface Contractors, implementation planning (to be compliant with base line program) and integrated tests to be performed at each phase of the Contractor's and Interface Counterparts' works; and

"Child" requirements as a result of interfacing shall be listed in the Interface Matrix.

The Engineer shall review such Interface Agreement and comment with justified observations.

c. Meetings

The contractor shall regularly chair meetings. The frequency shall be adjusted to an as need basis.

(4) Requests for Information

The contractor shall use RFI's (Request for Information) for clarification or to escalate an interface resolution.

4.4. Works Program

4.4.1. Programming Software and Structure of Programs

(1) Programming software to be used shall be Primavera P6 (Release 16 or later). The program submission shall be in both hard copy and soft copy. Electronic copy shall be in the compatible template with Primavera Cloud. All Programs shall be prepared in terms of durations of days and weeks from the Commencement. "Day" used throughout the contract shall mean "calendar day" and "Week" shall mean "calendar week". All programs shall be developed as critical path networks, and the Critical Path shall be clearly shown in the bar charts or networks. All programs should be submitted with standard Activity Reports (showing Times, Floats, etc.) and Narrative statements, explaining the programs. A Time Chainage Program shall be prepared using Tilos 7.0 (or latest version) or similar which allows import and export of linear works program with Primavera P6.

(2) All programs shall be developed by computerized Critical Path Method (CPM) network using the Precedence Diagramming Method (PDM) and shall be presented in either bar chart or time-scaled network diagram format, suitably colored to enable easy reading. The Critical path shall be clearly marked on the bar charts and networks. Cost and resource loading will be done on the program only if the Engineer asks for it.

(3) Details of the program structure are given in Appendix 2 attached hereto.

(4) The Contractor shall be responsible for teaching programming software to the Employer's staff who are monitoring the progress of the Works.

(5) During the initial mobilization period, the Contractor shall provide the Engineer with four (4) complete sets for each of these software packages (refer to item (1) shown

above) together with all documentation, standalone licenses, and maintenance contracts covering the full duration of the Project from Commencement Date to the issue of the Performance Certificate. The Contractor shall arrange the installation of these software packages as directed by the Engineer.

4.4.2. Different Program Submission Requirement

(1) Program

The Contractor shall submit a program that shall clearly and concisely demonstrates completion of the Milestones and Key Dates and also the whole of the works by the Time for Completion specified. All the programs shall be compatible with each other and shall be in sufficient detail to assure the feasibility of the Contractor's approach to meet the contractual obligations.

(a) Design Submission Program

This 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. It should take due account of the design co-ordination interface periods with other Interface Contractors, as planned by the Contractor. The design stages should be clearly identified and the appropriateness of design sequence and correlation with manufacturing activities established.

The Design Submission Program should take due account of the design coordination interface periods with other Interface Contractors and be consistent with the Works Program.

(b) Works Program

This shall indicate how the Contractor intends to organize and carry out the Works and achieve stages and complete the whole of the Works by the Time of Completion. The Works Program should also meet the milestones of the Contract. The shipment schedule of major components shall be provided as part of the Works Program.

The scheduling approach to the design, manufacture, delivery, installation, testing, and commissioning, integrated tests and any other required tests, and their inter-relationships shall be shown in the Works Program. These shall contain sufficient detail to enable a clear and concise evaluation of the Contractors intentions.

The narrative statement shall also indicate which elements of the Works the Contractor intends to carry out off-shore and/or in the Republic of the Philippines, with details of the proposed locations of where any such work is to be carried out, the facilities available and any third party undertaking the Contractor may have in this regard. In particular, the Contractor must state the assumptions made in respect of the interfaces with the Employer, the Engineer, other contractors, and third parties both in detail and time, and any requirements for information on matters, which would affect his works.

(c) Time Chainage Program

This shall indicate all Key Dates and Access Dates in the contract documents and identify potential interface milestones with other Contractors if these are not be specified in the contract document. It should include all the major activities from mobilization, site preparation, construction, installation, and testing & commissioning along the alignment.

It should be prepared based on the general approach and method of installation. The construction direction and sequence of works shall be consistent. The planned resources and construction rate should be applied to associated activities.

For the specific works, which are not linear, in the depot, station, and substation, shall be prepared separately (if necessary) and summarized in the overall Time Chainage Program.

(2) Post - Contract Programming Requirements

After the contract award, the Contractor shall submit:

a) Detailed Time Program (Baseline Program)

The Contractor shall develop and detail out his Design Submission Program and Works Program submitted in a Detailed Time Program (including Detailed Works Program and Detailed Design Submissions Program), within 28 days after the Commencement Date. This should incorporate suitable modifications as per the requirements of the Engineer, and amendments to take into account the work of other interfacing contractors.

The program shall make provision for the time required for review procedures, determining and complying with the requirements of all those, whose consent, permission, authority, and license is required prior to the execution of any work.

The Contractor shall note that at the time of submission, his Programs have yet to be coordinated with the other Interface Contractors. These shall not prevent the Contractor from submission of programs using approximate dates for work of the other Interface Contractors (where such dates are not available), which has an impact on the other Interface Contractor's programs. Such programs shall be amended subsequently to take into account the actual schedules of the other Interface Contractors. It is the Contractor's responsibility to ensure timely coordination with all the Interface Contractors to finalize his programs so as not to affect the progress of the Works or those of the Interface Contractors.

The Detailed Time Program shall be reviewed by the Engineer within 21 days. Additional re-submission and review may be required as per the Conditions of Contract. Upon acceptance of the program by the Engineer and the Employer, the Detailed Time Program shall be deemed as "Baseline Program", against which the progress of the Works shall be measured.

b) Time Chainage Program

This should be updated and submitted with the Detailed Time Program. It will serve as a general guideline for all site activities. Detailed construction program, if required by the Engineer should be developed and aligned to all the start and finish dates in Time Chainage Program. aa

4.4.3. Baseline Program Updating and Revisions

As the Works progresses, it may be necessary for the Contractor to update the Baseline Program, based on the approved variations, actual dates, and progress, but such updating shall only be carried out in accordance with GC8.3 or on the instruction of the Engineer or when directed by the Employer. Any revised program and supporting report shall describe the revised methods which the Contractor proposes to adopt in order to expedite progress and complete within Time for Completion. No revisions shall be made to the contract completion date, except as authorized by the Employer, and as authorized under the Contract. Each revision of the Baseline Program should be submitted with an updated Time Chainage Program if the site activities are adjusted to meet the original or revised completion dates.

4.4.4. The Contractor may be asked to submit by the Engineer, subprograms of a particular portion of the Work or other programs like, what–if programs showing different options, based on work requirement.

4.4.5. It should be noted that once trial operations commence and operation control is undertaken by the O&M concessionaire then there will be restrictions to access the sections which are in his operational control and duration during which works can be undertaken. Works should be planned and undertaken in accordance with these restrictions.

4.5. Quality Assurance Management Plan

4.5.1. The supplying Contract shall be executed within the framework of an efficient quality system. The international standard ISO 9001 is the standards of reference for the QA requirements applicable to the Contractor's (or subcontractor's) activities:

(1) Design,

(2) Manufacturing,

(3) On-site activities.

4.5.2. The Contractor shall submit an Outline Quality Assurance Management Plan, illustrating the intended means of compliance with the Employer's Requirements and setting out in a summary form an adequate basis for the development of the more detailed document. The Outline Quality Assurance Management Plan shall contain sufficient information to demonstrate clearly the proposed method of achieving the Contractor's quality objectives with regard to the requirements of the Contract. Details about Quality Assurance Management Plan to be followed are given in Appendix 5 attached hereto.

4.5.3. The Contractor shall prepare the Quality Assurance Management Plan in detail and carry out the works subject to it.

4.5.4. The Quality Assurance Management Plan submitted to the Engineer for Approval as per the schedule of Table 4-1 of Appendix 4 attached hereto, shall contain sufficient information to demonstrate clearly the proposed method of achieving the quality objectives with regard to the requirements of the Contract.

4.5.5. The Quality Assurance Management Plan shall indicate the approach and structure that the detailed plan will take and shall include the following:

(1) A summary of the project requirements including all proposed quality activities;

(2) All quality assurance and quality control procedures proposed by the Contractor for his use in the execution of the Works;

(3) A list of all the codes of practice, standards, and specifications that the Contractor proposes to apply to his work; The Contractor shall provide the Engineer and Employer a hard and soft copy of any Standard or Code of Practice referenced in any submission or as may be required in the execution of the works. Should the Standard or Code of Practice be in another language other than English then an English translation shall be provided;

(4) The Contractor's proposals for internal and subcontractor quality assurance audits; and;

(5) 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 stored;

(6) Quality Control Points and Quality Hold Points during verification, surveillance, tests, trial, and commissioning activities;

(7) Procedure for maintenance of records of inspection/tests.

4.5.6. The Quality Assurance System shall be applied without prejudice to, or without in any way limiting, any Quality Assurance System that the Contractor already maintains.

4.5.7. The Contractor shall maintain the Quality Assurance Management Plan updated during the course of the execution of the Contract. All amendments to the original and approved Quality Assurance Management Plan shall be notified to the Engineer. The quality plan shall comprise:

(1) A Management Quality Plan for control of management related activities;

(2) A Design Quality Plan for control of design-related activities;

(3) A Manufacturing (including Inspection and Testing) Quality Plan for the control of related activities;

(4) Testing and Commissioning (including Integrated Testing and Commissioning) Quality Plan.

4.5.8. The Contractor shall submit a detailed organization chart identifying the responsibilities, authority, and interrelation of all personnel who manage, perform, and verify work involving quality in respect of all the Quality Plans. The organization chart shall be specific to this Contract. The chart shall identify the Quality Management Representative who shall act as the Quality Coordinator for the Contractor in all dealings with the Engineer.

4.5.9. The Contractor shall audit all the activities in each Quality Plan at quarterly intervals or other such intervals as the Engineer may require ensuring the continuing suitability and effectiveness of the quality management system. The Contractor shall make available upon request any document, which relates to his recent internal audits.

4.5.10. The Engineer will require compliance audits of the Contractor's and suppliers' quality system to be conducted. Not less than two (2) weeks a notice will be given by the Engineer. During audits, the Contractor shall provide suitably qualified staff to accompany the auditors.

4.5.11. All suppliers and subcontractors used by the contractor shall be given a Notice of No Objection prior to the commencement of the manufacture and commencement of their works. A detailed submission for each supplier shall be made which shall include as a minimum, scope of works, company organization, experience in supplying product or service, and quality management systems. Supplier familiarization visits, Quality Inspections at the manufacturer's facilities, First Article inspections, Type Tests, Routines Tests, and Factory Acceptance Tests shall be undertaken for all material and equipment to be supplied for this contract. For all these inspections and tests a maximum of four people will attend from the Employer and Engineer. All costs associated with these inspections either offshore or onshore including transportation, accommodation, insurances, expense, etc. for the Employers and Engineers staff shall be borne by the Contractor.

4.5.12. Prior to any Quality Inspections, First Article inspections, Type Tests, Routines Tests and Factory Acceptance Tests, all submissions related to the inspections and tests shall be given a Notice of No Objection.

4.5.13. Prior to the start of any construction activities or the installation of any equipment, a mockup shall be constructed which shall be given a Notice of No Objection by the Engineer and shall be used as the standard for all future installation. The items to be included in the mockups and the locations of the mockups shall be agreed with the Engineer.

4.6. System Assurance Management Plan

4.6.1. The Contractor shall submit, within 45 days from Commencement Date of the Works, a comprehensive System Assurance Management Plan (SAMP), as per the requirements of the Contract, for the Engineer's Approval.

4.6.2. The Contractor shall carry out the system assurance activity based on EN50126, JIS Standard, IEC62278, or internationally accepted equivalent. The SAMP and program shall be certified by the Contractor's internal department or by a third-party independent engineer from the design and manufacturing sector. The SAMP shall be specifically developed for this Contract. The SAMP shall address Reliability, Availability, Maintainability, and Safety (RAMS). This shall ensure the E&M Systems has a high degree of reliability and minimized downtime.

4.6.3. The SAMP shall also include a configuration management tracing system. This system shall be in place throughout the contract to ensure that all deliverable items of equipment are of the same configuration. All changes to equipment and configuration change control processes shall include the phases of configuration identification, control of changes, and configuration verification.

4.6.4. The SAMP shall ensure that the E&M Systems are designed and developed to:

(1) Be safe, with either proven operational evidence or have adequate evidence-based justifications for their use;

(2) Be safe including proven electromagnetic compatibility;

(3) Be certified for revenue service;

(4) Be reliable;

(5) Be optimized for maintainability;

(6) Have high levels of inherent availability.

4.6.5. This plan is intended to provide the basis for integrating system assurance across the Project, leading to the achievement of safety certification and the delivery of world-class RAM performance across the project.

4.7. Site Safety Management Plan

4.7.1. The Contractor shall submit a Site Safety Management Plan, which shall contain sufficient information to demonstrate clearly the Contractor's proposals for achieving effective and efficient safety procedures in the installation, assembling, testing, and commissioning of the Railway Systems. The Site Safety Management Plan should include an outline of the safety procedures and regulations to be developed and the mechanisms by which they will be implemented for ensuring safety requirements, site safety, and transportation of Railway System equipment.

4.7.2. The Outline Site Safety Management Plan shall be headed with a formal statement of policy in relation to safety and shall be sufficiently informative to define the Contractor's Site Safety Plan and set out, in summary, an adequate basis for the development of the site safety.

4.7.3. The Contractor, its Sub-Contractors and suppliers of any tier and all employees performing any part of the Contract Works on the Site shall comply in every aspect with the provisions of any relevant statutory regulations, procedures manuals, and notices and/or with requirements of Philippines law as may be considered applicable to the Works or "The Guidance for Management Safety for Construction Works in Japanese ODA Project", September 2014, Japan International Cooperation Agency (JICA), whichever is the more onerous.

4.7.4. The Contractor shall submit a Site Safety Management Plan for the Engineer's Approval as per the schedule of Table 4-1 of Appendix 4 attached hereto. The Site Safety Management Plan shall contain sufficient information to demonstrate clearly the Contractor's proposals for achieving effective and efficient safety procedures and solutions in the installation, assembling, testing, and commissioning of the Railway Systems.

The Site Safety Management Plan shall contain, but not limited to, details of the following:

(1) A policy statement signed by the top management of the Contractor, declaring that the Contractor shall ensure that safety and health are given the highest priority in all aspects of the Works.

(2) The statutory and contractual obligations regarding safety and health imposed on the Contractor, and the means by which the Contractor shall supervise, monitor, and audit his site safety assurance system to ensure due compliance with these obligations.

(3) Site organization structure for safety staff, which shall identify personnel to be engaged solely on-site safety assurance purposes and shall list their responsibilities;

(4) The powers vested in the Safety and Health Manager and other safety staff which would enable them to take urgent and appropriate action to make safe the Site and accident prevention practices.

(5) Emergency procedures and rescue teams. The Contractor shall formulate emergency procedures and organize rescue teams to deal with emergencies on the Site.

(6) Procedures during typhoons and heavy rainstorms, and emergency organization to maintain safety on Site during typhoons and heavy rainstorms;

(7) Methods of promoting awareness of site safety and health amongst all persons directly or indirectly associated with the Works.

(8) The frequency, coverage, and application of accident prevention and safety management courses. All workmen and supervisory staff shall be required to attend a safety induction course before they are allowed to commence work on Site, and thereafter at intervals of not more than six (6) months.

(9) An accountable record of all trained persons shall be kept by the Contractor. Each individual who has successfully completed training shall be given a unique identity card (ID).

(10) The safety equipment which will be required for the Works, including the quantity, sourcing, standards of manufacture, storage provisions, and means of ensuring proper and where appropriate mandatory utilization by all workmen and staff employed directly or indirectly by the Contractor.

(11) Protection of authorized visitors and prevention of entry of unauthorized persons to Site;

(12) Records to be prepared and maintained by the Safety Officer and safety staff. The records shall include all examination reports and test certificates required under the relevant regulations.

(13) Regulations and procedures covering all safety and health aspects of the Contract, including but not limited to the following, where applicable:

1) Housekeeping
2) Traffic control and transportation
3) Fire control precautions and Fire procedures
4) Working on the Operation Railways
5) Excavation
6) Welding, cutting operations and equipment
7) Electrical equipment
8) Personnel protection clothing and equipment
9) Lifting cranes, hoists, and other lifting appliances
10) Scaffolding and work platforms
11) Hand tools and portable power-driven tools
12) Structural steel erection

(14) This Plan shall consider the role of O&M Concessionaire during the staged opening for passenger service; particularly constraints that the O&M concessionaire may impose on sections that are in his operational control. For example, the possibility of restricted access curtailed work durations, etc.

Terms of reference, membership, and frequency of meetings of site safety working groups;
A comprehensive site safety and health checklist which when completed shall serve to record whether the Contractor complies with his statutory and contractual obligations at the time of the inspection.

4.7.5. Security of the railway operation shall be the first priority in the Site Safety Management Plan because the accident will cause significant disaster. It should draw attention to the following point, (1) Safety for Works in the Vicinity of Existing operating PNR lines; (2) Safety for Third-Party Disaster that the residents connecting to NSRP-South will concern; (3) Safety for prevention of railway accidents that the working personnel of the works will execute their procedure for. The detail for these three aspects of the Safety Plan are given below:

(1) Safety for Works in the Vicinity of Existing Operating PNR lines

Any adjacent works shall be restricted in order to ensure safety during the train operation. This restriction also includes the use of construction equipment such as backhoes, mobile cranes, and tracked loaders. The use shall not infringe the construction gauge of PNR's rolling stocks during their operation at any time. Where that equipment will be required to work in and on an area of the construction gauge, the manipulation of the equipment shall be conducted within non-traffic window time of the train operation.

Restricted activities in the vicinity of the PNR lines shall be carefully planned and applications for permission to carry out the restricted activities shall be submitted to the PNR. The restricted activities shall only be carried out after permission is obtained from the PNR and the Engineer. The provisions and approval requirements as stipulated by PNR shall be followed.

Construction activities within the railway protection and safety zones shall be considered restricted activities in the following cases:

1) The movement or operation of any crane, whether fixed or mobile, hoist, ladder, drilling or piling equipment, excavator, or any other mechanical equipment or vehicle;

2) The installation of boreholes, wells, sheet piles, pile foundations, ground anchors, and horizontal tie-backs;

3) The storing and placing, or causing or allowing the storage or placement of, any goods, material or thing or any solid, liquid or gaseous matter or substance;

4) The digging or excavation of trenches or pits, the carrying out of earthworks and backfilling, or the shifting or pushing of earth or soil from one area to another, whether or not such activities are carried out manually or by mechanical means;

5) The erection of poles, offices, sheds, warehouses, workshops, shelters, tents, scaffolding, maintenance towers, ladders, hoardings, and other similar temporary structures; and

6) The use of explosive material for the purpose of blasting, demolition, or removal of rocks.

The slope face of cut and embankment works shall be properly protected so that collapse due to the works will not happen during or after their construction. This protection will ensure to avoid collision between collapsed material and operational rolling stocks and to prevent the obstruction on track rails that causes derailment. It is essential that a proper retaining wall prevents the collapse of an excavated ditch/pit that may damage an adjacent rail roadbed structure.

Where temporary storages of the construction material and equipment are adjacently located along the railway track, proper clearance between the storages and track shall be kept. This clearance means allocating the storage out of the area of a roadbed level in principle. If the storage will inevitably overlap the roadbed level, the storage shall also be considered that stored goods will not interfere with the train operation in case of a load collapse and scatter.

(2) Safety for Third Parties

It is essential that the hoarding will isolate the construction works from any third party interfacing with MCRP. The hoarding will consist of existing PNR's fencing and supported by temporary barriers such as crowd control and traffic barrier. These temporary barriers would be arranged at locations that the third-party individuals could easily enter the works site. Such entry points should be equipped with noticeable information boards and picket guards to ensure that individuals entering the site are well informed.

The traffic diversion for the loading and unloading of materials/equipment into site premises shall be managed in safe manner. The traffic diversion shall consist of traffic barriers, markings, signs, and impact attenuators as necessary. In addition, the traffic personnel shall guide construction working vehicles and direct traffic flow on the road. The management plan of this traffic diversion shall also include obtaining consent from the relevant authorities to mitigate the traffic jam due to the relevant works.

Any utilities that will be affected by the construction works shall be protected. This protection shall comply with the regulations of the relevant authorities such as electricity, telecommunication, water supply, sewerage, gas, and the lands owned by PNR itself. Before executing the protection works, each alignment condition shall carefully be identified with visual inspections and official registers. Especially, underground lines shall ensure the identification accompanied by the trial trench if that alignment condition would be controversial between the record and on-site conditions. This trial trench should also observe to detect abandoned lines with surveillance of the relevant authorities.

(3) Safety organization for prevention of railway accidents

The security organization for the works in the railway roadbed level shall be established in accordance with PNR's safety regulation. This organization provisionally assigns the following responsible personnel:

1) A Superintendent who is responsible for this organization for the prevention of accidents. He is obligated to arrange preventive measures and communicates with the relevant department such as stations, operation controls, and maintenance in case of emergency.

2) A Foreman who is responsible for the safety instruction and working procedures of their laborer,

3) A Railway Watchman who is responsible of the approaching/passing train to motion the personnel for confirming their perception and evacuation, and

4) A Laborer who is instructed to execute the works by the superintendent/foreman considering the safety precautions such as the railway track entry, site ambulation, track crossing, prohibition of solo works, and evacuation from the approaching/passing train.

Railway watchmen shall be assigned in full service at each working site, and this deployment shall also relay information of the approaching/passing train through intermediate one where the direct sight could be impractical. Before starting the works, the deployed watchman shall motion the superintendent/foreman about their readiness. Once the train has been perceived, the watchman shall repeat their motion until the personnel will reply to their perception and evacuation. Then the watchman shall motion the rolling stock operator for a clearance on the track is safe.

The measures for an abnormal case, where accidents may happen, shall immediately be taken with the train protection communicating with the relevant department in order to obey its direction. It should prevent railway disaster with any sort of the following train protection.

4.7.6. The Contractor shall erect temporary safety fences and hoarding to prevent unauthorized access to its work sites and to the railway during the works train operation. The design of fences and hoarding, and material use therein shall Site Safety Management Plan be given a Notice of No Objection by the Engineer before starting installation.

4.7.7. The Contractor shall designate a member of his staff as a Safety Officer in addition to the Safety Manager. The Contractor shall maintain a First Aid Post at all times when personnel are on Site. First Aid Boxes shall be maintained in a fully equipped state at all times. The Contractor shall ensure that at least one employee on every working shift, is a trained First Aider, capable of administering first aid competently until the arrival of professional help, in an accident situation.

4.7.8. The Contractor shall be fully responsible for the safety of the Works, his personnel, his subcontractors' personnel, the public, and any persons directly or indirectly associated with the Works, or on or in the vicinity of the Site. The Contractor shall treat safety measures as high priority in all his activities throughout the execution of the Works.

4.7.9. The Contractor shall submit to the Engineer, regular Site Safety Reports, and shall notify immediately the occurrence of an accident involving his staff or that of his subcontractors, or to any person within the area of the Site for which the Contractor is responsible.

4.7.10. Other training should include:

1. Conduct/Ethics/Behavioral Coaching
2. Gender-Based Violence (GBV) and Sexual Harassment (SEAH) Awareness and Response Training
3. HIV-AIDS Awareness and Response Training
4. Other relevant training that the Employer and Engineer may deem necessary.

Employment status should include monitoring of the above-mentioned training content compliance.

4.7.11. The Contractor shall be responsible for all matters related to the safety health and welfare of its Sub-Contractors and suppliers of any tier and all employees performing any part of the Works on the Site, and shall comply in every respect with the provisions of all relevant statutory regulations, procedures, manuals, and notices and with all requirements of the Philippine laws as are applicable, including but not limited to:

(a) ADB recommendations to DOTr concerning COVID-19 dated 21st May 2020:

(i) World Health Organization. 2020. Considerations for Public Health and Social Measures in the Workplace in the Context of COVID-19. Geneva.

https://www.who.int/publications-detail/considerations-for-public-health-and-social-measures-in-the-workplace-in-the-context-of-covid-19

(ii) Government of the United Kingdom. 2020. Working Safely During COVID-19 in Construction and Other Outdoor Work: Guidance for Employers, Employees and the Self-Employed.

https://assets.publishing.service.gov.uk/media/5eb961bfe90e070834b6675f/working-safely-during-covid-19-construction-outdoors-110520.pdf

(iii) The Canadian Construction Association. 2020. COVID-19 – Standardized Protocols for All Canadian Construction Sites.

https://www.cca-acc.com/wp-content/uploads/2020/04/CCA-COVID-19-Standardized-Protocols-for-All-Canadian-Construction-Sites-04-16-20.pdf

4.8. Software Quality Assurance Management Plan

4.8.1. The Contractor shall submit a Software Quality Assurance Management Plan for the Engineer's Approval as per schedule of Table 4-1 of Appendix 4.

4.8.2. The Software Quality Assurance Management shall include the cybersecurity and threat management, the transfer of relevant software copyrights and intellectual property rights.

4.9. Risk Management Plan

4.9.1. The Contractor shall produce a Risk Management Plan (RMP) in accordance with ISO 31000 and/or PMI-Standard Practice for Project Risk Management. The Risk Management Plan shall describe how the Contractor intends to:

(1) integrate risk management into the team culture, planning, construction activities, and decision-making processes;

(2) Anticipate and respond to the changing nature of the works, social, environmental, and regulatory requirements proactively;

(3) Mitigate risks pragmatically to a level that is As Low As Reasonably Practicable (ALARP) given the particular circumstances of each situation;

(4) Implement a robust and sustainable risk register that is created, maintained, and managed in accordance with the Risk Management Plan, and

(5) Ensure consistency and uniformity for all project risk mitigation measures as well as providing a basis for the review and control of the mitigation measures.

4.9.2. The Contractor shall, within twenty-eight (28) days of the Commencement Date, prepare and submit to the Engineer his Risk Management Plan in accordance with Clause 4.10.1

4.9.3. The Contractor shall, within 30 days of the commencement date and at all times throughout the duration of the Contract, engage at least one Risk Management Representative to be employed and based full time on the Project. The Contractor shall submit the Risk Representative's CV and credentials to the Engineer for approval.

4.9.4. The Risk Management Representative shall be suitably qualified (minimum degree qualification in Risk Management or railway/construction/risk related subject) and ideally shall have at least ten (10) years of experience in risk management at a minimum level of Assistant Manager.

4.9.5. The Risk Management Representative shall be employed solely on project risk management activities.

4.9.6. Risk Organization Structure

(1) The Contractor shall establish an effective risk management reporting structure to enable structured communication in managing and supporting the risk management process.

(2) The Contractors senior site representative (Project Manager or equivalent) shall be responsible for the overall risk management function.

4.9.7. Project Risk Management Process

4.9.8. The Contractor shall implement a risk management process which shall:

(1) Identify risks and their associated impact(s) on the Works in terms of design, technical, procurement, constructability, health & safety program, cost, third parties, financial, reputation and political risk along with operational risk, natural event risk, human factor risk and environmental risk & impacts;

(2) Analyze risks by estimating the probability of their occurrence and the time and cost impact of each risk event;

(3) Minimize the impact of risks on the project objectives through the identification and implementation of appropriate risk mitigation measures;

(4) Allocate risks to the most appropriate risk owner and risk Actionee to implement the risk mitigations, and

(5) Evaluate the success or otherwise of the implemented risk mitigations and establish the need for further action until the risk can be closed out.

4.9.9. Risk Identification

(1) Within thirty (30) days from the submission date of the Contractors RMP, the Contractor shall undertake an initial risk workshop to consider all associated risks on the Contract and to populate the Contractors risk database. Following the initial populating of the Contractors risk database, the Contractor shall be responsible for the regular updating and use of the risk database as a management tool.

(2) The Contractor shall review and update the risks stored in the risk database regularly (at least once every month) to ensure that the risk information is current.

(3) The Contractor shall systematically identify all possible risks which have a potential impact on the Project.

4.9.10. Risk Workshops

(1) The Contractor shall schedule and attend regular monthly risk workshops to

identify, review, and report on risks associated with delivery of the Contract and to continually update his risk database.

(2) The risk workshops shall be led by a competent member (ideally Project Director) of the Contractor team who has experience in the construction methods proposed and in risk management and shall be facilitated by the Contractor's Risk Management Representative. Other Contractors management staff, including risk owners, and where appropriate, sub-contractors and or other technical specialists who are involved in daily construction activities, shall be required to attend the risk workshops.

(3) The Contractor shall invite representatives from the Engineer and Employer to attend each risk workshop to assist and actively participate in risk identification and the review and development of associated risk mitigation measures.

4.9.11. The Contractor will utilize Active Risk Manager (ARM), a web-based project risk database, and provide two user licenses for the Engineer and one for the Employer. The Contractor shall maintain a record of all identified risks and issues and opportunities, including their status and history, in the risk database. The Contractor shall be responsible for updating and maintaining the risk database on an ongoing basis throughout the Contract duration.

4.9.12. Treatment of Risks

(1) The Contractor shall minimize the impact of risks on the project through the identification and carrying out of appropriate mitigation actions. Risk mitigations shall be SMART i.e. specific, measurable, attainable, realistic, and time-bound.

(2) Risk mitigations recorded in the risk database shall be complete, unambiguous, and sufficient to reduce the risk level So Far As Is Reasonably Practicable (SFAIRP). The risk mitigations shall also be described in sufficient practical detail so that they can be readily understood.

(3) Risk mitigations for each individual (single) risk shall be allocated to a risk owner, who shall be a staff member of the Contractor, and who shall be responsible for ensuring that the mitigation measures identified on that risk are completed as required.

4.9.13. Risk Monitoring and Control

(1) Through the monthly risk workshops the Contractor shall review the current risk exposure and as appropriate the probabilities of occurrence and associated impacts.

(2) Through the monthly risk workshops, the Contractor shall actively monitor the implementation of risk mitigation measures. Any necessary changes to previously agreed mitigations shall be recorded in the risk database.

4.9.14. Risk Close Out

(1) Residual project risks are defined as those project risks that have a probability of occurrence greater than zero and could affect future railway operations. The Contractor shall use the risk closeout process to identify residual project risks for handover to the Employer at the completion of the handover phase of the Project.

(2) The Contractor shall submit to the Engineer for approval its Project Risk Close-Out Register before issuance of the Taking Over Certificate. The Project Risk Close-Out Register shall form one of the conditions precedents to issuance of the Taking Over Certificate.

4.9.15. Risk Management Audits

(1) The Engineer may undertake audits on the Contractor to assess the effectiveness of their implementation of risk management activities as stated in the Risk Management Plan and on the policy and procedures as set out in the Contract. Audits will be conducted once every six (6) months throughout the duration of the Contract.

(2) Following each audit, a formal audit report will be issued by the Engineer for the Contractor to respond to and take any necessary corrective or preventative actions. Should there be any unsatisfactory observations or non-conformances identified during the audit, the Contractor shall propose to the Engineer, for approval, corrective/preventive actions, together with an appropriate closeout date, within 14 days after receiving the audit report.

(3) The Engineer will approve the proposed corrective actions and verify and accept the proposed corrective/preventive actions by the Contractor. Subsequently, the Engineer will verify the evidence for closure of the unsatisfactory observation/NCR during the next audit.

(4) The Engineer will inform and may invite the Employer to attend and observe the audit sessions.

4.10. COVID-19 Risk Management Plan

4.10.1. The Contractor shall submit a COVID-19 Risk Management Plan to safeguard all people on Site through a monitoring, education, and PPE approach. Application of the COVID-19 Risk Management Plan shall comply with DPWH Department Order No. 39, 2020 issued 19th May 2020 or any successor to the Order.

4.11. Environmental Management Plan

4.11.1. The Contractor shall submit an Environmental Management Plan illustrating the intended means of compliance with the Republic of the Philippines's standards, law, ordinance, and other regulations on the environment and the Employer's Requirements. The Environmental Management Plan shall also contain sufficient information to demonstrate clearly the proposed method of achieving the environmental objectives with particular reference to air, water, noise, vibration, and waste.

4.11.2. The Contractor shall submit, within 60 days after the Commencement Date, a detailed and comprehensive Environmental Management Plan to the Engineer for approval. The Environmental Management Plan shall contain sufficient information to demonstrate clearly the proposed method of achieving the environmental objectives with particular reference to air, water, noise, vibration, and waste together with a monitoring plan. A Noise and Vibration Analysis Report shall be submitted as part of the Environmental Management Plan. The Contractor shall also comply at all times with any other mandatory requirements, local safety, security, Project Environmental Impact Statement (EIS) report, and other regulations in force and to which the Works are subject, including any requirements specified by the fire brigade.

4.11.3. The provisions listed herein regarding environmental protection shall apply to and be binding upon the Contractor for any works on the Site and the persons employed by Subcontractors. The Contractor shall ensure that proper and adequate provisions to this end are included in all Subcontracts placed by him. These provisions shall not be applicable in the case of emergency works necessary for saving of life and property or safety of the Contract Works.

4.11.4. The Environmental Management Plan (EMP) shall include the technological approaches which aim to implement an efficient, effective, practical and economical application of the technologies in order to prevent, eliminate or control the negative impacts. Example of the environmental management efforts through the technological approaches are:

(1) Control air and noise pollution as affected by the operation of heavy-duty equipment in the construction phase;

(2) Anticipate the occurrence of erosion and landslides from earthworks;

(3) Control the quality of surface water as well as underground water, as affected by construction works and disposal of liquid wastes;

(4) Collect and store used oil and lubrication fluids in a drum;

(5) Provide temporary toilets; and

(6) Anticipate and control any interruption to traffic stability during the construction.

4.11.5. The Contractor should comply with the EMP (Environmental Management Plan) and EMoP (Environmental Monitoring Plan) that are described in the latest version of the EIA report for the MCRP and NSRP-South. The Draft EIA's requirement for the Contractor's Environmental Management Plan (construction Stage) are given below in Table 4 -1

4.11.6. The Draft EIA's requirement for Contractor's Environmental Monitoring (Pre-construction Stage) and Construction stage are given below in Table 4 - 2 and Table 4 - 3 respectively

4.11.7. The draft plans are for information only and the contractor is expected to prepare a specific plan based on project-specific requirements.

Table 4 - 1: Draft EIA's Requirement for Contractor's Environmental Management Plan (Construction stage)

Category	**Item**	**Expected Environmental and Social Impacts**	**Key Mitigations Measures**
Pollution control	Air pollution	Air pollution caused by emissions of gas from construction machine and vehicle, dust from construction works and materials as well as construction traffic	1) Sprinkling water at construction site 2) Proper storage of construction materials including covering sand and gravel that are easily diffused into the atmosphere 3) Covering bulk materials during transportation 4) Regular maintenance of construction machines and vehicle reduce emissions
	Water pollution	1) Discharging turbid water from construction site 2) Generation of domestic wastewater from temporary construction office or related facilities	1) Discharging turbid water through sedimentation ponds or after simple turbid water treatment 2) Installation of temporary septic tanks or other wastewater treatment facility for workers
	Waste	1) Surplus soil waste and other waste from construction 2) Waste of existing devices replaced with newly installed devices such as bricks, ballast, etc. 3) Solid and liquid wastes discharged from temporary construction office and other facilities	1) Reduce, reuse and recycle of construction and other types of waste 2) Disposal of waste in a proper way 3) Installation of temporary sanitation facilities such as septic tank at construction office and other facilities
	Noise and vibration	Impacts of noise and vibration by construction machineries and vehicles	1) Installing noise barrier and selecting low-noise equipment as needed,

Category	Item	Expected Environmental and Social Impacts	Key Mitigations Measures
			especially near the residential area and/or sensitive receptor 2) No construction activities with heavy equipment during nighttime if there are any sensitive receptors nearby 3) Prior notice of construction schedule near the residential area
	Offensive odor	Offensive odor due to excavation or dredging in drainage channels or creek	Consideration of additional mitigation measures depending on an odor source and condition
Natural Environment	Flora, fauna, and biodiversity	Loss of trees and other plant species	Replanting trees in suitable area as needed based on prior consultation with the relevant administrative authorities
	Hydrological situation/drainage system	Potential impacts on hydrological situation or drainage condition surrounding of MCRP&NSRP-South Line due to improvement of drainage system of MCRP &NSRP-South Line	1) Site patrol 2) Consideration of additional mitigation measures if any issues are confirmed
Social Environment	Existing social infrastructure and services	1) Road traffic congestion in the surrounding area during the construction period of level crossing and other facilities 2) Inconvenience for PNR	1) Advance announcement of construction schedule 2) Preparation and implementation of the Traffic Management Plan by the Contractor including arrangement of watchmen and detour road signs
	Infectious diseases such as HIV/AIDS	Risks for infectious diseases due to inflow of construction workers	Awareness of public health for workers and local communities
	Working condition including occupational	1) Accidents in the operation of construction machinery and other works	1) Compliance with the requirement of Labor Law 2) Preparation of a safety

Category	Item	Expected Environmental and Social Impacts	Key Mitigations Measures
	health and safety	2) Risk of occupational health and safety for workers in case of severe working conditions	and health management plan and enlighten occupational safety to workers 3) Providing proper personal protective equipment (PPE) such as helmet, safety jacket, gloves, and safety shoes for workers
Others	Traffic accident	The risk of accidents would be higher for passengers, informal occupants, and other nearby residents due to their habits of crossing railway lines and the land of PNR by walk and occupation on railway yard and the land of PNR with shops, huts, and vendors	Manage the construction site to prevent local people from entering the site by barricading and the site security gate.
	Climate change	GHG emissions from construction vehicles and machines	Saving on electricity in construction sites and offices such as vehicle idle reduction.
	Hazardous materials and oil management	Spoil of fuel or hazardous substance that is used for construction work	Training workers on appropriate handling of fuels and chemicals Measures for spill control and leakage control system

Table 4-2: Draft EIA's Requirement for Contractor's Environmental Monitoring (Pre-construction stage)

Category	Key Monitoring Item	Location	Frequency
Common	1) Review and update of the Environmental Management Plan based on the detailed project design 2) Preparation of safety management plan for construction phase	Project area	Once before commencement of construction work

Table 4-3: Draft EIA's Requirement for Contractor's Environmental Monitoring (Construction stage)

Category	Key Monitoring Item	Location	Frequency
Common	Progress of conducting mitigation measures	Project area	Monthly and quarterly during the construction period
Air quality	1) Site patrol 2) Checking received complaints from residents 3) Monitoring of air quality	Representative point(s)of construction site(s)	1) Monthly 2) Whenever received 3) When needed
Water quality	1) Site patrol 2) Monitoring of parameters stipulated by National Environmental Quality (Emission) Guideline	Creeks nearby construction site(s)	1) Monthly 2) Biannually
Waste	1) Site patrol and housekeeping at construction site 2) Checking waste-disposal method	Construction site(s)	1) Monthly 2) Monthly
Noise and vibration	1) Site patrol 2) Received complaints from residents 3) Monitoring the noise and vibration level	Construction site(s)	1) Monthly 2) Whenever received 3) When needed
Cutting of trees	1) Check of species and number of trees that need be cut 2) Prior consultation with the relevant administrative authorities in charge.	Construction site(s)	1) Quarterly 2) Once or more
Existing social infrastructure and services	1) Collection of complaints 2) Physical observation of road traffic condition 3) Interviewing/discussing with Traffic Police	Construction site(s)and surroundings	1) Whenever received 2) Every day of the construction period 3) When necessary
Infectious diseases such as HIV/AIDS	1) Received complaints from residents 2) Record of awareness activities	Construction site(s)	1) Quarterly at minimum 2) Quarterly
Working condition including occupational health and safety	1) Site patrol 2) Record of implementing the safety and health management plan	Construction site(s)	1) Monthly at minimum 2) Quarterly
Traffic accident	1) Site patrol 2) Record of accidents 3) Record of safety-awareness campaign and other measures	Construction site(s)	1) Monthly at minimum 2) Monthly 3) Monthly

Category	Key Monitoring Item	Location	Frequency
Hazardous materials and oil management	1) Site patrol to check the condition of handling or storing hazardous materials 2) Record of training on handling hazardous materials for workers	Construction site(s)	1) Monthly 2) Quarterly

4.11.8. The Contractor shall submit, within 60 days from Commencement Date of the Works the following for the Employer's assessment and approval:

1. Code of Conduct

The Contractor shall furnish a copy of their Code of Conduct which should include specific prohibitions against GBV, and in particular, a prohibition of any sexual activity with children, defined as anyone under the age of 18, residing in the project area. It shall also further define a range of sanctions proportionate to the event, for example, warnings for incidents of community harassment, such as catcalling, versus dismissal for incidents of sexual abuse.

2. GBV Action Plan

A GBV Action Plan, which should include mechanisms, sanctions, and mitigation procedures in handling GBV-related cases during project implementation. The GBV Action Plan must be compliant with the Legal and Policy Framework provided by the Employer. It shall properly address the requirements stated under GC 6.8, 6.9, and 6.11.

The Contractor has the following options in formulating the GBV Action Plan:

(i) Sub-Contracting a local GBV Service Provider

The Contractor has the option to subcontract a local GBV Service Provider to handle GBV-related cases during project implementation.
The Contractor shall submit a company profile of their nominated GBV Service Provider as part of the Bidding Documents, for the Employer's assessment and approval. The nominated GBV Subcontractor must provide items listed in Section (ii), to measure their capacity in handling GBV-related cases for the project.

(ii) Formulation of a project-specific GBV Action Plan

Contractors should demonstrate that they have the capacity to manage GBV risks. For the project's GBV risks to be properly addressed, it is necessary to have an effective 'GBV Action Plan', which outlines:

- How the project will put in place the necessary protocols and mechanisms to address the GBV risks; and,
- How to address any GBV incidents that may arise.
  The GBV Action Plan needs to include specific arrangements for the project by which GBV risks will be addressed. This includes components such as:
- Awareness Raising Strategy, which describes how workers and

local communities will be aware and sensitized to GBV risks, and the Employer's responsibilities under the CoC;

- Policies Governing the Workplace, which details clear policy regarding non-tolerance of sexual harassment in the workplace. These are also expected to be included, as minimum requirements, in the Contractor's Code of Conduct. Illustrative templates should be developed for these policies.
- GBV Intake Mechanism, which will detail how the Employer will receive GBV-related complaints, data- gathering in relation to the complaints, and the necessary subsequent procedures thereafter;
- GBV Referral Mechanism, to which the Employer will refer GBV survivors to necessary government offices, local police, and other potential sources of further action and services;
- GBV Monitoring and Evaluation Strategy, which describes the safety measures to be implemented for the benefit of monitoring the general condition of the project;
- GBV Allegation Procedures; how the project will provide information to employees and the community on how to report cases of GBV CoC breaches to GRM.

4.12. Inspection, Testing, and Commissioning Management Plan

4.12.1. The Contractor shall submit an Inspection, Testing, and Commissioning Management Plan as per schedule of Table 4-1 of Appendix 4 attached hereto, for the Engineer's Approval as specified in Chapter 9 of this Employer's Requirement - General Requirement (ERG) and required in the Employer's Requirement - Technical Requirement (ERT).

4.13. Earthing and Bonding Strategy Plan

4.13.1. The Contractor shall submit for approval an Earthing and Bonding Strategy Plan which shall include such items as methods of earthing, separation, resistance values, etc. This document will ensure consistency across multiple Civil and E&M Systems Contractors.

4.14. Review Periods for Contractor's Submissions

4.14.1. The Engineer shall review those Contractor's plans, designs, and program submissions which require his Approval or otherwise within 21 days from receipt of the hard copy of the submissions. The Contractor shall re-submit his plans and programs within 14 days of the receipt of the Engineer's comments.

The Engineer will endeavor to review and respond to the Contractor on the adequacy and acceptability of the Contractor's submissions and re-submissions as soon as reasonably possible, but the Contractor should always allow for a 21- day review period.

The Contractor shall allow in his program a 21-day review period for all submissions to the Engineer.

Any submissions received that do not meet the required quality and content shall immediately be rejected by the Engineer and shall not be subject to review.

4.15. Failure to Make Submissions

4.15.1. Failure of the Contractor to submit any plan and program, or any required revisions thereto within the time limits stated shall be sufficient reason for certification that the Contractor is not performing the work required in a timely manner. The Engineer may certify retention of payment under the Milestone-related Cost Center proposed for the Contractor until his plans and programs are accepted/consented by the Engineer.

4.16. Plans and Program Revision

4.16.1. The Contractor shall revise his plans and programs whenever necessary, with the consent of, or as required by the Engineer to ensure completion of the Works within the Time for Completion for the Works.

4.17. Planning and Programming Staff

4.17.1. The Contractor shall employ sufficient number of planning and programming staff competent in the use of the programming software and with a good knowledge of the type of work required to be performed by the Contractor under the Contract.

The Engineer shall have the discretion to require the Contractor to replace his planning and programming staff if the Engineer considers that they do not have the training or skill required for this specialized nature of work.

4.18. Project Calendar

4.18.1. Project Weeks shall commence on a Monday. A day shall be deemed to commence at 0001 hours on the morning of the day in question. Where reference is made to the completion of an activity or Milestone by a particular week, this shall mean by midnight on the Sunday of that week.

4.19. Progress Reporting

4.19.1. Progress Reports, as detailed in Appendix 3 attached hereto, shall be regularly submitted by the Contractor, on a monthly basis.

4.19.2. The contractor shall submit weekly progress dashboards, one for the overall contract, and other individual dashboards for each railway system. The dashboards shall be accompanied by a detailed Material Control Schedule which tracks and records all material procurement activities. The formats used are to be agreed upon and given a Notice of No Objection by the Engineer.

4.20. Co-ordination and Interface with Interface Contractors and Others

4.20.1. The Contractor is responsible for detailed co-ordination of his design, manufacturing, construction, testing and commissioning activities with those of the Interface Contractors and Consultants whether or not specifically mentioned in the Contract, who may be working for the purpose of the Project. The interfaces also cover all works undertaken on adjacent projects such as MMSP and NSCR.

4.20.2. The Contractor shall note that there are other contractors, consultants, agencies, etc. which the Employer may engage from time to time, and with whom the Contractor shall have to similarly co-ordinate. Such coordination responsibilities of the Contractor shall include the following, but need not be limited to:

(1) To provide all information reasonably required by the Interface Contractors in a timely and professional manner to allow them to proceed with their design, manufacturing, construction activities, and to meet their milestones and work program dates, if any.

(2) To ensure that the Contractor's requirements are provided to all other Interface Contractors, in a timely and reasonable manner.

(3) To obtain from the Interface Contractors information reasonably required, to enable the Contractor to meet his own design submission dates.

(4) To ensure close coordination with the contractors in charge of the Signaling System in respect of the provision of Signaling System equipment in the cars and finalizing the interface between the rolling stock and Signaling System equipment.

(5) Where the execution of the work of the Interface Contractors depends upon the site management or information to be given by the Contractor, the Contractor shall provide to such Interface Contractors the services, or the correct and accurate information required, enabling them to meet their own program or construct their own works.

(6) To ensure that there is no interference with the works of Interface Contractors.

(7) To attend regular coordination meetings convened by the Interface Contractors and the Engineer. The Contractor shall conduct separate meetings with the Interface Contractors as necessary to clarify particular aspects of the designated requirements of the Works. A record of the decisions taken in each such meeting shall be furnished to the Engineer. The party who convenes the meetings shall prepare minutes recording all matters discussed and agreed at the meeting.

(8) To ensure that all correspondence, drawings, meeting minutes, programs, etc. relating to the Contractor's coordination with the Interface Contractors are issued to all concerned parties and four copies issued to the Engineer no later than seven calendar days from the date of such correspondence and meetings.

4.20.3. The Contractor shall, in carrying out his co-ordination responsibilities, raise in appropriate time and provide sufficient information for the Engineer to decide on any disagreement between the Contractor and the Interface Contractors as to the extent of services or information required to pass between them.

4.20.4. If such disagreement cannot be resolved by the Contractor despite having made all reasonable efforts, then the decision of the Engineer shall be final and binding on the Contractor.

4.20.5. Where an Interface Contract is yet to be awarded, the Contractor shall proceed with the co-ordination activities with the Engineer until such time as the Interface Contractor is available. The Contractor shall provide the Interface Contractor with all information necessary to enable the Interface Contractor to follow-on and proceed with their co-ordination.

4.20.6. Any claim of additional costs by other Interface Contractors as a result of the Contractor's failure to keep to specified dates shall be borne by the Contractor. The Contractor shall note that the information exchange is an iterative process requiring the exchange and updating of information at the earliest opportunity and shall be carried out on a regular and progressive basis in order for the process to be completed for each design stage by the specified dates.

4.20.7. The Contractor shall establish a dedicated Interface co-ordination team of managers, engineers, supervisors, technical staff, experts, and support staff, led by an Interface Coordinator reporting to the Contractor's Project Manager. The primary function of the team is to provide a vital link between the Contractor's design and manufacturing teams and the Interface Contractors. The Engineer shall have the right to require the replacement of the Coordinator if in his opinion the Coordinator is unable to meet the coordination requirements of the Contract. The Contractor's attention is drawn to the need for the Coordinator to establish effective dialogues and communication links with the Interface Contractors. The Contractor's coordination team shall comprise a mix of personnel with experience in both design and manufacture of rolling stock necessary for effective coordination.

4.20.8. The Coordinator shall assess the progress of co-ordination with the Interface Contractors by establishing lines of communications and promoting regular exchange and updating of information so as to maintain the Contractor's program.

4.20.9. The complexity of the Project and the importance of ensuring that the work is executed within time limitations require detailed programming and monitoring of progress so that early program adjustments can be made in order to minimize the effects of potential delays.

4.20.10. The Coordinator in conjunction with the Interface Contractors shall identify necessary provisions in the Works for plant, equipment, and facilities of the Interface Contractors. These provisions shall be allowed by the Contractor in his design of the Works.

4.20.11. During the course of the Contract, information will be obtained in a number of ways, including direct inspection, regular site meetings, the obtaining of progress reports, and the use of turn around documents to obtain design and program data. Turnaround documents shall be issued to the Interface Contractors to be returned giving the current positions on their program.

4.21. Spare Parts Management Plan

4.21.1. The Contractor shall submit for Approval by the Employer a Spare Parts Management Plan. This plan shall include, but not limited, to the following:

(1) List of O&M Spares

(2) Quantities of O&M Spares together with calculation to determine holding and usage.

(3) List of proposed Capital Spares and lead for purchase by the Employer.

4.21.2. The Contractor shall submit the Spare Parts Management Plan not later than twelve (12) months prior to the issue of the Taking Over Certificate for a System, a Section, or the Works.

5. WORKS TRAIN OPERATIONS

5.1. Requirements during the Construction

5.1.1. The Contractor shall implement works train operation which shall be in accordance with the Works Train Manual that has been given a Notice of No Objection by the Engineer.

5.1.2. The Contractor shall prepare for Approval and implement a Works Train Manual that will cover the operation of its works trains and the management of access to the site: The manual shall cover, but not be limited to, the following topics:

(1) General Safety Requirements, including training and qualification, accident prevention, riding on works train, track crossing and clearance, safety inspection, work train notice, personal protective equipment, warning sign and notices, smoking, etc.;

(2) Definitions of Defined and Restricted Areas.

(3) Communication Rule, including the use of communication equipment, radio communication rules, hand signals, train horn signals, and line side signage;

(4) Signal Rules including signal types and meaning, and safety requirements and precautions to be observed while operating works train, etc.;

(5) Rule Governing Track Access and possession's etc.; for all contractors engaged on this project.

(6) Management of access for all parties and planning through regular Works Trains Meetings.

(7) Work Permits for high risk works such as working at height, confined space, hot work, lifting work, etc.;

(8) Work Train Operations Rules for normal, degraded, and emergency operation and include planning of works train activities, execution of works train activities, fault reporting and handling, adverse weather arrangement, incident and accident management and investigation, etc.;

(9) Turnout and Switch Operation including qualification of switch operator, turnout and switch operation safety requirements and work process;

(10) Traction Power Control Rules, including general operation safety requirement, emergency power cut, authorization to interrupt traction power supply, power isolation for engineering possession, testing electrical power supply to the power rail, use of power rail short circuit device, local operation of traction power switchgear and transfer switch, confirmation of clear area, notification of traction power supply restoration, permission to restore traction power supply, etc; and

(11) Track Trolley Operation Rules including types of track trolleys, restriction on the use of track trolleys, personal protective equipment to be worn when using a track trolley, loading and unloading, pre-use check (wheels & brakes), warning lamps, operating a track trolley, moving over points, securing and storing a track trolley when not in use, etc.

5.1.3. Whilst working in the tunnel sections additional suitable ventilation shall be provided by the contractor to ensure air quality standards are met and that an airflow of 0.3 m/s is maintained.

5.1.4. The contractor shall provide portable earths and live line testers to ensure construction work undertaken by any party will remain safe when being undertaken in the vicinity of energized tracks.

5.1.5. The contractor shall provide all multi-aspect lamps and flags and associated equipment for protecting the work site during possessions

5.1.6. A temporary communication system and equipment for the works train operation such as portable radios shall be provided. Additionally, other communication equipment shall be provided to allow communication with all other Works Train operation staff.

5.1.7. Prior to the track becoming a Defined Area all-access, egress, and areas close to the track shall be secured with necessary barriers and signage provided and installed by the Contractor.

5.1.8. The Contractor shall be responsible for managing all access and permits to the railway until handover to the Employer for commencement of Operations.

6. DESIGN SUBMISSION REQUIREMENTS

6.1. General

6.1.1. The objective of the design submission process is to ensure that the proposed resulting works comply with the ERT, are capable of being produced consistently to exacting quality standards, achieve low life cycle costs, and can be operated safely to the satisfaction of the Engineer.

6.1.2. The system and all equipment shall be able to withstand the environmental conditions experienced along the entire NSCR alignment. Where figures are not stated the contractor shall submit for approval the conditions to which the design has been based which shall include temperature, relative humidity, solar radiation, wind velocity, lightning, vibration and shock, proximity to coastal areas, flood and earthquake.

6.1.3. The design submissions include Design Reports, which shall include design calculations, simulation and calculation, and all other design-related information and Design Drawings.

6.1.4. In the event that a statutory body (e.g., Government of Republic of the Philippines - Department of Transport, etc.) requires design information in a particular format, it shall be incumbent upon the Contractor to provide the same, as directed by the Engineer.

6.2. Review of Data

6.2.1. As soon as practicable after Contract award, the Contractor shall review all applicable data, criteria, standards, directives, and information provided to him as the basis for design. Any apparent inconsistencies or erroneous information shall be brought to the attention of the Engineer. Such information shall not alleviate the Contractor from his responsibilities under the Contract.

6.3. Format of Deliverables

6.3.1. The format and exchange of all deliverables shall be in accordance with the "BIM Information Management Flow" which shall be issued by the Engineer.

6.3.2. Drawing and CAD Standards. Reports, calculations, specifications, technical data, and similar documents shall be provided in A4 format, and one of the copies shall be ring bound to facilitate photocopying. A3 size drawings included in documents shall be folded to A4 size.

6.3.3. Drawing and CAD Data Format:

Within 30 days after the Commencement Date, the Contractor shall have prepared and submitted the Drawing and CAD procedure together with sample drawings and corresponding CAD data to demonstrate his understanding and compliance with Drawing and CAD Standards.

6.3.4. Building Information Model (BIM) Execution Plan for LOD 100 to 500

Within 30 days after the Commencement Date, the Contractor shall submit their BIM Execution Plan for LOD 100 to 500. The contents of this plan shall cover:

(1) Equipment to be deployed;

(2) Project Information;

(3) BIM design process;

(4) BIM information exchange;

(5) BIM and Facility Data Requirement;

(6) Collaboration and interfacing procedures;

(7) BIM Model Quality control procedures;

(8) BIM model structure;

(9) Technology Infrastructure Needs;

(10) BIM Project Deliverable;

(11) Delivery Strategy;

(12) Virtual Design Reviews and Clash Analysis.

The contractor shall produce all designs in internationally accepted and CAD and 3D formats given a Notice of No Objection by the Engineer. The details are of which are to be provided given a Notice of No Objection by the Engineer. The Contractor shall develop BIM models of all elements as a single system/discipline 3D model; each model shall be spatially coordinated in conjunction with the BIM models of the civil works and interfacing works, provided progressively by the Engineer and Interfacing Contractors, into a three-dimensional federated model using 3D object-based software; allowing for the fully coordinated design drawings to be annotated and extracted as required.

The final "as-built" model shall be LOD 500 (as per CIC BIM Forum LOD definition).

All the Contractors shall propose and submit to the Employer and Engineer the Line Replacement Unit (LRU) level for the BIM to identify the details on interface with

CMMS.

6.4. Number of Copies

6.4.1. The following quantities of drawings and other documents shall be submitted to the Engineer, including preliminary, pre-final, and final design submissions, the final contract document, and all other submissions. These drawings and documents are in addition to those required for the exchange of information between the Interface Contractors and other submissions to statutory, governmental, and local authorities if required.

(1) 4 full-size sets of paper drawings (folded and collated)

(2) 4 sets of Design Reports including design documents and calculations, structural analysis, simulation and calculation, and all other design-related information.

(3) 4 sets of all other submissions.

(4) 2 sets of each of the above in electronic format

6.5. Design Submission Program

6.5.1. The Contractor shall prepare the Design Submission Program which sets out fully the Contractor's anticipated program for the preparation, submission, and review of the Design Packages, the Final Design Submission, and the Installation and Manufacturing Drawing Submissions and for the Issue of Notices in relation thereto.

6.5.2. The Design Submission Program shall:

(1) be consistent with and its principal features integrated into the Works Program, and show all relevant major activities;

(2) identify dates and subjects by which the Engineer's decisions should be made;

(3) make adequate allowance for periods of time for review by the Engineer;

(4) indicate the Design Interface and Coordination requirement and periods for each Interface Contractor;

(5) include lists of requisite design details for each and every component or equipment of all systems.

The Contractor shall update the Design Submission Program suitably if the Engineer observes any deviation.

6.5.3. For the system and components of the Works or the Plant, the Contractor shall submit documents and drawings describing function description, product description, interface requirement description, RAM requirement description, life cycle calculations, type and routine test specifications, list, and details of spares, related calculations, etc. The Design Submission Program shall also include a listing of various plans, processes, and other submissions.

6.6. Design Process

6.6.1. The Contractor shall deploy the staff having sufficient experience in the design of similar works at all times to maintain liaison with the Engineer. The principal requirement of the design phase is to undertake the design during this phase in three stages:

(1) the preparation of the Preliminary Design;

(2) the preparation of the Pre-final Design; and

(3) the preparation of the Final Design.

6.7. Preliminary Design

6.7.1. The purposes of the Preliminary Design submission are as follows:

(1) State the design criteria;

(2) Design the overall system, and propose the system configuration;

(3) Identify the functions of each system, equipment, or other elements within the overall design, and specify the relationships and interfaces between elements of the system;

6.8. Pre-Final Design

6.8.1. In the Pre-final Design stage, the Preliminary designs (including interfaces with those of Interface Contractors of the Employer, and the Contractor's vendors) are required to be fully developed. In this stage, each element of the system will be considered and preliminary specifications with supporting calculations developed. Preliminary electrical and control schematics shall be developed to illustrate how various operational and functional requirements are achieved including structural analysis, simulation, and calculation. Software design and development shall also be carried out at this stage.

6.8.2. Manufacturing can only commence after receiving Approval from the Engineer. This submission shall include sufficient detail from prospective suppliers to demonstrate that they have an adequate understanding of the requirements. It will include either evidence of or proposals for design verification such as analysis and simulation. Interfaces with other Interface Contractors shall be finalized by this stage.

6.9. Final Design

6.9.1. The purpose of the Final Design submission is to agree with the Engineer that the equipment is satisfactory, compliant with the specification, fit for purpose, and safe. The Final Design shall be the level of design developed to the stage where all manufacturing drawings (including those received from Interface Contractors of the Employer, and vendors of the Contractor) are fully defined and specified and in particular:

(1) Calculations and analyses are complete;

(2) All main and other significant elements are delineated; and

(3) All other works, including studies, investigations, and reports are complete.

6.10. Design Submission and Review Procedure

6.10.1. All design submissions from the Contractor shall be accompanied by a Design Review Certificate Application (DRCA) notice. The forms and numbering system of the DRCA notice shall be subject to the issuance of a Notice of No Objection by the Engineer.

6.10.2. Upon receipt of design submissions from the Contractor, a copy of the DRCA will be signed, dated, and returned by the Engineer.

6.10.3. The Engineer shall issue a Design Certificate Consent (DCC) Sheet properly dated and numbered to the Contractor for each of the DRCA. The DCC will carry status as Notices of "Reject", "Notice of No Objection with Comments", "Notice of No Objection" and decisions made by the Engineer in response to the DRCA made by the Contractor. The

DCC sheet properly dated and numbered shall be sent to the Contractor. The consent sheet number shall be the same as the Design Review Certificate Application number except that the letters "DRCA" are replaced by "DCC".

6.10.4. When significant comments are noted by the Engineer on the design submission, the DRCA shall be returned "Rejected", and signed by the Engineer. One copy of the DRCA shall be returned to the Contractor together with the comments on why the submission was rejected.

6.10.5. When minor comments are noted by the Engineer on the design submission and it is "Notice of No Objection with Comments" the DRCA will have the appropriate decision indicated upon it and be signed by the Engineer. One copy of the DRCA, together with comments, will be returned to the Contractor.

6.10.6. A submission will be rejected automatically if not signed by the Contractor's Representative or the Contractor's Authorized Design Representative.

6.10.7. Upon receipt of a decision sheet from the Engineer, the DCC will be signed, dated by the Contractor, and returned to the Engineer.

6.10.8. To ensure efficient information management on the project the Engineer has determined that a web-based Electronic Document Management System (EDMS), shall be the only recognized method of transmittal for formal project correspondence, documents, drawings, models, data, and information. Where it is necessary to transmit original signed documents, these shall be acceptable forms of correspondence only when they have been issued via the EDMS. The format of all transmitted files shall be in both the native form and the Portable Document Format (PDF).

The Contractor shall use the EDMS selected by the Engineer during the whole project life cycle. The EDMS shall be used by all participants engaged on the Project, including the Contractor, Interface Contractors, Subcontractors, sub-Subcontractors, manufacturers, suppliers, and their subsequent legal successors in title.

All costs associated with licenses and/or tokens required for the EDMS shall be borne by the Contractor.

6.11. Engineer's Review

6.11.1. The Engineer will complete his review of the submission within 21 calendar days, after which the review comments will be furnished to the Contractor in writing. The Contractor shall then meet with the Engineer to discuss the review comments. Within two weeks of the receipt of the Engineer's comments, the Contractor shall submit his proposals for implementation in the next submission. Where the comments are minor, such proposals may be clarified by calculations, part prints, etc. acceptable to the Engineer and included in the Contractor's next submission.

6.11.2. After the Engineer reviews the design submissions, the Contractor shall update the documentation incorporating the Engineer's observations and also other design requirements. For all subsequent submissions, the Contractor shall demonstrate that all the previous comments by the Engineer have been incorporated. The Comments previously issued by the Engineer shall also become part of the submission.

6.11.3. The design submissions for the relevant design of Railway Systems shall require Approval by the Engineer.

6.11.4. Any submissions received that do not meet the required quality and content shall immediately be rejected by the Engineer and shall not be subject to review.

6.12. Final Design Document Delivery

6.12.1. To achieve agreement with the Engineer on the completion of the design and to allow the formal submission of the Final Design, the Contractor shall submit a list of all accepted design submissions to the Engineer for review along with self-adhesive stickers signed by the Contractor's Representative. If there is Approval by the Engineer, he shall then sign and return the self-adhesive stickers to the Contractor for affixing to the amended Final Design documents including Drawings (original) prior to their submission under the Final Design Document Delivery.

6.12.2. Based on the Engineer's review of the Final Design Submission, the Contractor shall then re-submit the entire Final Design Submission together with the following documents:

(1) joint statements of completed design interface with the Interface Contractors of the Employer, if applicable;

(2) a signed statement confirming that he has incorporated all comments of the Engineer;

(3) a Design Certificate duly endorsed, in the form accepted by the Engineer.

These above jointly will be known as "Final Design Document Delivery".

6.13. As-Built Drawings and Records

6.13.1. The As-Built Drawings are intended to show the Works exactly as constructed. These are prepared by amending the installation and manufacturing drawings to take into account changes necessitated by manufacturing methodology. These drawings shall be completed on a regular basis as the Works progress.

The As-Built Records shall include all record photographs, all test results, and all inspection records and shall be endorsed by the Contractor as true records of the execution of the Works.

The Contractor shall supply to the Engineer, the required numbers and types of copies of the relevant As-Built Drawing/Completion Drawings. The Works shall not be considered to be completed for the purpose of taking over until the Engineer has received these drawings.

6.13.2. Two full-size sets of paper copies and one set of electronic files of the As-Built Drawings shall be submitted to the Engineer prior to the commencement of the Tests on Completion.

Prior to the issue of the Handover Certificate and in accordance with the Conditions of Contract, the Contractor shall supply the 7 full-size sets and two sets of the electronic file of the As-Build Drawings and the 5 sets of hard copies and two sets of the electronic file the As-Build Records.

6.13.3. During the Defect Notification Period, if the Works would be modified due to the failure of the Contractor, the updated As-Built Drawings and Records shall be re-submitted at the end of the Defect Notification Period.

6.14. Post-Acceptance Changes

6.14.1. The changes to accepted drawings, whether they are initiated by the Contractor or the Engineer, shall be submitted through the procedure prescribed in Sub Clause 6.10 above. Upon acceptance of the post-acceptance change, the Engineer shall issue a DCC to this effect. Submission as a result of a post-acceptance change shall use a new DRCA number, i.e., not a previously used one.

6.14.2. The Contractor may propose an alternative procedure for implementing post-acceptance changes (hardware and software) for review of the Engineer.

6.14.3. For requesting any change to the accepted design, the Contractor shall submit the relevant design details for review of the Engineer. The Contractor shall not implement any change without receiving Approval from the Engineer.

6.15. Approval of Manufacturers and Suppliers

6.15.1. Details of all the proposed materials, assembly and component suppliers, manufacturers, and sub-contractors shall be submitted for Engineer's Approval.

6.15.2. The Contractor shall demonstrate in the submissions for supplier/manufacturer approval that all the proposed suppliers/manufacturers have successfully manufactured the same or similar items before for previous projects.

6.15.3. Information to be submitted for manufacturers and supplier's approval shall, as a minimum, be:

(1) name of Supplier;

(2) previous experience of supplying similar materials, component, assembly, or service;

(3) list of similar items supplied, or services rendered;

(4) for materials, components, and assemblies the internal testing facilities at the Supplier/manufacturer's works; and

(5) Supplier/manufacturer's quality procedures, organization, and certification.

6.15.4. The Contractor shall obtain Approval for the materials, assemblies, and components and their supplier/manufacturer or sub-contractor prior to confirming any order with a supplier, manufacturer, or sub-contractor. Supplier familiarization and quality inspections shall be undertaken as stated in Clause 4.5.11.

6.16. Material Control Schedule

6.16.1. The Contractor shall produce and submit for Approval a Material Control Schedule (MCS). The format of MCS shall be given a Notice of No Objection by the Engineer and shall contain the following minimum information:

(1) Materials, assembly or component description;

(2) Name, supplier/manufacturer;

(3) Country of supply/manufacturer;

(4) Drawing number, status, etc;

(5) Purchase order number/reference;

(6) Quantity;

(7) Approval status;

(8) Planned and actual production start date(s);

(9) Planned and actual finish date (s);

(10) Planned and actual date or release for shipment;

(11) Planned and actual arrival on Site;

(12) Date and quantity required on-site;

(13) Mode of transportation;

(14) Comments/actions; and

(15) Planned and actual installation requirements.

6.16.2. The MCS shall be updated and maintained as a live document.

6.16.3. Where the MCS shows a delay from the planned dates, the contractor shall provide for Approval details of the measures that will be undertaken to recover any delay experience.

6.17. Method Statements

6.17.1. The Contractor shall submit for the approval Method Statements and an Inspection and Testing Plans addressing all construction/installation procedures, safety, and health requirements, environmental control measure, and quality control procedures for each task not less than fifty-six (56) days prior to the start of the related construction/installation activities.

6.17.2. The Method Statement, material submissions, and Inspection and Testing Plan shall have received Approval prior to the contractor commencing any work on the task described.

6.17.3. Method Statements originating from sub-contractors shall have been reviewed and approved by the contractor prior to the submission.

6.17.4. Before the commencement of work, specific Method Statement training shall be provided to the supervisors and workers involved in the work, on the agreed safe work method and safety precautions to be implemented.

6.17.5. The Contractor shall provide to each of their site representative(s) involved with the works approved Method Statement(s), Inspection and Testing Plan(s), and other related document(s).

7. DOCUMENT AND DRAWING SUBMITTALS AND REVIEW

7.1. General

The Contractor shall transmit all submissions to the Engineer according to the procedure laid down in the following paragraphs. The general requirements are as follows:

The Contractor shall provide a non - web-based system of transmittal for formal project correspondence, documents, drawings, and information and ensure efficient information management on the Project. The Contractor shall provide the Project-wide use of the system during the Design and Construction Phases and also the Defects Notification Periods.

7.2. Project Document Control Procedure

Within twenty-eight (28) days after Commencement Date, the Contractor shall submit a Project Document Control Procedure to the Engineer for review, which shall include but not be limited to the following:

(1) a document approval system which shall specify the level of authority for approval of all documents and material before submission to the Engineer,

(2) a system of issuing documents to ensure that pertinent documents are issued to all appropriate locations,

(3) a document change or re-issue system to ensure that only the latest revision of a document can be used, and

(4) a submission identification system that identifies each submission uniquely by the following:

Contract number, Discipline, Submission number; and Revision indicator.

7.3. Document Submissions

7.3.1. The Contractor shall submit a Drawing Register to the Engineer in electronic copy and hard copy with each submission of drawings and at an interval agreed by the Engineer. The drawing register shall be in a format submitted for review and given a Notice of No Objection by the Engineer and shall include each document reference number, version, date, title, and data-file name.

7.4. Submission and Response Procedure

7.4.1. General

Where submissions related to the Works are required, except where specific procedures are given for certain items, all submissions shall be submitted and reviewed according to the procedure laid down in the following clauses.

7.4.2. Proposal

Each submission shall be accompanied by a brief introduction to explain which equipment, part, or section of the Contract Works to which the submission refers, listing the documents enclosed with the submission, and describing in outline how all relevant requirements of the Works Requirements are achieved by the proposals.

7.4.3. Submission Response Request

For each submittal, the Contractor shall prepare a Submission Response Request (SRR) carrying the date of submission, the submission reference number, the submission title, and the authorized signature of the Contractor's responsible engineer to confirm that, in the opinion of the Contractor, the submission:

(1) complies with all relevant requirements of the Works Requirements,

(2) conforms to all interface requirements,

(3) contains, or is based on auditable and proven or verified calculations or design criteria,

(4) has been properly reviewed by the Contractor, according to the Contractor's Quality Assurance System, to confirm its completeness, accuracy, adequacy, and validity,

(5) has taken account of all requirements for approval by statutory bodies or similar organizations, and that where required, such approvals have been granted, and

(6) contains 2 (two) properly signed copies of the Design Certificate (Form DC),

(7) Each design submission shall be accompanied by a design statement and compliance matrix which describes the scope and content of each submission, its underlying assumptions, and non-conformances.

7.4.4. Reports and Records

(1) The Contractor shall submit reports and records to the Engineer in a format and periodicity agreed by the Engineer. Reports and records shall be signed prior to submission by the Contractor's agent or by a representative authorized by the Contractor.

(2) The Contractor shall submit the documents as required by the Engineer as Project records in full and on time. The Engineer shall determine the adequacy of the Project record.

(3) The Contractor shall establish and maintain a place for the storage and archiving of all the documents relating to the Contract Works but not required to be submitted to the Engineer.

(4) Project records will eventually be used by the Employer to manage, operate, and maintain the Contract Works after the completion of the Project under construction and for future reference.

(5) The Contractor shall also submit the Interface Register with the status of the Interface progress along with the Monthly Progress report in the format as agreed by the Engineer with a 3 months extract showing those interface activities achieved during the previous month and those projected for the 2 months period ahead with details of any interfaces currently in progress and any that have been missed with mitigation proposals.

8. MANUALS AND DOCUMENTS

8.1. Manuals and Documents for Equipment and Systems

The Contractor shall produce manuals and documents for all the equipment and systems supplied in Railway System works. These shall include, but may not necessarily be limited to, the following:

(1) System Documents - a comprehensive description of all system principles at block diagram level,

(2) Operating/User Manuals - broken into as many sub-sections as may be necessary and providing sufficient information to enable non-technical staff to fully exploit the facilities of each system,

(3) Workshop Documents - installation and circuit descriptions, full schematics, circuits, wiring diagrams, mechanical construction drawings, and itemized parts list to enable all maintenance rectification and setting-up to be carried out,

(4) Software System Documents - for each software package and each piece of equipment which incorporates programmable devices and for which bespoke software has been prepared specifically for this application, source code listings with comprehensive comments shall be provided for all bespoke software together with configuration listings for all configured standard software packages,

(5) Equipment Room Documents - all wiring diagrams and circuits, equipment layout, terminal and cable listing, and including such external equipment as may be necessary for completeness.

(6) Maintenance and Servicing Manuals - to specify requirements, procedures, and service intervals for planned preventative maintenance and in addition to convey sufficient information on equipment principles and practice to enable first line fault diagnosis and rectification by technician staff.

8.2. Operation Manuals

8.2.1. The Contractor shall provide Operation manuals explaining the purpose and operation of the complete system together with its component subsidiary systems and individual item of equipment. The characteristics, ratings, and any necessary operating limits of the equipment shall be provided.

8.2.2. Content Structure

The Contractor shall arrange all documentation in accordance with the following guidelines for all Operation manuals:

(1) The first section shall be an overview of the functions provided by the systems.

(2) All functions shall be described, and all operator input clearly defined.

(3) All system operating sequences shall be explained.

(4) All indications and alarms shall be described together with the appropriate operator response.

(5) Descriptions of indications and operator inputs shall be accompanied by pictures or screenshots of the control interface.

(6) Lengthy technical descriptions of the systems in sections on operator input shall be avoided and if required shall be segregated into an appendix for reference.

(7) Relevant system block diagrams, drawings, flow charts, etc. shall be provided where these assists understanding of the text and the significance of the equipment alarms and status indications.

8.3. Maintenance Manuals

8.3.1. The Maintenance Manuals shall provide detailed instructions for the Railway Systems. These manuals shall be produced with due regard to the qualification of personnel who shall be required to refer to them. These documents will be issued as controlled documents and should therefore be collated and numbered in proper order corresponding to the contents and index pages. Nomenclature of equipment, diagrams, and figure numbers or units shall be consistent throughout the text. In order to comprehend the text, diagrams, drawings, sketches, and actual photographs shall be added where necessary. All manufacturers' literature identification codes or stamp markings shall be omitted. Precautions and warnings regarding the safety of life and equipment shall be included where applicable. Manuals shall be clearly identified as being:

(1) Preventive maintenance,

(2) Recovery/corrective maintenance, and

(3) Software maintenance.

8.3.2. The Contractor shall arrange all documentation in accordance with the following guidelines for all Maintenance manuals:

(1) The first section shall be an overview of the functions provided by the systems.

(2) All functions shall be described, and all operator input clearly defined.

(3) All system operating sequences shall be explained.

(4) All indications and alarms shall be described together with the appropriate operator response.

(5) Descriptions of indications and operator inputs shall be accompanied by pictures or screenshots of the control interface.

(6) Lengthy technical descriptions of the systems in sections on operator input shall be avoided and if required shall be segregated into an appendix for reference.

(7) Relevant system block diagrams, drawings, flow charts, etc. shall be provided where these assists understanding of the text and the significance of the equipment alarms and status indications.

8.4. Electronic Manuals

8.4.1. The Contractor shall provide manuals in the electronic format. This is in addition to the submission of manuals in hard copies.

8.4.2. The format of the electronic copies shall be proven in at least two other applications and shall allow for links between parts catalogue and maintenance instructions.

8.4.3. The Document Management System and language used shall be subject to the Engineer's review.

8.5. Operating/User Manuals and Maintenance and Servicing Manuals

Operating/User Manuals and Maintenance and Servicing Manuals shall be divided into indexed sections explaining the subject matter in logical steps. Most manuals shall consist of A4-size printed sheets bound in stiff-cover wear-resistant binders clearly and uniformly marked with the subject matter and reference number. Where alternative sizes are proposed, (e.g. A5/A6 pocketbooks of schematic wiring diagrams) these shall be for review and acceptance. The binding shall allow for all subsequent changes and additions to be readily affected.

Information shall be provided in pictorial form wherever and whenever possible and shall include step-by-step instructions and views of the particular equipment including exploded views.

The Contractor shall provide clarifications and amendments to the manuals as necessary during the execution of the Contract. Updates shall be provided for the originals and all copies.

8.6. Submission of Manuals and Documents

The Contractor shall submit at least (a) System Documents, (d) Software System Documents, and (e) Equipment Room Documents in Sub-Clause 8.1 for review by the Engineer prior to Factory Acceptance Tests. All the other documents shall be submitted by the Contractor before the installation construction starts.

The Operating/User Manuals, the Maintenance and Servicing Manuals, and other technical manuals and documents shall be prepared in English and Tagalog.

All the manuals and documents shall be reviewed and given a Notice of No Objection by the Engineer.

8.7. Number of Submission Copies

The Contractor shall provide six (6) copies of all manuals and documents (and one CD) for the use of the Engineer and the Employer.

9. MANPOWER AND WORKFORCE

9.1. Local and Overseas Filipino Worker (OFW)

For onshore works in the Philippines, the Contractor is encouraged and highly recommended to accommodate and give priority to local and Overseas Filipino Workers (OFW) displaced by COVID-19, and workers availing the Balik Probinsya Bagong Pag-asa program should not be less than 10% of their workforce, unless no such workers are available for the project as certified by the Department of Labor and Employment (DOLE) Regional / Provincial / Field Offices.

9.2. Engagement of Staff and Labor
The Contractor shall take pro-active measures to encourage the employment of women and PWDs with the aim to achieve at least 20% women and 5% PWDs in skilled and unskilled positions in all stages of construction.

10. INSPECTION, TESTING, AND COMMISSIONING

10.1. General

10.1.1. Inspection, Testing, and Commissioning shall comply with all requirements of the GC supplemented, amplified, modified, or superseded as applicable by the PC, the ERT, and the ERG.

The Contractor shall perform all inspection, testing, and commissioning activities to satisfactorily demonstrate that when completed, the Works would be fit for the purposes for which the Works are intended as defined in the Contract.

The Contractor shall provide all necessary equipment and test instruments, special tools, emulators, simulators, and test software, to carry out the test at his cost. The use of this test equipment, tools, and others shall be subject to approval by the Engineer.

The Contractor shall carry out the FAT at the premise of designated manufactures.

The Contractor shall be responsible for providing temporary electricity supply, all instruments, gauges, test equipment, tools, accessories, personnel, services, and necessary facilities required for the execution of all tests and inspection. Wherever necessary, the Contractor shall provide two or more sets of testing equipment, tools, and others to expedite testing. All test equipment shall be accompanied with the appropriate calibration certificate by a testing authority of the equipment.

The Contractor shall submit the Inspection, Testing, and Commissioning Management Plan for the Engineer's review as per the schedule furnished in Table 4-1 of Appendix 4 attached hereto. The purpose of the Inspection, Testing, and Commissioning Management Plan is:

(1) To provide evidence as to how the Contractor will plan and program his tests and inspection and test activities; and

(2) To allow the Contractor to indicate his "Witness and Quality Hold Points" for selected operations.

10.1.2. The Inspection, Testing, and Commissioning Management Plan shall be prepared in accordance with the Employer's Requirement – ERT. This plan shall also include integrated testing and commissioning of trains in the section and service trials before introduction in revenue service. The plan shall contain, but not limited to, the following topics:

(1) the Contractor's methodology for inspection, testing, and commissioning;

(2) all Inspections and Quality Hold Points;

(3) inspection, testing, and acceptance operations performed on the parts during and after fabrication;

(4) inspection, testing, and acceptance operations performed on sub-assemblies composed of these parts if any;

(5) inspection or test operations performed during on-site activities;

(6) tests, inspections, and examinations performed on systems assembled in shop and site;

(7) the interdependency and inter-relationship with Interface Contractors and their commissioning program;

(8) the objectives of each test and criteria for successful tests;

(9) organization chart and Curriculum Vitae of key personnel in the testing and commissioning team; and

(10) documentation for conducting tests and submission of testing and commissioning procedures.

10.1.3. The Contractor shall submit a testing and commissioning programme. This programme shall contain full details of the contents and sequences for all tests to be carried out, together the procedures, standards or limits to be achieved for each test including verification and validation. As part of the commissioning programme, a commissioning strategy report shall be agreed by the commissioning panel or other arrangements to be advised by the Engineer, and shall also be submitted by the Contractor for confirmation of acceptance of the alternative arrangements. In addition, the testing and commissioning programme shall be updated and submitted periodically to the Engineer for control and monitoring of the Contractor’s progress.

10.1.4. Inspection Hold Points

(1) The Contractor shall propose a set of inspection hold points in the Inspection, Testing, and Commissioning Management Plan. The hold points shall be structured so that a formal hold point is allowed for each significant element of the Railway System item’s manufacturing process. At each hold point, the Engineer shall hold a formal inspection, or advice that the inspection has been waived.

(2) The manufacturer of each Railway System equipment or part thereof shall not proceed until the inspection by the Engineer has been completed or while waived.

(3) No equipment shall be considered ready for delivery without the Engineer’s endorsement in writing. The Contractor shall bear the cost of attendance of the inspections including travel, flight charge from Manila to the place where the inspection will be made, lodging, local transportation, safety equipment, etc., for the Employer’s and Engineer’s Personnel. If the inspection is not be completed satisfactorily, the additional inspection attended by the Employer’s and Engineer’s Personnel will be arranged and the cost of attendance for such additional inspection shall be borne by the Contractor.

(4) Once the Inspection and any required remedial actions are completed to the satisfaction of the Engineer, he shall give consent for Railway System equipment’ shipment and/or dispatch.

10.1.5. The Contractor or his subcontractor is responsible for the execution and recording of all inspections and tests which are to be found on the Inspection, Testing, and Commissioning Management Plan. All the technical conditions of the material manufacturing and testing have to be included in the material and part acceptance certificates.

10.1.6. For manufacturing and on-site activity surveillance, the Contractor will develop and implement a test and commissioning plan, which includes acceptance tests.

10.1.7. The Engineer will then check the plans to see whether it meets the requirements or not. The Engineer shall inform the Contractor in writing within a reasonable period after receipt of the following information;

(1) that the Contractor's proposed methods of inspection, testing, and commissioning (including Integrated Testing and Commissioning) have the consent of the Engineer;

(2) in what respects, in the opinion of the Engineer about the Contractor's proposed methods, etc.;

(3) fail to comply with the Employer's Requirements and/or the Final Design Document;

(4) would be detrimental to the Works and/or to the other works comprising the Project;

(5) do not comply with the other requirements of the Contract; or

(6) as to the further documents or information which is required to enable the Engineer to properly assess the proposed methods of inspections etc.

10.1.8. In the event that the Engineer does not give his consent, the Contractor shall take such steps or make such changes in the said methods or supply such further documents or information as may be necessary to meet the Engineer's requirements and to obtain his consent. The Contractor shall not change the methods of inspection, testing, and commissioning (including Integrated Testing and Commissioning) which have received the Engineer's consent without further review and consent in writing of the Engineer.

10.1.9. Notwithstanding the foregoing provisions of this Chapter, or that certain of the Contractor's proposed methods of inspection, etc. may be the subject of the consent of the Engineer, the Contractor shall not be relieved of any liability or obligation under the Contract.

10.1.10. The Engineer shall have the facility to monitor all tests and have access to all test records. Ample time shall be allowed within the testing program for necessary alterations to equipment, systems, and designs to be undertaken, together with re-testing prior to final commissioning.

10.1.11. Unless agreed in writing by the Engineer, personnel engaged in testing shall be independent of those directly engaged in the design or installation of that equipment however, subject to the approval of the Engineer the system designer could be engaged in the design qualification tests such as type tests and first article inspections.

10.1.12. All test equipment shall carry an appropriate and valid calibration label and / or certificate.

10.1.13. For each of the identified tests, the Contractor shall produce a test report, in three copies, and an approved format, within an agreed period following the test, for acceptance by the Engineer. The Contractor shall sign all reports of tests. The Engineer reserves the right to reasonably call for additional tests if considered necessary.

10.2. Non-Conformity and Deviation Disposition

10.2.1. The Non-Conformity and Deviation detected/observed during manufacturing, testing and commissioning shall be grouped into essentially three types and shall be dealt with as under:

(1) Type 1: Non-conformity not in violation of the ERT or design documents originated by the Contract and given a Notice of No Objection by the Engineer.

(2) Type 2: Non-conformity with the ERT or design or documents issued by the Contractor and given a Notice of No Objection by the Engineer, but which can be reconciled with the applicable specification.

(3) Type 3: Non-conformity with the ERT or design or documents issued by Subcontractors and given a Notice of No Objection by the Engineer which cannot be reconciled with the applicable specification. Some examples of this group of non-conformity but not limited to are:

- Equipment, component, or system unable to meet functional or performance requirements;
- Critical dimensions (involved in the stress analysis report of interface dimensions) out of tolerance;

- Inspection or control not carded out and is impossible to be repeated;
- Component without appropriate identification to ensure its recording.

10.2.2. These types of non-conformity shall be recorded in a Non-conformity Report (NCR) and reported by the Contractor to the Engineer for processing and disposition. The Contractor shall propose the final solution and submit to the Engineer for his Approval during a meeting before implementation.

10.3. Engineer's Stop Work Order (SWO)

10.3.1. The Engineer or his representative will have the general responsibility to verify that during manufacturing and construction the associated control or test operations performed by the Contractor is in accordance with the relevant submissions that have been given a Notice of No Objection and the requirements of the contract.

10.3.2. A stop-work order is issued when significant situations adverse to quality or safety are noted and immediate action is required.

10.3.3. The stop-work order shall be issued under the following conditions:

(1) Equipment procured by the Contractor is not able to meet the specified quality level,

(2) Use of non-approved drawings or documents during the manufacturing of items or equipment by the Contractor (or his Subcontractor),

(3) Repetitive non-conformity without appropriate corrective action by the Contractor (or his Subcontractor),

(4) The Contractor (or his Subcontractor) frequently ignores the Engineer's observations regarding inspections, or

(5) When a significant non-compliance of the Quality Assurance Management Plan or Safety Plan is detected.

10.4. Engineer's Corrective Action Request (CAR)

10.4.1. During the course of performing audit or inspection, the Engineer may identify situations that are contrary to product quality or may lead to products of indeterminate quality, and in such a situation the Engineer shall issue a Corrective Action Request (CAR).

10.4.2. On receipt of CAR, the Contractor shall take Corrective Action and shall return the CAR to the Engineer. In this regard, the Engineer's decision shall be final.

10.5. Test Groups

10.5.1. The Contractor shall structure his testing plan based upon the following testing stages:

(1) Type Test

A Type test is a requirement for first production items in respect of each major component or assembly or sub-assembly, in order to demonstrate that the design conforms to all relevant technical requirements, is fit or purpose in the environmental conditions specified, as well as satisfying any additional features that may result from the needs of the RAMS process.

(2) First Article Inspection

The Inspection, Testing, and Commissioning Management Plan shall list all major sub-systems and shall identify those which the Contractor proposes to be subject to First Article Inspection (FAIs). The Engineer will advise any adjustments required and the Contractor shall prepare a visit schedule for inspection of those items as required by the Engineer.

(3) Routine Tests

Routine Tests shall be carried out on items of equipment or sub-systems to be installed in substantial numbers across the railway, or that have a bearing on the overall performance of the railway system.

(4) Factory Acceptance Tests

Factor Acceptance Tests (FATs) shall be conducted at the place of manufacture of the system and comprehensively represent the system in terms of architecture and load, to demonstrate the performance of the system and the approved final design.

(5) Post Installation Check

Post installation and prior to powering up equipment, a check shall be carried out on the installation, wiring and readiness of the sub-system to be powered.

(6) Partial Acceptance Tests

Partial Acceptance Tests (PATs) shall comprise a local test conducted on sub-system/geographic commissioning lot.

(7) Site Acceptance Tests

Site Acceptance Tests (SATs) shall comprise testing of the complete system excluding interfacing systems, i.e., with interfacing systems simulated to demonstrate end to end performance.

(8) System Integration Tests

System Integration Tests shall test the system across the whole railway system fully integrated with any interfacing systems.

(9) Performance Demonstration Tests

This phase of testing shall demonstrate the overall performance of the delivered system as a part of the railway.

11. DEFECTS LIABILITY

11.1. Remedying Defects

11.1.1. The Defect Notification Period of the Railway Systems shall be seven hundred and thirty (730) days from the date of Handover of the Railway Systems subject to any extension under the Conditions of Contract and Sub-Clause 11.1.3 below.

11.1.2. The Contractor shall be responsible for any defect or failure attributable to defective design, material or workmanship, outcome, or notified by (or on behalf of) the Employer during the Defect Notification Period. The Contractor will not be liable for damage caused because the Engineer or the Employer or any other third parties did not follow the written operation and maintenance instructions or did not use the trains in accordance with the technical documents.

11.1.3. During the Defect Notification Period, if any defect, imperfection, or other faults will require any design modification to a component of equipment, the Defect Notification Period of that part shall re-start from the date when such modification of the or component of equipment is completed to the satisfaction to the Engineer and commissioned into service.

11.1.4. During the in-service Defects Notification Period (DNP), the Contractor shall demonstrate successful achievement of the RAM performance targets, which will be a prerequisite of the application for a Performance Certificate to be issued by the Employer.

Failure to meet the E&M Systems and Track works RAM targets within the DNP shall mean that the DNP shall be extended until such time as the RAM targets has been met.

Regardless of the above, the maximum DNP is 4 years from the date of issue of the Taking Over Certificate.

11.2. Defect Notification Period

11.2.1. During the Defect Notification Period, the Contractor will undertake the necessary remedial works for defect or damage due to the Contractor's failure at his own risk and expense including spare parts and consumables, if required, and labor.

11.2.2. All the equipment and material necessary for testing and remedying defect or damage in connection with the Defect Notification Period will be provided by the Contractor bearing all the related expenses.

11.2.3. Notwithstanding that the Contractor has provided the O&M Spares in accordance with the list agreed with the Engineer, the Contractor shall be fully responsible, entirely at his own cost, for the failure of all items during the Defects Notification Period that is not in the list of O&M Spares and shall replace them as soon as reasonably possible. In the event that any item fails before the time that the Contractor has indicated in the Spare Parts Management Plan that it will need to be replaced, such failure shall be deemed to be and shall be treated as a defect.

11.2.4. The Contractor shall propose the plan for how he will perform his obligation for the Defect Notification Period including the set-up of the service organization, during the Defect Notification Period. The plan shall include the service organization including both in the Republic of the Philippines and abroad, communication line with the Employer and/or the Engineer, stock of spare parts for Defect Notification Period, etc. During the Defect Notification Period, the Contractor shall be responsible, free of charge, for the repair of defects/damage and replacement of components where the system does not conform to functional specification and performance requirements specified in the Employer's Requirements. Normal wears and tears are excluded from these defects.

11.2.5. 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 the customs 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 in the Republic of the Philippines or abroad and its return to the Site after repairs.

11.2.6. All replacement and repairs under the Defect Notification Period shall be carried out by the Contractor promptly and completed to satisfaction of the Engineer, on notification of the defect by the Employer and/or the Engineer on behalf of the Employer so that no Railway System equipment is unfit for service for more than twenty-four (24) hours or another period the Engineer may agree to, which shall exclude the time taken for withdrawal/ induction of trains from/to services. The Employer or the Engineer on behalf of the Employer will notify the Contractor in writing of any defect together with a brief description thereof. Upon receipt of such notice, the Contractor shall within a reasonable period of time and at his own costs remedy this defect. If within a reasonable time, the Contractor fails to fulfill his obligations after a reasonable amount of trials for remedying the defect (at least three trials), the Engineer may fix by written notice a reasonable final time for completion of the Contractor's obligations. In case the Contractor fails to fulfill his obligations within such final time, the Employer may himself undertake the necessary remedial works or employ a third party to do so, always at the risk and expense of the Contractor.

12. SOFTWARE MANAGEMENT AND CONTROL

12.1. Prescriptive Framework

12.1.1. All software to be developed or modified shall follow the normative requirements of standards proposed by the Contractor. The Contractor shall define within the Software Quality Assurance Management Plan what techniques and measures are to be applied for software development.

12.1.2. The Plan shall require the Contractor to provide all changes, bug fixes, updates, modifications, amendments, and new versions of the programs, as required by the Engineer. The Engineer may also direct to provide a copy of the previous version of software till such time the new version of software is proven.

12.1.3. The Contractor shall provide all tools, laptop computers, or any special device to upload/download the software, equipment, manuals, and training necessary for the Engineer to maintain all software provided under this Contract. The documentation of software may be supplied after the expiry of the Defect Notification Period under the terms and conditions to be mutually agreed at the time of the contract negotiation.

12.1.4. When a fault is discovered in delivered software or an error in the associated documentation, the Contractor shall take the necessary steps to rectify such faults and errors at the earliest opportunity. The Contractor shall supply to the Engineer, full details, in writing, as to the nature of the corrective action proposed or taken. These changes shall be documented in the form of a Software Engineering Change Proposal (SECP), which shall be given a Notice of No Objection from the Engineer. The documentation of software may be supplied after the Defect Notification Period, under the terms and conditions to be mutually agreed at the time of the contract negotiation.

12.1.5. It will be incumbent upon the Contractor to take responsibility for any changes required to the software.

12.1.6. It shall provide a cybersecurity framework for the identification and protection of Critical Cyber Assets to support reliable operation of the system, and to protect these assets from cyber-attacks.

12.2. Software Framework

12.2.1. All the software produced or supplied for the Project shall be subject to a defined quality framework. The Contractor shall use a Quality Assurance System which is compliant with ISO 9000 series and others and meet the requirements as stipulated in the ERT. ISO 9000-3 is considered appropriate for low criticality software (safety integrity level 0 or1). The quality framework requirements for safety integrity level 2 and above are supplementary to the requirements of IEC62279 or EN 50128.

12.3. Software Management Control

12.3.1. The Contractor shall assign the Software Manager and/ or Software Quality Manager, where software development or modifications are required, under the Contract.

12.4. Auditing

12.4.1. The Engineer may carry out an audit of the software. Further external independent audits may also be arranged at the Engineer discretion. The Contractor shall allow the ISA to view the software documentation as deemed required without any hindrance.

12.4.2. The Contractor shall conduct audits through an assigned internal software auditor to ensure the process is compliant with ISO 9001, ISO 12207, and EN 50128 or equivalent standards.

12.5. Software Acceptance

12.5.1. The Contractor shall also submit an Operational Safety Report (Software) (OSR(S)) for software acceptance by the Engineer.

12.5.2. The Operational Safety Report (Software) shall include, as a minimum

(1) OSR(S) – Introduction.

Shall describe the nature of software sufficiently to ensure that the Engineer is given a comprehensive overview of primary characteristics such as structure, functions, criticality, volume, and language.

(2) OSR(S) - Evidence of Quality Management.

Shall provide evidence to demonstrate that the software development has been subject to acceptable quality assurance.

(3) OSR(S) - Evidence of Safety Management.

Shall provide evidence to demonstrate that the software development has been subject to acceptable safety management.

(4) OSR(S) - Technical Report.

Shall describe how software integrity has been achieved.

(5) OSR(S) - Operation and Maintenance Report.

Shall describe the software operation and maintenance characteristics.

(6) OSR(S) - Restrictions for Use.

Shall define what restrictions are applied to the use of the software.

12.5.3. The sub-systems and associated software-based systems should be accepted as a whole system. Both the embedded and application software shall have different version references for acceptance.

12.6. Availability of Source Code and Development Tools

12.6.1. With the exception of Commercial off-the-shelf (COTS) software, the Engineer shall be provided with access to the software documentation including source code listings and development tool details; unless it is tagged as an intellectual property. This would help the Employer for the application and maintenance of that COTS software and can make minor changes when the railway configuration changes. The documentation of software may be supplied after the expiry of the warranty period, under the terms and conditions to be mutually agreed upon during the contract negotiations. Balance source code with all relevant documentation shall be kept by the contractor in an Escrow account. The initial three years lease of the Escrow account shall be paid by the contractor.

12.6.2. Complete documentation of non-intellectual property software to be supplied by the Contractor, as above, which enables the Employer to debug and implement the parameter of the system, if considered necessary. The Employer's engineers shall be fully trained and made conversant with the software and other related issues as found necessary during the Contract execution to enable the Employer to operate, maintain, repairing the system efficiently.

12.6.3. After loading and the satisfactory functioning of the software, the Contractor shall supply two back-up copies of the software, including any new versions adopted along with their installation procedure. The documentation of software along with training material may be supplied after the Defect Notification Period, under the terms and conditions to be mutually agreed during the contract negotiations.

12.7. Re-Use of Existing Software

12.7.1. Where existing software (defined to module-level) is to be re-used without modification, the Contractor shall provide acceptable evidence to the Engineer as to why that software is suitable for use in the proposed application. This evidence may be historical (certified evidence of previous satisfactory use in a similar environment and application), or it may be sought as cross acceptance from another railway authority or statutory body. Software re-use shall not be acceptable, without a detailed review, where the proposed application is of the same or lower safety integrity level (SIL) than the current application.

12.8. Test Software

12.8.1. All test software, with the exclusion of built-in test software, shall be produced in accordance with a quality system controlled under the requirements of accepted international standards. Test software shall be developed and documented using structured techniques and shall be designed to be maintainable throughout the duration of the Contract. All test software shall be documented to be supportive of maintenance. Any test software, which is to be delivered to the Engineer (for long-term testing use), shall be fully documented including source code listings to allow the Engineer to maintain the software for the life of the supported system.

12.9. Software Rights

12.9.1. The Contractor shall ensure that the Employer/the Engineer or its licensee is granted all necessary rights to use software embodied in the equipment and there are no restrictions attached to the use of any information supplied by the Contractor which might later prevent or hinder the Employer/the Engineer or its licensee from modifying or adopting or extending the system. The documentation of software may be supplied after the Defect Notification Period, under the terms and conditions to be mutually agreed during the contract negotiations. The Contractor shall indemnify the Employer/the Engineer, its heir, or licensees against the claim of any party, subcontractor for the unauthorized possession, or use of the software supplied.

13. SUPPLY OF SPARE PARTS, SPECIAL TOOLS, AND TEST EQUIPMENT

13.1. Details of supply

13.1.1. The Contractor shall provide spare parts, tools and test equipment for the maintenance of all Systems included in the Contract, in accordance with the provisions of this Section, as part of the Works:

(1) Spare parts including (but not limited to) sub-assemblies and those to be supplied by its sub-contractors of any tier ("Spare Parts");

(2) Special tools, jigs, fixtures and gauges and test, and maintenance equipment, including those to be supplied by its subcontractors of any tier ("Special Tools and Test Equipment"),

13.1.2. The recommended list of O&M spares and Capital spares shall be updated for the review by the Employer at the time of completion of the Technical Design and again at the time of Construction/Installation Design with the identity of parts by source, OEM part number, and individual price. A final update with the same details shall be made one year before the completion of the works. O&M Spare parts shall be delivered to the Employer no later than six (6) months before the completion of Works.

13.1.3. The information supplied in respect of each spare parts, special tool, and test equipment shall include, but shall not be limited to, the following:

(1) Core data - main assembly/equipment
  1) manufacturer/brand name
  2) manufacturer's type/model number
  3) rating
  4) serial number if applicable
  5) total number of the main assembly/equipment supplied under the contract

(2) Core data - sub-assembly of main assembly/equipment
  1) manufacturer/brand name
  2) manufacturer's type/model number
  3) rating
  4) serial number, if applicable
  5) total number of sub-assemblies in the main assembly/equipment supplied under the Contract

(3) Individual item of main/sub assembly/equipment
  1) manufacturer order number
  2) parts 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

3) manufacturer/brand name
4) the manufacturer's part number (if different from the ordering number)
5) the subcontractor's ordering part number/reference, if applicable
6) recommended quantity
7) unit of measurement
8) unit price CIF to Manila including delivery to designated location
9) total number of the Spare Parts in the sub-assembly of the main assembly/equipment supplied under the Contract
10) total number of the Spare Parts in all the sub-assemblies of all the main assemblies/ different equipment supplied under the Contract

TheContractorshallensurethattheorderingpartnumbersspecifiedshallenable the Employer to procure the exact item in the future without reference to the Contractor.

(4) Primary data

1) parts catalogue number/cross-reference (illustrated parts catalogues to be submitted together with the spares schedules to the Employer.
2) drawing number

(5) Secondary data

1) lead times stating whether forex-stock or for product manufactured upon receipt of order.
2) delivery schedule(s).
3) supplementary information:
    - special handling instruction, e.g., for fragile materials, hazardous substances, radioactive materials, etc.
    - storage requirements, e.g., overall dimensions including special packing (if any) for bulky materials, materials with limited shelf life, climate-controlled conditions, etc.
    - statutory requirements, e.g., licenses, test certificates, etc.
    - interchangeability information
    - tailor-made product for the Contract or a standard bought-in product
    - the source of the Spare Part or Special Tool and Test Equipment, including the manufacturer's name and address together with that of his agent in the Philippines and local sources
    - supplementary sheets to be used for detailed information that is important to the Employer's future procurement.

13.2. Manufacture and delivery of Spare Parts

13.2.1. The Spare Parts to be delivered by the Contractor shall be manufactured at the same time as the Permanent Works are being constructed/installed. They shall be manufactured, works tested, and inspected in accordance with the relevant quality system, suitably packed and labeled, and delivered to the Employer by the Contractor. Before any spares are delivered to the Employer, the Contractor shall submit to the Employer's a shipment advice notifying details such as date of dispatch, date of arrival, vessel name, etc. as well as a packing list to indicate the contract number, variation order number, the lot size, quantity, and weight.

13.2.2. All spares shall be fully interchangeable with their corresponding part and configured to the latest revision during the Defects Liability Period. For spares such as electronic components, lamps, fuses, and high-use items, the Contractor shall ensure that a minimum of two alternative sources of supply are available.

13.2.3. If any item is due to become unavailable after the end of the Defects Notification Period, or where support of an item before the end of the design life of the Works will become unavailable, or if the Contractor subsequently ceases trading, the Contractor undertakes to transfer the relevant intellectual property rights, design rights, and technology to the Employer, following which the Employer shall have full rights to the manufacturing drawings, schedules, software and any other information needed to manufacture the relevant item. Such rights shall give the Employer complete freedom to manufacture the items in the Philippines or anywhere else in the world. The Contractor shall also undertake to notify the Employer two years in advance of the intended cessation of spares availability of any item.

13.2.4. If any Spare Part is rendered obsolete by a design change or material change during the design life of the Works supplied under the Contract, the Contractor shall design a replacement item to match the identical mechanical and electrical interfaces as the former item.

13.2.5. If, as a result of changes in technology, any Spare Part is not completely interchangeable with the original item, or the performance of any Spare Part is different from the original item, then the Contractor shall purchase the same from the Employer, at a price agreed between the parties, such quantities of the obsolete Spare Part as the Employer may possess.

13.3. Testing and Commissioning Spares

13.3.1. In addition to the O&M Spares, the Contractor shall keep on the Site throughout the installation, erection, and commissioning periods, sufficient stocks of Spare Parts to enable immediate replacement of any item in the Permanent Works found to be defective or in any way in non-conformance with the Specification during the installation, erection and commissioning period ("Testing and Commissioning Spares").

13.3.2. The Contractor shall supply and deliver the Testing and Commissioning Spares on or before the commencement of any Partial Acceptance Tests (PAT) or as defined in the ERT.

13.3.3. The Contractor shall submit to the Employer's for review a list of all Testing and Commissioning Spares that shall be made available during the installation, erection, and commissioning period.

13.3.4. The Contractor shall not be entitled to use any of the O&M Spares and/or Capital Spares (if any) to replace any item in the Permanent Works during the installation, erection, and commissioning periods.

13.4. O&M Spares

13.4.1. The quantities of recommended Spare Parts to be supplied by the Contractor to the Employer shall be included in the Spare Parts Management Plan.

13.4.2. Notwithstanding the quantities defined in the Spare Parts Management Plan, the quantities of O&M Spares shall be sufficient for the full operation of the Works for a period of four (4) years after the Employer’s Taking Over of the Works ("O&M Spares”).

13.4.3. At the end of the Defects Notification Period, the stock of O&M spares shall be replenished and handed to the Employer to cover a further period of two (2) years of operation and maintenance.

13.4.4. The Contractor shall supply and deliver the O&M Spares no later than six (6) months before the completion of a System, a Section, or the Works.

13.4.5. The Contractor shall submit the spares schedules for the O&M Spares in hard copies (including the illustrated parts catalogues) as well as soft copies to the Employer for review.

13.4.6. All spares quantities shall be rounded up to the nearest deliverable unit e.g., cable shall be delivered in complete drums, liquids in complete sealed containers, small parts in complete packs.

13.5. Special Tools and Test Equipment

13.5.1. The Contractor shall supply tools, special tools, and test equipment for maintenance needs for all equipment and systems provided under the Contract. Tools, special tools and test equipment shall be provided for scheduled and unscheduled maintenance, including inspections, servicing, preventive maintenance, corrective maintenance, overhaul, and testing.

13.5.2. The Tools, Special Tools and Test Equipment (together with the relevant calibration certificates) required to carry out all the functions described in the Operation and Maintenance Manual or as required by the Technical Requirement (ERT) shall be suitably packed and labeled, consigned to the Employer by the Contractor and delivered to the Employer in accordance with the Employer’s instructions not later than the date scheduled for stage commissioning. The extent of supply shall include protective carrying cases as may be appropriate for the storage and use of each item.

13.5.3. All Special Tools and Test Equipment shall be supplied with Operation and Maintenance Manuals, complete diagrams, schematics, assembly and connection drawings, calibration instructions, and circuit diagrams/descriptions for future maintenance.

13.5.4. Where the Contractor has used the Special Tools and Test Equipment for installation and commissioning of the Permanent Works, he shall refurbish and re-calibrate each item to the satisfaction of the Employer prior to handover to the Employer, accompanied by the Certificate of Calibration traceable to a recognized Japanese or Philippine National Standard or other appropriate Standard previously reviewed and given a Notice of No Objection by the Engineer.

13.5.5. Where any item of Special Tools and Test Equipment is provided by the Contractor, it shall be accompanied by drawings, manuals, and full operating instructions to enable them to be used by suitably skilled (but not necessarily specially trained) personnel in a non-hazardous manner and to achieve the desired result in terms of accuracy and quality.

13.5.6. The Contractor shall provide the means and instructions which describe the parameters of each item of Special Tools and Test Equipment that are critical to their proper methods of use and which enable the Employer's staff using the Special Tools and Test Equipment to achieve the proper performance and operation. Such means and instructions shall include, but not be limited to, any routine checking, or recalibration needs for the Special

Tool and Test Equipment itself.

13.6. Coding and Tagging of all Equipment, Spare Parts and Special Tools and Test Equipment

13.6.1. All Equipment, Spare Parts, Special Tools, and Test Equipment to be delivered to the Employer shall each carry a tag suitably marked, bar-coded (as directed by the Engineer), and numbered to sustain harsh environments.

13.6.2. Each individual item of equipment shall be fitted with permanent identifications label in accordance the with the coding and numbering convention and requirement developed by the CMMS for all E&M components, parts, and equipment.

13.6.3. In this respect the term "individual item of equipment" shall refer to a complete assembly of components and to each removable submodule within the complete assembly.

13.6.4. The identification label shall be permanently attached in such a way that it shall not become detached or illegible during the lifetime of the system from any cause including wear and tear, environmental effects (such as rain, direct sunlight, etc.) or any other influence. Preference shall be given to embossed or engraved metallic labels mechanically fastened by riveting or similar means to the item to which they refer.

13.6.5. All labels shall be easily cleaned to remove dirt and debris (including grease and oil) without disturbing the legibility properties.

14. PACKAGING, SHIPPING, AND DELIVERY

14.1. General

14.1.1. The Contractor shall be fully responsible for the provision and maintenance of acceptable storage facilities for the Plant and any materials or equipment he intends to use for carrying out of the Works or for incorporating into the Works.

14.1.2. The Contractor shall prepare, protect and store, in a manner to be accepted by the Engineer, all equipment and materials so as to safeguard them against loss or damage from repeated handling, from climatic influences, and all other hazards arising during transport, shipment, or storage on or off the site. Secured and covered storage shall be provided for all equipment and materials other than those accepted by the Engineer as suitable for open storage.

14.1.3. The Contractor must write the following items on all packages, but not limited to them.

(1) Name of packing content

(2) Quantity of packing content

(3) Size and weight of package

(4) Precautions of package handling

(5) Packing number or contract number

14.1.4. The Contractor must prepare a packing list and check it at the time of both shipment and delivery.

14.1.5. When the Contractor delivers a package from a temporary site to an actual use site, the

Contractor must deliver it carefully by grasping its packing contents and observe strict precautions of package handling.

14.2. Crating

14.2.1. The Contractor shall provide all packing, crates, and marking. The consignments for shipment shall be packed and marked in accordance with the Engineer's instructions. In doing so, it shall comply with the following requirements;

(1) Each case, crate, or package shall be waterproof, rot-proof, and insect/rodent-proof, of robust construction, and suitable for the intended purpose. The Contractor shall, in determining the packing materials to be used, take cognizance of the climatic conditions likely to occur during the period of transport, shipment, and storage.

(2) Each case, crate, or package shall be legibly and indelibly marked in large letters with the site address, Contract number, "right way up", opening points, and other markings as necessary to permit materials to be readily identified and handled during transit and when received at the Site.

(3) Each case, crate, or package 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 case or package. The distribution of additional copies of each packing list shall be in accordance with the Engineer's instruction.

(4) All items heavier than 100 kg shall be marked on the outside of the case to show the gross and net weights, the points for slinging, and where the weight is bearing.

(5) Care shall be taken to prevent movement of items within cases, crates, or packages 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.

(6) Plug connected electronic circuit boards shall be removed from their racks, packed, and shipped separately.

(7) All packing shall be free from sharp edges to prevent injury to persons or other objects.

(8) Each bulky/heavy case, crate, or package shall include wedge(s) for easy loading and unloading by mechanical handling equipment such as a forklift truck.

(9) Electronic circuit boards, integrated circuits (IC), and the like shall be well protected by using appropriate packing, e.g., anti-static bubble bag or similar.

(10) Rubber products and the like shall be suitably packed to avoid damage including but not limited to hardening, deformation, and peel-off.

14.3. General Precautions

14.3.1. Spare parts shall be tropicalized in their packing for prolonged storage in accordance with appropriate international standards and shall be suitably and individually labeled to indicate:

(1) shelf life and date of manufacture;

(2) type or condition(s) of storage and special handling information;

(3) description of item and relevant part number;

(4) serial number, if applicable;

(5) inspection/test certificate number and batch number; and

(6) Contract number, variation order number, and item number.

14.3.2. Tubes, cable, and conductor ends, and other similar openings shall be properly sealed and blanked off to prevent ingress of dirt or moisture. Flanged ends shall be protected by adhesive tape or jointing material covered by a properly secured wooden blank not smaller than the flange itself. Plain tube ends shall be closed off with bungs or plugs or suitable materials firmly fixed in position.

14.3.3. Particular care shall be taken to prevent mechanical transport-related damage or corrosion of shafts and journals where they rest on timber or other supports which may contain moisture. At such points, wrappings impregnated with anti-rusting composition and of sufficient strength to resist chafing under the pressures and movements during transit shall be used.

14.3.4. Spare ball and roller bearings and similarly protected items shall not be removed from the manufacturer's wrappings or packing.

14.3.5. Fragile materials shall be packed in such a way that they shall not be damaged during transit and when they are properly unpacked for quality inspection. Glass items shall be capable of being easily re-packed without removing the original wrappings or packing for long-term storage within the same packing case.

14.3.6. Appropriate precautions in accordance with the Contractor's safety regulations, the regulations of the Employer, and statutory regulations shall be taken in respect of all hazardous, toxic, inflammable, etc. materials.

14.4. Packing Procedures

14.4.1. All required inspection/test certificates shall be supplied and packed together with individual material. All packaging materials and procedures shall be subject to review by the Engineer.

14.4.2. All empty cases, crates, or packages, whether or not returnable, shall be removed from the Site by the Contractor or stored by the Contractor in such a way that they do not interfere with the progress of the works of the Contractors.

14.5. Shipping

14.5.1. The Contractor shall notify the Engineer ten (10) days in advance of any expected shipment date and give further notification of the actual shipment date and routing when such information is subsequently established. This shall complement the inspection requirements prior to delivery as specified herein.

14.5.2. Two copies of packing lists and quality certificates shall be attached to each case or package to be shipped. One copy shall be placed inside the package and the second copy shall be enclosed in a watertight enclosure on the outside of each case or package. A copy of packing lists and quality certificates shall be sent to the Engineer after each package of the Works, the equipment, spare parts, and other items to be shipped have been shipped.

14.5.3. Without prejudice to any other provisions of the Contract, and unless otherwise specifically described, the Contractor shall be responsible for all legal requirements, duties, dues, taxes, and other such requirements and expenditures required for the importation of the Works, the equipment, spare parts, and other items to be supplied under the Contract into Republic of the Philippines.

14.5.4. The Contractor shall clear the Works, the equipment, spare parts, and other items to be supplied under the Contract through Republic of the Philippines' customs/ Philippine port in accordance with all Government of Republic of the Philippines' Enactments.

14.6. Delivery

14.6.1. The Contractor shall deliver the materials/equipment and all items to be supplied under the Contract to the Site.

14.6.2. The Contractor shall unload the materials/equipment and all items to be supplied under the Contract at the designated delivery point and positioning or storing them.

14.6.3. Any part of the materials/equipment or any item to be supplied under the Contract that is damaged in transit shall not be considered as delivered until repairs or replacements have been made and all necessary spare parts or items have been delivered to the Site.

14.6.4. All documents, manuals, drawings, and other deliverables shall be delivered to an address in the Republic of the Philippines to be designated by the Engineer in writing.

14.6.5. The Contractor shall store and secure the Works, material/equipment, spare parts, and other items until the same has been inspected and are considered delivered at the designated point by the Engineer.

14.6.6. The Contractor shall remove temporary fittings required for shipment and re-assembly of equipment and shall complete this prior to the equipment or parts thereof being inspected and before they are considered delivered.

14.6.7. An item shall be considered delivered when all damages have been repaired and all documentation and post-delivery preparation have been completed to the satisfaction of the Engineer.

15. TRAINING

15.1. General

15.1.1. The Contractor shall be required to train, or arrange training for, selected members of the Employer's Railway Operations staff in accordance with the requirements of the Railway Operator's program. These staff will include the Employer's and the Railway Operator's Instructors who will require training in technical matters according to their intended function and in instructional techniques. An important objective of the training is to increase the ability to operate, control, supervise, and carry out maintenance work on Plant and Equipment supplied and installed by the Contractor.

15.2. Training Requirements

15.2.1. Contractors shall be required to provide the following four (4) types of training:

(1) Training for Experts who will be instructors

(2) Training for OCC staff

(3) Training for station staff

(4) Training for technical staff including Railway Systems operation and maintenance staff

15.2.2. The Contractor shall provide training for OCC staff and station staff before the Trial Runs or Trial Operation.

15.2.3. The Contractor shall consider the methodology of the knowledge transfer. Knowledge includes not only the system itself but also matters related to the operation.

15.3. Training Periods

15.3.1. The Contractor shall propose appropriate man-months of training to be provided along with rates for adjustment to these requirements. The rates shall include, but not be limited to, providing instructors, training facilities, and all teaching aids, materials, and equipment necessary to fulfill the training requirements.

15.4. Language of Training Courses

15.4.1. All training courses will be conducted in English.

15.5. Training Instructors

15.5.1. The Contractor's training instructors shall be fully qualified and experienced electrical and mechanical engineers, who have a good knowledge of the English language. They will have had the experience of training engineers or technicians of the level stated on similar topics and will be fully familiar with the Plant and Equipment supplied and installed in the Works.

15.6. Contractor's obligation to obtain Approval of Instructors

15.6.1. Should, in the opinion of the Engineer, any of the Contractor's training instructors not be considered as competent or do not have suitable language skills, attitude or aptitude for carrying out the training courses for whatever reason, the Contractor shall remove the said person and replace him as soon as possible with an acceptable substitute.

15.7. Employer's Railway Operations Staff

15.7.1. Where the Employer's or the Railway Operator's staff (trainees) will be assigned to the Contractor (or his Subcontractor(s)) for the purposes of training. All such trainees must be properly supervised and monitored by the Contractor and/or Subcontractor's qualified training supervisor to ensure that each trainee has the best opportunity to benefit from the theoretical and practical experience.

15.8. Training Program

15.8.1. The Contractor shall develop and plan detailed training programs using training methods most appropriate to the subject matter and the level of trainee specified. Details of these training programs shall be submitted to the Engineer not later than six (6) months from the award of Contract. The objectives, content, method, location, timing, and duration of each program as provided in the Contractor's proposals.

15.9. Training Courses

15.9.1. The Contractor's training courses shall be programmed in phase with the progress of manufacture and installation to ensure that trainees are present during all stages of the manufacture, installation, testing, commissioning, and integration testing of the Plant and Equipment that is the subject of the training program. The Contractor shall ensure that the courses fully encompass all aspects of the basic design and operation principles, manufacture, installation, testing, commissioning, and maintenance of the Plant and Equipment with maximum effort being directed at instruction in the maintenance of the installed Plant and Equipment.

15.10. All Necessary Railway Operational Instruction Aids and Material

15.10.1. The Contractor shall use all necessary teaching aids such as technical literature, manuals, photographs, drawings, films, models, and all other instructional materials as may be necessary for the training of the Railway Operator's personnel. Instructional use in the performance of Training will become the property of the Employer for the purposes of Railway Operations and Maintenance.

15.11. Plant and materials set aside for Training Purposes

15.11.1. In general, the Contractor shall use Plant and materials specifically set aside for training purposes. However, the Contractor may use, for the training of the Railway Operator's staff, subject to the agreement of the Engineer, Installed Plant and Equipment when no other such plant and materials are otherwise available. The Contractor shall not use for this purpose and spare parts or assemblies that form the O&M Spares.

15.12. Protective Clothing-Training

15.12.1. The Contractor shall provide all special or protective clothing required by the trainee; undergoing instructed training. Personal items of clothing shall be of new issue and may be retained by the trainee on completion of the training course.

15.13. Monitoring

15.13.1. Throughout the training program, the Engineer shall have free access to all training sessions to monitor the progress of the trainees and the Contractor's training instructors.

15.14. Training Practical Tests and Aptitude Reports

15.14.1. To ascertain that the objectives of the courses have been achieved the Contractor shall set periodical theoretical and practical tests for the trainees. The results of these tests together with a report on the trainees' general attitude, ability, technical knowledge, aptitude, and attendance record shall be forwarded at regular intervals to the Engineer who may also require the submission of additional reports in special cases.

15.15. Monitoring of Training Progress

15.15.1. Methods for monitoring progress shall include, but will not necessarily limited to:

(1) Theoretical tests and systems of assessment;

(2) Practical test pieces and objective systems of assessment;

(3) Progress reports.

15.16. Records of Training Progress to be Maintained

15.16.1. Records of the progress of trainees shall be kept up to date and shall be made available to the Engineer for examination when required.

15.17. Issue Test Results and progress to the Engineer

15.17.1. Copies of the records of individual trainees, showing all test results and reports of progress, shall be sent to the Engineer on completion of each training course.

15.18. Training Location and Facilities

15.18.1. The training of selected Employer's and Railway Operator's staff shall be carried out at such locations where the greatest benefit for trainees may be gained. This may be in the Republic of the Philippines or at places of manufacture, assembly, or testing or such other locations as may be necessary. All places of training shall be approved by the Engineer. Details of the facilities to be provided shall be included with the detailed training programs submitted by the Contractor.

15.19. Occupational Health and Safety of Trainees

15.19.1. The Contractor shall be responsible for the safety, health, and welfare of trainees when under training. Accordingly, an explanation of the safety rules and codes shall form part of a general induction course to be given by the Contractor and where considered necessary the Contractor shall issue a rulebook for which the trainee shall sign indicating his acceptance and understanding thereof. This shall include a specific COVID-19 Risk Management Plan which shall be issued with the bid and resubmitted within 28 days of Award of Contract. This resubmission shall contain modifications to reflect the changes which have occurred between the Date for Submission of the Bid and Award of Contract.

15.20. Administration

15.20.1. The Contractor shall be:

(1) Responsible for the reception of, and hotel and travel arrangements for each trainee in regions other than Manila;

(2) Responsible for the general welfare of trainees under its control.

16. SITE OFFICE AND SITE OFFICE MANAGEMENT

16.1. Site Restrictions

16.1.1. The particular use to which the Site is put shall be submitted to the Employer together with the Engineer for review with the following particulars:

(1) drawings showing the layout of the Site Office for the Contractor, accommodation, access roads, and major facilities;

(2) drawings showing the layout and the construction details of the Employer's and Engineer's office; and

(3) proposals for the Employer's and Engineer's Site accommodation as defined by Clause 15.2.1 and 15.2.2 below.

16.2. Site Office Facilities

16.2.1. Employer's and Engineer's Site Offices

The Contractor shall provide two joint Employer's and Engineer's site office, one located in the MCRP section and the other in the NSRP South section.

Both offices in the MCRP and NSRP South sections shall be provided within 90days prior to the first access date for each section. The site office shall have spaces for the 40 vehicles.

The locations, layout drawings, and specifications for the offices and other facilities shall be submitted for review and approval to the Engineer 180days before the scheduled first access date or to coincide with the Contractor 's planning of their respective offices,

The Employer's and Engineer's site office shall have sufficient space for forty (40) staff excluding the office support staff (e.g., Secretary, Janitors, Administrative Personnel, IT, etc.) equipped with following facilities:

(1) Air conditioning units. (Adequate and sized relative to the office size and number of occupants.)

(2) Office Furnitures: 40 Desks with Drawers and chairs, (plus 10 spares for open assignment or transient office workers), 2 meeting tables, 25 portable chairs, Filing Cabinets, etc.

(3) 2 -Meeting rooms with Noise-Reduction panels, whiteboard, and projector. (Fully equipped1- large room for 10-12 persons, and 1 -small room for 5-6 persons).

(4) 1- Pantry Room with Dining Facility. (Fully furnished with kitchen sink with faucet and drain system including grease trap, microwave oven, refrigerator, hot/cold water dispenser (with consumable purified water), pantry cabinet with utensils organizer, pantry cleaning materials, and consumables.

(5) 1- Break Room. (Fully furnished with sofa, tables, chairs.)

(6) 1- E&M Equipment and Office Storage Room. (Equipped with Lockers)

(7) Separate Toilet and Bath Facilities for both Gender (Prefabricated Cabin Toilet, composed of water closet (Western /European type) with spray hose and flushing system, washbasin with mirror, urinal with flush valve (for male toilet), bath shower, electrical inlet connections, waterproof emergency light, exhaust fan, steps/ladder, non-skid flooring with drains, toilet & bath cleaning equipment/materials and consumables, tissue paper holder, towel holder and hooks, liquid hand soap, sanitizer

and tissue paper.

(8) Computer network system with 5 Desktop Computers (8-Core Processor / 32GB RAM / CUDA Accelerated Graphics with 8 GB of VRAM) and Monitors (29") and associated equipment. (Includes Telephone lines, Internet Wi-Fi, Conference Call equipment, Projector, licensed software, extension cords, etc.)

(9) 2 no's Photocopy machines,2 no's printers and its consumables.

(10) Adequate office lighting and electrical power outlets.

The Contractor shall be responsible for the maintenance of the Employer's and Engineer's site office with support staff knowledgeable of administration and IT functions and provide office cleaning (Janitorial) services. The Contractor shall supply all the necessary office equipment and stationery including paper for photocopy machine, electricity, drinking water, coffee, and other office facilities supplies, and consumables need by the Employer and Engineer.

The office and parking area shall be accessed by a temporary concrete road connecting to the Public Street or Highway. A concrete pathway shall be provided on all sides of the office.

16.3. Site Management

16.3.1. The particular use to which the Site is put shall be submitted to the Engineer in form of a plan for site facilities for review within 120 days after the Commencement Date. The Contractor shall:

(1) confine his use of the areas of the Site to purposes having been Approved by the Engineer who reserves the right to extend, amend or restrict the uses to which areas of the Site will be put;

(2) where required under the Contract, provide and maintain fencing and lighting around and within the areas of the Site when or where necessary for the safety and convenience of the public or others or as directed;

(3) refrain from depositing rubbish or causing nuisance or permitting nuisance to be caused and, except where reviewed and Approved by the Engineer, depositing earth on or removing earth from areas of the site;

(4) refrain from felling trees, other than those specifically identified in the Contract to be felled, and refrain from depositing earth around the trunks of trees and protect all trees remaining on-site to the satisfaction of the Engineer;

(5) except where otherwise provided, not permit any person to reside on the site;

(6) not use any part of the Site or the Works for advertising purposes except with the acceptance of the Employer and Engineer.

The Site shall be maintained in a clean and tidy condition. Materials, including those required for temporary works, shall be stored in an orderly manner. The Contractor shall, throughout the period of the Contract, provide a central collection point on site for collecting all empty cans, drums, packing, and other receptacles capable of holding water. The Contractor shall ensure the regular collection and removal of such debris from the site. After every shift of works, all work areas shall be cleaned and made tidy to the satisfaction of the Engineer. The Contractor shall ensure that gases, fuels, explosives, and other dangerous goods are stored and handled in a safe manner and in accordance with the statutory regulation pertaining to their storages and handlings. The Contractor shall be responsible for obtaining the requisite licenses at his own cost.

16.3.2. The Contractor shall provide all necessary protective clothing, safety equipment, hand tools, ladders, trestles, power supply, and replacement equipment for the Employer and Engineer staff engaged in Site Inspection and Maintenance (Protective clothing, safety boots, high visibility vests, safety glasses and safety field kits for 120 personnel and 20 spares). For specific activities such as working at heights, a safety harness shall be provided.

16.3.3. Because of the multi-disciplinary nature of the project, several different parties may require access to the same portion of the Site during the construction phase, for the installation, erection, and testing of the Works. To facilitate the organization and coordination of access and occupation requirements, the Contractor shall maintain a close liaison with other contractors.

16.3.4. As soon as any or all of the Contractor's installations, including offices, are no longer required for the execution of the Works, the Contractor shall with the agreement of the Engineer remove those facilities and ensure that the area is left free of debris, excess materials, and obstructions.

16.4. Services

16.4.1. The Contractor shall provide Electricity, Water, and Gas to the Site Office(s) as part of the Operating and Maintenance expenses.

16.4.2. The Contractor shall also provide the emergency electricity supply equipment at his risk and cost. The Contractor shall, at his risk and cost, provide any apparatus necessary for his use of these services and for measuring the quantities consumed. The Contractor shall pay, or reimburse at actual costs, the fees for the quantities consumed of such utilities, as applicable. The Contractor shall comply with all regulations of the utility companies and Government departments concerned and the rule of the Employer for usage of such utilities.

16.4.3. If lighting is not provided in the specific areas allocated to the Contractor, he should make his own arrangements. The Contractor shall be solely responsible for the security and housekeeping of the area, plant, and possessions allocated to him. The Contractor shall provide and maintain all facilities required by him in the area allocated for his use and all other work required to allow the Contractor to fulfill his obligations under the Contract.

16.4.4. The Firefighting and First-Aid equipment shall be provided in accordance with the recommendations of the Employer and Engineer. (Examples: Fire-Extinguishers, Fire-Blanket, First-Aid kits, etc.)

16.5. Accommodation

The Contractor shall provide suitable living accommodation for eight (8) staff from the Employer and eight (8) staff from the Engineer in the vicinity of the working location. The location of the accommodation shall move progressively based on the working location. The accommodation shall be provided from six (6) months prior to first site access to issuance of the final Taking Over Certificate.

17. ROAD TRAFFIC AND TRANSPORTATION

17.1. General

17.1.1. The Contractor shall conform to the applicable requirements under the law, act, regulations, and decision issued by the Government of the Republic of the Philippines and/or the Governmental authorities and imposed in the Republic of the Philippines. The Contractor shall ensure compliance with the requirements regarding the registration of vehicles. Vehicle size and load limitations shall be in accordance with all statutory requirements.

17.2. Transportation to Site

17.2.1. The Contractor shall make all arrangements and assume full responsibility for transportation to the Site of all plant, equipment, materials, and supplies needed for the proper execution of the Works. Procedures for the access to and from the Site shall be coordinated with the relevant authorities if required.

17.2.2. The Employer will obtain any required permits or licenses from relevant authorities for the import of the Goods intending to form or forming part of the Permanent Works or required for the sole purpose of carrying out the Works. Furthermore, the Employer shall assist the Contractor in procuring any necessary Government consent and in obtaining clearance through Customs of the Goods imported for the Works. The cost of any permits shall be borne by the Contractor.

17.2.3. If requested by the Contractor, the Employer shall facilitate the transport of the imported items for Railway System works, via railway from Manila Port or an available nearest port to the Site, which, however, will not relieve the Contractor of any of his obligation under the Contract. The Contractor shall inspect the condition of Railway System equipment at Manila Port or an available nearest after customs clearance and also at the Site when arrived at the Site.

17.2.4. The Contractor shall use such routes and rights of access to the site as proposed by the Contractor and agreed by the Engineer from time to time. Routes for 'very large' or 'very heavy' loads shall be discussed with the Engineer in advance and all arrangements thereafter shall be submitted to the Engineer. In this context, the definition of the terms "very large" and "very heavy" refers to articles that cannot be transported by normal road vehicles or be handled by readily available methods.

17.2.5. The Contractor shall be responsible for obtaining permission from the traffic police and other relevant authorities to move "very large" and "very heavy" loads and for arranging police escorts if required. The Contractor shall ensure that all roads and pavements, etc. leading to and around the Site are kept free from obstructions and shall not cause inconvenience or hindrance to traffic or persons either by its vehicle or its workmen, scaffolding, plant, materials, equipment, etc. All workmen working on the road shall wear approved reflective safety vests at all times.

17.2.6. The Contractor shall repair damage caused to existing roads, footpaths, steps, cables, sewers, drains, etc. and shall reinstate the same at his own expense to the satisfaction of the relevant authorities.

17.2.7. Access road planning during construction/installation time in viewpoint of maintaining work progress for supply of materials and manpower, removal of construction disposals through public roads outside of MCRP &NSRP-South and railway in MCRP & NSRP-

South. It is required to secure transportation access from major roads for this project works.

17.2.8. Traffic Control Plan should be prepared and developed by the Contractor before or during the construction time. The Contractor strictly shall apply the plan with taking prior permission from the Employer, the relevant agencies, the Engineer / the Project Manager, and taking consent from the residents concerned.

17.2.9. The major access routes for construction vehicles will be the trunk road running in parallel with the MCRP and NSRP-South line. It is required to have some alternative plans to prevent the access roads from passing through high population and public density areas, such as residence and commercial areas, school, and hospital areas.

18. MEETING REQUIREMENTS

18.1. General

The Employer and the Engineer will conduct project meetings throughout the Contract period to enable an orderly review of the progress of the Works to be undertaken, and to provide for a systematic discussion of problems and issues if any.

Besides the project meetings above, the Employer and the Engineer will also conduct regular technical, construction and commissioning meetings with the Contractor at least once a fortnight at a location designated by the Engineer.

The Contractor shall also arrange and attend meetings as required by the Engineer.

The Contractor shall endeavor to ensure that his Subcontractors, suppliers, and sub-consultants attend meetings when so required.

As for the meetings not included in this requirement, such as the Contractor's relations with his Subcontractors and materials suppliers, and discussions relative thereto, these matters are the Contractor's responsibility and shall not be a part of project meetings content.

Persons designated by the Contractor to attend and participate in the project meetings shall have all required authority to commit the Contractor to solutions agreed upon in the project meetings.

To the maximum extent practicable, the Contractor should advise the Engineer at least 24 hours in advance of project meetings regarding all items to be added to the agenda.

The Contractor shall compile minutes of each meeting and within 5 days furnish three copies to the Engineer for review and acceptance . The Contractor may make and distribute such other copies as he wishes.

All meetings shall be scheduled as per requirement. However, generally, Project progress and track possession meetings will be held monthly, and site meetings and the operating meetings fortnightly. Necessary coordination shall be made to establish a mutually acceptable schedule for meetings.

To the maximum extent practicable, monthly meetings will be held at the Engineer's Office, and site meetings at the Engineer's site office.

18.2. Monthly Progress Meetings

The Monthly Progress Meetings will be held at dates, intervals and times as determined by the Engineer. The agenda for the monthly progress meeting shall follow the contents of the Monthly Progress Report. It may also be necessary to hold review meetings at regular intervals at management levels as deemed necessary by the Engineer. Such meetings shall generally be arranged at the place of activity concerned.

18.2.1. Attendance: To the maximum extent practicable, the same person or persons who shall represent the Contractor at project meetings shall attend throughout the progress of the Works including the person responsible for Document Control. Subcontractors, material suppliers, and others may be invited to attend those project meetings in which their aspects of the Works are involved.

18.2.2. The Contractor shall submit a Project Progress Report to the Engineer. The Project Progress Report shall be prepared in accordance with the Engineer's requirement and shall include, but shall not be limited to, the following items:

(1) Executive Summary

A summary of major events, overall progress, delays, recovery and financial matters. The Contractor's organization chart highlighting any changes to key personnel.

(2) Contract Summary

Contract Particulars and Variation Orders. This section shall contain detailed information about the financial and commercial status of the Contract, including details of actual and anticipated claims covering cost and time extensions.

(3) Design Progress / Manufacturing Progress / Installation Progress / Testing and Commissioning Progress / Trial Operations;

A summary of the Contractor's manufacturing / installation progress with details of ay areas of concern or delay and any areas of technical difficulties incurred or expected to be specifically highlighted, together with details of the Contractor proposals for corrective actions. A summary of manpower, plant and equipment on site shall also be included.

(4) Design

Summary, including critical design issues and interfaces and status of design submissions.

(5) Manufacturing Status

This section shall contain detailed descriptions of all manufacturing achievements in the month including any problems encountered, comparing the planned works with the actual works.

(6) Procurement and Delivery Status

This section shall contain the detailed progress of all procurement items and delivery activities (construction and permanent plant), both planned and actual.

(7) Discussion on any other business.

(8) Environmental Management

(9) Quality Assurance and Quality Control

(10) Progress Videos and Photographs

(11) Updated Baseline Programme with progress update status as at the report cut-off date as specified by the Engineer.

(12) Risk Management / Register Report

(13) Other items as required and to be advised by the Engineer.

18.3. Programme Analysis Report

18.3.1. The Contractor shall submit a Programme Analysis Report to the Engineer together with the Monthly Progress Report and all related programme submissions which shall comprise a narrative statement that identifies the basis of the Contractor assumptions and to include:

(1) The content required to be included in any programme or supporting document needs to be clearly identified and described to ensure a clear understanding of the scope / requirements of each document provided, i.e., activity detail and activity durations, sequence of working etc.

(2) The critical path of the Works;

(3) Daily and weekly working hours, holidays and shift patterns;

(4) Assumed production outputs for all major activities and areas of the Works.

(5) An overall manpower forecast detailing individual traders and other sub-contract / indirect labor, commissioning teams etc. to illustrate the build-up of manpower resources. The format is to be in accordance with the Engineer's requirements;

(6) List of major items of plant or equipment that are required to be procured identifying the required lead times;

(7) S-curves and histograms showing the planned weekly figures for each principle quantity, major items of equipment and major manpower trades;

(8) Any programme constraints, giving details of the constraints and the substantiation thereto;

(9) When supplied with a Three Month Rolling Programme or current Baseline Programme, it shall include a summary of progress achieved in the previous period in terms of principle quantities (planned versus actual) and time gain / loss in terms of days for each activity;

(10) All computerized network diagram and bar chart updates shall be accompanied by the following output reports;

A complete listing of activities sorted by sub-network early start . early finish with total "float time" calculated for each:

A tabular report of design submittals;

A tabular report of test, demonstrations inspections; and

S-curves indicating the "scheduled" and "actual" progress in a cumulative fashion, the schedules progress curve shall be prepared to show early and late profiles.

(11) Outline installation method statements;

(12) Details of access and working arrangements, in particular with interfacing parties;

(13) Assumed periods for dealing with third party works such as utility companies, interfacing contractors or statutory bodies etc.;

(14) Details of the proposed sub-contract arrangements;

(15) Coding libraries and structures;

(16) Programme recovery / mitigation analyses.

19. LIAISON WITH OTHERS

19.1. Approvals from Government Authorities and Agencies

The Contractor shall assist the Employer to make all necessary arrangements with and obtain all necessary approvals from Government departments, utility agencies, and other relevant competent authorities.

19.2. Meetings with the Engineer

The Contractor shall arrange and attend meetings as required by the Engineer. The Contractor shall use its best endeavors to ensure that its Subcontractors, suppliers, and sub-consultants attend meetings when so required.

19.3. Meetings with the O&M Concessionaire

The Contractor shall arrange and attend meetings with the O&M Concessionaire. These meetings shall commence from the time the O&M Concessionaire is appointed until the end of the Defects Notification Period.

19.4. Meetings with Government Departments and Agencies

When the Contractor arranges meetings with External Interfacing Parties including government departments and utility undertakings or Interface Contractors, it shall inform the Engineer at least four (4) official working days (excluding general holidays) or such shorter period permitted by the Engineer, before they are to be held and shall give the Engineer and the Employer the agenda and objective of the meetings.

19.5. Correspondence with Government Departments and Agencies

Copies of correspondence received from or dispatched to Government Departments, utility undertakings, and Interface Contractors shall be submitted to the Engineer for information within two (2) days of receipt or dispatch.

20. INTERFACE MANAGEMENT

20.1. General

The Contractor's responsibility for interface coordination shall include interfacing with the previously described Interface Contractors and those who may be identified in the future such as local authorities, statutory bodies, utility undertakings, private service providers, consultants, or other contractors whether or not specifically mentioned in this Contract. This responsibility is not limited to a particular number of Interface Contractors.

Each of the Project Contractors shall be responsible for coordinating their own works with those of Interfacing Contractors, Statutory Authorities and other External Parties, whether or not specifically identified herein, and in order to do so, they are required to participate in an information transfer and management process in accordance with the procedure given below.

The System-Wide E&M Works are the most significant element of the Interface Information flow requirements; therefore, the Contractor shall take a pivotal role in the overall Interface Management process of the Project.

Appendix 7 contains the Outline Interface Matrix (OIM)with the respective civil packages from which the Contractor shall subsequently develop a consolidated draft Detailed Interface Matrix and shall convene the first of a series of regular Interface Coordination Meetings which will be chaired by the Engineer and shall be attended by all interfacing Contractors. The consolidated document shall be reviewed and revised following these meetings and shall be released as a Consolidated Detailed Interface Matrix (CDIM), which will be monitored and used for Interface coordination and progress monitoring. The CDIM shall include all interfaces i.e., Intra System Interfaces, Inter-systems, and external Interfaces.

The Contractor shall develop an Outline Interface Matrix (OIM) for each of the following but not limited to:

a) Track Works
b) Signaling System.
c) Telecommunications
d) Power Supply system at substations.
e) Power Distribution System
f) Overhead Contact line System
g) Automatic Fare Collection System
h) Depot & Workshop Facility installation at depots.
j) Platform Screen Doors
k) any other system under the scope of work or specified elsewhere in the contract.

The CDIM will continue to be a live document, subject to modification and addition by common agreement between the Package Contractors as the Works proceed

The Contractor shall prepare detailed System Architecture Drawings (SAD) covering all areas of scope included in the Contract. Level 0, Level 1, and Level 2 SAD's shall be submitted and given a Notice of No Objection during the preliminary, pre-final, and final design stages respectively.

20.2. Exchange of Information with Interfacing Contractors

The Contractor shall communicate, coordinate, and exchange information directly with Interface Contractors. Information necessary to fulfill the Contractor's interface obligations shall be directly requested and obtained from the Interface Contractors; receipt and acknowledgment procedures is required. Conversely, the Contractor shall provide directly to the Interface Contractors information within the Contractor's scope.

The Contractor shall develop and submit for approval by the Engineer an Interface Control Document for each sub-system and Other Works Contractor. The Interface Control Document shall be a "live" common document between each sub-system and other Contractors and external parties, which will be revised and re-submitted by the Contractor to ensure that it remains current, and at other times as directed by the Engineer. It shall be signed off by the Contractor, his sub-contractors, and the interfacing Contractors, prior to submission. The submission date of each Interface Control Document shall be coordinated with that of the respective other parties. The Interface Control Document shall:

a) Clearly identify the demarcation between the sub-system, his subcontractors, and Other Works Contractors;
b) Describe detailed physical, electrical/ mechanical, and functional interfaces (such as protocols, software, and data structures) between the sub-system, his sub-contractors, and Other Works Contractors;
c) Identify the information to be exchanged between the sub-system, his sub-contractors, and Other Works Contractors with a timeline that complies with the overall Project program as well as the contracts of the respective parties;
d) Define Design, Manufacture, Supply, Installation, Testing, and Commissioning responsibilities;
e) Address the Design, Manufacture, Supply, Installation, Testing and Commissioning program of the interfaces to meet the key dates of each contract, and highlight any program risks requiring the Engineer's attention;
f) Specify the proposed method and schedule for verifying interface integrity along with any requirements, whether temporary or permanent, relating to the physical installation of each party's equipment or materials used for the Works; and
g) Include test procedures and a program to demonstrate the performance and integrity of the integrated systems.

The Contractor shall communicate and co-operate with the Interface Contractors to identify and resolve potential interface problems.

The Contractor shall allow for the fact that many of the design activities of the Interface Contractors may proceed concurrently to the construction of this Contract. Specific dates for the delivery of this and other required information shall be confirmed between the Contractor and the Interface Contractors.

The Contractor's program shall allow for the timing of availability of necessary interface information from the interfacing parties.

20.3. Request for Information

All requests for information (RFI), acknowledgment of receipt of information, and any official communication between the Contractor and the Interface Contractors shall be made in writing with a copy to the Engineer for information.

20.4. Interface and Co-ordination with Interfacing Contractors

The Contractor shall advise the Engineer in writing of any problems encountered in obtaining necessary information and/or lack of co-operation from any Interface Contractor. In the event that the Engineer considers that the resolution of an interface is not proceeding satisfactorily, the Engineer will review the matter and establish a coordinated plan directing the Contractor and the Interface Contractors as to the required action.

20.5. Meetings with Interfacing Contractors

The Contractor shall conduct regular meetings with the Interface Contractors to clarify particular aspects of the interface requirements of the Contract Works and the related works. The party who convenes the meeting shall prepare minutes recording all matters discussed and agreed at the meeting. The Contractor shall advise the Engineer in advance of the date, time, and location of such meetings as he may elect to attend.

20.6. Issuance of Information Related to Interfaces and Coordination

The Contractor shall ensure that copies of all correspondence, drawings, meeting minutes, programs, etc. relating to the Contractor's coordination with Interface Contractors are issued to all concerned parties and the Engineer no later than two (2) calendar days from the date of such correspondence and meetings.

20.7. Liability for Failed Interfaces

Any claim of additional costs by Interface Contractors resulting directly from the Contractor's failure to keep to specified dates shall be borne by the Contractor. The Contractor shall note that the information exchange is an iterative process requiring the exchange and updating of information at the earliest opportunity and shall be carried out on a regular and progressive basis in order for the process to be completed for each stage of the Works.

20.8. Design Co-ordination with Interface Contractors

The Contractor shall undertake design co-ordination with Interface Contractors within periods for design interfacing and coordination. The Contractor may commence design interfacing with Interface Contractors prior to the given period once information has been developed to a level where meaningful interaction can take place. The end of the design interfacing and co-ordination period indicates the deadline for receipt by the Engineer of a notice from the Contractor and each of the Interface Contractors stating that design co-ordination has been completed and that designs have been reviewed to ensure consistency between the designs proposed by the Contractor and the respective related Works Contractor. Typically, design interaction should include the followings:

Definition and agreement with Interface Contractors of interface areas, Contract limits, shared loads, physical work interfaces, sequence of installation, and or testing of systems.

The Contractor shall fully co-ordinate the design of the Contract Works with the design of Interface Contractors and shall follow the interfacing requirements detailed in the Technical Requirements (ERT).

The Contractor shall ensure that the requirements of each Interface Contractor are fully coordinated and provided for in the design of the Contract Works. The Contractor shall interface and liaise with Interface Contractor and other contractors in accordance with the requirements of the Technical Requirements (ERT).

Definition and design approach by the Contractor with Interface Contractors for civil and structural works or type, size and location of equipment and control rooms, access routes thereto, embedded ductwork and other cast-in items such as lifting hooks and eyes, fixing bolts and sockets, agreement of installation programming, preparation of coordinated installation plan, etc. shall be done.

Where an Interface Contract is yet to be awarded, the Contractor shall proceed with the coordination activities with the Engineer until such time as the Interface Contractor is available. The Contractor shall provide the Interface Contractor with all information necessary to enable the Interface Contractor to follow-on and proceed with their co-ordination.

20.9. Construction Interfaces and Co-ordination

The Contractor shall undertake installation during periods for installation interfacing and coordination. The installation interface and co-ordination period indicate when its Subcontractors and/or Interface Contractors shall have access to areas within works areas for Interface Contractors to undertake their work. It shall be incumbent on the Contractor to define more closely with Interface Contractor the details of its activities within areas where work is to be carried out and to require the same to be described in interface documents. During the installation interface period, the Contractor shall have priority in working within areas to which access has been granted. The end of the installation interface period indicates when the Contractor shall finish its principal installation work within the given areas to which access has been given.

The Contractor shall coordinate and cooperate with Interface Contractors on all site-related matters including but not limited to site access and occupation, safety, verification of work compatibility, and survey control. The Contractor shall advise the Interface Contractors in advance when a construction item is ready for field inspection to verify compatibility with the interfacing parties' needs and shall facilitate access to the Site for the Interface Contractors.

On advice from the interfacing parties that an as-constructed interface-related element is ready for inspection, the Contractor shall:

- Conduct on-site inspections of the work elements and give comments in writing to the Interface Contractors.
- Agree in writing to the interfacing parties that the as-constructed work meets the interface requirements.

20.10. Interface Management Plan

Interface Contractors are listed in Section 4.3.1 of this ERG are to be included in Interface Management Plan and the Organization Chart (Interfacing).

The Contractor shall fully co-ordinate the design of the Contract Works with all relevant bodies and entities, in particular government authorities, departments and regulatory bodies, utility companies, and the consultants and contractors of adjacent Projects whether ongoing or planned.

Interface issues and their resolution shall be regularly addressed in the Monthly Progress Report. All submissions shall conform to interface requirements.

As a minimum, the IMP shall contain the content as in Table 20.1 below. The intention of each section of IMP is described by the text inside the right-hand column in italics.

Table 20.1: Interface Management Plan

1	**Introduction**	
1.1	Purpose of the Document	Describe the methodology to be adopted by the Contractor in managing all interface issues
1.2	Overview	Project overview of the Contractor and Interface Contractor interfaces
2	**Resource Management**	
2.1	Organization and Roles & Responsibilities	Description of organization structure
2.2	Resource Requirement	Detailed description of the manpower, tools, logistics shall be included in this section
3	**Interface Requirements**	
3.1	Allocation of Interface Requirements	This is an introduction to Section 3.2 below
3.2	Interface Description between Contractors	Outline Interface Matrix (OIM) shall be included in this section
3.3	Areas of Concern	Process for managing the interface concern
4	**Process Management**	
4.1	Change of Interface Requirement	The process for the management of interface requirement change to be addressed in this section
4.2	Verification and Validation of Interface Requirements	The approach to be adopted by the Contractor to manage verification and validation of interface requirements shall be addressed in this section
4.3	Testing and Commissioning on Interfaces	The approach to be adopted by the Contractor for the management of interface in the Testing and Commissioning stage shall be addressed in this section
4.4	Quality Procedures	Contractor's internal quality procedures applicable for the interface management shall be listed here

5	**Document Management**	
5.1	Reference Documents	All applicable reference documents shall be listed in this section
5.2	Structure of Reference Documents	The structure of reference documents shall be addressed in this section
5.3	Version Control of Interface Documents	Configuration management of interface documents shall be addressed in this section
6	**Communication**	
6.1	Terms of Reference of Interface Meetings	The terms of reference of interface meetings shall be addressed here
6.2	Exchange of Information between Contractors	The process for the exchange of information between the pair-wise contractors (Interface Contractors) shall be stated here
6.3	Submission to Engineer	The approach to be adopted by the pair-wise contractors on the submission of the Interface Management Plan to the Engineer shall be described here
6.4	Request for Employer's Attention	The criteria and methodology on requesting for the Employer's attention shall be mentioned here

21. SYSTEM ASSURANCE

21.1. General

21.1.1. System Assurance Management is applicable for all stages of the E&M systems and Track works development, including design, manufacture, testing, commissioning, systems integration, trial operations, and in-service operations.

21.1.2. The Contractor shall submit a comprehensive System Assurance Management Plan (SAMP) which contains all requirements within section 4.6 of this document, for the Engineer's review.

The System Assurance Management Plan shall cover Reliability, Availability, Maintainability and Safety, Electromagnetic Compatibility (EMC), and Fire Safety strategy.

The System Assurance Management Plan shall comprise a program showing in detail the timing of each activity and the anticipated dates for submission of system assurance documentation. The program will break down the planned activities into discrete stages of work as a minimum design, manufacturing, installation, testing and commissioning and RAM demonstrations.

System Assurance Management Plan shall clearly identify the reviews to be performed at the end of each stage of the program. System Assurance Report shall be submitted at the end of each stage of the program which covered all the subjects above. The Subsystem Assurance Plans will be consistent in approach with the System Assurance Management Plan. The SAMP shall be certified by the Contractor's internal department or by a third-party independent engineer from the design and manufacturing section. The SAMP shall be specifically developed for this Contract.

21.1.3. A Taking Over Certificate (TOC) will be issued in accordance with General and Technical specifications of the contract, when all E&M systems/subsystems, Track Works and fully integrated works have successfully completed tests and integrated testing.

21.1.4. A Performance Certificate will be issued by the Engineer for the total performance of the E&M systems and Track works. This Performance Certificate is required to be achieved by the end of the Defect Notification Period (DNP). Prerequisites to obtain the Performance Certificate includes: Each E&M systems and Track works asset achieves its RAM and Safety targets.

21.1.5. The Contractor shall provide sufficient documented information for review by the Engineer. It is expected that the design demonstration of the E&M systems and Track works performance shall be achieved through supplier-based material self-certification, including cross-references to proven and accredited in-service performance of E&M systems and Track works supplied in a similar railway application.

21.1.6. With regard to Safety, it is expected that certification shall be achieved through supplier-based information via application of cross-references to previously certified acceptances from a reputable body (e.g., train operators, national railways authorities, independent accredited safety bodies, etc.) of similarly supplied E&M systems and Track works equipment, with a product-generic safety case application to be made based on existing safety certification.

21.1.7. System Assurance shall define system assurance processes and principles by which the Contractor shall deliver an integrated railway fit for acceptance by the Employer:

System Assurance shall:

1) Develop requirements for safety, RAM, and EMC;

2) Demonstrate compliance with the Employer requirements for safety, RAM, and EMC;

3) Deliver the required documentation, including safety cases, safety justifications, risk assessments, risk analysis, and demonstration of compliance with safety requirements;

4) Support compliance to safety legislation and standards for the purpose of certification of the various components of the Project for revenue service;

5) Define system assurance processes and principles by which the Interface Contractors/subcontractors shall deliver an integrated railway fit for acceptance by the Employer;

6) Deliver a compliant RAMS/EMC environment, as demonstrated in the design

verification and validated in the integrated testing and commissioning stage of the Project. In doing so, deliver safe functionality of all equipment for operational running, assuring the safety of passengers, staff, and the public.

21.1.8. The Employer shall conduct audits during design, development, manufacture, and testing and commissioning phases to ensure that the Contractor has met all relevant System assurance requirements. The Engineer shall give 7 days' notice to the Contractor about the audit arrangement. The Contractor shall provide all necessary assistance to enable the Employer or his representative to complete the audit.

21.1.9. The Contractor shall follow System Assurance international standards primarily IEC 62278, IEC62279, and IEC 62425 or equivalent CENELEC standards, subject to review by the Engineer.

Table 21.1: E&M systems and Track works RAM and Safety Targets

RAM / Safety Targets	
E&M systems and Track works Operational Availability to support Train service	99.95%
Passenger serious injuries	<=2 per 20 Million passengers
Staff lost Time Injury	<=2 per 200,000 Manhours worked.

21.2. System Safety Assurance Management

21.2.1. The Contractor shall submit a System Safety Assurance Plan, which shall contain sufficient information to demonstrate clearly the Contractor's proposals for achieving effective and efficient safety procedures in the design, manufacture, testing, and commissioning of the Railway Systems. The System Safety Assurance Plan shall cover safety procedures and regulations to be developed and the mechanisms by which they will be implemented for ensuring safety including Hazard Analysis, Fire control, EMC/EMI control, Safety Integrity Level requirement, site safety, etc.

21.2.2. The Contractor shall submit a System Safety Assurance Plan according to IEC 62278 or EN 50126 (Railway Applications- Specification and Demonstration of Reliability, Availability, Maintainability, and Safety) or any other equivalent international standard for the Engineer's review as per schedule of Table 4-1 of Appendix 4 attached hereto.

21.2.3. System Safety Assurance Plan shall detail, but not limited to, the following:

(1) Organization of the Safety team.

(2) Management of Safety-related interfaces with other contractors.

(3) Provisions and procedures for providing feedback to and interacting with other disciplines in the Contractor's team, e.g., RAM, design, maintenance, and commissioning.

(4) Identified Safety requirements (including interfaces).

(5) Planned Safety assessments/analysis to demonstrate that the system safety requirements are met by the Contractor's design.

(6) Safety methods to be used for the safety analysis.

(7) Management of subcontractors' Safety requirements.

(8) Safety-related software management

(9) Quality management

(10) Configuration management

(11) Verification and validation of assessments, including data.

(12) Validation of Safety requirements during manufacture, installation, commissioning, and maintenance.

(13) Audits and Review activities.

(14) Record keeping of Safety assessments/analysis.

(15) Hazard Log Management.

(16) List of deliverables, including interim items listed within this document.

(17) High-level schedule for deliverables.

21.2.4. The Contractor shall provide the following, but not limited to:

(1) The Hazard Analysis report shall evaluate and ensure that all the hazards are identified and satisfactorily resolved to an acceptable level.

(2) Safety assessment report demonstrating the Safety requirements are in compliant with Technical Requirements (ERT).

(3) The Fire Safety Analysis report shall evaluate and ensure inter alia that the fire loadings of material proposed to be used, and the fire withstand ratings, etc. are as per the requirements specified in the Employer's Requirements – Technical Requirements (ERT).

(4) The EMC/EMI Control Plan shall evaluate and ensure that the requirements for electromagnetic compatibility and interference according to IEC 62236 or EN 50121 and as specified in the Employer's Requirements - Technical Requirements (ERT) all elements of the system are met.

(5) Design Safety Case and Final Safety Case to be submitted for the Employer's approval.

21.2.5. Electrical/electronic/programmable electrical safety-critical equipment shall be assigned a Safety Integrity Level (SIL), depending on the contribution of this equipment to safety risks also as specified in Employer's Requirements – Technical Requirements (ERT).

For example, a Computer-based Interlocking (CBI) System shall be at SIL 4 level.

Where not specified, the Contractor shall determine SIL requirements for electrical/electronic/programmable electronic safety-critical items in accordance with EN 50126, EN 50129, or IEC 61508 standards.

21.2.6. The Contractors shall prepare a Safety-Critical Item List of equipment and LRUs classified by their impact on safety for Employer review.

21.2.7. The Contractor shall submit an Engineering Safety Validation Plan, including but not limited to:

a) the list of safety field verifications and validations for systems/subsystems/equipment during construction, manufacturing, installation, and systems interfaces integration testing;

b) the schedule of safety field verifications and validations;

c) the purpose of each verification and validation;

d) the acceptance criteria by reference to any related safety study;

e) the recommended method of testing, including the processing of key software safety issues in verification and validation;

f) the plan for witnessing the results of verification and validation;

g) the recommended format of the engineering safety validation report;

h) the submission list of the Contractor's test reports; and

i) the recommended assessment procedure with respect to deficiencies in the verification and validation results.

21.2.8. Independent Assessment:

The Employer may appoint Independent Engineers and/or Independent Safety Assessors (ISA) to assess and advise on compliance with Contract requirements on System Assurance. The Contractor, interface contractors, subcontractors, and suppliers shall provide necessary assistance to Independent Engineers and Assessors, as required.

The independent assessment may undertake the following, but is not limited to:

1) Safety audits;

2) Safety reviews;

3) Design reviews;

4) Witnessing testing activities;

5) Review of the safety and quality organizational activities;

6) Review of the safety process; and

7) Assessment of hazard logs and safety cases.

21.2.9. The Contractor shall appoint their own Independent Safety Assessor for assessing safety-critical subsystems and/or safety-related software in accordance with EN 50128 and EN 50129.

Refer to APPENDIX 6 – Engineering Safety Management Plan for detailed Safety requirements.

21.3. Reliability, Availability, and Maintainability Management

21.3.1. The Contractor shall submit a RAM Plan as per IEC 62278 or EN 50126 or any other equivalent international standard for all the applicable Systems including but not limited to train control system, Rolling Stock, Signaling, PSD, Telecommunications, OCS, AFC, Power supply system, Power distribution system, OCC, Depot Equipment and SCADA to comply with the Technical Requirements (ERT) and given a Notice of No Objection by the Engineer.

21.3.2. The RAM Plan shall set out the principles by which RAM targets as specified in Employer's Requirements – Technical Requirements (ERT) are compliant for different Rail Systems and the RAM activities undertaken by the Contractors to achieve them.

21.3.3. Specific RAM Plans shall be developed by the Contractors for their scope of work that set out responsibilities of RAM requirements, team members, methodologies, tasks, task flow, progress reporting, and a description of reporting, reviews, and RAM deliverables.

21.3.4. The RAM Plan shall be applicable to design, development, production, installation, testing and commissioning, operation, and maintenance phases of the works.

21.3.5. The Contractor shall submit the RAM Plan for review by the Employer. The first draft of these plans shall be submitted to the Employer for review within 90 days of the Commencement Date of the Works.

21.3.6. All RAM calculations shall use an annual operation of 19 hours a day, 7 days a week, with engineering downtime of 5 hours a day.

For E&M Systems and Trackwork to achieve 99.95% or above, operational (timetable) service availability, the system shall be inherently fault-tolerant. Single point failures that are not safety-critical shall not cause a train service to be delayed or interrupted.

Table 21.2: E&M systems and Track works RAM Targets

Item	**System**	**RAM Target**	
		Availability (%)	**MTTR**
1	Track	99.96%	4 hours
2	Signalling	99.98%	0.5 hours
3	Backbone Transmission System (BTS)	99.99%	4 hours
4	Public Address System (PA)	99.95%	0.5 hours
5	Passenger Information System (PIS)	99.95%	0.5 hours
6	Power SCADA	99.99%	0.5 hours
7	CCTV	99.8%	0.5 hours
8	Power Supply	99.995%	0.5 hours
9	Power Distribution	99.995%	0.5 hours
10	Overhead Catenary System (OCS)	99.995%	0.5 hours
11	Automatic Fare Collection (AFC)	99.5%	0.5 hours
12	Depot Equipment	95%	4 hours
13	Radio System (GSM-R)	99.99%	4 hours
14	Voice and Data system (office telephone & data)	99.8%	0.5 hours

Item	**System**	**RAM Target**	
		Availability (%)	**MTTR**
15	Voice and Data system (mission-critical telephones)	99.95%	0.5 hours
16	Master Clock and Time distribution	99.8%	0.5 hours
17	Platform Screen Doors (PSD)	99.98%	1 hour
18	Computerized Maintenance Management System (CMMS)	95%	4 hours
19	Integrated Operations Control Center (IOCC)	99.95%	1 hour

**All the above values, may be subject to further review and revision.*

Table 21.3: PSD Performance Requirements

Sr. No.	**Performance requirement – Platform Screen Doors (PSD)**
1	PSD system shall have a failure rate of less than 1 in 1,000,000 operations cycle per door. (One operation cycle means one complete opening and closing cycle).
2	PSD system shall have MTTR as 60 minutes unless otherwise specified. (This time shall not include the time taken for the technician to arrive at the fault reported site).

21.3.7. Where appropriate, the Contractor shall also specify RAM (Reliability, Availability, and Maintainability) requirements for the design, operation, and maintenance of subsystems where the failure mode, effects, and criticality analysis (FMECA) identifies failure modes that have a maintenance, operations or safety impact, using the risk assessment methodology.

21.3.8. The Contractor shall conduct a Preliminary RAM Analysis which shall give an initial indication of any RAM problems which may arise which might affect the performance of the E&M Systems and Track works.

21.3.9. The Contractor shall adopt Reliability Block Diagram, Fault Tree Analysis, FMECA, or other appropriate methodologies to conduct RAM modelling and predict RAM performance so as to verify that the design of systems/sub-systems can achieve the Performance or RAM targets.

21.3.10. The Contractor shall provide RAM Demonstration Plan and RAM Demonstration report as necessary in the relevant stages of the project.

21.3.11. The Contractor shall provide a Reliability Critical item list which might impact the operations of the train or train service.

21.3.12. The Contractor shall provide all necessary references, assumptions, dependencies for the RAM data used for analysis.

The RAM evidence provided shall cover all RAM components of E&M Systems and Track works to be supplied and installed.

This shall include, but not limited to:

(1) Availability, based on system architecture and component reliability;

(2) Overall system availability;

(3) Availability proof for significant components and functions demonstrated by RAM analysis (i.e., calculated failure rates, Reliability Block Diagram, failure mode analysis, etc.);

(4) Determination of Reliability Critical item list;

(5) Recommended preventive and corrective maintenance program;

(6) Mean Active repair time analysis of all major modules;

(7) Predicted holding spares requirements for the duration of the E&M Systems and Track works operational life cycles;

(8) Lifecycle costs for ownership of the asset, i.e., capital, leasing, performance costs, part life renewal, preventive maintenance, fault and repair, spares and consumables, utilities (e.g. electric power, etc.), and decommissioning.

21.3.13. The Contractor shall supply further RAM data as requested by the Employer. The Contractor shall provide a RAM model of the final design which demonstrates the achievement of the RAM targets.

The RAM Model shall be supported by validated data from suppliers that are conforming to the corresponding sub-system RAM Targets.

21.3.14. The Contractor shall commence the use of the Data reporting analysis and corrective action system (DRACAS) prior to any factory or site acceptance tests and report to the Engineer on a regular basis.

21.3.15. During the DNP, the Operator shall collect and maintain data on the RAM performance to support the operational service availability. The Contractor shall collect RAM performance data from the Operator and submit monthly RAM Demonstration Reports to the Engineer.

21.3.16. In case the Contractor is not able to achieve the planned RAM targets, the Contractor shall take necessary corrective measures either by way of change of design of the relevant equipment/ component or software modification.

21.3.17. The Contractor shall analyze each and every failure or defect of the components of various equipment to determine the root cause of failure and to propose corrective measures, subject to review by the Engineer.

21.3.18. A record shall be maintained for each and every defect/failure in accordance with the DRACAS report to be submitted by the Contractor and reviewed by the Engineer.

21.3.19. Correction shall be made to components or subsystems that either fail to attain predicted availability levels or show Pattern Failure at the Contractor's expense.

21.3.20. During the in-service Defects Notification Period (DNP), the E&M Systems and Track works shall demonstrate successful achievement of the RAM targets, which will be a prerequisite of the application for a Performance Certificate to be issued by the Employer.

Failure to meet the E&M Systems and Track works RAM targets within the DNP shall mean that the DNP shall be extended until such time as the RAM targets has been met.

Regardless of the above, the maximum DNP is 4 years from the date of issue of the Taking Over Certificate.

21.3.21. Availability shall be assessed by the following measure:

$$\text{Percentage Availability} = \left[\frac{1- [DT(OPM) + DT(CM)]}{} \right] X\ 100 \quad \text{Total Time}$$

Where:

(1) Total Time, is the time in hours in the assessment period, multiplied by the number of E&M equipment commissioned under the contract;
a. Assessment period: Shall be no less than 6 months running during DNP;

(2) DT(OPM), or Down Time due to Other Preventive Maintenance, is the total downtime in hours due to Preventive Maintenance other than Service checks, summed over all sessions carried out on all E&M equipment, commissioned under the contract during the assessment period;

(3) DT(CM), or Down Time due to Corrective Maintenance, is the total downtime in hours due to Corrective Maintenance, summed over all sessions carried out on all E&M systems, and Track Works, commissioned under the contract during the assessment period. Any unreasonable delay in handing – over the E&M systems and Track Works for repairs for reasons not attributable to the Contractor shall be excluded. Time spent on E&M equipment integrity inspections after E&M systems and Track Works restorations arising from corrective maintenance work shall be included.

The contractor must provide a Maintenance Level 1 turnaround time of not more than 7 days and a Maintenance Level 2 turnaround time of not more than 30 days.

21.3.22. Maintainability Requirements: Simplicity of maintenance, operation, emergency procedures, and ease of restoration of equipment; these together with ease of access inside the equipment shall be taken into account throughout the development of the design.

The maintenance regime proposed for the E&M systems and Track Works shall be developed design stage. A Failure Mode Effect Criticality Analysis (FMECA) shall be developed to include required maintenance derived from each failure mode.

The E&M systems and Track Works shall incorporate design, which reduces maintenance, substantially improving service intervals and component replacement. The design shall also minimize Mean Time To Repair (MTTR) and costs throughout the design life.

The MTTR time measurement shall include on-site diagnostics and rectification of the failure (including software re-boot) up to the point that the system is restored to full functionality. In the event that the failure cannot be rectified, this time measurement shall include the time necessary to remove the failed piece of equipment from the System and replace it with a functioning one.

The MTTR does not include the time taken for designated personnel to arrive on-site (access time) to begin local diagnostic activities, neither the time taken for the replacement parts to be delivered to the site.

The Contractor shall submit the expected MTTR of the identified key E&M systems and Track Works subsystems.

21.3.23. The E&M Systems and Track Works shall operate with minimum attention between the specified inspection periods, and shall, under the operating conditions specified, operate between overhaul periods without requiring replacement of components other than those on the agreed list of consumable parts to be proposed by the Contractor and reviewed by the Engineer.

Special tools shall be avoided wherever possible. If they are required, they shall be supplied by the Contractor in sufficient quantities to meet the maintenance requirements.

Equipment design shall be modular to minimize downtime following the failures of equipment and components. Provision for mechanical handling devices shall be provided for any single piece of equipment weighing more than 35 kg. Equipment covers shall be provided with secure, visible, latching arrangements for easy inspection.

Should the electronic equipment be found to be faulty, the equipment shall enable fault finding to be carried out at the module level. This equipment shall allow fault finding down to the smallest replaceable item of equipment.

Equipment to which access will be required for fault finding shall be conveniently located. A list of such equipment and their location shall be supplied.

The E&M Systems and Track Works shall have provision for the isolation and where applicable, earthing of all electrical sub-systems to facilitate safe and systematic maintenance and fault diagnosis.

The above-mentioned features shall be suitably reflected in the respective design documents, as applicable, during the design stage.

21.4. Electromagnetic Compatibility (EMC) Management

21.4.1. The contractor shall prepare an EMC Management plan and evidence of EMC assurance submissions. The plan shall show that the process to manage risks due to electromagnetic disturbance is acceptable and meets the ALARP principle.

21.4.2. The EMC management plan shall capture how all supplied equipment and systems are verified compliant with the requirements of the relevant standards e.g. the EN 50121. This shall include:

(1) Appropriate tests standardized emissions and immunity conducted and radiated, continuous and transient.

(2) Good engineering practices for installation

(3) Specific design, implementation, and integration for earthing and bonding.

21.4.3. The Contractor's EMC submissions shall provide evidence showing that all equipment, systems, and installations have taken all necessary measures to ensure all objectives, contractual, and Employer's design requirements with regard to EMC are fully met.

21.4.4. The EMC management should take into account the current and future EMC Environment surrounding the railway corridor.

21.5. Engineering Change Management

21.5.1. The Contractor shall manage the Configuration Control of all software changes, and notify the Engineer through the Configuration and Change Control process, of any changes to Software or Hardware baselines, including an updated Schedule of all Software/Hardware assets/fixed or moveable, installed within the Station/Tunnel/Depot Systems or Trains.

21.5.2. The Change Management process shall be included in the System Assurance Management Plan.

21.5.3. Implementing Engineering Changes to the existing agreed baseline design can often introduce, new safety risks into the existing Design. It is therefore highly important that the Engineering Change, is managed through a defined Change Management process, and that the impact upon safety risk is considered as part of the change management process.

21.5.4. The Contractor and the respective Subcontractors shall implement a robust Engineering and Configuration Change Management Process, that nominally includes the following:

(1) A systematic identification process to identify possible hazards associated with the proposed change;

(2) Performance of a Risk assessment to determine the effects of the proposed change on the overall system risk;

(3) Identification of any necessary control measures, in order to reduce the overall safety risk to ALARP;

(4) Design solution details, to include the mitigation measures into the change;

(5) Review and approval of the proposed change by the Engineer and Employer.

21.5.5. To finalize the process, the Contractor shall prepare and submit to the Engineer an Impact Assessment Report, documenting the above to describe the effects of the change on system safety. This shall include the impact on related safety assumptions and requirements, systems and subsystems design and test, documented safety evidence and deliverables, etc.

22. REQUIREMENTS MANAGEMENT

22.1. The Contractor shall implement progressive assurance approach to manage & govern the project requirements in an integrated way with a complete traceability throughout the project lifecycle as per EN 50126.

22.2. The Contractor shall prepare and submit to the Engineer a Requirement Management Plan within thirty (30) days of the date of the commence date. The Requirement Management Plan shall define the processes employed by the Contractor to ensure that all appropriate requirements are managed to ensure the proposed design solution meets the design requirements and demonstrated through verification and validation evidence.

22.3. The Contractor shall implement "ComplyPro" as the Requirement Management software for tracking and management of requirements compliance in the project. All the costs associated with the software usage and maintenance shall be under the contractor's own cost.

22.4. The contractor shall appoint a suitably qualified and competent persons to carry out requirements management.

22.5. The Contractor shall develop a database of all requirements associated with a number of definition documents defined such as but not limited to, the ERG and ERT. The Contractor will then provide evidence that the identified requirements have been managed appropriately. The database shall:

(1) Ensure that the criteria for the purpose of verification and validation of the Requirements has been recorded with appropriate attributes assigned;
(2) Clearly identify requirements that have a direct impact on Safety and RAM performance.
(3) Hazard log management and Control measure management (Safety requirements);
(4) Interface register and Management;
(5) Ensure that compliance of the complete set of the Requirement can be demonstrated with evidence formally recorded;
(6) Ensure that the Requirements are consistent and traceable back to their sources, and any gap/mismatch in the Requirements are clearly identified;
(7) Establish formal deliverable which will support stage design reviews and the overall engineering management processes;
(8) Track and record Requirement changes and facilitate impact analysis on Requirement changes; and
(9) Track and record assumptions, if there are any, evaluating the stability of, and the impact on, the Project if any of the assumptions prove to be true of false, defining the actions necessary to make progress and monitor the assumptions, and scheduling when assumptions are to be validated and reviewed throughout the Project`s life duration.

22.6. The Contractor shall issue a monthly status report showing the status of the Requirement Management and information such as the number of open and closed requirements.

22.7. Each design submission shall be accompanied by a design statement and compliance matrix which describes the scope and content of each submission, its underlying assumptions, and non-conformances.

22.8. The Contractor shall use the Requirements Management software "ComplyPro" as the platform to implement the DRACAS process starting from Factory Acceptance Test; continue during site Testing and Commissioning, Trial run until handover to O&M Concessionaire.

22.9. Requirements Management evidence shall be presented as part of the design submission stages and at other regular stages in the manufacture, construction, implementation, installation, commissioning, and handover, as requested by the Engineer.

22.10. A final output of ComplyPro shall be the demonstration of achievement of the safety requirements for the work under the Contract and shall be used to support the final safety case.

22.11. The Contractor shall provide a minimum of 10 no. user licenses for the Requirements Management software "ComplyPro" to the Engineer and Employer which shall be used until the start of revenue service of the final section of the line.

22.12. The Contractor shall have sufficient licenses for their own use to cover their scope of works and activities to be undertaken.

23. ASSET MANAGEMENT

23.1. Asset management, work planning, work history, and asset performing reporting will be carried out using a Computerized Maintenance Management System (CMMS). The CMMS is a software-based system that will be available to the maintenance and operation organization with equipment at the Depots and OCCs.

23.2. The Contractor shall produce an Asset Management Plan within ninety (90) days after the commencing of work.

23.3. Plant and Material shall be designed to meet the Requirement for the specified design life in ERT.

23.4. The design life of the system and components shall be considered during the project design stage.

23.5. The total life cycle cost approach shall be adopted in evaluating design alternatives. System design shall be optimized with respect to the total cost of initial acquisition, operation, maintenance, system support, and disposal over the life cycle. The Contractor shall provide supporting data and technical analysis to demonstrate compliance with this requirement.

23.6. An adequate supply of spare parts and test equipment shall be made available for a period of time from completion of the Works in accordance with Obsolescence Management Plan. The Contractor shall notify the Employer/Operator at least six (6) months prior to deleting any component of the supplied equipment from general availability and guarantee to provide functionally replacement units for the remainder of such specified period of time.

23.7. All assets data are to be deposited and managed in the System Configuration Database Platform as part of the delivery of CMMS.

23.8. The Contractor shall provide an asset register for populating the CMMS Database server. The register shall comprise, but not limited to:

(1) Part name;
(2) Part number;
(3) Functional use;
(4) System, sub-system, equipment, and component-level hierarchy for populating the CMMS Database configuration;
(5) Maintenance requirements.
(6) Maintenance history;
(7) Asset Condition
(8) The useful life of asset.
(9) Spares stock holding;
(10) Supplier;
(11) Contact name and address.

23.9. The Contractor shall provide administrative schedule information for populating the CMMS database server. The schedule shall include but not limited to:

(1) Personnel details;
(2) Training;
(3) Warranties;
(4) Work schedule;
(5) Job cards.

23.10. All warranties shall be transferred to the Employer/Operator. All spares, special tools, and equipment shall be supplied to the owner/Operator.

23.11. The Contractor shall produce an Obsolescence Management Plan for review within ninety (90) days after the commencing of work.

23.12. The plan shall consider the project related risk associated with the obsolescence issue in connection with equipment/spare parts, hardware, and software during the design. And though to its first estimated obsolescence phase.

23.13. Obsolescence shall be evaluated by the Contractor when planning the levels of spares holding.

23.14. The Contractor shall submit an Obsolescence Management Report for review at the conclusion of the final design. The report shall contain details of the management of the system and components throughout the life of each asset.

24. DEMOBILIZATION AND CLOSING WORKS

24.1. Demobilization

This section specifies the carrying out of final closeout activities in preparation for completion of all construction and installation work under the Contract; all in accordance with the Contract Documents.

24.1.1. Demobilization will be considered as complete when all of the Contractor's Equipment, materials, personnel, Temporary Facilities, construction plant or otherwise belonging to the Contractor not required for the Defect Notification Period have been removed from the project site.

24.1.2. Demobilization shall include providing required submittals prior to close-out of the Works, including but not necessarily limited to the following:

- Spare parts, tools, equipment, machinery, and rail vehicles required by the Contract,
- Operating and maintenance data as required,
- Project "As-Built Drawings" and documentation as required,
- Railway equipment as required under these specifications,
- Schedule and price of Plant installed under the contract,
- Schedule of installed works and materials, and
- Contractor's completion report and photo and video record.

24.2. Closing Works

Closing works shall be inspected by the Engineer and/or the Employer as the condition's pre-requisite to completion inspections - written notice submitted by the Contractor requesting a final or partial completion inspection.

Inspection by the Engineer and/or the Employer shall mean that the Works is substantially complete, and the Contractor has:

- Inspected and checked all the Works installed,
- Compared all the Works with the drawings, specifications, and submittals given a Notice of No Objection by the Engineer.
- Confirmed that all conditions, provisions, and requirements of Contract Documents have been fulfilled, other than any maintenance and incidental works and procedures necessary to follow,
- Clean-up operations complete,
- Temporary Facilities and utilities properly disconnected and removed, except those needed for the Defects Liability Period,
- Systems, equipment, and devices properly adjusted, serviced, tested, and fully operable,
- Materials and finishes neat, clean and undamaged; accessory parts and items securely attached,
- Broken or damaged work repaired or replaced as required,
- Spare parts delivered and stored as required,
- Recovered materials catalogued and neatly stacked for removal by the Engineer,
- Test reports and other required documentation assembled and delivered to the Engineer,
- The documents including manuals, and warranties, assembled and delivered to the Engineer, and
- Written notice of readiness for Final Completion Inspection filed with the Engineer.

24.3. Training Completion

Training will be required to be completed before the commercial operation of trains by the Contractor. Training requirements details are given in Section14 of the General Requirements (ERG) as well as the Technical Requirements (ERT).

25. SECURITY AND INSURANCE

25.1. Security

The Contractor shall provide the following securities in accordance with the Contract requirement:

- Performance Securities; and
- Other Securities, as required under the Contract.

The detailed requirements are stipulated in the General Conditions and the Particular Conditions.

25.2. Insurance

The Contractor shall purchase and maintain the following insurances in accordance with the requirements stipulated in the General Conditions and Particular Conditions:

- Insurance for the Works (Contractor's All Risk Insurance);
- Insurance for the Contractor's Equipment;
- Insurance against Injury to Persons and Damage to Property (Third Party Liability Insurance);
- Cargo Insurance during Transport (Marine Cargo Insurance, Inland Transport Insurance);
- Insurance for Contractor's Personnel (Workers' Compensation, Employer's Liability);
- Automobile Liability Insurance; and
- Other Insurances as may be required under the Law of the Country or agreed specifically agreed between the Employer and the Contractor.

APPENDIX TO GENERAL REQUIREMENT

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APPENDIX 1- GENERAL ABBREVIATIONS

Abbreviation	Description
A0 to A6	International Document Paper Sizes
AC	Alternating Current
ANSI	American National Standards Institute
AFC	Automatic Fare Collection
AREMA	American Railway Engineering and Maintenance of Way Association
ASTM	American Society for Testing and Materials
BMS	Building Management System
BS	British Standard
CAD	Computer-Aided Design and Drafting
CAR	Corrective Action Request
CCTV	Closed Circuit Television
CDIM	Consolidated Detailed Interface Matrix
CIF	Cost, Insurance and Freight
CMMS	Computerized Maintenance Management Systems
CP	Contract Package
CP NS-02	Contract Package (Rolling Stock)
CP NS-03	Contract Package (Rolling Stock- Limited Express)
CPM	Critical Path Method
CT	Current Transformer
DC	Direct Current
DCC	Design Certificate Consent
DNP	Defect Notification Period
DOTr	Department of Transportation
DPWH	Department of Public Works and Highways
DRACAS	Data reporting analysis and corrective action system
DRCA	Design Review Certificate Application
E&M	Electrical & Mechanical
EDMS	Electronic Document Management System
EIA	Environmental Impact Assessment
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMP	Environmental Management Plan
EMU	Electric Multiple Unit
EN	European Norms
ER	Employer's Requirement
ERG	Employer's Requirements-General Requirements
ERT	Employer's Requirements-Technical Requirements
ETCS	European Train Control System
GC	General Conditions of Contract

Abbreviation	Description
GHG	Global Greenhouse Gas
GPS	Global Positioning System
HV	High Voltage
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronic Engineering
IP	Internet Protocol
IMP	Interface Management Plan
IOCC	Integrated Operation Control Center
ISO	International Standardization Organization
JDT	JICA Design Team
JEC	Japanese Electrotechnical Committee
JEITA	Japan Electronics and Information Technology Industry Association
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
JPEG	Joint Photographic Experts Group
LAN	Local Area Network
LED	Light Emitting Diode
LV	Low Voltage
MCRP	Malolos Clark Railway Project
MCS	Material Control Schedule
MMSP	Metro Manila Subway Project
MTBF	Mean Time Between Failures
MTTR	Mean Time to Restore
NC	Normally Closed
NGCP	National Grid Corporation of the Philippines
NO	Normally Open
NSCP	National Structural Code of the Philippines
NSCR	North South Commuter Railway
NSRP-South	North South Railway Project –South Line (Commuter)
NTC	Philippine National Telecommunication Commission
O&M	Operation and Maintenance
OCC	Operation Control Center
OCS	Overhead Contact line System
ODA	Official Development Assistance
OFC	Optical Fiber Cable
OIM	Outline Interface Matrix
OJT	On the Job Training
OSR(S)	Operational Safety Report (Software)
PC	Particular Conditions of Contract
PEC	Philippines Electrical Code
PH	Philippines

Abbreviation	Description
PNFC	Philippines National Fire Code
PNR	Philippine National Railway
PR	Public Relations
PSD	Platform Screen Door
PT	Potential Transformer
RAM	Reliability, Availability, Maintainability
RAMS	Reliability, Availability, Maintainability, and Safety
RSR	Technical Regulatory Standards on Japanese Railways and including explanation
RTU	Remote Terminal Unit
SAMP	System Assurance Management Plan
SCADA	Supervisory Control and Data Acquisition
SER	Station Equipment Room
SS	Substation
STRASYA	Standard urban Railway System for Asia
SPD	Surge Protection Device
SWO	Stop Work Order
TOC	Taking Over Certificate
TSS	Traction Substation
UIC	International Union of Railway Standards
UPS	Uninterruptible Power Supply
VLAN	Virtual LAN
VT	Voltage Transformer
XLPE	Cross-linked polyethylene

APPENDIX 2- PROGRAM

2.1 Time Scaled Network/ Bar Chart

2.1.1 The coding structure shall be such that the activities can be summarized to the various levels. The Contractor shall comply with the Employer's Work Breakdown Structure (WBS), Activity codes, Activity ID, etc. Refer to the Tables shown in this Appendix for the detail on WBS and Activity Codes. The Contractor can propose further breakdown and additional codes for project use upon the review and approval by the Employer or the Engineer. Each activity in the network shall be coded, as a minimum, with the following:

(1) Contract number, activity type, and unique identification numbers,

(2) Activity codes to indicate Unit, Segment, Stage or Phase, for e.g., design, manufacturing, delivery, installation, etc., and

(3) The Contractor shall note that the breakdown of the system into sub-systems is essential and shall be carried out not through further coding but activity descriptions in a consistent manner.

(4) For more details, the Contractor can refer to the Employer's Planning and Schedule Manual.

2.1.2 All logical and necessary relationships between activities shall be shown.

2.1.3 All key dates (if any) indicated in the Contract shall be shown. In addition to the key dates, the Contractor may require certain events that are critical to his work to be reflected in his programs as "milestones".

2.1.4 All the activities shall be loaded with associated costs in accordance with the Accepted Contract Amount (ACA) and Bill of Quantity (BOQ). An S-Curve should be generated accordingly to demonstrate the physical progress throughout the project period. A cashflow shall be prepared based on the forecast progress and contract terms & conditions.

2.1.5 If payment milestones are applicable for the contract, all the payment milestones shall be created and allocated with the agreed amount. A cashflow shall be generated accordingly.

2.1.6 The level of program development, information, and detail shall be sufficient to permit the Engineer to have a good appreciation of the Contractor's project management plan especially with regard to the coordination and timing of his work in relation to the work of the Interface Contractors and the obtaining of necessary approvals from the relevant local authorities. It shall demonstrate the ability to meet specified key dates through a logical work sequence that has taken account of the Project constraints.

2.1.7 Activities pertaining to review/acceptance by the Engineer and local authorities shall be identified. Where duration for review of the Contractor's submissions are specified elsewhere in the Contract, they shall be used.

2.1.8 Activities outside the scope of the Contract that may affect the Contractor's progress shall be shown.

2.1.9 The activity network shall be organized so that major work sections are carefully coordinated with Interface Contractors to allow opportunity for all to work with as minimal disruption as possible. Critical paths shall be identified.

2.1.10 Activity descriptions shall be brief and shall convey the nature and scope of the work. Uncommon abbreviations shall be explained in the legend. Float time shall be distinguished from schedule performance.

2.1.11 TheCPMNetworkDiagramshallbedevelopedtopermitmodificationtotheschedule and allows for impacts on the schedule to be analyzed by the introduction of "what if" statements into the input data.

2.1.12 The constraint shall be applied to only the Key Dates and Access Dates for calculating the floats. All the schedule assumptions shall be described and schedule lag shall be explained in the narrative.

2.2 Time Scaled Network/Bar Chart Details

2.2.1 Mobilization: The mobilization network/bar chart shall include key personnel, major team, major subcontractors, and setup of office, camp, plant & equipment, as well as the early procurement for long lead time items. In general, those activities shall be carried out within the first 120 days after the commencement of works, but not specific to the following phases.

2.2.2 Design: The design network/bar chart shall detail the various design, submission, and acceptance stages including approval by local authorities (if any) and Approval from the Engineer, preparation, submission, and Approval of drawings manuals and all other activities related to the design.

2.2.3 Manufacturing: The manufacturing network chart shall indicate the relationship and duration of the activities necessary to procure, fabricate, manufacture assemble equipment/complete car tests, ship, and deliver rolling stock in time to support the activities at the Site. It shall establish milestones for monitoring the progress of the manufacturing process. The network shall also cover activities of the Subcontractor as appropriate, including testing.

2.2.4 Construction and Installation: The on-site construction and installation activities shall detail the relationship and duration of the activities required for preparing, constructing, erecting, cabling all the Civil, MEP Trackwork, System works in the final location as per the drawings. The interface should be identified if multiple contractors have to carry out their works in parallel / in a specific sequence at the same site throughout a period. Certain intermediate milestones could be added to monitor and measure the key achievement.

2.2.5 Testing, commissioning, and acceptance: The factory and on-site testing and commissioning activities shall present the relationship and duration of those items relating to commissioning tests including those related to the Interface Contractors. The network/bar chart shall present the testing approach and sequence to be used, the deployment of resources in accordance with signaling milestone dates.

2.2.6 Integrated testing: The integrated testing network/bar chart shall indicate the activities required to verify the functioning of all subsystems and the rolling stock in conjunction with activities of the Interface Contractors.

2.2.7 Trial Runs: After completion of commissioning, the Contractor shall be required to take part in trial runs with other interface contractors as decided. The network/chart shall indicate tests, measurements, and interface tests required to be carried out to verify system performance and readiness for revenue service.

2.3 Program Standards

2.3.1 All the programs shall be prepared, monitored, updated, and revised based on good project planning, scheduling, and monitoring practices as accepted internationally, and under the guidance of ISO 21500 – 2012.

Table D - 1: DOTr Primavera Cloud – Schedule Work Breakdown Structure (WBS) Page 1 of 2

DOTr Primavera Cloud - Schedule Work Breakdown Structure (WBS)

Primavera Cloud - Work Breakdown Structure (WBS)				
Structure	**Level**	**Status**	**Description**	**Values**
Work Breakdown Structure	**L01**	Client defined	Contract	Predefined by DOTr
	L02		Stage	Predefined by DOTr
	L03		Location	*As applicable (to be reviewed / approved by DOTr/GCR)*
	L04		Disciplines & Systems L1 - aligned to BOQ	Predefined by DOTr
	L05		Disciplines & Systems L2 - aligned to BOQ	Predefined by DOTr
	LNN	Optional	*As applicable*	*As applicable (to be reviewed / approved by DOTr/GCR)*

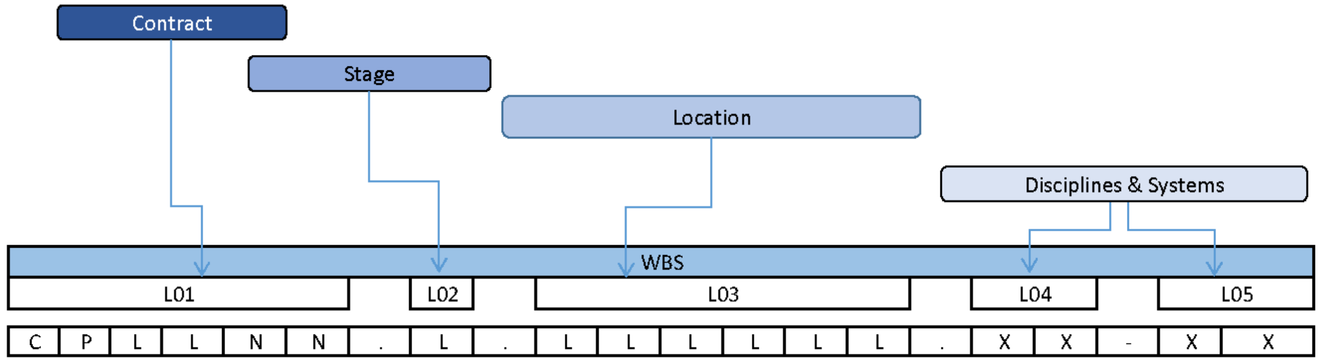

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Table D - 2: DOTr Primavera Cloud – Schedule Work Breakdown Structure (WBS) Page 2 of 2

DOTr Primavera Cloud - Schedule Work Breakdown Structure (WBS)

Example:

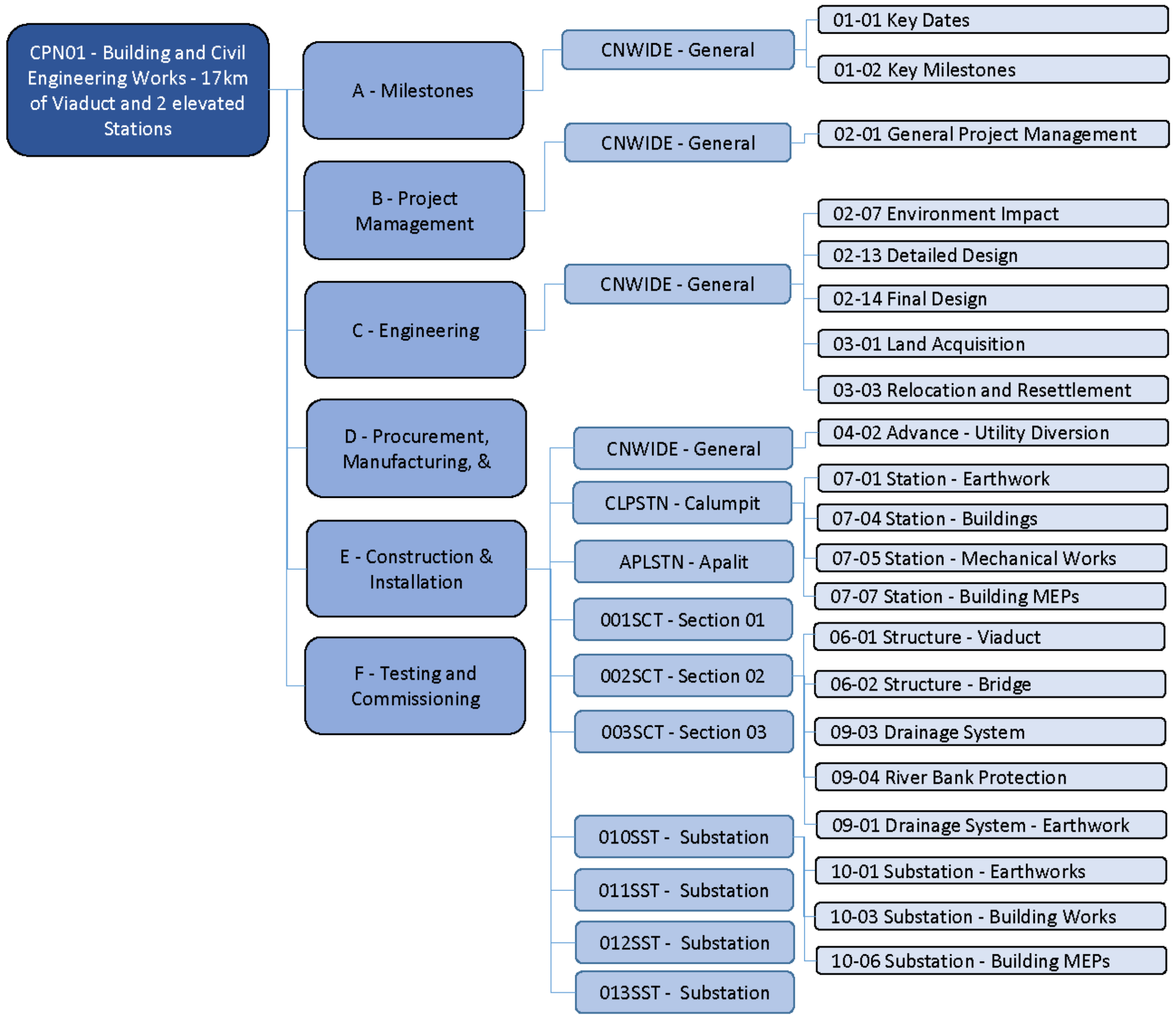

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Table D - 3: DOTr Primavera Cloud – Schedule WBS Dictionary Page 1 of 7

DOTr Primavera Cloud - Schedule WBS Dictionary

Work Breakdown Structure (WBS) Dictionary (Level 1 to Level 5)

WBS Level 1 - Contract

C	P	L	L	N	N	Description	Remarks
C	P		O	0	1	Building and Civil Engineering Works	
C	P		O	0	2	Building and Civil Engineering Works	
C	P		O	0	3	Rolling Stock - Commuter Trainsets	
C	P		O	0	4	E&M Systems and Track Works	
C	P		O	0	5	Building and Civil Engineering Works	
C	P		N	0	1	Building and Civil Engineering Works - 17km of Viaduct and 2 elevated Stations	
C	P		N	0	2	Building and Civil Engineering Works - 16km of Viaduct and 1 elevated Stations	
C	P		N	0	3	Building and Civil Engineering Works - 16km of Viaduct and 2 elevated Stations	
C	P		N	0	4	Building and Civil Engineering Works - 6.5km of mainline and 1.1km depot access line, 1 U	
C	P		N	0	5	Building and Civil Engineering Works - Depot (approx. 33ha)	
C	P		S	0	1	Building and Civil Engineering Works - 1.1 km of Viaduct and 1 Elevated Station	
C	P		S	0	2	Building and Civil Engineering Works - 7.9 km of Viaduct and 3 Elevated Station	
C	P		S	3	a	Building and Civil Engineering Works - 4.5 km of Viaduct, Atgrade, 1 atgrade Station and 1	
C	P		S	3	b	Building and Civil Engineering Works - 10.7 km of Viaduct, Atgrade, 1 semi U/G, 1 atgrade	
C	P		S	0	4	Building and Civil Engineering Works - 8.5 km of Viaduct and 2 Elevated Station	
C	P		S	0	5	Building and Civil Engineering Works - 12.8 km of Viaduct and 3 Elevated Stations	
C	P		S	0	6	Building and Civil Engineering Works - 10.3 km of Viaduct and 3 Elevated Stations	
C	P		S	0	7	Building and Civil Engineering Works - Depot (Approx. 20ha)	
C	P	N	S	0	1	E&M Systems and Track Works including PSD at all NSCR stations	
C	P	N	S	0	2	Rolling Stock-Commuter Trainsets (38 trainsets consisting of 8 cars, total 304 cars)	
C	P	N	S	0	3	Rolling Stock-Limited Express Trainsets (7 trainsets consisting of 8 cars, total 56 cars)	
						To be added when new contract is initiated	

WBS Level 2 - Stage (EPC/D&B phases)

					L	Description	Remarks
					A	Milestones	
					B	Project Management	
					C	Engineering (Concept, Preliminary, Detailed, Final, ICD, NOC etc)	
					D	Contract & Procurement (including manufacturing & delivery)	
					E	Construction & Installation	

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Table D - 4: DOTr Primavera Cloud – Schedule WBS Dictionary Page 2 of 7

DOTr Primavera Cloud - Schedule WBS Dictionary

C	P	L	L	N	N	Description	Remarks
					F	Testing & Commissioning (static, interface, dynamic, integration, Trial Operation)	
					G	Operation & Maintenance	

WBS Level 3 - Location / Section / Construction Front

L	L	L	L	L	L	Description	Remarks
						Pre-defined by DOTr	
P	R	W	I	D	E	Program Wide	
N	1	W	I	D	E	N1 Wide	
N	2	W	I	D	E	N2 Wide	
S	C	W	I	D	E	SC Wide	
C	N	W	I	D	E	General (Contract Wide)	
A	L	A	S	T	N	Station - Alabang	
A	N	G	S	T	N	Station - Angeles	
A	P	L	S	T	N	Station - Apalit	
B	A	L	S	T	N	Station - Balagtas	
B	A	N	S	T	N	Station - Banlic	
B	C	T	S	T	N	Station - Bicutan	
B	I	N	S	T	N	Station - Binan	
B	L	U	S	T	N	Station - Blumentritt	
B	O	C	S	T	N	Station - Bocaue	
B	C	L	S	T	N	Station - Bucal	
B	U	E	S	T	N	Station - Buendia	
C	B	Y	S	T	N	Station - Cabuyao	
C	M	B	S	T	N	Station - Calamba	
C	A	L	S	T	N	Station - Caloocan	
C	L	P	S	T	N	Station - Calumpit	
C	R	K	S	T	N	Station - Clark	
C	I	A	S	T	N	Station - Clark International Airport	
E	D	S	S	T	N	Station - EDSA	
E	S	P	S	T	N	Station - Espana	
F	T	I	S	T	N	Station - FTI	
G	U	I	S	T	N	Station - Guiguinto	
M	A	B	S	T	N	Station - Mabalacat	
M	L	B	S	T	N	Station - Malabon	
M	A	L	S	T	N	Station - Malolos	
M	L	S	S	T	N	Station - Malolos South	
M	A	R	S	T	N	Station - Marilao	
M	E	Y	S	T	N	Station - Meycauayan	
M	T	N	S	T	N	Station - Muntinlupa	
N	C	1	S	T	N	Station - New Clark City 1	
N	C	2	S	T	N	Station - New Clark City 2	

Table D - 5: DOTr Primavera Cloud – Schedule WBS Dictionary Page 3 of 7

DOTr Primavera Cloud - Schedule WBS Dictionary

C	P	L	L	N	N	Description	Remarks
N	C	3	S	T	N	Station - New Clark City 3	
N	I	C	S	T	N	Station - Nichols	
P	C	T	S	T	N	Station - Pacita	
P	A	C	S	T	N	Station - Paco	
C	S	F	S	T	N	Station - San Fernando	
S	P	D	S	T	N	Station - San Pedro	
S	T	M	S	T	N	Station - Santa Mesa	
S	T	R	S	T	N	Station - Santa Rosa	
S	T	O	S	T	N	Station - Santo Tomas	
S	D	L	S	T	N	Station - Sindalan	
S	O	L	S	T	N	Station - Solis	
S	C	T	S	T	N	Station - Sucat	
T	B	I	S	T	N	Station - Tabing Ilog	
T	K	T	S	T	N	Station - Tuktukan	
T	U	T	S	T	N	Station - Tutuban	
V	A	L	S	T	N	Station - Valenzuela	
V	L	P	S	T	N	Station - Valenzuela Polo	
C	M	B	D	P	T	Depot - Calamba	
C	R	K	D	P	T	Depot - Clark	
M	L	D	D	P	T	Depot - Malanday, Valenzuela	
0	0	1	S	S	T	Substation - 001 (N1)	
0	0	2	S	S	T	Substation - 002 (N1)	
0	0	9	S	S	T	Substation - 009 (N1)	
0	1	0	S	S	T	Substation - 010 (N2)	
0	2	2	S	S	T	Substation - 022 (N2)	
C	I	A	S	S	T	Substation - CIA Depot (N2)	
S	0	1	S	S	T	Substation - S01 (SC)	
S	1	8	S	S	T	Substation - S18 (SC)	
						Proposed by the Contractors and approved by DOTr/GCR	
X	X	X	S	C	T	Section/Construction Front (Contractor could propose as per their construction approaches and method statements)	
						To be updated if any new scope is included	

WBS Level 4 & Level 5 - Disciplines / Systems (Type & Group of Works)

Table D - 6: DOTr Primavera Cloud – Schedule WBS Dictionary Page 4 of 7

DOTr Primavera Cloud - Schedule WBS Dictionary

C	P	L	L	N	N	Description	GS No.	Remarks
	N	N	-	N	N	Description		Remarks
	0	1				**Project Key Dates & Milestones**		
	0	1	-	0	1	Key Dates		
	0	1	-	0	2	Key Milestones		
	0	1	-	0	3	Payment Milestones		
	0	1	-	0	4	Other Milestones (Interface/Intermidiate/not defined in the contract)		
	0	2				**General and Consultancy Services**		
	0	2	-	0	1	General Project Management (General Requirements)		**Level 5** is aligned to General Requirement in BOQ
	0	2	-	0	2	Data Collection & Concept Design		**Level 6**
	0	2	-	0	3	Geotechnical		Suggest to be aligned to the further breakdown (As per GS No.) in BOQ
	0	2	-	0	4	Land Based Survey	GS No.	Description - some examples below
	0	2	-	0	5	Aerial Survey	103	Possession of Site and Contractors Mobilization
	0	2	-	0	6	Business Modeling	104	Contractor's Temporary Facilities
	0	2	-	0	7	Environment Impact Assessment	105	Project Information Sign Boards
	0	2	-	0	8	Material Testing	106	Laboratory
	0	2	-	0	9	Interface coordination and management	107	Contractor's Project Organization and Management
	0	2	-	1	0	Specialist Design Consultancies	108	Site Office for the Employer and the Engineer
	0	2	-	1	1	Safety, Risk, Security, RAMS Services	110	Detailed Works Programme
	0	2	-	1	2	Preliminary Engineering	112	Surveying, Setting out of the Works and Staking
	0	2	-	1	3	Detailed Design and Engineering	114	Traffic Management
	0	2	-	1	4	Final Design and Shop Drawings	118	Environmental Management
	0	2	-	1	5	Legal Services	119	Document and Drawing Submittals and Reviews
	0	2	-	1	6	Meteorology & Seismology (incl Weather & Climate) Services	120	Submission and Response Procedure
							121	Operating and Maintenance Manuals and Documents
	0	3				**RAP (Resettlement Action Plan)**	122	Construction Photographs
	0	3	-	0	1	Land Acquisition (Paper works for utility relocation and tree permits)	123	Video Recordings
	0	3	-	0	2	LRIP (Liklihood Restoration and Improvement Program)	130	Securities and Insurance
	0	3	-	0	3	Relocation and Resettlement (proeject affected people)		
	0	3	-	0	4	GRM (Grievances Redress Mechanism)		
	0	4				**Advance & Enabling Works**		
	0	4	-	0	1	Demolition		
	0	4	-	0	2	Utility Diversion (or Protection)		
	0	4	-	0	3	Relocation of Existing Facilities		
	0	5				**Earthworks**		
	0	5	-	0	1	Earthworks		
	0	5	-	0	2	Maintenance Road/Access Road		
	0	5	-	0	3	Existing Road Realignment		
	0	5	-	0	4	Swampy Section		
	0	5	-	0	5	Subbase and Base Course		
	0	5	-	0	6	Surface Course		

refer to N-01 to N-05 BOQ

Table D - 7: DOTr Primavera Cloud – Schedule WBS Dictionary Page 5 of 7

DOTr Primavera Cloud - Schedule WBS Dictionary

C	P	L	L	N	N	Description	Remarks
	0	5	-	0	7	Structural Works	
	0	5	-	0	8	Miscellaneous Structures	
	0	5	-	0	9	Plumbing and Sanitary Works	
0	6					**Railway Structures**	**Level 6**
	0	6	-	0	1	Viaduct	Suggest to be aligned to the further breakdown in BOQ
	0	6	-	0	2	Bridges (Underbridge, Overbridge, etc)	Earthwork
	0	6	-	0	3	Underground Structures (Cut & Cover Tunnel, Bored Tunnel, Underpass etc)	Sub-Structural and Superstructural Works
	0	6	-	0	4	At Grade Structure	Drainage Works (In Viaduct)
	0	6	-	0	5	Utility Corridor	Miscellaneous Works
	0	6	-	0	6	Box Culvert	
0	7					**Stations (including SIG/COM/Railway Electric house)**	**Level 6**
	0	7	-	0	1	Earthworks	Suggest to be aligned to the further breakdown in BOQ
	0	7	-	0	2	Subbase and Base Course	
	0	7	-	0	3	Surface Course	
	0	7	-	0	4	Building Works	
	0	7	-	0	5	Mechanical Works	
	0	7	-	0	6	Miscellaneous Works	
	0	7	-	0	7	Building MEPs	
	0	7	-	0	8	Exterior Works / Related Facilities	
0	8					**Depots**	**Level 6**
	0	8	-	0	1	Major Buildings (OCC, WS & LRS)	Suggest to be aligned to each building in BOQ
	0	8	-	0	2	Small Buildings	**Level 7**
	0	8	-	0	3	Training Center	Suggest to be aligned to the further breakdown in BOQ
	0	8	-	0	4	Landscape	
0	9					**Drainage System & River Bank Protection**	
	0	9	-	0	1	Earthworks	
	0	9	-	0	2	Structural Works	
	0	9	-	0	3	Drainage Works	
	0	9	-	0	4	River Bank Protection Works	
	0	9	-	0	5	SAPANG BALEN River Plan (N-03)	
	0	9	-	0	6	Pump System for Underground and Gil Puyat Underpass (N-04)	
	0	9	-	0	7	Drain System for Detention Basin 1 & 2 (N-05)	
1	0					**Substations**	
	1	0	-	0	1	Earthworks	
	1	0	-	0	2	Subbase and Base Course	
	1	0	-	0	3	Building Works	
	1	0	-	0	4	Mechanical Works	
	1	0	-	0	5	Miscellaneous Works	

Table D - 8: DOTr Primavera Cloud – Schedule WBS Dictionary Page 6 of 7

DOTr Primavera Cloud - Schedule WBS Dictionary

C	P	L	L	N	N	Description	Remarks
	1	0	-	0	6	Building MEPs	
	1	0	-	0	7	Exterior Works / Related Facilities	
	1	1				**Trackwork**	
	1	1	-	0	1	Plain Line Track (Slab, ballast, etc)	
	1	1	-	0	2	Switches & Crossing	
	1	2				**Railway Systems**	
	1	2	-	0	1	Signal and Train Control System	
	1	2	-	0	2	Telecommunications System	
	1	2	-	0	3	Power Supply System	
	1	2	-	0	4	Power Distribution System	
	1	2	-	0	5	Overhead Catenary System (Overhead Contact line)	
	1	2	-	0	6	SCADA	
	1	2	-	0	7	Operation Control Center (OCC) System	
	1	2	-	0	8	Platform Screen Door System	
	1	2	-	0	9	Automatic Fare Collection System	
	1	2	-	1	0	Depot Equipments (Facility)	
	1	2	-	1	1	Training Facilities	
	1	2	-	1	2	Fire System	
	1	2	-	1	3	Asset Protection System	
	1	2	-	1	4	Maintenance Management Information System	
	1	2	-	1	5	Building Management System	
	1	3				**Client Procured Materials**	
	1	3	-	0	1	Rail	
	1	3	-	0	2	Ballast	
	1	3	-	0	3	Sleepers	
	1	3	-	0	4	Fasteners	
	1	3	-	0	5	Switches & Crossings	
	1	4				**Rolling Stock & Maintenance Vehicles**	
	1	4	-	0	1	Passenger Trainsets - Commuter	
	1	4	-	0	2	Passenger Trainsets - Limited Express	
	1	4	-	0	3	Maintenance Vehicles	
	1	4	-	0	4	Freight Trainsets	
	1	5				**T&C and Handover**	
	1	5	-	0	1	Testing & Commissioning (Static Test, Dynamic Tests, Integration Test, SODT)	
	1	5	-	0	2	Training	
	1	5	-	0	3	Final Documentation (as built drawing, manuals, etc)	
	1	5	-	0	4	Spare Parts/Special Tools	

NS01, NS02, NS03 are based on Payment Milestones (very high level in BOQ. to be subdivided by contractors)

Table D - 9: DOTr Primavera Cloud – Schedule WBS Dictionary Page 7 of 7

DOTr Primavera Cloud - Schedule WBS Dictionary

C	P	L	L	N	N	Description	Remarks
	1	**6**				**Operation Readiness & Trial Run**	
	1	6	-	0	1	Early Phase (Policies, Plans, mobilization)	
	1	6	-	0	2	O&M Management & Support Services (Management systms & tools, IT, procurement, D&B documentation, OHSSE, stakholders management, PMO, etc)	
	1	6	-	0	3	Deployment phase (Procedures and rule books, recruiting & training, fitout, etc)	
	1	6	-	0	4	Trial Run & Certification	
	1	**7**				**Provisional Sum / Dayworks**	

Table D - 10: Activity Codes Page 1 of 1

Activity Code

DOTr NSCR - P6 Activity Code

DOTr01 - Project Group

Code Value	Description
PW	Project Wide
N1	NSCR (Metro Manila to Malolos)
N2	MCRP (Malolos to Clark International Airport)
SC	NSRP - South (Metro Manila to Calamba)

DOTr02 - Sub-Phase

Code Value	Description
KD	Key Date
AD	Access Dates
KM	Key Milestones
IM	Interface Milestones
MB	Mobilization (Staff/Office/Camp/Facility)
PP	Management Plan and Procedures
MR	Meetings and Reporting
PM	Other Project Management
LA	Land Acquisition (RAP) related
SV	Survey & Study (data collection)
CD	Concept Design / System Design
PD	Preliminary Design / FEED
DD	Detail Design
FD	Final Design (Shop Drawings)
SW	Software Design & Development
IC	Interface Coordination Drawings
PR	Procurement
MF	Manufacturing & Fabrication (including TT, FAI, FAT)
TD	Delivery to Site (Overseas & Domestic)
TE	Construction Temporary facilities
AW	Advance works / Enabling works
YN	Construction Installation
PI	Post Installation Check-out Test
ST	Static Test
DY	Dynamic Test
SI	System Integrated Test
TO	Trial Operation, Trial Running
CA	Certification & Authority Approval
TR	Training (including plans and manuals)
OM	O&M related (Operation Readiness)
HO	Handover - Documentation/Spare parts/Special tools
DM	Demobilization / Site Rehabilitation

DOTr03 - Responsiblity

Code Value	Description
DOT	DOTr
NST	NSTren
ARP	Arup
GCR	GCR
CON	Contractors
PNR	PNR
NHA	NHA
SFH	SFHC

DOTr04 - Land Acquisition (Specific)

Code Value	Description
FSS	Feasibility Study Surveys
DDS	DED Surveys
LSV	Land and Structure Validation
NOT	Notice of Taking
APP	Appraisal
OTB	Offer to Buy
EXP	Expropriation
PYP	Payment Processing
TOT	Transfer of Title
PTE	Permit to Enter
TCU	DENR Tree Cutting
PCL	PROW Clearing (PAPs' structures)
NA	Not Applicable

DOTr05 - Subsytem/SubGroup

Code Value	Description
001	Project/Contract Wide
002	Professional and Technical Services
003	Resettlement Action Plan related
004	AD-Demolition
005	AD-Utility Diversion (or Protection)
006	AD-Relocation of Existing Facilities
007	EW-Earthworks
008	EW-Maintenance Road/Access Road
009	EW-Existing Road Realignment
010	EW-Swampy Section
011	EW-Subbase and Base Course
012	EW-Surface Course
013	EW-Structural Works
014	EW-Miscellaneous Structures
015	EW-Plumbing and Sanitary Works
016	STR-Viaduct
017	STR-Bridges (Underbridge, Overbridge, etc)
018	STR-Underground Structures (Cut & Cover Tunnel, Bored Tunnel, Underpass etc)
019	STR-At Grade Structure
020	STR-Utility Corridor
021	STR-Box Culvert
022	STN-Earthworks
023	STN-Subbase and Base Course
024	STN-Surface Course
025	STN-Building Works
026	STN-Mechanical Works
027	STN-Miscellaneous Works
028	STN-Building MEPs
029	STN-Exterior Works / Related Facilities
030	DPT-Major Buildings (OCC, WS & LRS)
031	DPT-Small Buildings
032	DPT-Training Center
033	DPT-Landscape
034	DSRB-Earthworks
035	DSRB-Structural Works
036	DSRB-Drainage Works
037	DSRB-River Bank Protection Works
038	DSRB-SAPANG BALEN River Plan (N-03)
039	DSRB-Pump System for Underground and Gil Puyat Underpass (N-04)
040	DSRB-Drain System for Detention Basin 1 & 2 (N-05)
041	SST-Earthworks
042	SST-Subbase and Base Course
043	SST-Building Works
044	SST-Mechanical Works
045	SST-Miscellaneous Works
046	SST-Building MEPs
047	SST-Exterior Works / Related Facilities
048	TW-Plain Line Track (Slab, ballast, etc)
049	TW-Switches & Crossing
050	SYS-Signal and Train Control System
051	SYS-Telecommunications System
052	SYS-Power Supply System
053	SYS-Power Distribution System
054	SYS-Overhead Catenary System (Overhead Contact line)
055	SYS-SCADA
056	SYS-Operation Control Center (OCC) System
057	SYS-Platform Screen Door System
058	SYS-Automatic Fare Collection System
059	SYS-Depot Equipments (Facility)
060	SYS-Training Facilities
061	SYS-Fire System
062	SYS-Asset Protection System
063	SYS-Maintenance Management Information System
064	SYS-Building Management System
065	PRC-Rail
066	PRC-Ballast
067	PRC-Sleepers
068	PRC-Fasteners
069	PRC-Switches & Crossings
070	RS-Passenger Trainsets - Commuter
071	RS-Passenger Trainsets - Limited Express
072	RS-Maintenance Vehicles
073	RS-Freight Trainsets
074	HO-Testing & Commissioning (Static Test, Dynamic Tests, Integration Test, SODT)
075	HO-Training
076	HO-Final Documentation (as built drawing, manuals, etc)
077	HO-Spare Parts/Special Tools
078	OPR-Early Phase (Policies, Plans, mobilization)
079	OPR-O&M Management & Support Services (Management systms & tools, IT, procurement, D&B documentation, OHSSE, stakholders management, PMO, etc)
080	OPR-Deployment phase (Procedures and rule books, recruiting & training, fitout, etc)
081	OPR-Trial Run & Certification
082	Provisional (others)

DOTr06 - Sub-Location

Code Value	Description
PRW000	Project/Contract Wide
STN001	Station - Alabang
STN002	Station - Angeles
STN003	Station - Apalit
STN004	Station - Balagtas
STN005	Station - Banlic
STN006	Station - Bicutan
STN007	Station - Binan
STN008	Station - Blumentritt
STN009	Station - Bocaue
STN010	Station - Bucal
STN011	Station - Buendia
STN012	Station - Cabuyao
STN013	Station - Calamba
STN014	Station - Caloocan
STN015	Station - Calumpit
STN016	Station - Clark
STN017	Station - Clark International Airport
STN018	Station - EDSA
STN019	Station - Espana
STN020	Station - FTI
STN021	Station - Guiguinto
STN022	Station - Mabalacat
STN023	Station - Malabon
STN024	Station - Malolos
STN025	Station - Malolos South
STN026	Station - Marilao
STN027	Station - Meycauayan
STN028	Station - Muntinlupa
STN029	Station - New Clark City 1
STN030	Station - New Clark City 2
STN031	Station - New Clark City 3
STN032	Station - Nichols
STN033	Station - Pacita
STN034	Station - Paco
STN035	Station - San Fernando
STN036	Station - San Pedro
STN037	Station - Santa Mesa
STN038	Station - Santa Rosa
STN039	Station - Santo Tomas
STN040	Station - Sindalan
STN041	Station - Solis
STN042	Station - Sucat
STN043	Station - Tabing Ilog
STN044	Station - Tuktukan
STN045	Station - Tutuban
STN046	Station - Valenzuela
STN047	Station - Valenzuela Polo
SSTN01	Substation - N1-01
SSTN02	Substation - N1-02
SSTN03	Substation - N1-03
SSTN04	Substation - N1-04
SSTN05	Substation - N1-05
SSTN06	Substation - N1-06
SSTN07	Substation - N1-07
SSTN08	Substation - N1-08
SSTN09	Substation - N1-09
SSTN10	Substation - N2-10
SSTN11	Substation - N2-11
SSTN12	Substation - N2-12
SSTN13	Substation - N2-13
SSTN14	Substation - N2-14
SSTN15	Substation - N2-15
SSTN16	Substation - N2-16
SSTN17	Substation - N2-17
SSTN18	Substation - N2-18
SSTN19	Substation - N2-19
SSTN20	Substation - N2-20
SSTN21	Substation - N2-21
SSTN22	Substation - N2-22
SSTS01	Substation - S-01
SSTS02	Substation - S-02
SSTS03	Substation - S-03
SSTS04	Substation - S-04
SSTS05	Substation - S-05
SSTS06	Substation - S-06
SSTS07	Substation - S-07
SSTS08	Substation - S-08
SSTS09	Substation - S-09
SSTS10	Substation - S-10
SSTS11	Substation - S-11
SSTS12	Substation - S-12
SSTS13	Substation - S-13
SSTS14	Substation - S-14
SSTS15	Substation - S-15
SSTS16	Substation - S-16
SSTS17	Substation - S-17
SSTS18	Substation - S-18
SSTD01	Substation - N1 Depot
SSTD02	Substation - N2 CIA Depot
SSTD03	Substation - SC Banlic Depot
DPT001	Depot - Calamba
DPT002	Depot - Clark
DPT003	Depot - Malanday, Valenzuela

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Table D - 11: DOTr Primavera – Schedule Activity ID Numbering System Page 1 of 3

DOTr Primavera Cloud - Schedule Activity ID Numbering System

Activity ID : ACTIVITY ID NUMBERING SYSTEM

Following section is extracted from Planning and Schedule Manual
All Project Schedules are developed by using Primavera P6 software. It defines each Design, Manufacturing, Installation and Testing activity for different sections and stages. It also establishes the sequence and logic between the activities. This section will explain the principles for Activity ID Numbering System.

In Primavera P6, it is allowed to have 20 digits for Activity ID. However, it is not easy to remember or recognize if the Activity ID is too long and complicate. Therefore, we consider using only 13 digits for Activity ID and group them into 4 blocks. The details of the 4 blocks coding structures will be explained as below:

Block 1		Block 2		Block 3		Block 4
OBS / Contract	-	PBS Code	-	ABS Code	-	ID Number
LLNN		LLL		LL		NNNN

Block 1 contains first to forth digit of the Activity ID and they represent OBS Code (Contract Number). Excluding first 2 letters (CP) of contract number, it comprises rest two letters (LL) and two numbers (NN).

Block 1
OBS / Contract
LLNN

Contract Number	SUBP Description
N01	Building and Civil Engineering Works - 17km of Viaduct and 2 elevated Stations
N02	Building and Civil Engineering Works - 16km of Viaduct and 1 elevated Stations
N03	Building and Civil Engineering Works - 16km of Viaduct and 2 elevated Stations
N04	Building and Civil Engineering Works - 6.5km of mainline and 1.1km depot access line, 1 U/G Stations
N05	Building and Civil Engineering Works - Depot (approx. 33ha)
S01	Building and Civil Engineering Works - 1.1 km of Viaduct and 1 Elevated Station
S02	Building and Civil Engineering Works - 7.9 km of Viaduct and 3 Elevated Station
S3a	Building and Civil Engineering Works - 4.5 km of Viaduct, Atgrade, 1 atgrade Station and 1 Elevaed Station
S3b	Building and Civil Engineering Works - 10.7 km of Viaduct, Atgrade, 1 semi U/G, 1 atgrade, and 2 Elevaed Stations
S04	Building and Civil Engineering Works - 8.5 km of Viaduct and 2 Elevated Station
S05	Building and Civil Engineering Works - 12.8 km of Viaduct and 3 Elevated Stations
S06	Building and Civil Engineering Works - 10.3 km of Viaduct and 3 Elevated Stations
S07	Building and Civil Engineering Works - Depot (Approx. 20ha)
NS01	E&M Systems and Track Works including PSD at all NSCR stations
NS02	Rolling Stock-Commuter Trainsets (38 trainsets consisting of 8 cars, total 304 cars)

Block 2 contains the fifth to seventh digit of the Activity ID and they represent Product Breakdown Structure code (PBS). In principle, it should align to client's WBS Level 4. However, with discussion and approval from the Client/GCR, it could be further broken down and added with new items as per scope of work.

Block 2
PBS Code
LLL

Subgroup	Description
GEN	General and Consultancy Services
RAP	RAP (Resettlement Action Plan)
ADW	Advance & Enabling Works
EWS	Earthworks
STR	Railway Structures
STN	Stations (including SIG/COM/Railway Electric house)
DPT	Depots
DRB	Drainage System & River Bank Protection

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Table D - 12: DOTr Primavera Cloud – Schedule Activity ID Numbering System Page 2 of 3

DOTr Primavera Cloud - Schedule Activity ID Numbering System

SST	Substations
TWK	Trackwork
SYS	Railway Systems
PRC	Client Procured Materials
RSV	Rolling Stock & Maintenance Vehicles
THO	T&C and Handover
OPR	Operation Readiness & Trial Run
PRS	Provisional Sum / Dayworks

Block 3 contains the eighth and ninth digit of the Activity ID and they represent Activity Breakdown Structure code (ABS). It consists of 2 letters (LL). Their details are listed below:

Block 3
ABS Code
LL

ABS	ABS Description
KD	Key Date
AD	Access Dates
KM	Key Milestones
IM	Interface Milestones
MB	Mobilization (Staff/Office/Camp/Facility)
PP	Management Plan and Procedures
MR	Meetings and Reporting
PM	Other Project Management
LA	Land Acquisition (RAP) related
SV	Survey & Study (data collection)
CD	Concept Design / System Design
PD	Preliminary Design / FEED
DD	Detail Design
FD	Final Design (Shop Drawings)
SW	Software Design & Development
IC	Interface Coordination Drawings
PR	Procurement
MF	Manufacturing & Fabrication (including TT, FAI, FAT)
TD	Delivery to Site (Overseas & Domestic)
TE	Construction Temporary facilities
AW	Advance works / Enabling works
YN	Construction Installation
PI	Post Installation Check-out Test
ST	Static Test
DY	Dynamic Test
SI	System Integrated Test
TO	Trial Operation, Trial Running
CA	Certification & Authority Approval
TR	Training (including plans and manuals)
OM	O&M related (Operation Readiness)
HO	Handover - Documentation/Spare parts/Special tools
DM	Demobilization / Site Rehabilitation

Block 4 contains the tenth to thirteenth digit of the Activity ID and they represent the ID number ranging from 0000 to 9999.

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Table D - 13: DOTr Primavera Cloud – Schedule Activity ID Numbering System Page 3 of 3

DOTr Primavera Cloud - Schedule Activity ID Numbering System

Block 4
ID Number
NNNN

ID No.	ID No. Description
0	ID No. 0000
⋮	⋮
9999	ID No. 9999

APPENDIX 3 - MONTHLY PROGRESS REPORTS

3.1 Submission

3.1.1 The Contractor shall submit to the Engineer, a Monthly Progress Report within 7 days after the last day of the period to which it relates. It shall be submitted in a format to which the Engineer shall have given his consent and shall contain sections/sub-sections for, but not be limited to, the topics listed below.

3.2 Financial Status

3.1.1 A summary sheet and narrative review of all significant financial matters, and actions proposed or taken with respect to any outstanding matters.

3.1.2 A spreadsheet summarizing each Cost Center, the budget, costs incurred during the period, costs to date, costs to go, cost forecast (total of costs to date and costs to go), and cost variance (difference between cost forecast and budget).

3.1.3 A spreadsheet indicating the status of all payments due and made.

3.1.4 List of Variations.

3.1.5 List of notice given under [Employer's Claims and notices] given under [Contractor's Claims] of the GC.

3.1.6 A report on the status of any outstanding claims. The report shall in particular provide interim updated accounts of continuing claims.

3.2 Progress

3.2.1 Chart and detailed descriptions of progress, including each stage of design, Contractor's documents, procurement, manufacture, delivery to site, installation, assembling, testing, commissioning, and trial operation.

3.2.2 Comparisons of actual and planned progress, with details of any events or circumstances which may jeopardize the completion in accordance with the Contract, and the measures being (or to be) adopted to overcome delays.

3.2.3 A simplified representation of progress is measured in percentage terms compared with percentage planned as derived from the Works Program.

3.2.4 Three Month Rolling Program, Time Chainage Program, and any other programs required by the Engineer.

3.2.5 Photographs and videos showing the status of manufacture and progress on the site.

3.3 Quality Assurance Reporting

3.4.1 Summarized report of quality assurance documents, test results, and certificates of materials. Two copies of these documents shall be submitted as a part of Quality Assurance reporting.

3.4 Milestones Status

3.4.1 A report on the status of all Milestones Items due to have been achieved during the month and forecasts of achievement of any missed Milestones, and those due in the next month.

3.5 Planning and Coordination

3.5.1 A summary of all planning/co-ordination activities during the month and details of outstanding actions.

3.5.2 A schedule of all submissions and consents/approvals obtained/outstanding.

3.6 Manufacturing progress reporting

3.6.1 Detailed description of all manufacturing achievements in the month including any problems encountered.

3.6.2 Material Control Schedule.

3.6.3 Summary of inspections and audits planned in the coming three months.

3.6.4 Summary of all issues raised during the inspections and audits that require closure.

3.6.5 For the manufacture of each main item of the Plant or component thereof, the name of the manufacturer, manufacture location, percentage progress, and the actual or expected dates of:

(1) Commencement of manufacture,

(2) Contractor's inspection,

(3) Tests, and

(4) Shipment and arrival at the Site.

The percentage progress shall be in the form of actual v's planned performance in respect of major equipment as required by the Engineer.

3.7 Contractor's Personnel and Equipment and Employer's Equipment

3.7.1 Detail description of Records of Contractor's Personnel and Equipment engaged.

3.8 Safety

3.8.1 Safety statistics, including details of any hazardous incidents and activities relating to environmental aspects and public relations and actions, proposed to prevent further occurrence.

3.9 Environment

3.9.1 A review of all the environmental issues during the past month to include all monitoring reports, mitigation measures undertaken, and activities to control environmental impacts.

3.10 Risk Management

3.10.1 A risk report shall be included within the Monthly Progress Report. The risk report shall describe the top five risks and issues, and risk management activities for the month. An appendix to the report shall include the contractors risk register printed from the Active Risk Manager (ARM), project risk database (listing all of the identified risks and issues) to be implemented by the Contractor, together with the risk detail sheet for each of the top five risks and issues.

3.11 Gender and Development

3.11.1 A summary of all recording, monitoring, investigation, and mitigation of all gender-based violence and sexual harassment-related cases committed by the Contractor's and Sub-Contractors' personnel to persons on and near the site.

APPENDIX 4 - SUBMITTALS REQUIRED

4.1. Submittals:

4.1.1. In accordance with the Employer’s Requirement-General Requirement, the Contractor shall submit, but not be limited to, the following plans within the time specified in the following Table.

Table 4-1: Submission of Plans

No.	Plan	To be submitted within	Sub-Section
1	Project Management Plan	15 days after the Commencement Date	4.2.2
2	Interface Management Plan	28 days after the Commencement Date	4.3.3
3	System Interface Plan	28 days after the Commencement Date	4.4.1
4	Detailed Time Program	28 days after the Commencement Date	4.5.2
5	Quality Assurance Management Plan	45 days after the Commencement Date	4.6.4
6	System Assurance Management Plan	45 days after the Commencement Date	4.7.1
7	System Safety Assurance Plan	45 days after the Commencement Date	20.2.1
8	Reliability, Availability and Maintainability Management Plan	90 days after the Commencement Date	20.3.1
9	Site Safety Management Plan	28 days after the Commencement Date	4.8.4
10	Software Quality Assurance Management Plan	90 days after the Commencement Date	4.9.1
11	Risk Management Plan	28 days after the Commencement Date	4.10.2
12	Environmental Management Plan (shall include Noise and Vibration Analysis Report)	60 days from the Commencement Date	4.11.1
13	Inspection, Testing, and Commissioning Management Plan	120 days after the Commencement Date	4.12.1 and 9.1.1
14	Earthing and Bonding Study Plan	28 days after the Commencement Date	4.13.1
15	Drawing and CAD Procedure	30 days after the Commencement Date	6.3.3

No.	Plan	To be submitted within	Sub-Section
16	Building Information Model (BIM) Execution Plan for LOD 100 to 500	30 days after the Commencement Date	6.3.4
17	Detailed Training Procedures	6 months prior to the Commencement of Training	14.8
18	Plan for Site Facilities	120 days after the Commencement Date	15.3.1
19	Traffic Control Plan	Before the start of Construction	16.2.8
20	Monthly Progress Reports	Monthly	4.16
21	Spare Parts Management Plan	not later than (12) months prior to the issue of the TOC for a System	4.21.2
22	Requirements Management Plan	30 days after the Commencement Date	21.3
23	Defects Notification Period Management Plan	Before handover	10.2.4
24	Method Statements	56 days prior to the start of construction	6.17
25	Operation and Maintenance Manuals	6 Months before handover	8.1
26	Project Document Control Procedure	28 days after the Commencement Date	7.2
27	Obsolescence Management Plan	within 90 days after commencement Date	22.11

APPENDIX 5 - QUALITY ASSURANCE REQUIREMENTS

5.1. Quality Assurance Management Plan

The Quality Assurance Management Plan shall define the Contractor's management structure and the quality management system for the execution of the Contract Works and shall, without limitation, define as follows:

(1) The summary of the project requirements including all proposed quality activities;

(2) All quality assurance and quality assurance procedures proposed by the Contractor for his use in the execution of the Works;

(3) A list of all the codes of practice, standards, and specifications that the Contractor proposes to apply his work;

(4) The Contractor's organization-managerial staff, with particular reference to any member of a partnership, consortium or joint venture, and the main Subcontractors. Organization charts shall be produced to illustrate the subdivision of the Contract Works into elements for effective technical and managerial control, the reporting structure, and the relationship between all parties involved;

(5) The appointment of a Quality Assurance Manager;

(6) The specific allocations of responsibility and authority given to managerial and technical staff with particular reference to the design and Site supervision of the Contract Works;

(7) The hierarchy and structure of the overall quality system documents to be applied to the Contracts, and clearly indicating any particular documents to be followed by individual key members of the Contractor if applicable;

(8) The Contract specific quality procedures work instruction and/or standard forms, if applicable;

(9) A full list of quality procedures works instructions, and/or standard forms, including any contract-specific documents, to be applied to the Contract. It shall be defined the specific ways to perform the related activities and the records to be generated as objective evidence of the activities performed or result achieved, and shall cover all the requirements of the Contract including, but not limited to, the following activities:

1) The review, approval, and updating of the quality system documents to ensure their continuing suitability and effectiveness;

2) Design control to all Permanent Works and/or Temporary Works, including design, works carried out by Subcontractors and sub-consultants. The procedures shall clearly define the review and verification;

3) Drawing management in main office and site office(s), including production, approval, updating, maintaining, storage and distribution;

4) Project document management, including registration, updating, indexing, filing, maintenance, storage, and distribution;

5) Monitoring and control of Subcontractors with respect to program, submission, and quality of works;

6) Monitoring of the submission and re-submission to the Engineer;

7) Monitoring of the ordering and delivery of materials, plant, and equipment;
8) Quality control of the Contract Works;
9) Quality audits on the Contractor and Subcontractors of any tiers; and
10) Establish and maintain a record in accordance with the Contract requirement provision.

The Quality Assurance Management Plan shall comprise of Management Quality Plan, Design Quality Plan, Manufacturing Quality Plan (including Inspection and Testing), and Testing and Commissioning (including Integrated Testing and Commissioning) Quality Plan.

5.1.1. Management Quality Plan

The Quality Management shall be implemented from the highest management level, and the Top Management of the Contractor JV shall bear overall responsibility for all Quality related matters and activities.

AManagementQualityPlanshallbepreparedwiththeorganizationcharthavinghierarchyan d structure, responsibility and authority allocations, quality procedures, work instructions, and standard forms and recording. The Plan should also include sub-contractors and manufacturers.

An overall organization chart should be prepared that gives the management structure for the Project which is engaged in the design, procurement, management, transportation, construction, and installation. The organization will allow for on-site and off-site functions.

The Contractor's Organization Chart for this project explains the organization position and lines of reporting for the Quality Assurance Manager and any Quality Staff. The Management Quality Plan should discuss the authorities of the Quality Assurance Manager and Quality Staff. The Management Quality Plan should help to plan, assess, and improve the organization's quality system for the Project.

5.1.2. Design Quality Plan

The Contractor shall prepare a Design Quality Plan for any design works. The Design Quality Plan shall define the Contractor's and the Designer's policy for the design works and shall, without limitation, define:

(1) The organization of the Contractor's and the Designer's design staff; Manufacturing Quality Plan, Testing and Commissioning Quality Plan,
(2) The specific allocations of responsibilities and authorities given to identified design staff or Subcontractors for particular design works;
(3) The hierarchy of quality management system documentation for managing and controlling design works, including design works of Subcontractors of any tier; and
(4) The list of procedures and instructions to be applied to manage and control the quality of the design works.

5.1.3. Manufacturing Quality Plan

Manufacturing Quality Plan shall define the Contractor's management structure and quality management system for the manufacture of the key items of the Contract Works, and the items as requested by the Engineer. Separate Manufacturing Quality Plans shall be prepared for each item of the Contract Works.

The Contractor shall prepare and maintain a full list of all the Manufacturing Quality Plans required for the Contract with submission status and shall submit to the Engineer upon request.

Each Manufacturing Quality Plan shall define, without limitation:

(1) The scope of works and the item covered by the plan;

(2) The organization of the Contractor and/or the Subcontractor responsible for the day-to-day management of the manufacture of the item;

(3) The specific allocations of responsibility and authority are given to personnel for the day-to-day management of the manufacturing activities with particular reference to the supervision, inspection, and testing of works; and

(4) The specific methods of manufacture, including but not limited to the following:

1) The particulars of the material to be incorporated into the items;

2) The manufacturing process in compliance with drawings and specifications;

3) The identification of referencing requirements for traceability of the manufactured items;

4) The identification of the inspection and test status of the materials and final manufactured items;

5) The disposition of nonconforming materials and manufactured items; and

6) The handling, storage, packaging, preservation, and delivery of the manufactured items.

5.1.4. Inspection and Testing Plans

Under the Manufacturing Quality Plan, Inspection and Testing plans shall be produced for all activities requiring inspection and/or test.

The Contractor shall prepare and maintain a full list of all the inspection and Test Plans required for the Contract with submission status and review status and shall submit to the Engineer upon request.

Each Inspection and Test Plan shall define, without limitation:

(1) The scope of activity covered by the plan;

(2) The sequence of work related to the activity covered by the plan;

(3) The personnel responsible for undertaking the inspection and/or test;

(4) The personnel responsible for certifying the inspection and test;

(5) The inspection and/or test method or a reference to the relevant standard of inspection and/or test;

(6) The frequency of the inspection and/or test;

(7) The compliance criteria of the inspection and/or test;

(8) The Quality Hold Point and Quality Assurance Points;

(9) The documents to be used for reporting the results of the inspection and/or test, and with examples of such documents incorporated into the Inspection and Test Plan; and

(10) The storage locations and filing of the records of the inspection and/or test.

5.2. Quality Assurance Manager

The Contractor shall appoint a suitably qualified and experienced full-time person as the Quality Assurance Manager to be responsible for the task of establishing the documented quality management system and ensuring that the quality management system is implemented and maintained effectively.

The Quality Assurance Manager shall be directly responsible to the senior level of management and is able to discharge his duties without hindrance or constraint. In addition, the Contractor shall make available any such resources that are necessary to ensure the effective implementation of the quality management system.

The Contractor shall submit for review by the Engineer details of qualifications, experience, authority, and responsibility of the proposed Quality Assurance Manager, as part of the Quality Organization Plan.

5.2.1 Quality Audits

The Contractor shall carry out Quality Audits on the Contract Works at regular intervals, or at such other intervals as the Engineer may require, ensuring the continuing suitability and effectiveness of the quality management system. Reports of each such audit shall be submitted promptly to the Engineer for review.

The Contractor shall submit for review by the Engineer details of the authority, qualifications, and experience of personnel assigned to quality audit activities before carrying out quality audits.

The Engineer may require Quality Audits on the Contractor and his Subcontractors of any tier to be carried out by his representative or the Employer's staff. In such a case, the Contractor shall afford to such auditors all necessary facilities and access to the activities and records to permit this function to be performed.

Upon receipt of Corrective Action Request (CAR) or similar document issued by the Engineer as a result of Quality Audits, the Contractor shall promptly investigate the matter and submit the proposed corrective and preventive actions within 14 days to the Engineer for review. The Contractor shall take timely corrective and preventive actions to rectify the matter and to prevent re-occurrence. Evidence to demonstrate effective implementation of corrective and preventive actions shall be submitted by the Contractor to the Engineer for review.

5.2.2. Notification of Nonconformities

If, prior to issue of the Taking – Over Certificate for the Contract Works or the relevant Section, the Contractor has used or proposes to use or repair any item of the Contract Works that does not conform to the requirements of the Contract, the Contractor shall immediately submit for review by the Engineer of such proposal and supplying full particulars of the non-conformity and, if appropriate, the proposed means of repair.

If the Engineer issues a non-conformity report or similar documents to notify the Contractor of any item of the Contract Works which does not conform to the requirements of the Contract, the Contractor shall promptly investigate the matter and, within 14 days of notification by the Engineer, submit to the Engineer for review the remedial measures and necessary actions to be taken to rectify the item and to preventer -occurrence.

The Contractor shall maintain and update a Non-conformity Register to indicate the status of all non-conformities that are identified by the Engineer and/or the Contractor. The Contractor shall submit the register for review upon request by the Engineer.

5.4. Monthly Progress Report on Quality Management System

The Contractor shall continuously monitor the performance of the quality management system and shall include in each Monthly Progress Report:

(1) The submission status and review the status of the quality system documents;

(2) An up-to-date audit schedule and status;

(3) Anup-to-date non-conformity register providing the status of all non-conformity identified by the Engineer or the Contractor within the reporting period and those nonconformities not yet satisfactorily closed; and

(4) A narrative appraisal of the performance of the quality management system, including any non-conformities, shortcomings, or problem areas identified and the corrective and preventative action taken or proposed.

The Contractor shall provide and maintain at all stages of the Contract Works, a quality control register, or registers to identify the status of inspections, sampling, and testing of the work, and all certificates. Such register shall be updated by the Contractor to show all activities in previous months and shall reach the Engineer's office before the 7th day of each month.

Each register shall:

(1) List the certificates received for each batch of goods and materials incorporated in the Contract Works and compare this against the certification required by the Contractor and the Contractor's quality plans;

(2) List the inspection and testing activities undertaken by the Contractor on each element of the Contract Works and compare these activities against the amount of inspection and testing required by the Contract and the Contractor's quality plans;

(3) Show the results of each report of inspection and/or test and any required analysis of these results and compare these results against the pass/fail criteria; and

(4) Summaries any actions proposed by the Contractor to overcome any nonconformity.

5.5. Quality Records

The Contractor shall ensure that all the quality records as objective evidence of the implementation of the quality management system are properly indexed, filed, maintained, updated, and stored in an acceptable software system. These records will be delivered to the Engineer in CD form upon completion of the Contract Works.

APPENDIX 6- ENGINEERING SAFETY MANAGEMENT PLAN

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1. INTRODUCTION

1.1. Purpose

The purpose of this document is for the Contractor to ensure a high level of safety shall be delivered to their end users and the public at large. This can only be achieved by following rigorous processes and standards for the management of engineering safety starting from concept development of a railway system and continuing until the commissioning and subsequent operation of the railway system.

This Engineering Safety Management Plan (ESMP) provides further details regarding the management of system engineering safety applicable to each section of North–South Commuter Railway project.

The purpose of the Engineering Safety Management Plan (ESMP) is therefore to define:

- the general organization regarding Safety management for this railway project
- the Safety management activities and processes to be planned for the project
- the respective roles and responsibilities of the different entities involved in the project with respect to Safety management activities
- with which principles and methods these activities should be carried out.

The present Engineering Safety Management Plan (ESMP) is established at the top level of the Employer "Department of Transportation, Philippines (DOTr)" program and calls for further Safety plans to be elaborated by the different Contractors involved in the design and construction of each Railway System, in accordance with their respective scope of works. Those subsequent Safety plans shall be in accordance with the guidelines set out in this document and in accordance to the applicable standards and regulations.

1.2. Scope

The scope of the Safety Plan (ESMP) covers all activities planned to ensure that all railway systems shall provide an acceptable level of safety for their users, operating staff and the public, when they are put into revenue service operation.

The work covers the following:

- Malolos Clark Railway Project, hereinafter shown as 'MCRP' and North South Railway Project - South Line (Commuter), hereinafter shown as 'NSRP-South', connecting with North South Commuter Railway, hereinafter shown as 'NSCR' with mutual through train operation.
- MCRP commences at Clark International Airport and connects to the NSCR at Malolos and the NSRP-South connects with the NSCR at Blumentritt.
- NSRP-South will connect to the Metro Manila Subway Project hereinafter shown as "MMSP" at Bicutan
- System wide contracts for the Complete North-South "NS" (E&M Systems and Track works; and Rolling stock) covering entire MCRP and NSRP-South.

- At the connections with NSCR and MMSP the E&M systems and track work shall be fully integrated to ensure full seamless interoperability between the various rail services.

- Depots located at Mabalacat on the MCRP and at Banlic on NSRP-South.

This Plan covers all disciplines employed for the delivery of an operational Railway System:

- E&M Systems (Trackwork, Signaling, Power Supply, Telecom, PSD, AFC, OCS, SCADA, Depot equipment, CMMS, etc.)
- Rolling Stock
- Operation & Maintenance.

Furthermore, it covers each of these disciplines throughout the entire life cycle of a railway project from the Concept phase, through the Design, Build and Operation phases till the Commissioning period.

Excluded from the scope are Civil Works (Infrastructure, Stations, Depots and related MEP systems) and activities related to ensuring health and safety for the staff and the public during the construction and the commissioning phases of the railway systems. These are covered by the Health, Safety and Environmental (HSE) Plan(s) and the Construction and Commissioning railway rule book of the respective projects.

1.3. Applicable Standards

The main applicable standards, as far as safety is concerned, are listed below:

- IEC 61508 - Functional safety of E/E/EPE: safety-related systems;
- EN 50126 or IEC 62278 - Railway Applications: The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS);
- EN 50128 or IEC 62279 - Railway Applications: Software for railway Control & Protection systems;
- EN50129 or IEC 62425 - Railway Applications: Safety related electronic systems for signaling;
- EN50122 or IEC 62128 – Railway applications — Fixed installations — Electrical safety, earthing and the return circuit Parts 1 – 3;
- EN50121 or IEC 62236 - Railway Applications: Electromagnetic compatibility (EMC);
- EN50159 or IEC 62280 - Railway applications: Communication, signaling and processing systems - Safety-related communication in transmission systems;
- IEC 60751 or EN50155 - Railway Applications: Electronic equipment used on rolling stock
- NFPA 130 - Standard for Fixed Guideway Transit and Passenger Rail Systems;
- Fire Code of the Philippines (RA 9514), 2019;
- National Japanese standards, e.g. Technical Regulatory Standards on Japanese Railways and/or, Japanese Industrial Standards (JIS);
- ISO 9001 Model for quality assurance in design, development, production, installing and servicing;
- ISO / IEC 90003 Guidelines for the application of ISO 9001 to the development, supply and maintenance of software;
- RA 11058- Department of Labor and Employment (DOLE) Occupational Safety and Health

Standard, Philippines

- Common Safety Methods defined in the Commission Regulation 352/2009 of the European Railway Agency.

- Any other equivalent international or local standards applicable for Railway applications.

Note: (1) The latest available version or edition of the above listed standards shall be applicable.

(2) The local Philippines standards to prevail over international standards with an agreement with the Engineer and Employer.

1.4. Abbreviations and Definitions

Table 1: Summary of Roles and Responsibilities

Term	Definition
ADB	Asian Development Bank
AFC	Automated Fare Collection System
ALARP	As Low As Reasonably Practicable
CBA	Cost Benefit Analysis
CoP	Code of Practice
CMMS	Computerized Maintenance Management System
D&B	Design & Built
DOTr	Department of Transportation, Philippines, The Employer
DRACAS	Data Reporting, Analysis and Corrective Action System
E/E/PE	Electrical/Electronic/Programmable Electronic Safety-related Systems
EMC	Electromagnetic Compatibility
ESMP	Engineering Safety Management Plan
ESVP	Engineering Safety Validation Plan
FAT	Factory Acceptance Test
FMECA	Failure Mode Effects and Criticality Analysis
FO	Full Opening
FTA	Fault Tree Analysis
GCR	Greater Capital Region Consortium, referred as "The Engineer" in the project
Hazard	A physical situation with a potential for human injury
HAZID	Hazard Identification study
HAZOP	Hazard and Operability Study
HSE	Health, Safety and Environment
IHA	Interface Hazard Analysis
IOCC	Integrated Operation Control Center
ISA	Independent Safety Assessor. A team of assessors, independent of design and development, to review and advise that the safety requirements of a specified project, product, process or contract conforms to the requirements of IEC 62278 or EN50126 or any applicable standard
JICA	Japan International Cooperation Agency

Term	Definition
LRU	Line Replaceable Unit is an essential element that can be replaced by operator or at first level of maintenance to restore the end element to an operational condition after a failure (or also as a preventive action).
MCRP	Malolos Clark Railway Project 'N2'
MEP	Mechanical, Electrical and Plumbing
MMSP	Metro Manila Subway Project
NSRP	North South Railway Project- South Line (Commuter) 'SC'
O&M	Operation and Maintenance
OCC	Operation Control Center
OCS	Overhead Catenary System
OSHA	Operations and Support Hazard Analysis
PDS	Power Distribution System
PHA	Preliminary Hazard Analysis
PNR	Philippines National Railway
PSD	Platform Screen Door
QAQC	Quality Assurance and Quality Control
QRA	Quantitative Risk Analysis
RAMS	Reliability Availability Maintainability and Safety
RS	Rolling Stock
SAM	Safety Assurance Manager
SCADA	Supervisory Control and Data Acquisition
SCIL	Safety Critical Items List
SIL	Safety Integrity Level
SIT	System Integration Test
SO	Sectional Operation
SOW	Scope of Work
SRP	Safety Review Panel
Subcontractor	A system supplier responsible for design, manufacture, delivery, installation, and commissioning of a subsystem.
TOC	Taking Over Certificate
TVS	Tunnel Ventilation System
Validation	Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use have been fulfilled
Verification	The activity of determination, by analysis and test, at each phase of the lifecycle, that the requirements of the phase under consideration meet the output of the previous phase and that the output of the phase under consideration fulfills its requirements
V&V	Verification and Validation

2. SYSTEM SAFETY REQUIREMENTS (HIGH LEVEL)

2.1. Safety Policy

The safety policy is intended to foster commitment to HSE from senior management and providing core objectives for the Program to achieve. Although those policies do not explicitly address Engineering Safety management, it is stated therein that:

"The goal is zero harm for the passengers, staff, project partner staff and customers to prevent injury and ill health. This goal is driven by our expectations of continual improvement in all activities both in this railway project and our project partner, based upon risk and organizational benefit".

This statement applies also for safety during operation of the railways and is therefore valid as an aspirational objective for Engineering Safety Management.

2.2. Safety Approach

The specification and demonstration of safety requirements shall follow the safety life cycle approach of IEC 62278 or EN 5016 or any other applicable standard and comply with the requirements of these standards. The standard prescribes specific safety tasks to be carried out in the different phases of a railway project with the aim of delivering a final railway system that is safe to its end users.

The safety approach is based on risk assessment, which needs to be started early in the project in order to have timely identification of adequate safety measures that will keep the inherent risks of the system to an acceptable level. These safety measures are then subsequently translated into safety requirements to be specified and later implemented throughout the project by the different responsible stakeholders.

The methodology for risk assessment should follow the Common safety methods principles set out in the applicable Safety standards as below:

- *Compliance with Code of Practice:* some hazards will be entirely covered by application of acknowledged rules and standards. The risk associated with those hazards will be considered acceptable, without the need of estimating that risk explicitly.

- *Equivalence with a proven system:* some hazards will be entirely covered by using systems that have similar characteristics to reference proven systems. The risk associated with those hazards will be considered acceptable, without the need of estimating that risk explicitly.

- *Demonstration of acceptable risk through explicit risk analysis:* hazards which are not entirely covered, either by Code of Practice, or by the use of similar reference systems, should be subject to an explicit risk analysis..

2.3. Safety Targets

While the Safety Policy aspires towards achieving a safety goal of zero harm, more realistic and demonstrable engineering safety targets need to be defined for use in the design and construction of the railway systems in this project.

The design safety objective for each railway project shall be to ensure and demonstrate that all the risks to safety of the passengers, workforce and members of public who may be affected by the operation of the railways are acceptable and As Low As Reasonably Practicable (ALARP). Definitions about risk acceptance criteria and guidance on risk evaluation are provided in 4.2.3 and 4.2.4

Furthermore, at subsystem level , any wrong side failure of key safety critical subsystems (wrong side failures which may credibly lead directly to catastrophic consequences) must be shown to be better than 10^{-9} per hour failure rate.

Based on those high-level safety objectives and risk acceptance criteria, specific targets shall be defined (either by Employer or by the Contractors) in the form of SIL for E/E/PE equipment performing safety functions on rail assets.

Table 2: E&M systems and Track works Safety Targets

Safety Targets	
Passenger serious injuries	<=2 per 20 Million passengers
Staff lost Time Injury	<=2 per 200,000 Man hours worked.

Refer Appendix B Generic Safety Requirements for sample list of safety requirements in this project.

3. SAFETY MANAGEMENT ORGANIZATION

3.1. Safety Management Organization

The Contractor shall provide the Safety Management Organization in accordance to the applicable Railway Safety Standards and shall be to be aligned with Employer's and the Engineer's Organizations.

Within the project's organization, Engineering Safety is managed by the Systems Engineering Department. This Department, which includes System and Safety Assurance resources and receives support from technical expertise, interacts on Engineering Safety issues with counterparts from the Contractors (the Safety Assurance Managers), through the Engineer's Safety Assurance Team.

Major safety documentation (such as Safety Cases) produced by the Contractor, after it has been reviewed by the Engineer, the Employer , and after it has been assessed by the ISA, will be submitted for Approval to a Safety Review Panel established by the Employer "DOTr".

The Figure below illustrates the general safety organization foreseen for the project.

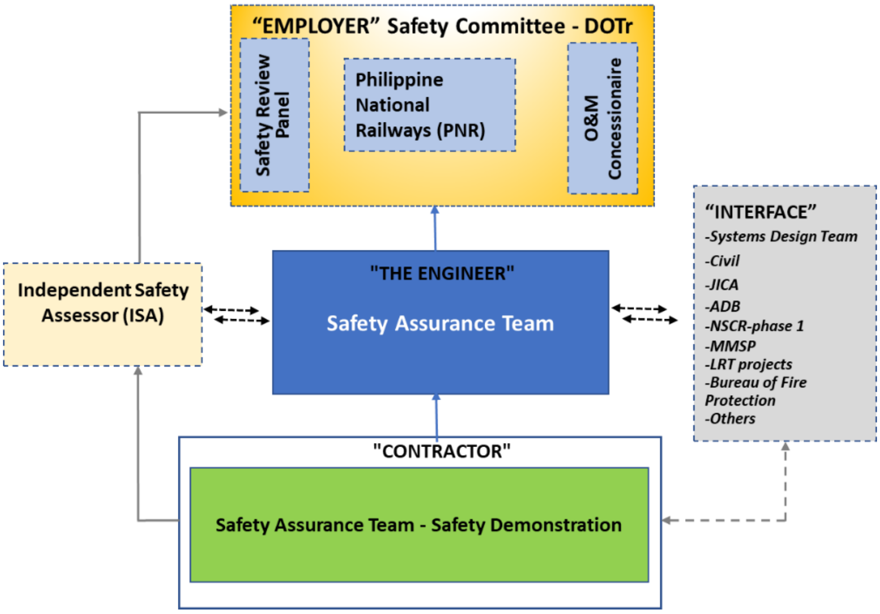

Figure 3-1: Project Safety Organization

3.2. Roles and Responsibilities

The roles and responsibilities of the different entities involved with ensuring safety of the Railway Systems have been defined and are reproduced in the table below.

Table 3: Summary of Roles and Responsibilities

Sl No.	Role	Responsibility
1	Department of Transportation - DOTr (Employer)	The Employer has specified a set of safety requirements and safety targets that must be attained by the railway systems. The safety process to be applied on the railway projects will be compatible with the requirements of the Employer's Requirements. The Employer, provides Approval to safety submissions provided by the Contractors and endorsed by the Engineer.
2	The Engineer	Employer appoints "The Engineer" in charge of managing the railway projects delivery on behalf of them. The Engineer's Safety Assurance Team will monitor the preparation of safety submissions by the Contractors, review and endorse them for the Employer's final Approval.
3	Contractor	The Contractor shall apply system and safety assurance throughout the life cycle stages listed in IEC 62278 or EN 50126, including design, construction, manufacture, installation, testing and commissioning and Defects Notification Period, to enable the Employer to achieve safety certification/approval for an operational railway. To show compliance with the safety requirements, the D&B Contractor will introduce a safety process for use in the project that is consistent with the Employer requirements. Responsible for the preparation of safety cases, hazard analysis and hazard logs. The Contractor may appoint their own ISA for assessing safety critical subsystems and/or safety-related software in accordance with relevant standards.

Sl No.	Role	Responsibility
4	Independent Safety Assessor (ISA)	The role and responsibility of the Assessor shall be to assess the safety process in order to ensure that a high standard of safety has been implemented on the Project. All along the Implementation process, the Assessor will evaluate the Safety Cases, taking into account the execution of safety processes and demonstration that all the identified safety hazards: ▪ *have been correctly controlled and mitigated in the design phase* ▪ *control measures and mitigations have been verified at different level of complexity during factory test, site installation tests, testing and commissioning and trial run tests.* The Assessor shall compile a safety assessment report to accompany each Safety Case they will evaluate. The Assessor shall recommend to the Employer, the start of revenue service of each railway system. The final decision of recommending start of operation to the future Safety Supervisory Authority belongs, however, to the Employer.
5	Operation & Maintenance Concessionaire	The Operator will produce a set of operation and maintenance procedures to manage a safe railway operation and maintenance under normal, degraded and emergency situations. The operator and maintainer will produce an operational safety case based on the subsystem and engineering safety cases developed by the D&B contractors.
6	Others - Interface	Oversee and manage the progress of the engineering and design progress for the E&M systems, rolling stock and trackwork contract and ensure system assurance are integrated into the project delivery. Responsible for the day-to-day management and control of the design program and development, and ensure the design is in compliance with contractual requirements. The D&B contractors/ Engineer shall coordinate with external organizations in order to ensure that safety risks

Sl No.	Role	Responsibility
		arising at their interfaces are identified and managed correctly.

3.3. External Safety Interfaces

During the course of this railway project, the Employer, the Engineer and the contractors shall have coordinate with external organizations in order to ensure that safety risks arising at their interfaces are identified and managed correctly. Here below are the main external organizations to be interfaced with.

Bureau of Fire Protection

During Commissioning, clearance from the Bureau of Fire Protection might also be necessary for a railway system to start revenue operation. In particular, emergency plans and procedures shall be elaborated in agreement with the Bureau of Fire Protection.

Other External Safety Interfaces

Other important external interfaces regarding safety shall be identified and managed for each specific project, such as:

Interfaces between railway projects such as, between NSCR phase 1 project, Metro Manila Subway (MMSP).

4. SAFETY MANAGEMENT PROCESSES AND ACTIVITIES

4.1. Safety Life Cycle

Safety activities will be present during all phases of each railway system life cycle from definition through to decommissioning. The following illustration shows the standard V for any project life cycle with its different phases in accordance with IEC 62278 or EN 50126, and the main RAMS input or output for each phase.

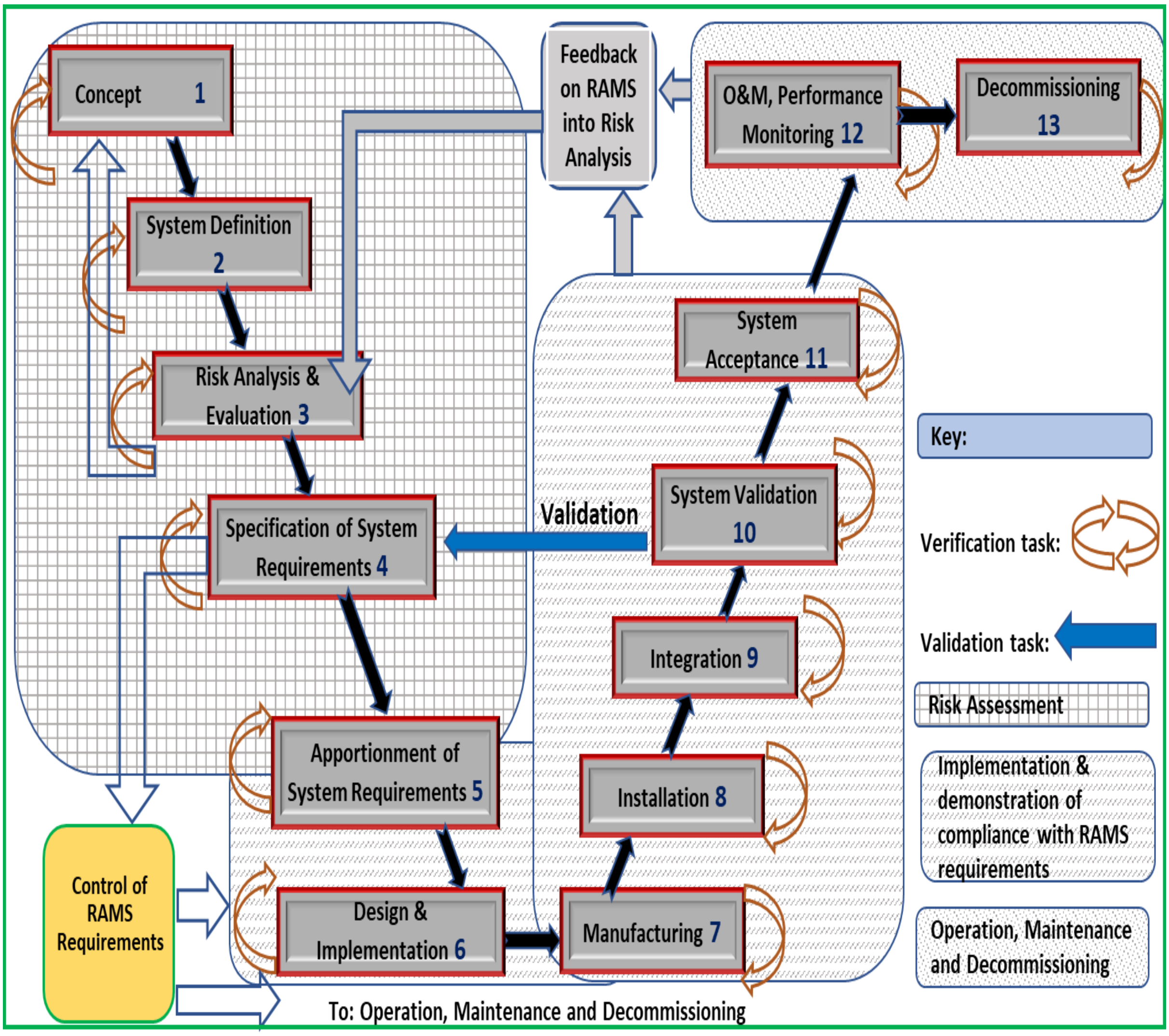

Figure 4-1: "V" Representation of System Lifecycle

Safety activities are conducted in parallel to the definition, design, construction and installation of the railway system. In the initial phases, the prime safety task consists in assessing the safety risks (risk assessment) of the project and defining consequently adequate safety requirements to be complied with by the different elements of the system.

In subsequent phases, the safety activities mainly consist in implementing the safety requirements and managing the associated hazards at the different level of the system, until final demonstration of safety is provided at the commissioning phase through appropriate evidence.

In reality there are iterations in the various phases of the project as the different entities involved shall perform activities at their own level of system definition. During detailed design, the Contractors refine the system definition, perform their own risk assessment on their scope of work, define further requirements and then also allocate and apportion requirements at a lower level of system definition.

4.2. Risk Assessment

The risk assessment methodology to be applied throughout each Project Life Cycle shall follow the principles of the risk assessment process set in out in the applicable Safety standards such as Common Safety Methods for risk assessment and its associated guidance. The process for risk assessment is illustrated in the Figure 4-2: Common Safety Methods Risk Assessment Process below. This is an iterative process which aligns with the safety process requirements, with a particular focus on phase 3 of the V cycle (Risk analysis). However, this process is applicable at different system level and during different phases of the design life cycle, hence the iterative nature of this process.

4.2.1. System Definition

A clear definition of the system to be assessed is a prerequisite for identifying hazards and evaluating the resulting risks related to the system.

The system definition shall contain at least the following elements:

- definition of scope and boundaries of system
- description of main elements of the system and their functions
- definition of operating modes of the system and their operating conditions (normal, abnormal, degraded and emergency)
- definition of maintenance conditions of the system
- definition of internal interfaces within the system
- definition of external interfaces of the system
- definition of environment conditions of system
- definition of assumptions for the system.

System definition has to be started at the Concept design stage for the entire scope of this Railway Project, but shall be also carried out according to the same principles by each Contractor and their suppliers for their own scope of work.

System definition, like the risk assessment itself, is an iterative process, meaning that the system definition evolves and becomes more detailed as the design progresses and new features (in particular new safety measures) are identified in the design process.

4.2.2. Hazard Identification

All reasonably foreseeable hazards that may arise within the scope of the system definition shall be identified by either top down or bottom up hazard analysis. The process of hazard identification starts at the definition and Concept Design stage with an overall Preliminary Hazard Analysis.

Hazard identification is carried out by the Contractors for their scope of work, based on their own system definition. Hazard identification is expected to be carried out through workshops (e.g. HAZID, HAZOP) involving adequate personnel for covering the scope of work to be investigated. Refer Appendix G Preliminary Hazard Analysis (PHA) for Hazard categories and examples of generic hazards.

Since a major aim of hazard identification is completeness, the following points shall be in particular considered in the hazard identification:

- participation of all the relevant technical disciplines
- identification of hazards at the interfaces (internal and external)
- identification of hazards in all modes of operation.

It is expected that most of the hazards of each Railway System are, at a high level of system definition at least, generic railway hazards. Although these should be identified and recorded in the Hazard Log(s) as far as relevant and applicable, particular focus should be initially devoted on hazards (or causes of hazards) that are specific to the context of each Railway Project.

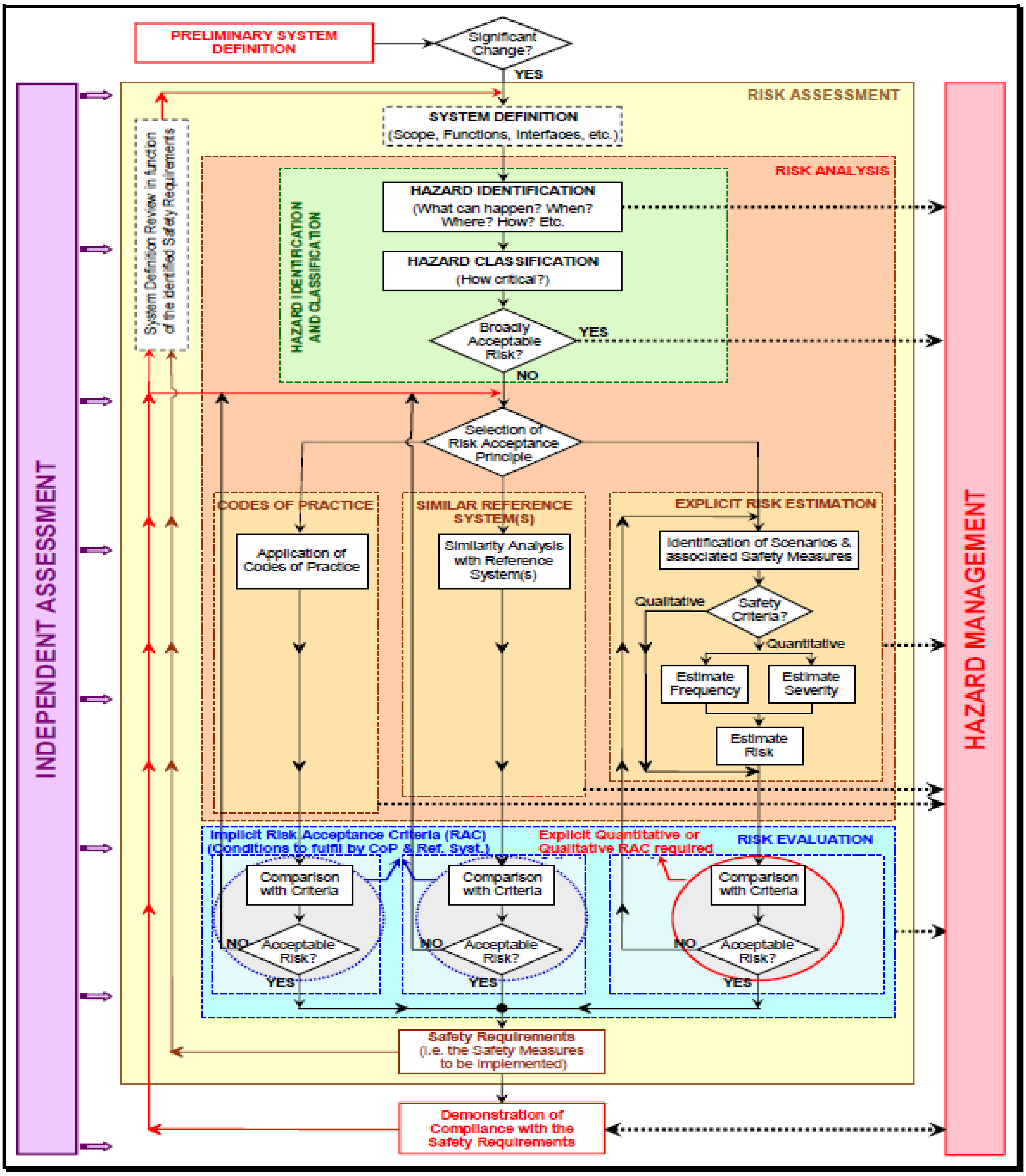

Figure 4-2: Common Safety Methods Risk Assessment Process

Once identified, the hazard must be analyzed in order to assess whether the resulting risk is acceptable, and if so under which conditions, assumptions or requirements, or whether additional safety measures (technical or operational) are necessary in order to reduce the risk to an acceptable level.

Each hazard identified and the related information shall then be recorded in a Hazard Log (see section 4.3).

4.2.3. *Risk Acceptance Criteria*

As stated in section 2.3, the safety objective is to drive each identified risk down to a level that is acceptable and As Low As Reasonably Practicable (ALARP). The Employer has defined a risk matrix that shall be used for determining risk acceptance criteria applicable for each railway system:

Table 4**:** Risk Acceptance Criteria

Frequency of an accident per Year (caused by Hazard)		**Severity of an accident (caused by Hazard)**			
		1	**2**	**3**	**4**
		Insignificant	**Marginal**	**Critical**	**Catastrophic**
8	**Frequent**	R2	R1	R1	R1
7	**Probable**	R2	R2	R1	R1
6	**Occasional**	R3	R2	R1	R1
5	**Rare**	R3	R3	R2	R1
4	**Unlikely**	R4	R3	R2	R2
3	**Remote**	R4	R4	R3	R2
2	**Improbable**	R4	R4	R3	R3
1	**Incredible**	R4	R4	R4	R4

A qualitative description of the frequency, severity and risk categories is provided in the tables below:

Table 5: Frequency of Hazard Occurrence

Frequency of Occurrence	**Description**
Frequent	Likely to occur frequently. The hazard will be almost continually experienced. (> 10 times per year)
Probable	Will occur several times yearly. The hazard can be expected to occur often. (> 1 times per year).
Occasional	Likely to occur several times in the system lifecycle. The hazard can be expected to occur several times. (> 1 times in a year to 10 years).
Rare	Likely to occur in the system life cycle. The hazard can be expected to occur a few times in the life cycle of the system. (> 1 times in 100 years).
Unlikely	Extremely unlikely to occur within the system life cycle. (> 1 times in 1,000 years).
Remote	Very unlikely to occur within the system lifetime. (>1 times in 10,000 years).
Improbable	Extremely unlikely to occur within the system lifecycle. (>1 times in 100,000 years).
Incredible	Not conceivably possible. It can be assumed that the hazard may not occur during the whole system life. (< 1 times in 100,000 years).

Table 6: Hazard Severity Levels

Severity Level	Consequence to Persons or Environment (Safety)
Catastrophic	Multiple fatalities (likely worst case) or extreme damage to environment
Critical	Single fatality (likely worst case) or large damage to environment
Marginal	Severe injury (likely worst case) or minor damage to environment
Insignificant	Minor injury (likely worst case) or minor system damage

Table 7: Risk Ratings

Ranking	Risk Evaluation	Risk Reduction/Control
R1	Intolerable	Shall be eliminated or reduced
R2	Undesirable	Shall only be accepted when risk reduction is impractical and with the agreement of Employer
R3	Tolerable	Acceptable with adequate control and the agreement of Employer
R4	Negligible	Acceptable without any agreement

The first objective is not to have any R1 risks at all, since these are intolerable.

R2 risks, although undesirable, may be accepted by the Employer only if it can be shown by cost benefit analysis that any risk reduction would be impractical. This would demonstrate such risks are ALARP.

R3 risks are acceptable with adequate control. These risks include risks which cannot be entirely eliminated but which are controlled by standards or elsewhere proven or approved safety measures. For those risks, compliance with standards or use of approved or proven systems is sufficient for demonstrating they are acceptable and ALARP.

Finally, R4 risks are negligible and can be accepted without any agreement. These risks do not need an ALARP demonstration. They must however be recorded in the Hazard Log with some justification on their classification.

4.2.4. Risk Evaluation

Evaluation of the risk is performed against the risk acceptance principles from the Common Safety Methods, as already mentioned in section 2.2.

If a risk is entirely covered by application of an adequate Code of Practice such as an international or local standard, then the risk can be considered acceptable and ALARP without the need for carrying out an explicit risk analysis and a cost benefit analysis. In the risk matrix, such risk can be at least classified as a R3 risk. The conditions for application of this risk acceptance principle are:

- The Code of Practice referred to must be acceptable to The Engineer, Employer and the Independent Safety Assessor.

- The appropriate coverage of the hazard(s) by the Code of Practice in the specific project context must be demonstrated.

If a risk is entirely covered by the use of a system or solution similar to a proven or approved reference system, then the risk can be considered acceptable and ALARP without the need for carrying out an explicit risk analysis and a cost benefit analysis. In the risk matrix, such risk can be at least classified as a R3 risk. The conditions for application of this risk acceptance principle are:

- The reference system referred to has already been proven in-use to have an acceptable safety level and would qualify for acceptance in Philippine.
- The reference system referred to has similar functions and interfaces as the corresponding system or solution to be used for the Project.
- The reference system referred to is used under similar operation and environment conditions as the corresponding system to be used for the Project.

If a risk is neither entirely covered by an adequate Code of Practice nor a reference system, then it shall be subject to an explicit risk analysis and a risk evaluation using the risk matrix from section 4.2.3. If the estimated risk lies in the R2 region, then an ALARP argument using cost benefit analysis shall be developed.

Any explicit risk analysis shall be able to stand to scrutiny. Therefore, the risk analysis should state clearly the methodology used for estimating the risk, the sources of input data, as well as the assumptions taken in the analysis/estimation.

4.2.5. Definition and allocation of safety requirements

Safety requirements to be fulfilled by the different elements of a railway system are the output of the risk assessment process described above. Each safety requirement is expected to come from one of the following sources:

- It is derived directly from an acceptable Code of Practice.
- It is derived from an adequate similar reference system.
- It is derived from an explicit risk analysis and evaluation.

Safety requirements shall be traced to the hazard(s) which they are contributing to control and are defined in terms of either:

- Functional requirements relating to a safety control measure system (functionality required).
- Technical requirements relating to a safety control measure (implementation characteristics).
- Contextual requirements relating to a safety control measure (operation and maintenance conditions).

The Employer along with The Engineer is responsible for incorporating safety requirements at the overall system level in the D&B contracts in accordance with this Safety Plan. Further safety requirements shall be defined by the D&B Contractors at their own level of scope definition.

4.3. Hazard Management

4.3.1.Hazard Logs

Hazards, once identified, shall be recorded in a hazard log, together with additional information relevant for the management of hazards.

The Contractor shall create and maintain an overall Hazard Log covering the whole project railway system. Hazard Logs shall be submitted to the Employer/O&M Concessionaire and maintained throughout the lifecycle of the project. The Hazard Log shall contain the following information:

Table 8: Hazard log **A**ttributes

No.	Field Name	Field Description
1	Hazard Number	A unique reference number
3	Mode	The operational state of the railway during which the hazardous condition exists. (e.g. Normal, Degraded, Emergency, Maintenance).
4	Date Hazard Identified	The date the Hazard Log entry was created.
5	Hazard Status	The current status of the hazard: new, open, resolved, closed.
6	Category	This Attribute categorize the Hazard to its possible consequence in terms of accident type and is multi-select and could be set to following values: *"Derailment", "Collision", "Fire", "Explosion", "Impact", "Entrapment", "Electrocution", "Trip/fall", "Others", "Heat Exhaustion", "Asphyxiation-Not Fire Related"*
7	System	The system or sub-system to which the Hazard relates. (e.g. SIG, RS, TVS, TRK, AFC, PSD, Power supply, etc.).
8	Function	The specific subsystem function, interface or O&M task under consideration.
9	Component	The constituents of the individual sub-system.
10	Interfacing Parties	This Attribute applies to interface Hazards and identifies the other Interfacing Contractors that are concerned by the Hazard (in its prevention or mitigation).
11	Interfacing Parties - Systems	The interfacing systems or sub-systems provided by the Interfacing Contractors.
12	Hazard Description	A description of situation or circumstance in which there is a potential for an accident to occur that may cause injury or fatality to personnel.
13	Cause of Hazard	The events, circumstances or conditions that result in the creation of the hazard.
14	Consequence of Hazard	A description of the resultant actual harm to persons.
15	Population at Risk	Describes the population (Passengers, Staff, Members or the Public) at risk due to the hazard.
16	Hazard Leader	This Attribute identifies the Leader of an Interface Hazard.
17	Hazard Leader - System	The System that is responsible for the management of the hazard.
18	Inherent Likelihood	The evaluated likelihood that the hazard and its credible worst-case consequence are realized before cause control measures are considered. Refer to Table 5.

No.	Field Name	Field Description
19	Inherent Severity	The evaluated severity of the credible worst-case accident before consequence control measures are considered. Refer to Table 6.
20	Inherent Risk Ranking	The evaluated inherent risk. Refer to Table 7.
Mitigations		
21	Control Measure & Requirements	Description of the risk reduction measures that are planned and documented to reduce the likelihood/consequence of the hazard being realized.
22	Control Measure Owner	Identifies the Owner(s) of Control Measure
23	Residual Likelihood	The evaluated likelihood that the hazard and its credible worst-case consequence are realized after cause control measures are considered. Refer to Table 5
24	Residual Severity	The evaluated severity of the credible worst-case accident after consequence control measures are considered. Refer to Table 6.
25	Residual Risk	The evaluated residual and ALARP risk. Refer to Table 7.
26	ALARP statement	A summary statement to support the claim that the residual risk is ALARP
27	Comments	Any additional comments to note.

Hazard Logs shall be maintained throughout the Project Life cycle, with regular updates, until eventually all hazards are closed. Hazard Logs shall be recorded in a Requirement Management tool, along with requirements and assumptions, in order to facilitate traceability and linking between safety requirements and hazards.

4.3.2.Closure of Hazards

A hazard may be considered closed when all safety requirements pertaining to the hazard have been implemented and validated, with approval from the Engineer and Employer.

4.3.3.Transfer of Hazards

A hazard may be transferred from one stakeholder to another when it is agreed that the control of the hazard falls within the responsibility of the latter. Such transfer, agreed by all concerned parties, must be documented in a hazard transfer sheet, so that it can ultimately be notified to and approved by the Engineer and the Employer. In case of disagreement between interfacing parties, Employer shall be called upon for arbitration.

4.3.4.Interface Hazards Management

Certain hazards arising at interfaces may have joint ownership between different stakeholders. This is the case for instance when a hazard is controlled by safety requirements to be implemented by more than one stakeholder. For these interface hazards, a clear allocation of responsibility must be established.

When interfaces are within the scope of one main Contractor (e.g. a Consortium), then it is up to this Contractor to allocate responsibilities and manage subsequently the resolution of the hazards across the involved stakeholders. This shall be however subject to supervision from the Employer and the Engineer .

When interfaces concern different Contractors, the Operator, or external organizations, then it is up to the involved stakeholders to agree on responsibilities and manage subsequently the resolution of the hazard between each other. In case of disagreement between interfacing parties, the Employer shall be called upon for arbitration.

4.3.5.Hazard Log management process

Using the principles stated above, each project shall establish a Hazard Log management process, explaining how hazard logs will be monitored, reviewed and eventually approved and in which the responsibilities of the various stakeholders involved in the project's hazards management at various stages of the hazard log life cycle are clearly defined.

4.4. Detailed Design & Construction- Safety Requirements Implementation

4.4.1.Contractors Safety Assurance Plan

At the start of the works, the D&B Contractors shall prepare a Safety Assurance Plan to detail how they comply with the requirements of IEC 62278 or EN 50126 or any other applicable international standards and to identify their process for demonstrating that their safety requirements are met.

This Safety Assurance Plan shall describe the following as a minimum:

- Organization of the Safety team, including the position within the Contractor's organization for the works.
- Management of Safety-related interfaces with other contractors.
- Provisions and procedures for providing feedback to and interacting with other disciplines in the Contractor's team, e.g. RAM, design, maintenance and commissioning.
- Identified Safety requirements (including interfaces).
- Planned Safety assessments/analysis to demonstrate that the system safety requirements are met by the Contractor's design.
- Safety methods to be used for the safety analysis.
- Management of subcontractors' Safety requirements.
- Safety related software management
- Quality management
- Configuration management
- Change management
- Verification and validation of assessments, including data.
- Validation of Safety requirements during manufacture, installation, commissioning and maintenance.
- Audits and Review activities.
- Record keeping of Safety assessments/analysis.

- Hazard Log Management.
- List of deliverables, including interim items listed within this document.
- High level schedule for deliverables.

Safety Assurance Plans are living documents which shall be regularly updated during the course of the Project.

4.4.2.Safety organization and competence

The Contractors shall ensure that safety assurance activities are entrusted to personnel with the right level of competence.

The team in charge of safety assurance activities should also have sufficient independence with respect to design and construction teams in order to ensure that major safety issues can be addressed and resolved at a high management level.

4.4.3.Apportionment of Safety Requirements

Based on their intended design, the Contractors shall perform their own Hazard Identification and shall create as a result their own Hazard Log, which they will populate with hazards (or causes of hazards) they are in charge of.

The Contractors shall also specify safety requirements for their design sub-systems and components (including SIL specification), which shall ensure that the system safety requirements that had been specified in the contract are met. This can be achieved by allocation of the contract system safety requirements, where applicable, or by applying the risk assessment process of section 4.2 at the system definition level corresponding to their scope.

The Contractors shall in any case ensure that there is a clear traceability between sub-system/components safety requirements and the higher-level system requirements, as well as with the associated hazards (subsystem/components hazard and higher-level system hazards).

Safety requirements specifications to subsystems and components shall be submitted to Employer and the Engineer for acceptance at each Design Review stage.

4.4.4.Safety Critical Items List

The Contractors shall prepare a Safety Critical Item List of equipment and LRUs classified by their impact on safety.

Safety Critical Item List is to be submitted to the Engineer and the Employer for acceptance at each Design Review stage.

4.4.5.SIL Specification

Electrical/electronic/programmable electrical safety critical equipment shall be assigned a Safety Integrity Level (SIL), depending on the contribution of this equipment to safety risks.

Table 9: E&M Systems and Track Works Safety SIL Targets

Item	E&M Sub-system	SIL Target
1	Automatic Train Protection System (ATP)	SIL 4

Item	E&M Sub-system	SIL Target
2	Signalling Supervision (ATS)	SIL 2
3	Signalling False Starting Protection	SIL 4
4	Signalling Interlocking System (CBI)	SIL 4
5	Signalling Train Over Run Protection	SIL 4
6	Signalling Train Detection	SIL 4
7	Signalling Speed Restriction	SIL 4
8	Radio Block Centre (RBC)	SIL 4
9	SCADA (Safety Functions)	SIL 2
10	ATP on-board equipment	SIL 4
11	PSD system	SIL 2
12	PSD interface with Signalling (Vital Signals)	SIL 4

Where not specified in standards for specific functions or equipment, SIL shall be determined in accordance with methodologies in line with IEC 61508, or any other applicable Safety standards and shall be subject to approval by the Employer, if not determined in the contracts.

4.4.6.Safety Analysis and Methods

Depending on their safety requirements and the type of systems they are in charge of, the Contractors shall have to carry out various safety analyses during the detailed design of their system, for the following purposes:

- Specification of safety requirements to sub-systems and components.
- Demonstration of fulfilment by design of the safety requirements.
- At Preliminary design Stage, some or all of the following analyses are to be expected:
  - Preliminary Hazard Analysis (to identify hazards within the system's scope)
  - System Hazard Analysis (focusing on inherent safety relevant failures of the system)
  - Operating and Support Hazard Analysis (OSHA) (focusing on interfaces with operation of the system)
  - Interface Hazard Analysis (IHA) (concentrating on internal and external interfaces of the system)
  - Quantitative risk assessment (where it is necessary to demonstrate that a risk is ALARP by explicit risk analysis).
- At Detailed design Stage, the following analysis would be expected, at least for complex and safety critical systems:
  - Sub-system Hazard Analysis
  - FMECA at component level for safety critical sub systems
  - Fault tree analysis to demonstrate achievement of a safety target (e.g. wrong side failure rate of a SIL)

- Update of IHA and OSHA
- Human factors studies
- Update of risk assessment where necessary.

The Contractor shall specify in its Safety Assurance Plan the safety analysis it plans to carry out as well the techniques and tools it will to use for these analyses.

4.4.7.Safety Reviews and Audits

Contractors shall be subject to regular internal safety reviews and audits during and construction/installation of their systems. The Contractors shall describe in their Safety Assurance Plans the process by which those internal reviews and audits shall take place.

Furthermore, the Engineer and the ISA shall also conduct their own safety reviews and audits. While the control from the Engineer will focus on processes, the ISA may look into the technical details of the system as part of its safety assessment. Therefore, all necessary documentation shall be made available for consultation to the ISA for this purpose.

The results of the Engineer and ISA safety reviews and audits shall be reported to the Employer.

4.4.8.Quality Assurance

The safety management process shall be accompanied by a quality assurance process in order to ensure that the development of systems is performed in such a way that the desired quality and performance is achieved upon delivery of the systems.

Contractors will be expected to produce a Quality Management Plan in which is described the quality assurance process that will be applied in support of the safety management process for the design, manufacturing, construction or installation of the systems.

4.4.9.Change and configuration management

As part of its configuration management, the Contractor shall evaluate the safety impact of any design change. The Contract must ensure that any change does not adversely affect the level of safety and propose if necessary, mitigation measures. The evaluation of the safety impacts of changes shall be recorded and documented.

4.4.10. Verification and Validation

In the different phases of the systems development life cycle, verification and validation activities shall be performed by the Contractors to ensure that all safety requirements are correctly fulfilled.

The Contractors shall be supported in these tasks by an Independent Safety Verification Engineer that will check during the development of the systems, from design until final validation, that the systems meet the standards required and other requirements set by the Employer.

The Contractors are expected to produce at the beginning of their design a Safety Validation Plan describing how all the safety related systems components are to be verified and validated. The Plan shall contain at least the following elements:

- the list of safety field verifications and validations for systems/ subsystems/equipment during construction, manufacturing, installation and systems interfaces integration testing;

- the schedule of safety field verifications and validations;
- the purpose of each verification and validation;
- the acceptance criteria by reference to any related safety study;
- the recommended method of testing, including the processing of key software safety issues in verification and validation;
- the plan for witnessing the results of verification and validation;
- the recommended format of the engineering safety validation report;
- the submission list of the Contractor's test reports; and
- the recommended assessment procedure with respect to deficiencies in the verification and validation results.

Where a safety related validation requires integration with other systems outside the scope of the Contractors, the Employer or Engineer shall be in charge of the validation.

4.4.11. Software Assurance

A software safety integrity level shall be determined for each item of safety related software in accordance with the requirements of applicable Software Safety standards.

The safety related software shall then be designed, coded, verified and validated in accordance with the applicable Software Safety standards. Safety critical software is expected to be assessed and certified for the specified SIL by an Independent Software Safety Assessor appointed by Contractor and approved by the Employer. Certificates and assessment reports should be attached to the safety cases.

4.5. Testing and Commissioning

Towards the Commissioning stage, the D&B Contractors shall establish Testing and Commissioning (T&C) Plans, where they will describe the testing activities that they shall perform for commissioning their systems, their schedule and the processes used for those testing activities.

The T&C Plans shall clearly indicate the tests serving for the validation of safety requirements in order to facilitate traceability with the safety information recorded in the Hazard Logs. The processes by which the results of the tests and their safety implications are assessed shall also be described in the T&C Plans.

System Integration testing shall be performed under the responsibility of a Contractor appointed by the Employer to act as Integrator.

A Data Reporting, Analysis and Corrective Action System (DRACAS) shall be used at this stage of the project to report and respond to incidents occurring during the testing phase.

4.6. Operation – Safety Management and Monitoring

The future Operator of each Railway System shall establish a Safety Management System demonstrating its capability in operating and maintaining the Railway System safely.

Safety Management procedures shall be written by the Operator in order to ensure:

a) Technical and operational safety requirements are met.

b) A safe utilization of the Sectional Operation for every passenger (in station and trains),

c) Safe working conditions for operator and maintenance staff within the Main line and the Depot area.

d) Accidents, incidents, near misses and other dangerous occurrences are reported, investigated and analyzed and that necessary preventive measures are taken.

These O&M Rules and Procedures elaborated by the Operational Readiness Committee, supported by the Contractor, shall be consistent with mitigation requirements resulting from the Contractor's risk analysis. The Contractor's Hazard Log shall identify hazards which will be mitigated by the O&M Rules and Procedures. The Rules and Procedures shall be checked by the Contractor with respect to its technical content and related safety.

The DRACAS shall be continued usage to report and respond to incidents occurring during the DNP phase of each sectional operation and full operation of the project.

5. SAFETY DEMONSTRATION

Safety demonstration of the works is required at different stages of each Project in order to obtain approval from the Employer. In addition, approval is also required from the Bureau of Fire Protection on fire and life safety issues.

The Contractor shall demonstrate successful achievement of the Safety targets which will be a prerequisite of the application for a Performance Certificate or handover certificate or Taking Over certificate (TOC) to be issued by the Employer for each of the Sectional Operations (SO) and for the Full Operation (FO) as per the project program.

Safety demonstration consists in the compilation of various documented evidences showing that safety requirements have been fulfilled and that safety risks are controlled to an acceptable level.

Submission and approval of the safety evidences has to follow the approval process established by Employer and the process established by the Bureau of Fire Protection for fire and life safety works.

5.1. Safety Approval Process

5.1.1. Approval Process

The general Safety approval process for the submission and review of submissions requiring acceptance from the Employer and leading to final safety approval and authorization to start revenue service can be summarized below:

- The Safety Assurance Manager shall be posted at Project site at least 02 months before receipt of prototype train and up to the expiry of warranty period.
- Submissions of safety documentation (*see section 6*) shall be prepared by Contractors.
- Safety documentation shall be submitted to the Engineer's Safety Assurance team and the Employer.
- Upon review the Engineer delivers either "*Notice of No Objection (NONO)*" or "*Notice of No Objection with Comments (NONOC)*" or "*Notice of* R*ejection (NOR)*" of the documents.
- After the documents have reached statement of "*Notice of No Objection (NONO)*" or at least "*Notice of No Objection with Comments (NONOC)*" status, the ISA will assess the documents.
- Key safety documents will be submitted to the Employer's Safety Review Panel after ISA assessment, for information or for formal approval.
- On the basis of acceptance of final commissioning and operational safety case by the Safety Review panel and ISA the Employer will recommend to the Operator to start revenue service.

5.1.2.Safety Review Panel

The Employer shall establish a Safety Review Panel (SRP) whose role consists in the following:

1. To ensure that the Railway project meets Employer Requirement to be operated safely and efficiently. This goal will be accomplished ultimately by SRP formally issuing the Commissioning Hand-Over Certificate and the Taking Over Certificate (TOC), following approval of related safety cases. These certificates are the output of a robust process of reviewing the project development progress up to completion.

2. To provide all the necessary information to Employer Safety Supervisory Authority that proves that a Railway project reaches all the safety and performance criteria developed from design to manufacture, building, supply, installation, testing, commissioning and acceptance. Based on all this background information, the Operator and Maintenance Concessionaire proof of readiness, and Taking Over Certificate (TOC), the Safety Supervisory Authority will be asked to issue the Revenue Service Approval that will allow commencing revenue operations.

3. To approve that Operator is fit to operate Railway System safely and at the performance level defined by the Employer.

Formal approval of the SRP will be sought at least for the safety assurance deliverables at the commissioning stages. In the preceding stages, the SRP will monitor the progress of the works on a regular basis and ensure any pending safety issues are resolved.

5.1.3. Bureau of Fire Protection Approval Process

As already mentioned in 3.3, the Bureau of Fire Protection has established its own approval process for the design of fire and life safety works. Clearance in the form an occupation permit delivered by Bureau of Fire Protection upon inspection of the assets at the commissioning stage is a pre-requisite for authorizing start of revenue service.

5.2. Safety Evidence

5.2.1. Fire and Life Safety Reports

The fire and life safety design for the E&M Systems and Track Works shall be primarily based on the requirements established in international fire and life standards, and those of the Philippines Bureau of Fire Protection.

Passenger safety shall be accomplished by incorporating design features combined with the development of procedures for the safe and efficient handling of normal, abnormal and emergency conditions.

The design of the system shall include provisions to detect and alarm unusual conditions, enabling a timely response and action by emergency response forces. As part of this integrated safety approach, design provisions shall enable safe and timely evacuation of patrons and personnel from structures, disabled vehicles, and facilities. The provisions shall also include necessary safeguards to protect passengers, system personnel, and emergency services during evacuation and shall minimize exposure to hazards created by fire and its related hazards; and unusual or unexpected incidents on the system.

The Contractor shall provide the E&M Systems and Track work be in compliance with the Employer Fire and line strategy.

The E&M Systems and Track Works shall be designed and constructed to appropriate internationally recognized standards using materials of low flammability, low smoke emission and low toxicity. All materials used in train shall be tested for flammability, smoke emission and toxicity in accordance with the appropriate international standards, certification of conformity to be provided, subject to the review of the Engineer.

The Contractor shall supply Fire and Life-safety Reports for applicable systems/sub-systems.
The fire and life safety reports shall contain relevant information and evidence under the following headings:

1) System description;

2) Design fire scenarios;

3) Fire and evacuation strategy interfaces;

4) Fire strategy outlines;

5) Means of escape;

6) Smoke ventilation and control systems;

7) Fire detection and alarm;

8) Fire suppression and firefighting systems;

9) Fire resistance and fire separation;

10) Emergency lighting, signage and power;

11) Communications Systems and procedures;

12) Fire service access and facilities; and

13) Fire management and emergency planning.

The Contractor shall provide the following:

a) Fire and life safety reports;

b) Operational fire and emergency strategies;

c) Operational Restrictions;

d) Hazardous materials report; and

e) BFP Philippines Fire and Life Safety compliance demonstration.

5.2.2. Safety Cases

Safety evidences to be addressed to Employer or/and to the future Railway Safety Supervisory Authority shall be produced by the Contractor in the form of Safety cases.

D&B Contractors shall prepare Design Safety Cases during the design and a Final Engineering Safety Case at the Commissioning Stage for handover. Operation of the railway shall be granted after review of the Operational Safety case to be prepared by the future Operator.

Design Safety Cases

At the end of each Design Stages the D&B Contractors shall prepare a Design safety case as per CENELEC or IEC standards. This shall include evidence of the safety activities carried out during the design of their system, and providing confidence that the design of their system meets the safety requirements. Hazard Logs shall be submitted as Annex to the Design Safety cases.

Final Safety Cases and Engineering Safety Case (prior to handover)

At the Commissioning stage, the D&B Contractors shall prepare their final Safety Cases for their respective systems. The Final Safety Cases shall contain the evidences and proofs that the system as built and installed fulfils all its safety requirements including its interface requirements for safe integration with other systems. The approval of Final Safety Cases by the Employer will condition the delivery of Taking Over Certificates during sectional and full line completion.

Demonstration of engineering safety for an entire railway line will require the integration of the final safety cases from different systems in order to show that hazards at the interfaces between technical systems are adequately controlled by the validation of safety requirements covering those interfaces.

The Engineering Safety Case shall demonstrate that all identified hazards have been satisfactorily closed out or have been transferred to the operator/maintainer for mitigation.

Hazard Logs, including evidence of hazards closure, shall be submitted as Annex to the Safety Cases.

The following Safety Cases shall be submitted for each sectional opening or sectional operation and for full operation of the project:

- System wide final Safety Cases (Power supply, Signaling/Train Control, PSD, Telecom, OCS, SCADA, Track, AFC, Depot Equipment, CMMS, etc.)

- Engineering Safety Case (integrating all of the above Safety Cases)

The final safety case shall be assessed by ISA for each sectional opening or sectional operation to issue Safety Certificates.

Operational Safety Case

In order to obtain final approval for starting Line revenue operation, the Line Operator or shadow operator shall prepare an Operational Safety Case. The Operational Safety Case integrates the Engineering Safety Case with evidences and proofs of adequate control of hazards which are not controlled entirely by technical systems (e.g. operational restrictions, Operation and Maintenance safety procedures, emergency management). Evidences about the Safety Management System of the Operator (*see section 4.6*) must also be documented in the Operational Safety Case.

Eventually the Operational Safety case provides the ultimate proof of safety of a Railway Line by demonstrating that all the safety risks arising from potential hazards on the Line are and will be controlled to an acceptable level, so that the Line can be considered fit for safe operation. Hazard Logs with evidence of adequate hazard closure shall be submitted as Annex to the Operational Safety Cases.

6. SAFETY DELIVERABLES

Below is a list of typical deliverables that will be expected during each Project life cycle.

6.1. Safety Assurance

The subsystem safety tasks shall be executed through all relevant stages of the system development lifecycle and in accordance with the following deliverable matrix. The minimum list of deliverables for Safety assurance is mentioned in the below table.

Table 10: Safety Deliverables

Sl No.	**Deliverable**	**Project Phase**					
		Design (Preliminary)	**Design (Pre-Final)**	**Design (Final)**	**Manufacture/ Installation**	**Testing & Commission**	**Acceptance / Handover**
1	Safety Assurance Plan	P	U*	U*			
2	Preliminary Hazard Analysis Report (IHA)	P	U*				
3	Deterministic Safety Assessment		P	U	U*	U*	
4	SIL Assessment Report			P	U*	U*	
5	Subsystem Hazard Analysis		P	U	U*	U*	
6	FMECA		P	U	U*	U*	U*
7	Interface Hazard Analysis (IHA)		P	U	U*	U*	
8	Operations and Support Hazard Analysis (OSHA)		P	U	U*	U*	
9	Hazard Log	P	U	U	U	U	U*
10	Quantitative Risk Analysis Report (FTA and/or ETA)		P	U	U*	U*	
11	Safety Critical Items List		P	U	U*	U*	
12	Safety Requirements Specifications		P	U	U*	U*	
13	Engineering Safety Validation Plan		P	U	U*	U*	
14	Design Safety Case (each subsystem)		P	U			
15	Final Safety Case (each subsystem)					P	U
16	Engineering Safety Case (Overall System level)					P	U
17	Fire and Life Safety report		P	U	U	U	U*

P- Prepare, U- Update, U- Update if necessary*

7. APPENDICES

Appendix A Competency Criteria

Appendix B Generic Safety Requirements

Appendix C System / Subsystem Hazard Analysis

Appendix D Operation And Support Hazard Analysis

Appendix E Interface Hazard Analysis

Appendix F: Failure Modes, Effects And Criticality Analysis

Appendix G Preliminary Hazard Analysis (PHA)

Appendix A Competency Criteria

Position	**Requirements**
System Safety Manager	▪ Have at least 10 years relevant experience in System Safety Management techniques and practices and knowledge of Railway Industry; ▪ Preferred at least 5 years' senior management experience in rail, infrastructure or similar to manage a team; ▪ Have relevant education in Engineering or a Chartered Engineer; ▪ Have success track records for handling system assurance management in accordance with CENELEC (EN50126, EN50128 and EN50129) or IEC standards for a similar railway project size; ▪ Have relevant experience in handling or participating to fire engineering studies, EMC control management and ergonomic studies; ▪ Experience in working on HAZOP methodology, Hazard Analysis, FMECA, QRA, FTA, Risk Assessment, Safety Demonstration, Safety Case; etc.; ▪ Experience in Management of V&V activities as per V-Lifecycle; ▪ Liaison with interfacing parties and other stakeholders.
Safety Engineer	▪ Have at least 5 years relevant experience in System Safety Management techniques and practices and knowledge of Railway Industry; ▪ Have relevant education in Engineering or a Chartered Engineer; ▪ Have success track records for handling system assurance management in accordance with CENELEC (EN50126, EN50128 and EN50129) or IEC standards for a similar railway project size; ▪ Have relevant experience in handling or participating to fire engineering studies, EMC control management and ergonomic studies; ▪ Experience in working on HAZOP methodology, Hazard Analysis, FMECA, QRA, FTA, Risk Assessment, Safety Demonstration, Safety Case; etc.; ▪ Experience in Management of V&V activities as per V-Lifecycle.

Appendix B Generic Safety Requirements

Serial No.	Safety Requirement Description	Subsystem
SR-01	The ETCS System shall monitor the time elapsed from one platform up to the next platform, for a train passing through a tunnel section. In case the time elapsed is larger than a threshold (to be agreed with the Engineer in further design stage), an alarm shall be triggered in the OCC.	SIG
SR-02	The ETCS System shall apply Emergency Brakes for a moving train, if an unauthorized mode is selected.	SIG
SR-03	In Off mode, the ETCS System shall command 100% braking effort, and shall command Emergency Brakes if movement is detected.	SIG
SR-04	Failure of fallback signals shall not result in degradation of ETCS normal operation.	SIG
SR-05	In case of a signaling system failure, a driver shall be able to drive the train at low speed without full ATP protection.	SIG
SR-06	The ETCS system shall ensure the safe metro operation of all rail vehicle movements on all tracks.	SIG
SR-07	The System shall prevent a controlled train from travelling in the opposite direction of its Movement Authority.	SIG
SR-08	The ETCS System shall ensure the train stops safely before a buffer (end of guideway).	SIG
SR-09	In the event of a single brake system failure, the guaranteed minimum emergency brake rate shall not be less than $1.04 m/s^2$." to ensure safe train separation is maintained.	SIG
SR-10	The ATP equipment shall be of "fail-safe design" with high availability and designed in accordance with SIL 4 requirements as stipulated in standards indicated in the applicable specifications	SIG
SR-11	The ETCS System shall apply the train Emergency Brake when it detects movement in the opposite authorized direction of travel for which the cumulative distance is greater than the maximum rollback tolerance distance.	SIG
SR-12	The ETCS System shall prevent train movement of controlled trains inside a traction power off area.	SIG
SR-13	The ETCS System shall ensure that a train does not depart a station until the "Closed and Locked" Status indicates all doors are closed and locked.	SIG
SR-14	When stopping at a platform, the ETCS System shall ensure that train doors on the opposite (non-opening) side of the train remain "Closed and Latched".	SIG
SR-15	The train shall stop within ±300 mm limits in order to enable automatic opening of ASDs (Automatic Sliding Door) through interfacing signals with the signaling system.	SIG
SR-16	The ETCS System shall prevent approaching trains from entering the power section occupied by the incident train.	SIG
SR-17	All ATP functions shall be vital functions and shall be designed and implemented in accordance with relevant standards. The Safety Integrity Level (SIL) shall be as follows: - ATP: SIL4	SIG, TEL, Power

Serial No.	Safety Requirement Description	Subsystem
	- CBI: SIL4 - Train Detection system: SIL4 - Radio Block Center (RBC): SIL4 - ATS (Signaling Supervision): SIL2 - Signaling False Starting Protection: SIL4 - Signaling Train Over Run Protection: SIL 4 - Signaling Speed Restriction: SIL 4 - Power SCADA (Safety Functions): SIL 2 - ATP on-board equipment: SIL4. -PSD system: SIL 2 -PSD interface with Signaling (Vital Signals): SIL 4.	
SR-18	The signals shall be installed at the trackside at breaking distance and visible to the Driver's eye view level	SIG
SR-19	Train washing mode shall be automatically/manually selected before trains pass through the washing plant. The speed shall be controlled at a low safe speed and avoid sudden accelerations.	SIG, RS
SR-20	The train shall not be able to move if one or more doors are not closed and locked. In case a door is unable to close or lock, it is possible to manually close and isolate it, so that the train can be withdrawn from service in Automatic Mode. In emergency cases passengers shall be able to open the door system from inside or outside of the train.	SIG, RS
SR-21	All buffer stops shall be positioned such that the required braking length can be safely achieved.	SIG, TRK
SR-22	Cables shall be fire retardant as a minimum according to IEC 60332-3.	All
SR-23	Cables shall be of zero halogen type according to IEC 60754-1.	All
SR-24	Cables shall be of low smoke emission type according to IEC 61034.	All
SR-25	Equipment mounting shall not obstruct the movement of staff or passengers during emergency. Passenger shall alight from vehicles to station platform on walkways and track bed in this case. All track mounted equipment and cables shall be fitted with ramps and covers for this purpose to protect passengers and equipment.	All
SR-26	Openings in walls and floors shall be sealed after the cable installation with a fireproof barrier, so that the original fireproof quality of the wall or floor is restored.	All
SR-27	Equipment, cables, drainage and other pipes, and all other materials shall be non-combustible and halogen-free when subject to heat or fire.	All
SR-28	Emergency traction power tripping is assessed as an on-demand safety function, the acceptable wrong side failure rate sets a requirement equivalent in accordance to applicable standards.	Power

Serial No.	Safety Requirement Description	Subsystem
SR-29	All conductive parts liable to become live from the voltage of the contact line under fault condition shall be directly connected to the traction system earth.	Power
SR-30	The emergency power system shall have a capacity and rating in accordance to IEC or EN or NFPA 130 or any applicable standards sufficient to supply all equipment required to be connected.	Power
SR-31	Provide the emergency power (UPS) for the emergency lighting Means of egress in the stations or tunnels in accordance with section 7.9 of NFPA 101 with minimum of 1.5 hours in the event of failure of normal lighting.	Power
SR-32	The power supply system for emergency purposes, in addition to the normal services to the station building, shall be one or more of the types of systems described in subsections 700.12(A) through 700.12(E) of NFPA 70.	Power
SR-33	All wiring materials and installations within trainways, other than for traction power, shall conform to the requirements of NFPA 70 and, in addition, shall satisfy the requirements of NFPA 130 6.3.3.2.2 through 6.3.3.2.9.	Power
SR-34	Conductive parts which cannot be directly connected to the traction system earth shall be protected by a voltage-limiting device. Voltage-limiting devices shall be used to make an open connection from exposed conductive parts to the return circuit to allow the interruption of the current in a short time to limit the voltage given in EN 50122.	Power
SR-35	The power supply for the PSD shall be provided with uninterrupted power supply system (UPS) to allow at least 5 cycle operation and 2 hours for monitoring.	Power, PSD
SR-36	The system shall comply with the EMC requirements in accordance with relevant standards.	All
SR-37	In general, routing of any kind of cables through smoke extraction paths shall not be allowed unless appropriate cable protection measures have been taken.	All
SR-38	Ensure no high inflammable material is used on guideway and surrounding area	All
SR-39	Where equipment with potential ignition sources, e.g. an arc, is installed within confined areas, the Contractor shall ensure that the equipment is stored in such a configuration that it is not possible to attain a critical mass from combustible materials.	All
SR-40	The Contractor shall isolate and protect safety critical cables and wires to minimize the impact on safety when there is a fire.	All
SR-41	AFC Gates shall be in accordance with NFPA 130 requirements 5.5.3.1 and 5.5.3.2, being designed so that their failure to operate will not prohibit movement of passengers in the direction of emergency egress.	AFC
SR-42	The Contractor shall isolate and protect safety critical cables and wires to minimize the impact on safety when there is a fire.	DEP
SR-43	Wires and cables smoke release tests and certification according to IEC 61034 for smoke density and IEC 60754 for toxicity shall be permitted.	DEP
SR-44	All Depot Equipment shall be designed to fail to a safe condition. Any failure of the equipment shall not cause any further mechanical damage or serious consequences;	DEP, Power
SR-45	Based on BS EN 62305 a lightning risks assessment evaluation shall be carried out to assist in the analysis of various criteria to determine the risk level of loss due lightning strike, risk	MEP

Serial No.	Safety Requirement Description	Subsystem
	assessment calculations to be performed by the contractor in order to define the required lightning protection level.	
SR-46	At the surface when measured at the nearest property line of a residence, commercial building or industrial building, the noise level shall meet local ordinances criteria.	MEP
SR-47	While Train on fire stops in tunnel, a fire alarm to be communicated to OCC either through passenger alarm or through vehicle automatic fire detection system.	OCC, RS, TEL
SR-48	To ensure Synchronized opening of PSD with train door	PSD
SR-49	The design of hardware and software of PSD shall be at least SIL 2 in accordance with IEC 61508 and IEC 62279	PSD
SR-50	All ASDs shall open/close after PSD received OPEN/CLOSE command from Signalling.	PSD
SR-51	ASD is equipped with obstacle detection device. The device will temporarily release the closing and automatic re-open when the door is obstructed.	PSD
SR-52	Audible sound as well as door indicating lights to be activated when the doors starts closing.	PSD
SR-53	Inscriptions and pictograms will be used to alert the passenger not to lean against ASDs	PSD
SR-54	Platform end doors equipped with emergency manual release mechanism on trackside to be located at both of the platform ends to allow evacuation from trackside into the platform area.	PSD
SR-55	Control of platform screen doors shall be possible from the LCPD (Local Control Panel for Driver) by the driver on the trackside and from LCPS (Local Control Panel for Station staff) by the station staff on the platform side.	PSD
SR-56	PSD shall be provided with the required insulation when passenger in contact with the PSD.	PSD
SR-57	Door control and operating arrangements shall be fail safe design.	PSD
SR-58	The entire construction and glazing of the PSD System shall withstand the pressure from non-stop train and the wind pressure from tropical storm.	PSD
SR-59	Platform Screen Doors shall be fabricated with non-combustible materials	PSD
SR-60	The closing force of the ASD is no more than 150N per door leaf. The maximum kinetic energy of the ASD is no more than 10J per door leaf. The target of open time is 2.5s to 3.0s and close time is 3.0s to 3.5s, however performance will be depended on final door weight and subject to compliance with specified impact force and kinetic energy constraints.	PSD
SR-61	The platform face of the screen and screen doors shall not have any footrest or handhold.	PSD
SR-62	A manual release latch shall be provided on the Automated Sliding Doors (ASD) to permit passengers to manually open the doors from the train side in an emergency situation.	PSD
SR-63	PSD shall be earthed to the station earth but all exposed surface shall be insulated to protect from electric shock.	PSD, RS, TRK, CIV
SR-64	PSD should be positioned as close as feasible to train body to prevent a person or child being trapped between a vehicle and the doors when the doors are closed. If the PSD cannot be located closed to the platform edge, a passenger detection system to detect any passenger	PSD, RS

Serial No.	Safety Requirement Description	Subsystem
	trapped between the PSD and train shall be used. The presence of a person between the PSD and train shall prohibit the train from leaving the platform.	
SR-65	Trains shall not be allowed to enter the station until the signalling system receives an 'ALL DOORS CLOSED' signal from the PSD System. It shall only be possible to start the train under normal conditions when all train doors and PSD doors are closed.	PSD, SIG
SR-66	When "All Doors Closed and Locked" output provide from PSD to Signalling is not confirmed and for there are some operation reasons, operator can use LCPD at trackside or LCPS at platform side to provide an "Interlock Override" to act as pseudo "All Door Closed and Locked" signal.	PSD, SIG
SR-67	All alarms and status through BMS (Building management system) shall be connected to OCC and through the optic fibre backbone provided by Telecom system.	PSD, MEP
SR-68	The entire RST structure, including any associated attachments, shall be free from sharp edges, weld spatter and swarf so as not to present hazards to passengers, operators, maintenance personnel and equipment used for maintenance or cleaning.	RS
SR-69	RS to have Obstacle Detection / Derailment System (ODDS) safety functions in their design	RS
SR-70	Emergency braking function to be a fail-safe design	RS
SR-71	RS shall provide physical separation of on-board electrical cubicles and enclosures for the general public, passengers, non-electrical workers and maintenance staff from any potential electrical hazards.	RS
SR-72	The production of any gas or concentration of gas from the batteries shall not at any time constitute a safety hazard. The enclosure shall be designed to prevent dust, sand or extraneous material settling on top of the battery.	RS
SR-73	No single defect or failure of any part of any train door system shall produce a situation capable of causing injury to any train door user.	RS
SR-74	No spurious electrical signals shall cause any train door to be released or opened unintentionally.	RS
SR-75	Electric shock/electrocution for passengers and staff during boarding/alighting of train shall be avoided. Touch voltage values shall be below the limits stated in IEC 62128-1, EN 50122-1 and IEC 60364-4-41.	RS
SR-76	The parking brakes, when applied, shall hold a stationary train in the AW4 loading condition indefinitely on the worst gradient (i.e. 4%) of the network in the worst operational conditions (i.e. AW4).	RS
SR-77	Emergency release levers (push bars) are located on all doors, so another door can be used for egress.	RS
SR-78	Design of vehicle (RS) to meet specified requirements for fire safety, including flammability and smoke emission characteristics.	RS
SR-79	Traction interlock due to door open status will prevent application of traction power.	RS
SR-80	TCMS (Train control management system) monitors the status of the Train Radio system, with alarm to train driver.	RS
SR-81	Train headlights & tail lights are provided for poor visibility / night conditions.	RS

Serial No.	Safety Requirement Description	Subsystem
SR-82	All circuits with the exception of the main traction circuits shall be protected by circuit breakers.	RS
SR-83	The Emergency Brake Circuit is a service proven design with a four-wire, double-break trainline following the active circuit principle. The EB Circuit is comprised of low complexity hardware.	RS
SR-84	Obstacle detection system on the train doors, with doors re-opening if obstacle is detected.	RS
SR-85	The system shall incorporate a walk surface/walkway or other approved means for passengers to evacuate a train at any point along the trainway so that they can proceed to the nearest station or other point of safety.	CIV, SYS
SR-86	Anti-clamber device at platform edge to be provided which will help prevent passengers from standing in the gap between the PSD and the train.	PSD, RS
SR-87	When the emergency door release handle in train is operated, the activated information shall be sent to OCC via SIG.	RS SIG
SR-88	When an obstacle is detected or the leading wheel set of the train derails, the emergency brakes shall be applied and an alarm sent to the OCC.	RS, SIG
SR-89	No High Voltage equipment is located where passengers can contact.	All
SR-90	Emergency Brake will be automatically initiated by SIG in case of loss of train integrity.	RS, SIG
SR-91	When train on fire stops in tunnel or station fire alarm will be activated for platform and station evacuation.	SCADA, MEP
SR-92	The escape way shall be free of any obstruction above the walking surface over minimum clearance areas as specified in NFPA 130, clause 6.3.2.1.	SCADA, TEL
SR-93	Interlocking shall be designed to ensure that a single failure shall not cause an uncontrolled hazardous situation.	SIG
SR-94	It shall be possible to safely prevent the automatic start of a train at any stabling or stop position while staff are approaching or entering the train.	RS
SR-95	The system shall include signage throughout the network to provide assistance, direction and warning to passengers and operations personnel to support normal, degraded and emergency operations. Signage shall include the following types: · Way finding signage: · System identification signs · Station name signs · Directional signs · Travel information displays · Metro network map · Local area map · Descriptive signs · Emergency exit signs · Trackside and tunnel signage · Other facility way finding signage · Warning, mandatory and prohibition signs. Signage may also be complimented by the use of the passenger information and public address systems.	SYS, CIV

Serial No.	Safety Requirement Description	Subsystem
SR-96	The fire detection and alarm system Manual call points for outdoor mounting shall have IP-65 enclosure protection and in explosion hazardous areas shall have explosion proof protection.	MEP, TEL
SR-97	Automatic fire detection shall be provided along the tunnel trainway and inside technical rooms located within tunnel sections.	MEP, TEL
SR-98	:Cant" and "gradient Cant" will be applied to curve and transition curve.	TRK
SR-99	Gauges and Clearances shall be in alignment with RS cross-section and kinematic envelope.	TRK
SR-100	Track structure shall be capable to contain the train path in the event of derailment (*Containment from tilting, running into the structure gauge of the opposite track and from colliding with bridge/tunnel equipment*).	TRK
SR-101	Buffer stops shall be capable for the rolling stock weight to stop without major damage.	TRK
SR-102	The desirable minimum main TD 'track distance' (*distance between two track distance centre lines*) shall be 4.00 m for higher operational speeds >100 km/h.	TRK, CIV
SR-103	To provide control and monitoring of Tunnel Ventilation system (TVS) during fire situation to ensure tenable environment conditions can be maintained.	MEP
SR-104	Provide necessary smoke control to achieve tenable conditions for passenger evacuation during emergency (fire) conditions in the tunnels, trackways and stations as per NFPA 130 specification or an equivalent international standard requirement. Cross-passageways shall also remain free of smoke during a tunnel fire incident.	MEP, CIV, SYS
SR-105	The Power SCADA (Safety Functions) shall be SIL 2	Power
SR-106	The ETCS Level 2 system shall always prevent train movement outside of the safe operating envelope by application of the service brake.	SIG
SR-107	The ERTMS / ETCS System shall ensure that the train shall be brought under control and not overrun the end of track buffers even under the worst failure conditions.	SIG
SR-108	Metrological and Seismic Monitoring System shall be provided for prevention of possible damage suffered from designated natural disaster to the railway facilities and safety of passengers	TEL
SR-109	Flooding detection and protection system shall be provided.	MEP, TEL
SR-110	Water leak detection and water level in the tanks shall be monitored by BMS in stations, tunnels, depot (wherever applicable).	MEP, TEL
SR-111	Fire detection and suppression system in OCC	MEP, TEL
SR-112	Emergency power supply system shall be provided in the stations, Tunnel, OCC	MEP, Power
SR-113	Adequate safety integrity level shall be ensured for switchover function of signalling systems between ETCS and CBTC at Bicutan station.	SIG

Note: The above safety requirements listed in the table are minimum and Contractor shall elaborate the list based on their analysis.

Appendix C System / Subsystem Hazard Analysis

Hazard ID	**Hazard Description**	**Hazard Cause**	**Consequences**	**Initial Risk**			**Mitigating Provisions**	**Residual Risk**			**Comments**
				Severity	**Probability**	**Risk Index**		**Severity**	**Probability**	**Risk Index**	

Hazard ID: Assign each hazard a unique number of the form "*SSHA-xxx"*, where "xxx" is a sequential number starting at 001 for each subsystem.

Hazard Description: Provide a brief description of the hazard.

Hazard Cause: Provide a list of the most likely cause/causes of the hazard.

Consequences: Describe the most reasonable credible mishap that could result from the hazard.

Mitigating Provisions: Provide a list of provisions intended to reduce the risk associated with the hazard.

Severity: Indicate the severity of the mishap based on the categories described in Table 6.

Probability: Indicate the probability of mishap occurrence based on the categories described in Table 5. Wherever possible, quantitative probabilities shall be provided.

Risk Index: Indicate the mishap risk level based on the method described in Table 7

Comments: List any additional information need to clarify any portion of the hazard record. List any recommendations for further action, including referral to other System Safety or Design activities.

Appendix D Operation and Support Hazard Analysis

System	O&M Process	Hazard ID	Hazard Description	Hazard Cause	Consequences	Initial Risk			Mitigating Provisions	Residual Risk			Comments
						Severity	Probability	Risk Index		Severity	Probability	Risk Index	

System: System under analysis.

O&M Process: General description of O&M process under analysis.

Hazard ID: Assign each hazard a unique number of the form OSHA-xxx, where "xxx" is a sequential number starting at 001.

Hazard Description: Provide a brief description of the hazard.

Hazard Cause: Provide a list of the most likely cause/causes of the hazard.

Consequences: Describe the most reasonable credible mishap that could result from the hazard.

Mitigating Provisions: Provide a list of provisions intended to reduce the risk associated with the hazard.

Severity: Indicate the severity of the mishap based on the categories described in Table 6.

Probability: Indicate the probability of mishap occurrence based on the categories described in Table 5. Wherever possible, quantitative probabilities shall be provided.

Risk Index: Indicate the mishap risk level based on the method described in Table 7.

Comments: List any additional information need to clarify any portion of the hazard record. List any recommendations for further action, including referral to other System Safety or Design activities.

Appendix E Interface Hazard Analysis

System	Interfacing System	Hazard ID	Hazard Description	Hazard Cause	Consequences	Initial Risk			Mitigating Provisions	Residual Risk			Comments
						Severity	Probability	Risk Index		Severity	Probability	Risk Index	

System: System under analysis.

Interfacing System: Interfacing system for the interfaces under analysis.

Hazard ID: Assign each hazard a unique number of the form IHA-xxx, where "xxx" is a sequential number starting at 001.

Hazard Description: Provide a brief description of the hazard.

Hazard Cause: Provide a list of the most likely cause/causes of the hazard.

Consequences: Describe the most reasonable credible mishap that could result from the hazard.

Mitigating Provisions: Provide a list of provisions intended to reduce the risk associated with the hazard.

Severity: Indicate the severity of the mishap based on the categories described in Table 6.

Probability: Indicate the probability of mishap occurrence based on the categories described in Table 5. Wherever possible, quantitative probabilities shall be provided.

Risk Index: Indicate the mishap risk level based on the method described in Table 7.

Comments: List any additional information need to clarify any portion of the hazard record. List any recommendations for further action, including referral to other System Safety or Design activities.

Appendix F: Failure Modes, Effects and Criticality Analysis

This analysis aims to characterise the failures of a system with a bottom-up process. It will be made in two stages:

- A preliminary FMECA based on the subsystem functions will be done,
- During the Final Design phase, this analysis will be updated by integrating the analysis of the components failures modes (i.e. hardware equipment and software): it is the detailed FMECA.

The following FMECA table can be used as reference:

Ref. No.	Subsystem	Item/LRU	Function description	Failure mode	Failure rate	Failure Cause(s)/ Mechanism(s)	Failure Effects at LRU level	Failure Effects at system level	Potential Hazard	Detection means	Initial Risk assessment			Actions / mitigation measures	Residual Risk assessment			Remarks
											Severity level	Probability of occurrence	Risk ranking		Severity level	Probability of occurrence	Risk ranking	

Moreover, a System FMECA will be performed at System level in order to:

- Assess criticality of failure consequences on revenue service and the availability of the System,
- Identify failure recovery strategies at the System level,
- Propose mitigation measures to reduce the impact of some item considered as large contributors to the availability
- Consolidate all the Sub-system level FMECA taking into account the operation procedures,
- Verify that the interfaces have been analyzed.

The Sub-system level FMECA will be undertaken down to LRU.

Ref. No: Assign each FMECA record a unique number of the form xx-yy-zzz; xx is the subsystem identifier, yy is the LRU/Item identifier and zzz is a sequential number starting at 001 for each LRU/component.

Subsystem: Provide a brief description of the Subsystem.

Item /LRU: Provide a brief description of the LRU or item .

Function description: Provide a brief description of the LRU or item function.

Failure Rate: Provide the total LRU or item failure rate in failures per million hours.

Failure Mode: Provide a brief description of the failure mode.

Failure Cause/Mechanism: Provide a brief description of the cause of the failure.

Failure Effects at LRU level: Provide a brief description of the effect of the failure mode on the function at LRU level.

Failure Effects at System level: Provide a brief description of the effect of the failure mode on the function at system level.

Potential Hazard: Provide a brief description of the worst reasonable credible hazard, if any that could be caused by the failure mode.

Risk Assessment: Indicate the mishap risk level based on the method described in Table 7.

Probability of occurrence: Indicate the frequency level based on the Table 5.

Severity: Indicate the severity level based on the Table 6.

Detection Means: Provide a brief description of the means by which the failure mode would become known. Indicate if failure is not detected by means other than inspection.

Actions / mitigation measures : Provide a brief description of any necessary or possible failure management actions that should be taken to permit continued safe operation of the train/system.

Remarks: List any additional information needed to clarify any portion of the FMECA record, list any recommendations for further action, including referral to other System Safety or Design activities.

Appendix G Preliminary Hazard Analysis (PHA)

The following can be considered as reference in Hazard identifications.

Table 1 – Hazard Categories and Subcategories

1. Derailment Hazards	
Der1	Potential vehicle derailment due to fault/ failure of rolling stock
Der2	Potential vehicle derailment due to fault/ failure of infrastructure
Der3	Potential vehicle derailment due to overspeed
2. Collision Hazards	
Col1	Potential collision between rail vehicles
Col2	Potential collision between rail vehicle and object/animal on the track
Col3	Potential collision between rail vehicle and rail structure/equipment
3. Fire Hazards	
Fir1	Potential fire in vehicle/station/trackside/depot etc.
Fir2	Person(s) exposed to smoke in vehicle/ station/ depot etc.
4. Explosion Hazards	
Exp1	Explosive device
Exp2	Potential for explosion exists
5. Impact Hazards	
Imp1	Potential impact between rail vehicle and person(s)
Imp2	Person(s) impact with heavy/falling/moving object(s)
Imp3	Person(s) exposed to pointed or sharp objects
6. Entrapment Hazards	
Ent1	Person(s) become trapped
Ent2	Potential for person(s) to become trapped by/ caught in equipment/ machinery
7. Electrical Hazards	
Ele1	Person(s) exposed to hazardous voltages on vehicle / track / station/ Tunnel
Ele2	Person(s) exposed to arcing
8. Trip/ fall Hazards	
Tf1	Person(s) fall from running train
Tf2	Person(s) fall from height
Tf3	Slip/Trip/Fall hazard present
9. Environmental Hazards	
Env1	Flooding, Typhoon
Env2	Exposure to noise
Env3	Potential heat exhaustion due to exposure to abnormally high temperatures
Env4	Person(s) exposed to hazardous materials
Env5	Person(s) exposed to hot object/ surface/ fluid
Env6	Asphyxiation/intoxication (not fire related)
Env7	Electromagnetic interferences

Table 2 – Generic Hazards

#	Keyword: Impacts
1	Potential impact between vehicle and another vehicle or buffer stop.
2	Potential impact between vehicle and object dropped/left on the guideway.
3	Potential impact between vehicle and guideway structure.
4	Potential impact between vehicle and person(s) on the guideway during guideway maintenance.
5	Potential impact between vehicle and person(s) on the guideway during evacuation.
6	Potential impact between vehicle and unauthorized person(s) on the guideway.
7	Potential impact between vehicle and person(s) in the depot.
8	Potential impact between vehicle and object falling from vehicle.
9	Potential impact between road vehicle and System structure.
10	Potential impact between person(s) and object falling/dropped from the System structure.
11	Potential collision of vehicle with infrastructure out of gauge due to equipment/tunnel/walls/bridge.
12	Potential collision of vehicle due to track defect.
13	Potential impact between person(s) and moving equipment within Stations, Depot, etc.

#	Keyword: Electrocution
1	Person(s) exposed to hazardous voltages on vehicle during maintenance.
2	Person(s) exposed to hazardous voltages on vehicle in service/operations.
3	Person(s) exposed to hazardous voltages on guideway during maintenance.
4	Person(s) exposed to hazardous voltages on guideway during evacuation.
5	Person(s) exposed to hazardous voltages in stations during maintenance.
6	Person(s) exposed to hazardous voltages on guideway having gained unauthorized access to guideway.
7	Person(s) exposed to hazardous voltages in stations during service/operations.
8	Person(s) exposed to hazardous voltages in depot.
9	Person (s) exposed to hazardous voltage due to fall of HV cable

#	Keyword: Trips & Falls
1	Fall hazard onto/from guideway (or elevated station) present during maintenance.
2	Fall hazard onto/from guideway (or elevated station) present during evacuation.
3	Fall hazard onto/from guideway (or elevated station) present during service/operations.
4	Unauthorized person(s) exposed to fall hazard onto/from guideway (or elevated station).
5	Trip/Fall hazard present within station (including stairs, escalators, platform edge).
6	Trip/Fall hazard present within vehicle.
7	Trip/Fall hazard present within depot. present within depot.
8	Trip/Fall hazard present at platform/vehicle gap.

#	Keyword: Poisoning
1	Person(s) exposed to toxins as a result of fire.
2	Person(s) exposed to toxins due to the presence of foreign object(s) containing toxic substance(s) in vehicle/station/depot etc.
3	Person(s) exposed to toxins due to the presence of toxic substance(s) in vehicle/station/depot structure/materials and/or equipment etc.

#	Keyword: Heat exhaustion
1	Potential heat exhaustion due to exposure to abnormally high temperatures existing in the working environment.
2	Potential heat exhaustion due to exposure to abnormally high temperatures in vehicle/station during service.
3	Potential heat exhaustion due to the loss of air cooling.

#	Keyword: Explosion
1	Explosive device with person(s) present.
2	Explosive device present following successful evacuation.
3	Potential for explosion exists in train, station, depot due to equipment fault/failure /mal-operation.

#	Keyword: Derailment
1	Potential vehicle derailment due to fault/failure of vehicle systems.
2	Potential vehicle derailment due to fault/failure of guideway.
3	Potential vehicle derailment due to over speed.
4	Potential vehicle derailment due to switch changing under it.
5	Potential vehicle derailment due to object on guideway.
6	Potential vehicle derailment due to object fallen on the track from the outside environment

#	Keyword: Burns/Scalds
1	Person(s) exposed to hot object/surface/fluid during maintenance.
2	Person(s) exposed to hot object/surface/fluid during service.
3	Potential fire in vehicle/station/depot etc. due to structure containing combustible material.
4	Potential fire in vehicle/station/depot etc. due to foreign object containing combustible material.
5	Potential fire in vehicle/station/depot etc. due to equipment fault/failure.
6	Potential fire in vehicle/station/depot etc. due to incorrect maintenance.

#	Keyword: Entrapment
1	Person(s) become trapped within/by vehicle due to equipment fault/failure.
2	Person(s) become trapped within lift due to equipment fault/failure.
3	Potential for AFC equipment, station layout, procedure, communications equipment etc. to inhibit/not facilitates ready evacuation.
4	Potential for person(s) to become trapped by/caught in equipment/ machinery during service.
5	Potential for person(s) to become trapped by/caught in equipment/ machinery during maintenance.

#	**Keyword: Puncture Wounds**
1	Person(s) exposed to pointed or sharp objects on vehicle during maintenance.
2	Person(s) exposed to pointed or sharp objects on vehicle in service.
3	Person(s) exposed to pointed or sharp objects on guideway during maintenance.
4	Person(s) exposed to pointed or sharp objects on guideway during evacuation.
5	Person(s) exposed to pointed or sharp objects on guideway having gained unauthorized access to guideway.
6	Person(s) exposed to pointed or sharp objects in stations during maintenance.
7	Person(s) exposed to pointed or sharp objects in stations during service.
8	Person(s) exposed to pointed or sharp objects in depot.

Table 3 – Emergency scenarios

Passengers/Staff-Under Normal operations	**Fall** onto track/into gap / **trapped**
	Sick or **injured** >> e.g. fall into / from train, crushed between train / PSD doors…
Degraded Operation	System **failure** >> e.g. in one-line section
	Train **rescue** (coupling) / Rescue failure
	Unsound conditions inside train >> loss of Air condition/lack of air renewal…. / TVS failure
	Perturbation or Person **intrusion**
Passengers/Staff-Emergency	**Death** or serious **injury** >>collision with vehicle / Dragged by train / Suicide...
Encroachments onto the Network	**Object intrusion** to track
	Hole punched into **tunnel**
Other Emergency scenarios	**Explosions** or **Bomb** threat or **Terrorism** action
	Crowd movement / panic / Civil unrest
	Hostages / Barricaded subject
	Hazardous material spills and releases
Crisis Situation	Tunnel / elevated **structure collapse**
	Train fall down from elevated section
	Unexpected crisis

Stations	**Fire** in station >> platform / Concourse / Back-of-house
Tunnels	**Fire** in tunnel
	Other hazard **prohibiting train movement** >> e.g. tunnel / Tack damage, object fall on track
	Train stops in tunnel
	Two **stalled trains** between stations
Elevated/At-Grade	**Fire** in elevated or at grade sections
	Train stops in elevated or at grade sections
Vehicles	**Train on fire** (on / under train) / **Engineering vehicle** >> In station, in switchbox >> in tunnel, in elevated or at grade section
	Collision / Derailment / Loss of Integrity >> Collision with train, other vehicle, structure, etc.
	Unauthorized person in **Control** of train
Depot/ OCC	**Fire** in depot /OCC
Natural Disaster	**Earthquake** or **Flood** or **Volcano** eruption
	Storm /High winds / **Tropical cyclone**
System	**Loss of power**
	Computer **system attacks (Cyber)**
	Vandalism

Table 4 – Examples of Preliminary Hazards

Level	Derailment	Collision	Fire Hazards	Explosion Hazards	Impact Hazards	Entrapment	Electric Hazards	Trip/Fall Hazards	Environmental Hazards
1st (generic)	- Derailment due to rolling stock failure - Derailment due to overspeed - Derailment due to infrastructure failure	- Collision between rail vehicles (including maintenance vehicle) - Collision between rail vehicle and obstacle on the track - Collision between rail vehicle and infrastructure	- Potential fire in vehicle/station/trackside/ depot - Person/s exposed to smoke in vehicle/station/depot etc.	- Explosion device - Potential for explosion exists	- Potential impact between rail vehicle and person/s - Person/s impact with heavy/falling/moving object/s - Person/s exposed to pointed or sharp objects	- Person/s become trapped - Potential for person/s to become trapped by/caught in equipment/machinery	- Person/s exposed to hazardous voltages on vehicle/track/station - Person/s exposed to arching	- Person/s fall from running train - Person/s fall from height - Slip/Trip/Fall hazard present	- (under Fire Hazards) (not really a Hazard, may be a Hazard cause) (is under Impact hazards or Entrapment, access control) Exposure to noise - Exposure to heat - Exposure to hazardous materials -Asphyxiation/intoxication (other than fire) - EMI
2nd (generic/ functional)	- Loss of train integrity - Speed control failure - Switch failure - Inappropriate gauge design - Unstable track - Loss of track integrity	- Signaling/route management failure - Train safe separation failure - Inappropriate moving authority - Incorrect operating procedures for non-communicating trains - Inappropriate track possession - Unsecured objects at height - Unsecured structures/ equipment within rail safety envelope - Incorrect operating requirements - Loss of structural resistance due to inappropriate earthing and bonding	- Inflammable substances stored or used in the railway System - Inappropriate fire protection (fire detection, fire suppression, smoke control) - Deficient fire structural protection - Incorrect evacuation requirements - Power equipment or cables undersized - Under-calculated evacuation paths - Incorrect or confusing evacuation instructions displayed or announced - Unclear or too complicated evacuation procedures	- Inflammable or explosive substances stored in the vicinity of the railway system - Incorrect handling of the explosive materials/substances - Criminal acts/ terrorism	- Inappropriate access control - Incorrect passengers/worker/public to moving train separation - Structure collapse due to wrong calculation or construction/installation - Incorrect fixing of equipment - Inappropriate working methods	- Incorrect access control/priorities - Inappropriate calculation of personnel/public escape areas - Machinery failure - Inappropriate Working methods	- Incorrect earthing and bonding - Live cables in reach of public or workers - Incorrect calculation or implementation of the electrical protection devices - Inappropriate power cut off design or equipment - Inappropriate power de-activation and activation procedures and control	- Incorrect materials used in evacuation paths or on public transfer - Inappropriate working methods - Train doors failures - Insufficient lighting	- inappropriate heat isolation - Inappropriate EMI control - Inappropriate noise control - (under Impact Hazards) (under Entrapment or Impact hazards) (under Fire hazards) - Incorrect dangerous substances handling and storage
3rd (functional failures)	- Kinematic envelope - Speed control - Structural resistance function - Switch protection - Track integrity	- Structural resistance function - Train separation - Kinematic envelope - Earthing and bonding	- Fire protection - Structural fire protection - Equipment fixing - Evacuation routes - Evacuation procedures and instructions - Power functions	- Structural resistance function - Equipment/materials location	- Access control - Passenger transfer - Architectural design - Equipment fixing - Track possession - Track evacuation - O&M Health & safety procedures	- Passenger transfer - Architectural design - Access control - Machinery protection - O&M Health & safety procedures	- Earthing and bonding - Power functions - Electrical protection - Access control	- Passenger displacement - Equipment/ material location - Lighting principles	- Environmental control - EMI Control

APPENDIX G - Preliminary Hazard Analysis (PHA)

Hazard Id	Mode	Category	Hazard description	Causes	Consequences
PHA-001	Emergency	Derailment,Collision,Impact,Trip/fall	Total loss of traction/station power	-Power supply Equipment failure	Panic, Slip/Trip/Fall due to loss of lighting within station, train or depot, loss of safety related equipment
PHA-002	Emergency	Electrical	Lightning strike in depot/station	-Electrical Storm	Staff exposed to physical harm, Local Fires
PHA-003	Emergency	Environment	Flooding	-Water accumulation in tunnel section, trackway due to strong rain,water leakage, -insufficient drainage or incorrect maintenance of drainage system	Derailment, structure and equipments damages
PHA-004	Emergency	Explosion	Presence source of explosion in depot	-High energy release due to equipment Failure / Caused by Staff, -Accumulation of explosive gases in electrical room, -Incorrect storage of explosive goods.	Staff exposed to smoke/fire/Physical Harm
PHA-005	Emergency	Fire	Presence of ignition source on guideway equipments.	-Insulation fault/Short circuit /Flammable materials in guideway and/or on the equipment installed in the guideway, -OCS Arcing or incorrect maintenance of equipment, -use of flammable materials by maintenance staff.	asphyxiation, Passengers exposed to fire and smoke
PHA-006	Emergency	Fire	Passengers trapped in station during evacuation.	-AFC/BMS failure, -Fire detection failure, -Obstructed station evacuation routes.	Delay in evacuation, Death of persons due to fire and smoke
PHA-007	Emergency	Fire	Presence of ignition source in station	-Insulation fault/Short circuit/flammable materials on the equipment installed in station or Incorrect maintenance of equipment in station,, -Use of flammable materials by maintenance staff in station.	asphyxiation, Passengers suffer burns and smoke related injuries, possibility of multiple fatalities
PHA-008	Emergency	Fire	Presence of ignition source in train (Train stopped at station or in tunnel)	-Equipment insulation fault/Short circuit/Flammable material used in train, -Heat released by braking system, -Incorrect maintenance, -Use of flammable materials by maintenance staff.	asphyxiation, Passengers suffer burns and smoke related injuries, possibility of multiple fatalities

Hazard Id	Mode	Category	Hazard description	Causes	Consequences
PHA-009	Emergency	Fire	Passengers fail to stay on emergency/safety walkway	-Wrong indication of route evacuation, -No direction indication or obstruction on walkway, -Operator error,discontinuous evacuation walkway, -Insufficient lighting.	Fall of passengers, injuries, Passengers trapped or caught in switch machine during evacuation
PHA-010	Emergency	Fire	Passengers trapped in train during evacuation (at station)	-Train/platform doors failure,operator fails to open the train/platform doors, -Train stopped at incorrect location (Misalignement).	Panic, Passengers exposed to somke/fire in train, Delay in evacuation
PHA-011	Emergency	Fire	Platform end doors (PED) unable to be opened by passengers from tunnel side during evacuation	-Exit doors/PED failure,or -Incorrect maintenance of PED.	Delay in evacuation,injuries, passengers exposed to smoke and heat stress
PHA-012	Emergency	Fire	Insufficient emergency egress in tunnel and station	-Size and quantity of egress facilities not comply with requirement & standards	Delay in evcuation, passengers exposed to smoke and heat stress
PHA-013	Emergency	Fire	Insufficient or no lighting on walkway	-Power supply failure, -Insufficient maintenance, -Emergency lighting failure, -Smoke accumulation	Delay in evacuation, fall of passengers onto trackway, Electrocution
PHA-014	Emergency	Fire	Train movement during evacuation	-Untimely propulsion command by SIG/Driver, -System fails to stop trains, -Operator fails to stop train, -Operator starts trains before evacuation complete, -SIG automatically starts train, -Uncontrolled evacaution (no time to stop trains), -Brake failure.	Delay in evacuation,passengers entrapped in train, fall of passengers onto trackway
PHA-015	Emergency	Fire	Presence source of ignition in OCC room.	-Insulation fault/Short circuit/flammable materials on the equipment installed in OCC or insufficient maintenance	Electrical shoc, Electrocution, Fire in OCC room, smoke
PHA-016	Emergency	Fire	Failure of triggering station "evacuation mode" when train on fire at Station	-SCADA,BMS (Building Management System), -Fire detection System Failure	Passengers exposed to smoke and fire
PHA-017	Emergency	Fire	Non incident train passing by a train on fire in viaduct	-Normal Operations have not been stopped. -Signaling system failure	Passengers exposed to smoke and fire in the passing train
PHA-018	Emergency	Fire	Presence of ignition source in Depot/ Stablin yard	-Equipment Failure / Caused by Staff/Design using flammable materials and emitting smoke	Staff exposed to smoke and fire
PHA-019	Emergency	Fire	Buffer stop does not stop train correctly within Depot	-Train exceeding buffer design speed, -System fails to reduce train speed at the end of track.	Staff exposed to physical harm

Hazard Id	Mode	Category	Hazard description	Causes	Consequences
PHA-020	Emergency	Fire	Smoke engulfing interior of the car	-Fire under Train / RS Dampers open.	Passengers exposed to smoke
PHA-021	Emergency	Fire	Leaking Diesel onto wayside causing possible fuel source	-Equipment failure or incorrect maintenance, -Diesel Tank structure failure	Increased fire Hazard, Slipping hazard for Trains
PHA-022	Emergency	Fire	Passengers unable to evacuate the train	-RS/PSD Doors fail to open, -Train Misalignment, -Operator Error	Passengers exposed to smoke and Fire, Passenger exposed to physical harm (Panic), Increased in evacuation time
PHA-023	Emergency	Fire	Passengers fall from walkway during evacuation OR hit by sharp/Protruding object	-Obstructions of Walkway/Wrong design of walkway (Narrow walkway), -Wrong Dynamic Signage Instruction, -Overcrowding of walkway (Pushing), -Insufficient lighting within Tunnel, -Uneven Surface of walkway (i.e. slippery).	Delay in evacuation Time, Physical harm to Passengers
PHA-024	Emergency	Fire	Following train reach area on fire within Tunnel	-Fire detection failure, Communications failure causing a failing to report incident, -Operator failure to stop following train, -Signalling System fails to react to Operator command, -Manual Mode train operation at time of the event.	Increased Passengers at risk of smoke and fire
PHA-025	Emergency	Fire	Passengers not using cross-passage as the nearest point of safety during evacuation	-Failure of PA System, -Lack of clear direction from Operator, -Failure of Dynamic Signage to indicate the xpassage direction to a point of safety. -Unclear/conflicting fixed signage.	Passengers exposed to untenable conditions, Evacuation delay, Passengers exposed to heat stress
PHA-026	Emergency	Fire	Increased time to reach cross-passage during train evacuation	-Failure of PA System, -Lack of clear direction from Operator, -Failure of Dynamic Signage to indicate the xpassage direction to a point of safety. -Unclear/conflicting fixed signage, -Xpassage spacing non compliance to NFPA130	Passengers exposed to untenable conditions, Evacuation delay, Passengers exposed to heat stress
PHA-027	Emergency	Fire	Additional duration for emergency services to reach the incident	-Operator failure to report incident to Emergency Services in timely manner, -Xpassages spacing non compliant to NFPA130, -Emergency Services unfamiliar with the railway environment	Train conditions become untenable before emergency services arrive. Passengers exposed to heat stress

Hazard Id	Mode	Category	Hazard description	Causes	Consequences
PHA-028	Emergency	Fire	Obstruction at cross-passage	-Maintenance staff leaving tools at cross-passages; -Defective infrastructure, -Equipments intrude the clear width of cross passage.	Passengers exposed to untenable conditions, Evacuation delay Passengers exposed to heat stress, crowding/passenger injury
PHA-029	Emergency	Fire	Non tenable temperature within non incident tunnel used for evacuation	-TVS Failure; -Tunnel Cooling Failure	Passengers exposed to heat Stress
PHA-030	Emergency	Fire	Uncontrolled evacuation at station in case of fire under/inside train and emergency on board	-Failure of PA/PIDs Announcements; -Communication Failure leading to no evacuatiuon messages being able to be made; -Station Staff failure to control Station Passengers	Passenger Panic, Risk of passanger Injury
PHA-031	Emergency	Fire	Failure to respond to passenger emergency onboard request.	-Communications failure (Wifi, CCTV); -Operator error	Increased injury to passenger
PHA-032	Emergency	Fire	Uncontrolled passenger evacuation from Train between stations.	-Failure of PA/PIDs Announcements -Communication Failure leading to no evacuation messages being able to be made -Operator failure to control Train Passengers evacuation	Eletrocution, Heat Stress, Risk of smoke and fire
PHA-033	Emergency	Fire	Non-Incident train trapped in incident area	-Evacuatiuon of incident Train (uncontrolled) forcing the immediate de-energisation of the area, -Catenary De-energised, -Siganlling failure to stop following train, -Signalling System fails to react to Operatorcommand to reverse the train, -Manual mode train operation at time of the event	Passenger exposure to smoke and fire
PHA-034	Emergency	Fire	Uncontrolled evacuation of passengers whilst traction power is energised	-Operator fails to control the evacaution, -System or operator fails to cut off traction power	Electrocution, hit by adjacent train on guideway during evacuation
PHA-035	Emergency	Fire	Excessive gap between train and walkway (upto 50 mm)	-CIV fails to reach walkway design requirements, -Interfacing paties fail to consider the inputs from CIV	Fall of passengers onto gap during evacuation
PHA-036	Emergency	Fire	Evacuation paths in depot obstructed	-Objects left on evacation path, -Equipments intrude clearance of evacuation path	Delay in evacuation

Hazard Id	Mode	Category	Hazard description	Causes	Consequences
PHA-037	Emergency	Impact,Entrapment	Automatic/Manul train coupling can not be ensured.	-RS failure/ SIG failure, -Operator unable to couple manually the trains, Train unable to move from the area where the auto-coupling is not possible.	Passengers entrapped inside the train,Panic,Trip/fall
PHA-038	Emergency	Impact,trip/fall,Electrical, Collision	Train moves during natural calamity	-Typhoon, flood, Earthquake, etc.	Electrocution, trip/fall, Impact with train and road vehicles, Collision might lead to Multiple deaths
PHA-039	Emergency,normal	Trip/fall	Overcrowding situation in train/station	-Lack of station supervision, -Insufficient procedures, -Timetable fails to meet passengers loading requirement	Pushing, fall of passengers, discomfort
PHA-040	Maintenance	DEPOT HAZARDS	Person run over by train in depot	-Staff (Maintainers/Operators) fail to follow procedures, -Poor or no procedures, -Operator/Driver moves the train while staff still present at track, Untimely train movement; -Insufficient precautions against passenger entering depot	Single fatalities and/or injuries
PHA-041	Maintenance	Impact	OCC Building collapse	-Incorrect maintenance or construction work -Natural disaster like earthquake, Typhoon	Impact, death of staff
PHA-042	Maintenance	Impact,collision	Unauthorised non ETCS train movement in Depot/Stabling yard and in mainline	-Deliberate act, human error, train brake failure	Collision, Impact, Injuries, deraillment
PHA-043	Normal	Bicutan station Hazards	Unintended train movement due to presence of 2 different E&M systems & RS in a section	-Inadequate ETCS - CBTC compatibility or synchronization with OCC - Incorrect Switchover function of signaling system - Human error and improper application of recovery procedures if the system becomes unavailable. - Mismatch in Track alignment - Miscommunication between MMSP Operator and NSCR Operator - Driver error	-Collision between trains, -derailment, -Multiple possible death, -Operation shutdown,
PHA-044	Normal	DERAILMENT / OVERTURN	Train gauge interface issue	-Fault in Trackway, -Inadequate Vibration and Structure study	Derailment, Multiple possible death
PHA-045	Normal	DERAILMENT / OVERTURN	Wheel- rail interface issue	-Wheel profile mismatch, Wear of track	Derailment, Multiple possible death

Hazard Id	Mode	Category	Hazard description	Causes	Consequences
PHA-046	Normal	Derailment,Collision,Impact	Unauthorised person in control of train (In driver cab OR in OCC room)	-Lack of supervision	Loss of train control, serious injuries/death due to derailment or collision
PHA-047	Normal	Electrical,Trip/fall	Dangerous touch potential between equipment and structures (passengers and maintenance staff)	-Failure to isolate electrical fault / damaged insulation, -Electrical equipment abnormally accessible or Maintenance error (Maintenance actions undertaken while equipment is in powered state)	Electrocution or charging of a person, Single fatalities and/or injuries
PHA-048	Normal	Environment	Explosion (air reservoir, pipes under pressure, catapult, ..)	-Fault in Electrical supply systems or HV equipments or Compressed Air Supply or Untimely HV powering on /catenary	Explosion might lead to Multiple possible death
PHA-049	Normal	Impact,collision	PSD structure infringes clearance envelope	-Incorrect installation/Maintenance of equipment, -Interfacing party (CIV) fail to comply with requirement.	Derailment, Collision between train and platform station
PHA-050	Normal	Impact,collision	Traction in the wrong side	-Failure on leader cabin selection circuit	Collision of a train with a person or an animate being, Single fatalities and/or injuries
PHA-051	Normal	Impact,collision	Train operating in excess of demanded speed	-Excessive speed on manual operation, -Failure on ATC/ETCS system, -Failure of speed sensor, -Loss of partial brake	Collision of a train in motion with a stopped or moving vehicle, Multiple possible death
PHA-052	Normal	Impact,collision	Untimely traction/movement during maintenance	-Traction inhibition failure, -Physical push to train or vehicle	Collision of a train in motion with a stopped or moving vehicle, Multiple possible death
PHA-053	Normal	Impact,collision	Failure of the emergency brakes	-Loss of emergency brake, -Mechanical failure on brake system	Collision of a train in motion with a stopped or moving vehicle or obstacle on the track, Multiple possible death
PHA-054	Normal	Impact,collision	Failure of the parking brakes to hold the rake under AW4 condition on critical gradients.	-Mechanical failure on parking brake system or Wrong installation	Collision of a train in motion with a stopped or moving vehicle or obstacle on the track, Multiple possible death
PHA-055	Normal	Impact,collision	No communication between OCC/passengers (PA/PIS)/driver cab	-Loss of communication	Collision of a train in motion with a still obstacle on the track Multiple possible death
PHA-056	Normal	Impact,collision	No external identification of the train (light and horn)	-Loss of External lightning	Collision of a train in motion with a still obstacle on the track, Multiple possible death
PHA-057	Normal	Impact,collision	Train rolls back or moves in an un-commanded direction	-Failure of brake system, -Failure on leader cabin selection circuit	Trap of a person on the track, Single fatalities and/or injuries

Hazard Id	Mode	Category	Hazard description	Causes	Consequences
PHA-058	Normal	Impact,collision	Mechanical failure of the couplers or gangway between cars of a train	-Mechanical failure of coupler	Collision with uncoupled train, derailment, Multiple possible death
PHA-059	Normal	Impact,trip/fall,Derailment,Collision	System does not detect train driving mode selector	-Mode selector position failure or incorrect maintenance.	Unauthorised train movement, Collision, derailment
PHA-060	Normal	Impact,trip/fall,Derailment,Collision	Train travels in the opposite direction	-Drivers not trained (start in the wrong direction), -Unauthorised train movement, -Deliberate act, -Failure of travel direction control	Collision with the following trains, severe injuries due to impact
PHA-061	Normal	Impact,trip/fall,Electrical	Unauthorised person in depot area or stabling yard	-Deliberate act by tresspasser, -Staff fail to ensure train is empty of passengers prior going to Depot.	Electrocution, trip/fall, Impact with train and road vehicles
PHA-062	Normal	Trip/fall	Traction with opened door(s)	-Traction inhibition failure	Single fatalities and/or injuries
PHA-063	Normal	Trip/fall	Untimely opening of a lateral door when train is in movement	-Failure of Door Control Unit (DCU)	Multiple possible death
PHA-064	Normal	Trip/fall	Untimely detection of a door closed and locked	-Doors system failure	Single fatalities and/or injuries
PHA-065	Normal	Trip/fall,Electrical	Flooding of ground level structurers and tunnels	-Stations building and depot levels flooded in extreme event	Electrocution, trip/fall Operation shut down. Electrical and signalling equipment rooms located at station ground floor.
PHA-066	Normal,Degraded	Collision	Train too close to other vehicle	-Train detection failure (trainside/wayside), -loss of train integrity, -Operator/Driver manual driving-Movement authority procedures error, -Incorrect Movement Authority provided by SIG, -Train overshoot (permissive working), -Braking failure.	Collision with other train
PHA-067	Normal,degraded	Derailment,Collision	Unsafe route set	-Incorrect switch status (Point machine) sent to SIG , -incorrect maintenance of switch machines, -wrong route setting by operator (locally or remotely)	Conflicting movement of trains which lead to collision with another train, derailment, train moved to de-energised section or to working zone. Multiple fatalities
PHA-068	Normal,degraded	Derailment,Collision	Parts on the train get detached.	-Tain construction failure or incorrect maintenance, -Wrong installation	derailment, collision between the object and coming train, person struck by the object
PHA-069	Normal,degraded	Electrical,Trip/fall	Train authorises doors opening when the train is not in the correct stopping position	-Spurious opening of train doors	Passenger falls from train on station track, Electrocution

APPENDIX G - Preliminary Hazard Analysis (PHA)

Hazard Id	Mode	Category	Hazard description	Causes	Consequences
PHA-070	Normal,degraded	Impact,collision	Undemanded train movement (in station during exchange)	-Traction inhibition failure, -Failure on leveling system, -failure on ATC system, -Mechanical wear	Collision of a train with a person or an animate being, Single fatalities and/or injuries
PHA-071	Normal,Degraded,Emergency	Impact,Trip/fall	Train moves during passenger exchange	-Wrong Departure Authorisation / Command, -Door Status Failures, -Propulsion/Brake failure/Incorrect maintenance, -driver mistake.	Fall of person, Trapping of person; Impact on person (object striking person)
PHA-072	Normal,Degraded,Emergency	Impact,Trip/fall	Person entrapped between train and platform or between the doors	-Overcrowded situation in platform and train, -Passengers risky behaviour, unconsciousness (children, elder people...), -Excessive gap between train and PSD, -Untimely train and platform doors closing, -Train and platform doors close simultaneously	Trap of person,death of passengers.
PHA-073	Normal,Degraded,Emergency	Trip/fall	Excessive gap between train and platform	-Train out of gauge and platfom structure damage	Fall of passengers in the gap,injuries,death
PHA-074	Normal,Emergency,Degraded	Collision,Derailment	Train over speed	-Speed Measurement failure, -wrong brake command (Train fails to brake or braking rate insufficient), -untimely acceleration / propulsion command error, -Failed or incorrect communication of speed restriction, -Insufficient deceleration due to impurties (rain, leaves, greasy material..) on guidway, -Insufficient deceleration due to wheel-track interface failure (incorrect design), -Driver not trained and not qualified.	Derailment, Collision, Multiple fatalities
PHA-075	Normal,Maintenance, Degraded	Derailment,Collision	Train infringes clearance envelope on guidway	-RS Maintenance vehicles failure; -Clearance envelope underdimensioned; -Incorrect maintenance of vehicle structure; -Excessive wind, pressure by passing train, air draught in tunnel, Track wear	Derailment, Collision, Multiple fatalities
PHA-076	Normal,Maintenance, Degraded	Electrical	Dangerous touch potential between equipment and structures	-Failure to isolate electrical fault / damaged insulation, -Electrical equipment abnormally accessible or Maintenance error (Maintenance actions undertaken while equipment is in powered state)	Electrocution, Electrical shock

Hazard Id	Mode	Category	Hazard description	Causes	Consequences
PHA-077	Normal,Maintenance, Degraded	Environment	Stray current on external utilities	-Excess of stray current on metallic pipes and cables may cause corrosion and at a lesser extent induced voltage.	Breakage of pipes and spillage, possible pollution, loss of property, fire, explosion. Corrosion of cable shield and terminals, short circuit, power outage.
PHA-078	Normal,Maintenance, Degraded	Environment	Electromagnetic emissions on wayside cables, external radio systems	-Induction caused by traction circuit,Induction caused by external power lines (radars, TV/radio transmitters).	Excess voltage across metallic parts and conductors, electrocution, interference to connected equipment
PHA-079	Normal,maintenance,emergency,degraded	Derailment,collision	Obstruction on track	-Tools and equipments left by maintenance, fallen objects (crane, tree, branches, stones, mud ...); -Tunnel structural fault/ collapse; -Objects thrown from station,flooding, wind.	Derailment, Collision
PHA-080	Normal, Degraded	Derailment,collision	Track structural failure	-Faulty design of guideway or incorrect maintenance, -incorrect installation of track, -earthquake, -excessive vibrations generated by RS, -Wrong interface with CIV	Derailment, Collision
PHA-081	Normal, Degraded	Collision	System fails to provide sufficient spacing between trains and infrastructure	-Driver manual driving-Movement authority procedures error, -Incorrect Movement Authority provided by SIG, RS brake system failure	Derailment, Collision
PHA-082	Normal, Degraded	Fire	Presence of ignition source on Transformer Substation (TSS) or Power Transformers	-Insulation fault/Short circuit /Flammable materials in TSS, -incorrect maintenance of equipment, -Geographic locations and proximity to civil structures, buildings, dwellings, storage areas, etc. -use of flammable materials by maintenance staff.	asphyxiation, Passengers exposed to fire and smoke

APPENDIX 7- OUTLINE INTERFACE MATRICES

ANNEX 1 – Civil Packages N-01 to N-05

ANNEX 2 – Civil Packages S-01 to S-07

ANNEX 3 – Civil Package CP05

ANNEX 4 – Civil Packages CP01 and CP02

ANNEX 1 – Civil Packages N-01 to N-05

A1. Substation System (SS-1 to SS-22) and Battery Post (BP-1 to BP-4)

A1.1. Substation & Battery Post (BP) Space and Building, Station, and Depot

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of penetrations with sleeves, troughs, and pipes	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree on the size and location of the penetrations.
2	Cast-in sockets (or inserts) including bolts, nuts, and washers, packing and shims	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall coordinate and agree on the size and location. CP NS-01 Contractor shall supply all necessary materials
3	Drilling for cable and pipe supports and/or equipment fixings.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree on the location, bolts size, and drilling method. CP NS-01 Contractor shall ensure that type of boll supplied matches the fixing provisions and that adequate construction tolerance are allowed between the fixing and the mounting slots of the brackets.
4	Openings in ceiling panels & access panels for CP NS-01's equipment	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree on the size and location. Supporting fixtures for CP NS-01's equipment shall be supplied and installed by CP NS-01.
5	Concrete plinths of CP NS-01 Equipment	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05	CP N-01, 02, 03, 04, 05	CP N-01, 02, 03, 04 05, and NS-01 Contractors shall coordinate for the design and agree on the size and locations of the concrete plinths.
6	Leakage water for CP NS-01 protection from ceiling of SER, SUR, COM AFC, etc.	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04 and 05	CP N-01, 02, 03, 04 and 05	CP NS-01 Contractor shall provide the space and access route and other requirements for and Leakage water treatment. CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall coordinate for the design and agree on the space and access provision, and cavity walls.
7	Lifting points (eye-bolts or similar) for CP NS-01's equipment installation / replacement	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree on the size and location.
8	The foundation of CP NS-01 equipment's in SER, SUR, COM, AFC, etc.	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and 05	CP N-01, 02, 03, 04 and 05	CP N-01, 02, 03, 04 05, and NS-01 Contractor shall coordinate and agree on the size and location.

A2. Power Distribution System

A2.1. Viaduct

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Cast-in sockets (or structural inserts), cast-in bolts, or blind holes in viaducts for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractor shall coordinate and agree on the size and location. Special kinds of sockets or fittings that be supplied by CP NS-01 Contractor. CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the breakers.
2	Supporting structures for power, telecom, and signalling cable for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the supporting structure.
3	Drilling for cable and pipe supports and/or equipment fixings.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the location, bolts size, and drilling method. CP NS-01 Contractor shall ensure that type of boll supplied matches the fixing provisions and that adequate construction tolerance are allowed between the fixing and the mounting slots of the brackets.
4	Cable recess and pipes either across-track or parallel to track, beneath track bed concrete for all trackway. (withdraw wires if necessary). And removal or hinged covers for the above-mentioned items	CPNS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree and on the size and location. CP NS-01 Contractor shall provide draw wires. CP N-01, 02, 03, 04, and NS-01 Contractor shall protect the water ingress.

A2. Power Distribution System

A2.2. Station and Depot

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of Penetrations with sleeves, troughs, and pipes	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree on the size and location of the penetrations.
2	Cast-in sockets (or inserts) including bolts, nuts, and washers, packing and shims	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall coordinate and agree on the size and location CP NS-01. The contractor shall supply all necessary materials.
3	Drilling for anchors	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP NS-01 Contractor shall coordinate with CP N-01, 02, 03, 04, and 05 Contractor on the location, size, and drilling method.
4	Openings in ceiling panels & access panels for all CP NS-01's equipment where required.	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree on the size and location. Supporting fixtures for CP NS-01's equipment shall be supplied and installed by CP NS-01.
5	Concrete plinths of CP NS-01 equipment.	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05	CP N-01, 02, 03, 04, 05	CP N-01, 02, 03, 04 05, and NS-01 Contractors shall coordinate for the design and agree on the size and locations of the concrete plinths.
6	The foundation of CP NS-01 equipment's in SER, SUR COM AFC and like	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and 05	CP N-01, 02, 03, 04 and 05	CP N-01, 02, 03, 04 05, and NS-01 Contractors shall coordinate and agree on the size, weight, and location.
7	Lifting points (eye-bolts or similar) for CP NS-01's equipment installation/replacement	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree on the size and location.
8	Oil fence around fuel tank, oil transformers, oil collecting pit, inspection cover, and associated drain pipe.	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the size and location.

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
9	Leakage water for CP NS-01 protection from ceiling of SER, SUR, COM AFC, etc.	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04 and 05	CP N-01, 02, 03, 04 and 05	CP NS-01 Contractor shall provide the space and access route and other requirements for and leakage water treatment. CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall coordinate for the design and agree on the space and access provision, and cavity walls.
10	Cable recess, trough, and pipes either across-track or parallel to track, beneath track bed concrete for all trackway. (withdraw wires if necessary). And removal or hinged covers for the above-mentioned items	CP NS-01	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree and on the size and location. CP NS-01 Contractor shall provide draw wires. CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall protect the water ingress.
11	Cable recess, troughs, and pipes either across road or parallel to road, beneath road pavement concrete for all roadway. (withdraw wires if necessary). And removal or hinged covers for the above-mentioned items	CP NS-01	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree and on the size and location. CP NS-01 Contractor shall provide draw wires. CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall protect the water ingress.

A3. Overhead Contact System

A3.1. Viaduct

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Cast-in sockets, cast-in bolts, or blind holes in viaducts for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractor shall coordinate and agree on the size and location. Sockets that be supplied by CP NS-01 Contractor. CP N-01, 02, 03, 04, and NS-01 Contractor shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the breakers.
2	Supporting structures for power, telecom, and signalling cable for CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the supporting structure.
3	Cable recess and pipes either across-track or parallel to track, beneath track bed concrete for all trackway. (withdraw wires if necessary). And removal or hinged covers for the above-mentioned items	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the size and location. CP NS-01 Contractor shall provide the draw wires. CP N-01, 02, 03, and 04 Contractors shall protect the water ingress.

A3. Overhead Contact System

A.3.2 Station and Depot

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of Penetrations with sleeves, troughs, and pipes	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01, Contractors shall coordinate and agree on the size and location of the penetrations.
2	Cast-in sockets (or inserts) including bolts, nuts, and washers, packing and shims	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree on the size and location. CP NS-01 Contractor shall supply all necessary materials and templates.
3	Special structural supports for anchors in station structural frames	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03 and 04	CP NS-01 Contractor shall coordinate with CP N-01, 02, 03, and 04 Contractors on the location, size, weight, and fixing method.
4	Earthing or grounding devices and wiring for arrester and grounding wire of OCS in station and Depot (if necessary) system	CP NS-01	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 05, and NS-01 Contractor shall coordinate and agree on the size and location. CP-NS-01 Contractors shall supply the earthing devices for the station and depot.
5	Cable recess, trough, and pipes either across-track or parallel to track, beneath track bed concrete for all trackway. (withdraw wires if necessary). And removal or hinged covers for the above-mentioned items	CP NS-01	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree and on the size and location. CP NS-01 Contractor shall provide draw wires. CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall protect the water ingress.
6	Cable recess, troughs, and pipes either across road or parallel to road, beneath road pavement concrete for all roadway. (withdraw wires if necessary). And removal or hinged covers for the above-mentioned items	CP NS-01	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree and on the size and location. CP NS-01 Contractor shall provide draw wires. CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall protect the water ingress.

A4. Signalling System (SER, SUR, CER, CUR, CCR), Communication System (COM) and Automatic Fare Collection System (AFC)

A.4.1 Viaduct

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Cast-in sockets, cast-in bolts, or blind holes in viaducts for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractor shall coordinate and agree on the size and location. Sockets that be supplied by CP NS-01 Contractor. CP N-01, 02, 03, 04, and NS-01 Contractor shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the breakers.
2	Supporting structures for power, communication, and signalling cable for in both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP N-01,02, 03, 04, and NS-01 Contractors shall coordinate and agree that adequate construction tolerance is allowed between fixing and mounting slots of the supporting structure.
3	Drilling for cable and pipe supports and/or equipment fixings	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the location, bolts size, and drilling method. CP NS-01 Contractor shall ensure that type of bolt supplied matches the fixing provisions and that adequate construction tolerance are allowed between the fixing and the mounting slots of the brackets.
4	Cable recess and pipes either across-track or parallel to track, beneath track bed concrete for all trackway. (withdraw wires if necessary). And removal or hinged covers for the above-mentioned items	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree and on the size and location. CP NS-01 Contractor shall provide draw wires. CP N-01, 02, 03, 04, and NS-01 Contractor shall protect the water ingress.

A4. Signalling System (SER, SUR, CER, CUR, CCR), Communication System (COM) and Automatic Fare Collection System (AFC)

A.4.2 Station and Depot

No.	Interface Item	Design Requirements	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of Penetrations with sleeves, troughs, and pipes	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree on the size and location.
2	Cast-in sockets, cast-in bolts, or blind holes in structural frame for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree on the size and location. Sockets that be supplied by CP NS-01 Contractor. CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the breakers.
3	Supporting structures for power, communication, and signalling cable in both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the supporting structure.
4	Drilling for cable and pipe supports and/or equipment fixings.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree on the location, bolts size, and drilling method. CP NS-01 Contractor shall ensure that type of boll supplied matches the fixing provisions and that adequate construction tolerance are allowed between the fixing and the mounting slots of the brackets.

No.	Interface Item	Design Requirements	Design	Material Supply	Fix or Construction	Remarks
5	Cable recess, troughs, and pipes either across-track or parallel to track, beneath track bed concrete for all trackway. (withdraw wires if necessary). And removal or hinged covers for the above-mentioned items	CP NS-01	CP NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate and agree and on the size and location. CP NS-01 Contractor shall provide draw wires. CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall protect the water ingress.
6	Leakage water protection from ceiling of SER. SUR, COM, AFC rooms, etc.	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04, 05 and/or NS-01	CP N-01, 02, 03, 04 and 05	CP N-01, 02, 03, 04 and 05	CP NS-01 Contractor shall provide the space and access route and other requirements for Leakage water treatment. CP N-01, 02, 03, 04, 05, and NS-01 Contractors shall coordinate for the design and agree on the space and access provision, and cavity walls.
7	The foundation of CP NS-01 equipment's in SER, COM, AFC rooms.	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and 05	CP N-01, 02, 03, 04 and 05	CP N-01, 02, 03, 04, 05, and NS-01 Contractor shall coordinate and agree on the size and location.

A5. Other Facilities in Depot

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of Penetrations with sleeves, troughs, and pipes	CP NS-01	CP NS-01	CP NS-01	CP N-05 and/or NS-01	CP N-05 and NS-01 Contractors shall coordinate and agree on the size and location.
2	Cast-in sockets, cast-in bolts, or blind holes in structural frame for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP N-05 and/or NS-01	CP N-05 and NS-01 Contractors shall coordinate and agree on the size and location. Sockets that be supplied by CP NS-01 Contractor. CP N-05 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the breakers.
3	Supporting structures for power, communication, and signalling cable in both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP N-05 and/or NS-01	CP N-05 and NS-01 Contractor shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP N-05 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the supporting structure.
4	Drilling for cable and pipe supports and/or equipment fixings.	CP NS-01	CP NS-01	CP NS-01	CP N-05 and/or NS-01	CP N-05 and NS-01 Contractors shall coordinate and agree on the location, bolts size, and drilling method. CP NS-01 Contractor shall ensure that type of boll supplied matches the fixing provisions and that adequate construction tolerance are allowed between the fixing and the mounting slots of the brackets.
5	Opening for duct of equipment	CP NS-01	CP NS-01	CP N-05 and/or NS-01	CP N-05 and/or NS-01	CP N-05 Contractor shall coordinate to design the size of the opening based on equipment provided by CP NS-01 Contractor

A6. Automatic Fare Collection System

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of Penetrations with sleeves	CP NS-01	CP NS-01	CP N-01, 02, 03 and 04	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01, Contractors shall coordinate and agree on the size and location.
2	Box outs – full or part depth.	CP NS-01	CP NS-01	CP N-01, 02, 03 and 04	CP N-01, 02, 03 and 04	CP N-01, 02, 03, 04, and NS-01, Contractors shall coordinate and agree on the size and location.
3	Recesses and trenches formed in screed or finishes for CP NS-01 services.	CP NS-01	CP NS-01	CP N-01, 02, 03 and 04	CP N-01, 02, 03 and 04	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the size and location. CP N-01, 02, 03, and 04 Contractors shall provide adequate thickness of screed or finishes. CP N-01, 02, 03 and 04 Contractors shall provide the removable or hinged covers and frames (where required) in finishes over recesses and trenches.
4	Cable pipes, ducts, etc. (including draw wires) embedded into concrete or screed, buried in earth, pavement, and road. Pulling chambers (where required) with covers.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the size and location. CP N-01, 02, 03, and 04 Contractors shall ensure the cable pipes, ducts, etc. which are protected from ingress of water The pulling chambers shall be provided with drainage.
5	Cast-in sockets including bolts, nuts, and washers, packings and shims	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the size and location. CP NS-01 Contractor shall supply all necessary materials and templates.
6	Drilling for anchors	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP NS-01 Contractor shall coordinate with CP N-01, 02, 03, and 04 Contractors on the location, size, and drilling method.

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
7	Conduits, (pull, junction, and/or surface) boxes, sheet metal trunking, and ducting, which are cast into concrete and including draw wires.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03 and 04	CP N-01, 02, 03, 04, and NS-01 Contractor shall coordinate and agree on the size and location. CP N-01, 02, 03, and 04 Contractor shall execute that the finishing work of the infilling gap between a wall and a box/conduit which is scheduled to install at the wall in advance. The protection of all ends and joints shall be executed by CP N-01, 02, 03, 04, and 05 Contractor. The conduits shall be assembled by CP NS-01 Contractor. Fixing of conduits to the re-bar shall be executed by CP N-01, 02, 03, 04, and 05 Contractors under CP NS-01 Contractor's supervision. CP N-01, 02, 03, 04, and NS-01 Contractors shall implement jointly an inspection before casting.

A.7 Platform Screen Doors

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
	Drilling for fixing base plates of PSD	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the location, bolts size, and drilling method. CP NS-01 Contractor shall ensure that type of boll supplied matches the fixing provisions and that adequate construction tolerance are allowed between the fixing and the mounting slots.
	Recesses and trenches formed in screed or finishes for CP NS-01 services.	CP NS-01	CP NS-01	CP N-01, 02, 03 and 04	CP N-01, 02, 03 and 04	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the size and location. CP N-01, 02, 03, and 04 Contractors shall provide adequate thickness of screed or finishes. CP N-01, 02, 03 and 04 Contractors shall provide the removable or hinged covers and frames (where required) in finishes over recesses and trenches.
	Cast-in sockets including bolts, nuts, and washers, packings and shims	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03, 04 and/or NS-01	CP N-01, 02, 03, 04, and NS-01 Contractors shall coordinate and agree on the size and location. CP NS-01 Contractor shall supply all necessary materials and templates.
	Conduits, (pull, junction, and/or surface) boxes, sheet metal trunking, and ducting, which are cast into concrete and including draw wires.	CP NS-01	CP NS-01	CP NS-01	CP N-01, 02, 03 and 04	CP N-01, 02, 03, 04, and NS-01 Contractor shall coordinate and agree on the size and location. CP N-01, 02, 03, and 04 Contractor shall execute that the finishing work of the infilling gap between a wall and a box/conduit which is scheduled to install at the wall in advance. The protection of all ends and joints shall be executed by CP N-01, 02, 03, and 04 Contractor. The conduits shall be assembled by CP NS-01 Contractor. Fixing of conduits to the re-bar shall be executed by CP N-01, 02, 03, and 04 Contractors under CP NS-01 Contractor's supervision. CP N-01, 02, 03, 04, and NS-01 Contractors shall implement jointly an inspection before casting.

ANNEX 2 – Civil Packages S-01 to S-07

A1 Substation System (S1, SS-1 to SS-18)

A1.1 Substation Space and Building, Station and Depot

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of penetrations with sleeves, troughs, and pipes	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location of the penetrations
2	Cast-in sockets (or inserts) including bolts, nuts, and washers, packing and shims	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. CP NS-01 Contractor shall supply all necessary materials
3	Drilling for cable and pipe supports and/or equipment fixings	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the location, bolts size, and drilling method. CP NS-01 Contractor shall ensure that type of bolt supplied matches the fixing provisions and that adequate construction tolerances are allowed between the fixing and mounting slots of the brackets.
4	Openings in ceiling panels & access panels for CP NS-01's equipment	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the location. Supporting fixtures for CP NS-01's equipment shall be supplied and installed by CP NS-01.
5	Concrete plinths of CP NS-01 Equipment	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate for the design and agree on the size and locations of the concrete plinths.
6	Leakage water for CP NS-01 protection from ceiling of SER, SUR, COM, AFC, etc.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP NS-01 Contractor shall provide the space and access route and other requirements for and Leakage water treatment. CP S-01 to S-07 and NS-01 Contractors shall coordinate for the design and agree on the space and access provision, and cavity walls.
7	Lifting points (eye-bolts or similar) for CP NS-01's equipment installation / replacement	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate for the design and agree on the size and location.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
8	The foundations of CP NS-01 equipment in SER, SUR, COM, AFC, etc.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate for the design and agree on the size and location

A2 Power Distribution System

A2.1 Viaduct, U-shaped Ground Structure, and Transitions

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Cast-in sockets (or structural inserts), cast-in bolts, or blind holes in viaducts for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. Special kinds of sockets or fittings that shall be supplied by CP NS-01 Contractor. CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the brackets.
2	Supporting structures for power, telecom, and signaling cable for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP S-01 to S-07 and NS-01 Contractor shall coordinate and agree adequate construction tolerances to be allowed between the fixing and the mounting slots of the supporting structure.
3	Drilling for cable and pipe supports and/or equipment fixings.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the locations, bolts sizes, and drilling method. CP NS-01 Contractor shall ensure that type of bolts supplied to match the fixing provisions and that adequate construction tolerances are allowed between the fixing and the mounting slots of the brackets.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
4	Cable recesses and pipes either across-track or parallel to track, beneath track bed concrete for all trackway, (withdraw wires if necessary), and removable or hinged covers for the mentioned above items.	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 Contractor shall provide draw wires. CP S-01 to S-07 shall ensure that the structures containing electrical equipment are watertight and shall undertake tests to prove that as directed by the Engineer.

A2.2 Station, Substations, and Depot

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Locations and sizes of Penetrations with sleeves	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the sizes and locations of the penetrations.
2	Cast-in sockets (or inserts) including bolts, nuts, and washers, packing and shims	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. CP NS-01 Contractor shall supply all necessary materials.
3	Drilling for anchors	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07	CP NS-01 Contractor shall coordinate with CP S-01 to S-07 Contractors on the locations, sizes, and drilling methods.
4	Openings in ceiling panels & access panels for all CP NS-01's equipment where required.	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. Supporting fixtures for CP NS-01's equipment shall be supplied and installed by CP NS-01.
5	Concrete plinths of CP NS-01 Equipment.	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07	CP S-01 TO S-07 and NS-01 Contractors shall coordinate for the design and agree on the size and locations of the concrete plinths.
6	Foundation for CP NS-01's equipment in SER, SUR COM AFC and like	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate for the design and agree on the sizes, weights, and locations.
7	Lifting points (eye-bolts or similar) for CP NS-01's equipment installation / replacement	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the sizes and locations.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
8	Oil bunds around fuel tanks, oil transformers, oil collecting pit, inspection covers, and associated drain pipes.	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the sizes and locations.
9	Protection against water ingress from/through ceiling of SER, SUR, COM, AFC, etc. for CP NS-01 equipment	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07	CP NS-01 Contractor shall provide the space and access route and other requirements for any equipment shielding to protect against water ingress through ceiling. CP S-01 to S-07 and NS-01 Contractors shall coordinate for the design and agree on the sizes and locations and any cavity walls.
10	Cable recesses, troughs, and pipes either across-track or parallel to track, beneath track bed concrete for all trackway, (withdraw wires if necessary), and removable or hinged covers for the mentioned above items.	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 Contractor shall provide draw wires. CP S-01 to S-07 and NS-01 Contractors shall protect against water ingress.
11	Cable recesses, troughs and pipes either across road or parallel to road, beneath track road pavement concrete for all roadway, (withdraw wires if necessary), and removable or hinged covers for the mentioned above items.	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 Contractor shall provide draw wires. CP S-01 to S-07 and NS-01 Contractors shall protect against water ingress.
12	Earthing and grounding system	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. NS-01 Contractor shall supply the earthing devices for station & depot.

A3 Overhead Contact System

A3.1 Viaduct, U-shaped Ground Structure, and Transitions

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Cast-in sockets, cast-in bolts, or blind holes in viaducts/structures for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. Sockets that be supplied by CP NS-01 Contractor. CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the breakers.
2	Supporting structures for power, telecom, and signaling cable for CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the supporting structure.
3	Cable recesses, troughs, and pipes either across-track or parallel to track, beneath track bed concrete for all trackway, (withdraw wires if necessary), and removable or hinged covers for the mentioned above items.	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 Contractor shall provide draw wires. CP S-01 to S-07 and NS-01 Contractors shall protect against water ingress.

A.3.2 Station, Substations and Depot

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of Penetrations with sleeves	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location of the penetrations.
2	Cast-in sockets (or inserts) including bolts, nuts, and washers, packing and shims	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. CP NS-01 Contractor shall supply all necessary materials and templates.
3	Special structural supports for anchors to station structural frames	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07	CP NS-01 Contractor shall coordinate with CP S-01 to S-07 Contractor on the location, size, weight, and fixing method and supply brackets that fix to the existing station frames, i.e., no provision made within the station frames for bracket fixing.
4	Earthing or grounding devices and wiring for arrester and grounding wire of OCS in station and Depot (if necessary) system	CP NS-01	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. The grounding provided by CP S-01 to S-07 will be via the reinforcement in the structure and piles, welded connections where required, and the provision of attachment points for the grounding system. The main room earth bars connected to the station earth will be provided and installed by S-01 to S-07 Contractors but checked by NS-01 Contractors. CP NS-01 Contractor shall supply the earthing devices for station and depot. NS-01 will provide surge arrestors and copper tapes etc. to connect to the earthing points provided by CP S-01 to S-07 Contractors.

A4 Signaling System (SER, SUR, CER, CUR, CCR), Communication System (COM) and Automatic Fare Collection System (AFC)

A.4.1 Viaduct, U-shaped Ground Structures, and Transitions

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Cast-in sockets, cast-in bolts, or blind holes in viaducts/structures for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. Sockets shall be supplied by CP NS-01 Contractor. CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree adequate construction tolerances are allowed between the fixing and the mounting slots of the brackets.
2	Supporting structures for power, communication, and signaling cable for in both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree that adequate construction tolerance is allowed between fixing and mounting slots of the supporting structure.
3	Drilling for cable and pipe supports and/or equipment fixings	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the locations, bolts sizes, and drilling methods. CP NS-01 Contractor shall ensure that type of bolt supplied matches the fixing provisions and that adequate construction tolerance are allowed between the fixing and the mounting slots of the brackets.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
4	Cable recess and pipes either across-track or parallel to track, beneath track bed concrete for all trackway. (withdraw wires if necessary). And removal or hinged covers for the mentioned above items	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 Contractor shall provide draw wires. CP S-01 to S-07 and NS-01 Contractors shall protect against water ingress.

A.4.2 Station

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of Penetrations with sleeves	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-06 and/or NS-01	CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree on the size and location of the penetrations
2	Cast-in sockets, cast-in bolts, or blind holes in structural frame for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-06 and/or NS-01	CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree on the size and location Sockets that be supplied by CP NS-01 Contractor. CP S-01 to S-07 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the brackets.
3	Supporting structures for power, communication, and signaling cable in both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-06	CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the supporting structure.
4	Drilling for cable and pipe supports and/or equipment fixings.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-06 and/or NS-01	CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree on the locations, bolts sizes, and drilling methods. CP NS-01 Contractor shall ensure that type of bolt supplied matches the fixing provisions and that adequate construction tolerance are allowed between the fixing and the mounting slots of the brackets.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
5	Cable recess and pipes either across-track or parallel to track, beneath track bed concrete for all trackway. (withdraw wires if necessary). And removal or hinged covers for the mentioned above items	CP NS-01	CP NS-01	CP S-01 to S-06 and/or NS-01	CP S-01 to S-06	CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 Contractor shall provide draw wires. CP S-01 to S-06 and NS-01 Contractors shall protect against water ingress.
6	Protection against water ingress from/through ceiling of SER, SUR, COM, AFC, etc. for CP NS-01 equipment	CP NS-01	CP NS-01	CP S-01 to S-06	CP S-01 to S-06	CP NS-01 Contractor shall provide the space and access route and other requirements for any equipment shielding to protect against water ingress through ceiling. CP S-01 to S-06 and NS-01 Contractors shall coordinate for the design and agree on the sizes and locations and any cavity walls.
7	Foundation for CP NS-01's equipment in SER, SUR COM AFC and like	CP NS-01	CP NS-01	CP S-01 to S-06 and/or NS-01	CP S-01 to S-06 and/or NS-01	CP S-01 to S-06 and NS-01 Contractors shall coordinate for the design and agree on the sizes, weights, and locations.

A5 Electrical and Mechanical Facilities in Station and Depot

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Openings for equipment ducts	CP NS-01	CP NS-01	CP S-01 to S-07 and/or NS-01	CP S-01 to S-07	CP S-01 to S-07 Contractor shall coordinate to design the size of the openings based on equipment provided by CP NS-01 Contractor

A6 Automatic Fare Collection System

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of Penetrations with sleeves	CP NS-01	CP NS-01	CP S-01 to S-06	CP S-01 to S-06	CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree on the sizes and locations.
2	Box outs – full or part depth.	CP NS-01	CP NS-01	CP S-01 to S-06	CP S-01 to S-06	CP S-01 to S-06 and NS-01, Contractors shall coordinate and agree on the sizes and locations.
3	Recesses and trenches formed in screed or finishes for CP NS-01 services.	CP NS-01	CP NS-01	CP S-01 to S-06	CP S-01 to S-06	CP S-01 TO S-06 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP S-01 TO S-06 Contractor shall provide adequate thickness of screed or finishes. CP S-01 TO S-06 Contractor shall provide the removable or hinged covers and frames (where required) in finishes over recesses and trenches.
4	Cable, pipes, ducts, etc. (including draw wires) embedded into concrete or screed, buried in earth, pavement, and road, pulling chambers (where required) with covers.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-06	CP S-01 TO S-06 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP S-01 TO S-06 Contractor shall ensure the cable, pipes, ducts, etc. are protected from ingress of water, and pulling chambers shall be provided with drainage and lockable covers.
5	Cast-in sockets including bolts, nuts, and washers, packing, and shims.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-06 and/or NS-01	CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 shall supply all necessary materials and templates.
6	Drilling for anchors	CP NS-01	CP NS-01	CP S-01 to S-06 and/or NS-01	CP S-01 to S-06 and/or NS-01	CP NS-01 Contractor shall coordinate with CP S-01 to S-06 Contractors on the locations, sizes, and drilling methods.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
7	Conduits (pull, junction and/or surface boxes, sheet metal trunking and ducting which are cast into concrete including provision of draw wires.	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-06 and/or NS-01	CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP S-01 to S-06 Contractors shall execute finishing works including gap filling for recessed / surface mounted boxes/conduits which are installed in advance of the finishing works. CP S-01 to S-06 Contractors shall protect all ends and joints or conduits and boxes. The conduits and boxes shall be supplied and installed by the CP NS-01 Contractor. Providing electrical continuity between conduit and rebar shall be done by CP S-01 to S-06 Contractors under the supervision of CP NS-01 Contractor. All electrical continuity between conduit and rebar shall be inspected and tested jointly by CP S-01 to S-06 and NS-01 Contractors before casting and confirmed after casting.

A7 PSD's

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Drilling for fixing base plates of PSD	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-06 and/or NS-01	CP NS-01 Contractor shall coordinate with CP S-01 to S-06 Contractors on the locations, bolt sizes, and drilling methods. CP NS-01 Contractor shall ensure that type of bolts supplied match the fixing provisions and that adequate construction tolerances are allowed between the fixings and the mounting slots.
2	Recesses and trenches formed in screed or finishes for CP NS-01 services	CP NS-01	CP NS-01	CP S-01 to S-06	CP S-01 to S-06	CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP S-01 to S-06 Contractors shall provide adequate thicknesses of screed and finishes. CP S-01 to S-06 Contractors shall provide the removable or hinged covers and frames (where required) in finishes over recesses and trenches.
3	Cast-in sockets including bolts, nuts, and washers, packing and shims	CP NS-01	CP NS-01	CP NS-01	CP S-01 to S-06 and/or NS-01	CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 shall supply all necessary materials and templates.
4	Conduits, (pull, junction, and/or surface) boxes, sheet metal trunking, and ducting, which are cast into concrete and including draw wires.	CP NS-01	CP NS-01	CP S-01 to S-06	CP S-01 to S-06	CP S-01 to S-06 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP S-01 to S-06 Contractors shall execute finishing works including gap filling for recessed / surface mounted boxes/conduits which are installed in advance of the finishing works. CP S-01 to S-06 Contractors shall protect all ends and joints or conduits and boxes.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
						The conduits and boxes shall be supplied and installed by the CP NS-01 Contractor. Providing electrical continuity between conduit and rebar shall be done by CP S-01 to S-06 Contractors under the supervision of CP NS-01 Contractor. All electrical continuity between conduit and rebar shall be inspected and tested jointly by CP S-01 to S-06 and NS-01 Contractors before casting and confirmed after casting.

ANNEX 3 – Civil Package CP05

A1 Substation System (TSS1)

A1.1 Substation Space and Building, Station

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of penetrations with sleeves, troughs, and pipes	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the size and location of the penetrations
2	Cast-in sockets (or inserts) including bolts, nuts, and washers, packing and shims	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. CP NS-01 Contractor shall supply all necessary materials
3	Drilling for cable and pipe supports and/or equipment fixings	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the location, bolts size, and drilling method. CP NS-01 Contractor shall ensure that type of bolt supplied matches the fixing provisions and that adequate construction tolerances are allowed between the fixing and mounting slots of the brackets.
4	Openings in ceiling panels & access panels for CP NS-01's equipment	CP NS-01	CP NS-01	CP NS-01	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the location. Supporting fixtures for CP NS-01's equipment shall be supplied and installed by CP NS-01.
5	Concrete plinths of CP NS-01 Equipment	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate for the design and agree on the size and locations of the concrete plinths.
6	Leakage water for CP NS-01 protection from ceiling of SER, SUR, COM, AFC, etc.	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and CP NS-01 Contractor shall provide the space and access route and other requirements for and Leakage water treatment. CP05 & NS-01 Contractors shall coordinate for the design and agree on the space and access provision, and cavity walls.
7	Lifting points (eye-bolts or similar) for CP NS-01's	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate for the design and agree on the size and location.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
	equipment installation / replacement					
8	The foundations of CP NS-01 equipment in SER, SUR, COM, AFC, etc.	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate for the design and agree on the size and location

*If NS-01 do not provide information timely then the installation work shall be undertaken by NS-01

A2 Power Distribution System

A2.1 Viaduct, U-shaped Ground Structure, and Transitions

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Cast-in sockets (or structural inserts), cast-in bolts, or blind holes in viaducts for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. Special kinds of sockets or fittings that shall be supplied by CP NS-01 Contractor. CP05 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the brackets.
2	Supporting structures for power, telecom, and signaling cable for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP05 and NS-01 Contractor shall coordinate and agree adequate construction tolerances to be allowed between the fixing and the mounting slots of the supporting structure.
3	Drilling for cable and pipe supports and/or equipment fixings.	CP NS-01	CP NS-01	CP NS-01	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the locations, bolts sizes, and drilling method. CP05 and CP NS-01 Contractor shall ensure that type of bolts supplied to match the fixing provisions and that adequate construction tolerances are allowed between the fixing and the mounting slots of the brackets.
4	Cable recesses and pipes either across-track or parallel to track, beneath track bed concrete for all trackway, (withdraw wires if necessary), and removable or hinged covers for the mentioned above items.	CP NS-01	CP NS-01	CP05	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP05 and CP NS-01 Contractor shall provide draw wires. CP05 shall ensure that the structures containing electrical equipment are watertight and shall undertake tests to prove that as directed by the Engineer.

A2.2 Station, Substations,

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Locations and sizes of Penetrations with sleeves	CP NS-01	CP NS-01	CP NS-01	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations of the penetrations.
2	Cast-in sockets (or inserts) including bolts, nuts, and washers, packing and shims	CP NS-01	CP NS-01	CP NS-01	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. CP NS-01 Contractor shall supply all necessary materials.
3	Drilling for anchors	CP NS-01	CP NS-01	CP NS-01	CP05	CP NS-01 Contractor shall coordinate with CP05 Contractor on the locations, sizes, and drilling methods.
4	Openings in ceiling panels & access panels for all CP NS-01's equipment where required.	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. Supporting fixtures for CP NS-01's equipment shall be supplied and installed by CP NS-01.
5	Concrete plinths of CP NS-01 Equipment.	CP NS-01	CP NS-01	CP05	CP05	CP05 and NS-01 Contractors shall coordinate for the design and agree on the size and locations of the concrete plinths.
6	Foundation for CP NS-01's equipment in SER, SUR COM AFC and like	CP NS-01	CP NS-01	CP05	CP05	CP05 and NS-01 Contractors shall coordinate for the design and agree on the sizes, weights, and locations.
7	Lifting points (eye-bolts or similar) for CP NS-01's equipment installation / replacement	CP NS-01	CP NS-01	CP NS-01	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations.
8	Oil bunds around fuel tanks, oil transformers, oil collecting pit, inspection covers, and associated drain pipes.	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
9	Protection against water ingress from/through ceiling of SER, SUR, COM, AFC, etc. for CP NS-01 equipment	CP NS-01	CP NS-01	CP05	CP05	CP NS-01 Contractor shall provide the space and access route and other requirements for any equipment shielding to protect against water ingress through ceiling. CP05 and NS-01 Contractors shall coordinate for the design and agree on the sizes and locations and any cavity walls.
10	Cable recesses, troughs, and pipes either across-track or parallel to track, beneath track bed concrete for all trackway, (withdraw wires if necessary), and removable or hinged covers for the mentioned above items.	CP NS-01	CP NS-01	CP05	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 Contractor shall provide draw wires. CP05 and NS-01 Contractors shall protect against water ingress.
11	Cable recesses, troughs and pipes either across road or parallel to road, beneath track road pavement concrete for all roadway, (withdraw wires if necessary), and removable or hinged covers for the mentioned above items.	CP NS-01	CP NS-01	CP05	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 Contractor shall provide draw wires. CP05 and NS-01 Contractors shall protect against water ingress.
12	Earthing and grounding system	CP NS-01	CP NS-01	CP NS-01	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. NS-01 Contractor shall supply the earthing devices for station & depot.

*If NS-01 do not provide information timely then the material and installation work shall be undertaken by NS-01

A3 Overhead Contact System

A3.1 Viaduct, U-shaped Ground Structure, and Transitions

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Cast-in sockets, cast-in bolts, or blind holes in viaducts/structures for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. Sockets that be supplied by CP NS-01 Contractor. CP05 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the breakers.
2	Supporting structures for power, telecom, and signaling cable for CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP05 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the supporting structure.
3	Cable recesses, troughs, and pipes either across-track or parallel to track, beneath track bed concrete for all trackway, (withdraw wires if necessary), and removable or hinged covers for the mentioned above items.	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 Contractor shall provide draw wires. CP05 and NS-01 Contractors shall protect against water ingress.

*If NS-01 do not provide information timely then the material and installation work shall be undertaken by NS-01

A.3.2 Station, Substations

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of Penetrations with sleeves	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the size and location of the penetrations.
2	Cast-in sockets (or inserts) including bolts, nuts, and washers, packing and shims	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. CP NS-01 Contractor shall supply all necessary materials and templates.
3	Special structural supports for anchors to station structural frames	CP NS-01	CP NS-01	CP NS-01	CP05	CP NS-01 Contractor shall coordinate with CP05 Contractor on the location, size, weight, and fixing method and supply brackets that fix to the existing station frames, i.e. no provision made within the station frames for bracket fixing.
4	Earthing or grounding devices and wiring for arrester and grounding wire of OCS in station (if necessary) system	CP NS-01	CP NS-01	CP NS-01	CP NS-01	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. The grounding provided by CP05 will be via the reinforcement in the structure and piles, welded connections where required, and the provision of attachment points for the grounding system. The main room earth bars connected to the station earth will be provided and installed by CP05 Contractor but checked by NS-01 Contractor. CP NS-01 Contractor shall supply the earthing devices for station and depot. NS-01 will provide surge arrestors and copper tapes etc. to connect to the earthing points provided by CP05 Contractor.

*If NS-01 do not provide information timely then the installation work shall be undertaken by NS-01

A4 Signaling System (SER, SUR, CER, CUR, CCR), Communication System (COM) and Automatic Fare Collection System (AFC)

A.4.1 Viaduct, U-shaped Ground Structures, and Transitions

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Cast-in sockets, cast-in bolts, or blind holes in viaducts/structures for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP05 or CPNS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. Sockets shall be supplied by CP NS-01 Contractor. CP05 and NS-01 Contractors shall coordinate and agree adequate construction tolerances are allowed between the fixing and the mounting slots of the brackets.
2	Supporting structures for power, communication, and signaling cable for in both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP05 or CPNS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP05 and NS-01 Contractors shall coordinate and agree that adequate construction tolerance is allowed between fixing and mounting slots of the supporting structure.
3	Drilling for cable and pipe supports and/or equipment fixings	CP NS-01	CP NS-01	CP NS-01	CP05 Or CPNS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the locations, bolts sizes, and drilling methods. CP NS-01 Contractor shall ensure that type of bolt supplied matches the fixing provisions and that adequate construction tolerance are allowed between the fixing and the mounting slots of the brackets.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
4	Cable recess and pipes either across-track or parallel to track, beneath track bed concrete for all trackway. (withdraw wires if necessary). And removal or hinged covers for the mentioned above items	CP NS-01	CP NS-01	CP05 or CP NS-01	CP05 or CPNS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 Contractor shall provide draw wires. CP05 and NS-01 Contractors shall protect against water ingress.

*If NS-01 do not provide information timely then the installation work shall be undertaken by NS-01

A.4.2 Station

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of Penetrations with sleeves	CP NS-01	CP NS-01	CP NS-01	CP05 or CP NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the size and location of the penetrations
2	Cast-in sockets, cast-in bolts, or blind holes in structural frame for both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP05 or CP NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the size and location Sockets that be supplied by CP NS-01 Contractor. CP05 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the brackets.
3	Supporting structures for power, communication, and signaling cable in both CP NS-01 temporary and CP NS-01 permanent services.	CP NS-01	CP NS-01	CP NS-01	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the size and location. The supporting structures shall be supplied by CP NS-01 Contractor. CP05 and NS-01 Contractors shall coordinate and agree that adequate construction tolerances are allowed between the fixing and the mounting slots of the supporting structure.
4	Drilling for cable and pipe supports and/or equipment fixings.	CP NS-01	CP NS-01	CP NS-01	CP05 or CP NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the locations, bolts sizes, and drilling methods. CP NS-01 Contractor shall ensure that type of bolt supplied matches the fixing provisions and that adequate construction tolerance are allowed between the fixing and the mounting slots of the brackets.
5	Cable recess and pipes either across-track or parallel to track, beneath track bed concrete for all	CP NS-01	CP NS-01	CP05 or NS-01*	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 Contractor shall provide draw wires.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
	trackway. (withdraw wires if necessary). And removal or hinged covers for the mentioned above items					CP05 and NS-01 Contractors shall protect against water ingress.
6	Protection against water ingress from/through ceiling of SER, SUR, COM, AFC, etc. for CP NS-01 equipment	CP NS-01	CP NS-01	CP05	CP05	CP NS-01 Contractor shall provide the space and access route and other requirements for any equipment shielding to protect against water ingress through ceiling. CP05 and NS-01 Contractors shall coordinate for the design and agree on the sizes and locations and any cavity walls.
7	Foundation for CP NS-01's equipment in SER, SUR COM AFC and like	CP NS-01	CP NS-01	CP05 or NS-01	CP05 or CP NS-01*	CP05 and NS-01 Contractors shall coordinate for the design and agree on the sizes, weights, and locations.

*If NS-01 do not provide information timely then the material and installation work shall be undertaken by NS-01

A5 Electrical and Mechanical Facilities in Station and Depot

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Openings for equipment ducts	CP NS-01	CP NS-01	CP05 or NS-01*	CP05	CP05 Contractor shall coordinate to design the size of the openings based on equipment provided by CP NS-01 Contractor

*If NS-01 do not provide information timely then the material shall be undertaken by NS-01

A6 Automatic Fare Collection System

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Location and size of Penetrations with sleeves	CP NS-01	CP NS-01	CP05	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations.
2	Box outs – full or part depth.	CP NS-01	CP NS-01	CP05	CP05	CP05 and NS-01, Contractors shall coordinate and agree on the sizes and locations.
3	Recesses and trenches formed in screed or finishes for CP NS-01 services.	CP NS-01	CP NS-01	CP05	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP05 Contractor shall provide adequate thickness of screed or finishes. CP05 Contractor shall provide the removable or hinged covers and frames (where required) in finishes over recesses and trenches.
4	Cable, pipes, ducts, etc. (including draw wires) embedded into concrete or screed, buried in earth, pavement, and road, pulling chambers (where required) with covers.	CP NS-01	CP NS-01	CP NS-01	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP05 Contractor shall ensure the cable, pipes, ducts, etc. are protected from ingress of water, and pulling chambers shall be provided with drainage and lockable covers.
5	Cast-in sockets including bolts, nuts, and washers, packing, and shims.	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 shall supply all necessary materials and templates.
6	Drilling for anchors	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 or NS-01*	CP NS-01 Contractor shall coordinate with CP05 Contractor on the locations, sizes, and drilling methods.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
7	Conduits (pull, junction and/or surface boxes, sheet metal trunking and ducting which are cast into concrete including provision of draw wires.	CP NS-01	CP NS-01	CP NS-01	CP05 or NS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP05 Contractor shall execute finishing works including gap filling for recessed / surface mounted boxes/conduits which are installed in advance of the finishing works. CP05 Contractor shall protect all ends and joints or conduits and boxes. The conduits and boxes shall be supplied and installed by the CP NS-01 Contractor. Providing electrical continuity between conduit and rebar shall be done by CP05 Contractor under the supervision of CP NS-01 Contractor. All electrical continuity between conduit and rebar shall be inspected and tested jointly by CP05 NS-01 Contractors before casting and confirmed after casting.

*If NS-01 do not provide information timely then the material and installation work shall be undertaken by NS-01

A7 PSD's

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Drilling for fixing base plates of PSD	CP NS-01	CP NS-01	CP NS-01	NS-01	CP NS-01 Contractor shall coordinate with CP05 Contractor on the locations, bolt sizes, and drilling methods. CP NS-01 Contractor shall ensure that type of bolts supplied match the fixing provisions and that adequate construction tolerances are allowed between the fixings and the mounting slots.
2	Recesses and trenches formed in screed or finishes for CP NS-01 services	CP NS-01	CP NS-01	CP05 or CPNS01*	CP05 or CPNS01*	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP05 Contractor shall provide adequate thicknesses of screed and finishes. CP05 Contractor shall provide the removable or hinged covers and frames (where required) in finishes over recesses and trenches.
3	Cast-in sockets including bolts, nuts, and washers, packing and shims	CP NS-01	CP NS-01	CP NS-01	CP05 or CPNS-01*	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP NS-01 shall supply all necessary materials and templates.
4	Conduits, (pull, junction, and/or surface) boxes, sheet metal trunking, cable tray, cable ladders and ducting, which are cast into concrete and including draw wires.	CP NS-01	CP NS-01	CP05 or CPNS01*	CP05 or CPNS01*	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. CP05 Contractor shall execute finishing works including gap filling for recessed / surface mounted boxes/conduits which are installed in advance of the finishing works. CP05 Contractor shall protect all ends and joints or conduits and boxes.

No	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
						The conduits and boxes shall be supplied and installed by the CP NS-01 Contractor. Providing electrical continuity between conduit and rebar shall be done by CP05 Contractor under the supervision of CP NS-01 Contractor. All electrical continuity between conduit and rebar shall be inspected and tested jointly by CP05 and NS-01 Contractors before casting and confirmed after casting.
6	Facilities in PSD room i.e earthing terminals, air conditioning ,lighting, fire protection, concrete plinth, floor and wall finishes,	CP NS-01	CP-05	CP-05	CP05	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations. Main earthing system and connection to earthing terminal for PSD room shall be provided by CP05 Contractor.
7	Power supply : The power supply shall be connected from the System Main Power Distribution Board	CP NS-01	CP NS-01	CP NS-01*, CP05	CP NS-01*, CP05	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations.
8	Insulation Membrane	CP NS-01	CP05	CP05	CP05	Membrane to be installed by CP01 and CP02. CP NS-01 to supervise and assist in the testing of the insulation of the platform floor insulation membrane installed by the civil contractor.

*If NS-01 do not provide information timely then the material and installation work shall be undertaken by NS-01

ANNEX 4 – Civil Packages CP01 and CP02

A.7 Platform Screen Doors

No.	Interface Item	Design Requirement	Design	Material Supply	Fix or Construction	Remarks
1	Drilling for fixing base plates of PSD	CP NS-01	CP NS-01	CP NS-01	CPNS-01	CP01 and 02, and NS-01 Contractors shall coordinate and agree on the location, bolts size, and drilling method. CP NS-01 Contractor shall ensure that type of boll supplied matches the fixing provisions and that adequate construction tolerance are allowed between the fixing and the mounting slots.
2	Recesses and trenches formed in screed or finishes for CP NS-01 services.	CP NS-01	CP NS-01	CP N-01, 01 and 02 or CPNS01*	CP01 and 02 or CPNS01*	CP01, 02, and NS-01 Contractors shall coordinate and agree on the size and location. CP01 and 02 Contractors shall provide adequate thickness of screed or finishes. CP01 and 02 Contractors shall provide the removable or hinged covers and frames (where required) in finishes over recesses and trenches.
3	Cast-in sockets including bolts, nuts, and washers, packings and shims	CP NS-01	CP NS-01	CP NS-01	CP01, 02 and/or NS-01	CP01, 02 and NS-01 Contractors shall coordinate and agree on the size and location. CP NS-01 Contractor shall supply all necessary materials and templates.
4	Conduits, (pull, junction, and/or surface) boxes, sheet metal trunking, cable tray, cable ladders and ducting, which are cast into concrete and including draw wires.	CP NS-01	CP NS-01	CP NS-01	CP01 and 02 or CPNS01*	CP01, 02 and NS-01 Contractor shall coordinate and agree on the size and location. CP01, 02 Contractor shall execute that the finishing work of the infilling gap between a wall and a box/conduit which is scheduled to install at the wall in advance. The protection of all ends and joints shall be executed by CP01, 02 Contractor. The conduits shall be assembled by CP NS-01 Contractor. Fixing of conduits to the re-bar shall be executed by CP01, 02 Contractors under CP NS-01 Contractor's supervision. CP01, 02 and NS-01 Contractors shall implement jointly an inspection before casting.

6	Facilities in PSD room i.e earthing terminals, air conditioning, lighting, fire protection, concrete plinth, floor and wall finishes,	CP NS-01	CP-01& CP02	CP-01& CP02	CP-01& CP02	CP05 and NS-01 Contractors shall coordinate and agree on the sizes and locations.. Main earthing system and connection to earthing terminal for PSD room shall be provided by CP01 & CP02 Contractor.
7	Power supply : The power supply shall be connected from the System Main Power Distribution Board	CP NS-01	CP NS-01	CP NS-01*, CP-01& CP02	CP NS-01*, CP-01& CP02	CP01, CP02 and NS-01 Contractors shall coordinate and agree on the sizes and locations.
8	Insulation Membrane	CP NS-01	CP01 and 02	CP01 and 02	CP01 and 02	Membrane to be installed by CP01 and CP02. CP NS-01 to supervise and assist in the testing of the insulation of the platform floor insulation membrane installed by the civil contractor.

*If NS-01 do not provide information timely then the material and installation work shall be undertaken by NS-01

Please note that design requirement mentioned in the above Annexes are not exhaustive. The Contractor will further elaborate the requirements in close co-ordination with interface Contractors. Associated Interfaces works not mentioned in the above tables but which may be inferred to be necessary for stability, or completion, or effective interface & integration or the safe reliable and efficient operation of the Works to be carried out by the Contractor. The Interface work shall include any work which is necessary to satisfy the Employer's Requirements, the Contractor's Proposal and Schedules, or is implied by the Contract, or arises from any obligation of the Contractor and shall be Fit for the Purposes for which they are intended.

APPENDIX 8- OUTLINE INTERFACE DEMARCATION WITH MMSP AND NSCR

APPENDIX 8- OUTLINE INTERFACE DEMARCATION WITH NSCR

Discipline	NSCR Interface at Malolos		NSCR Interface at Solis, Blumentritt and Tutuban Junction	
	NS-01	**CP04**	**NS-01**	**CP04**
Trackwork	Track work demarcation shall follow from demarcation line at Ch. 34k751 (North of Malolos Station)	Track work demarcation shall follow from demarcation line at Ch. 34k751 (North of Malolos Station)	All track and associated work shall start at PR1-64 Ch. 0+495 South of Solis Station.	All track and associated work shall be done up to PR1-64 Ch. -0+495 South of Solis Station.
Signaling	NS-01 shall follow track demarcation for Signaling works NS-01 shall terminate signal/data cables in the SER of N1 section There shall be interface at CBI level, ETCS level and ATS level for smooth interoperability During design stage there shall be interface with CP04 for deciding various parameters of ETCS There shall be interface for Integrated OCC (IOCC) for overall control from Mabalacat OCC.	CP04 shall follow track demarcation for Signaling works CP04 shall connect their equipment to cable terminations done by NS-01 CP04 shall interface for CBI, ETCS and ATS level. CP04 shall interface for common parameters of ETCS including RBC demarcation handover. CP04 shall interface for transfer of control to IOCC.	NS-01 shall follow track demarcation for Signaling works NS-01 shall terminate signal/data cables in the SER of N1 section There shall be interface at CBI level, ETCS level and ATS level for smooth interoperability During design stage there shall be interface with CP04 for deciding various parameters of ETCS. There There shall be interface for Integrated OCC (IOCC) for overall control from Mabalacat OCC.	CP04 shall follow track demarcation for Signaling works CP04 shall connect their equipment to cable terminations done by NS-01 CP04 shall interface for CBI, ETCS and ATS level. CP04 shall interface for common parameters of ETCS. CP04 shall interface for transfer of control to IOCC.

Discipline	NSCR Interface at Malolos		NSCR Interface at Solis, Blumentritt and Tutuban Junction	
	NS-01	CP04	NS-01	CP04
Telecoms	NS-01 will follow the Telecoms Work Demarcation with CP04 for all Telecom Systems works. NS-01 will terminate all Telecom Systems work at CP04's Malolos Station. All Telecom Interfaces between NS-01 and CP04 will be done at CP04's Malolos Station. There will also be an interface between NS-01 and CP04 with regards to the requirements of IOCC in Mabalacat Depot.	CP04 will facilitate and provide all the necessary terminations for NS-01 at Malolos Station. All Telecom Interfaces between NS-01 and CP04 will be done at CP04's Malolos Station. There will also be an interface between NS-01 and CP04 with regards to the requirements of IOCC in Mabalacat Depot.	NS-01 will follow the Telecoms Work Demarcation with CP04 for all Telecom Systems works. NS-01 will terminate all Telecom Systems work at CP04's Solis Station. All Telecom Interfaces between NS-01 and CP04 will be done in CP04's Solis Station. There will also be an interface between NS-01 and CP04 with regards to the requirements of IOCC in Mabalacat Depot.	CP04 will facilitate and provide all the necessary terminations for NS-01 at Solis Station. All Telecom Interfaces between NS-01 and CP04 will be done in CP04's Solis Station. There will also be an interface between NS-01 and CP04 with regards to the requirements of IOCC in Mabalacat Depot.
Power Supply	PSCADA and Intertripping between substations.	PSCADA and Intertripping between substations.	PSCADA and Intertripping between substations.	PSCADA and Intertripping between substations.
Power Distribution	6.6kV distribution cable from interconnecting 6.6 kV switchgear VCB in TSS No.9 to SS No.10 shall be scope of NS-01.	6.6kV switchgear VCB in TSS9 shall be scope of CP-04	Supply and install 6.6kV distribution cables from SS No.1 to Solis Station's 6.6 kV switchgear incomer.	Provision of 6.6 kV switchgear in Solis Station for 6.6kV distribution cable from SS No.1 provided by NS-01. The 6.6 kV cables from Solis to TSS 2 is under CP04 scope.
Overhead Line	Overlaps from adjacent tensions lengths	Overlaps from adjacent tensions lengths	Overlaps from adjacent tensions lengths. Splicing onto adjacent tension length maybe necessary subject to the detailed design for	Overlaps from adjacent tensions lengths. Splicing onto adjacent tension length maybe necessary subject to the detailed design for this

Discipline	NSCR Interface at Malolos		NSCR Interface at Solis, Blumentritt and Tutuban Junction	
	NS-01	CP04	NS-01	CP04
			this area.	area.
Platform Screen Door	PSD's for all stations by NS-01	PSD's for all stations by NS-01	PSD's for all stations by NS-01	PSD's for all stations by NS-01
CMMS	CP NS-01 CMMS shall interface with CP 04 MMS for exchanging the database and common GUI.	CP NS-01 CMMS shall interface with CP 04 MMS for exchanging the database and common GUI.	CP NS-01 CMMS shall interface with CP 04 MMS for exchanging the database and common GUI.	CP NS-01 CMMS shall interface with CP 04 MMS for exchanging the database and common GUI.
AFC	Reconciliation will be done at Level 4. There will be no direct interface at Level 3 and below equipment between NS-01 and CP04.	Reconciliation will be done at Level 4. There will be no direct interface at Level 3 and below equipment between NS-01 and CP04.	Reconciliation will be done at Level 4. There will be no direct interface at Level 3 and below equipment between NS-01 and CP04. Tutuban station will be connected to the NS-01 network infrastructure following telecoms.	Reconciliation will be done at Level 4. There will be no direct interface at Level 3 and below between NS-01 and CP04. Tutuban station will be connected to the NS-01 network infrastructure following telecoms.
Training	Train Simulator and Signaling Simulator database exchange.	Train Simulator and Signaling Simulator database exchange.	Train Simulator and Signaling Simulator database exchange.	Train Simulator and Signaling Simulator database exchange.

APPENDIX 8- OUTLINE INTERFACE DEMARCATION WITH MMSP

Discipline	MMSP INTERFACE			
	NS-01	**CP106**	**NS-01**	**CP107**
Trackwork	**Bicutan Station (Southside)** The block joint in between the double-ended points of Northbound and Southbound lines with NSCR lines will act as a boundary limits for the respective projects. IRJ will be supplied by NS-01.	**Bicutan Station (Southside)** The block joint in between the double-ended points of Northbound and Southbound lines with NSCR lines will act as a boundary limits for the respective projects.	Rail-wheel interface study	Provision of wheel interface information to be used in rail-wheel interface study
Signaling	In addition to the track demarcation, NS-01 shall supply, install, test and commission signaling way side at MMSP line in coordination with CP04 for interoperability. There shall be interface at CBI level for availability of route, exchange of slots and train approaching station The interface shall cover operation of PSDs from the	CP106 shall install way side equipment on MMSP track in coordination with NS-01 for normal train operation as well as for interoperability. There shall be interface at CBI level for availability of route, exchange of slots and train approaching station The interface shall cover operation of PSDs from the Signaling system in-charge at	NS-01 shall supply, install, test and commission GSM-R radio on CP107 Rolling stock. For this purpose, NS-01 shall develop interface matrix for all related aspects with CP107 matrix and interface at all stages of the project with NS-01	CP107 shall interface for development of interface matrix and interface at all stages of the project with NS-01.

Discipline	MMSP INTERFACE			
	NS-01	CP106	NS-01	CP107
	Signaling system in-charge at that time. NS-01 shall interface with CP106 for design, installation, testing and commission of on - board ETCS system interfaces with on-board CBTC system on CP107 Rolling stock, NS-01 shall interface with CP106 for MMSP Depot test track for set up test facility for ETCS	that time. CP106 shall interface with NS-01 for design, installation, testing and commission of on - board CBTC system interfaces with on-board ETCS system on CP107 Rolling stock, CP106 shall interface for MMSP Depot test track for Train testing in ETCS mode by NS-01.		
Telecoms	NS-01 will follow the Telecoms Work Demarcation with CP106 for all Telecom Systems works. NS-01 will facilitate and provide all Telecom Systems work terminations for CP106 either or both at FTI and Bicutan Stations. NS-01 will provide connectivity for the Backbone, Radio Systems (GSM-R), PABX, PA System. NS-01 will supply, test, and	CP106 will follow the Telecoms Work Demarcation with NS-01 for all Telecom Systems works. CP106 will terminate all Telecom Systems work termination to NS-01 either or both at FTI and Bicutan Stations. CP106 will supply all equipment to connect to the NSCR backbone system. CP106 will supply, install, test, and commission the equipment for Millimeter-wave,	NS-01 shall supply, install, test, and commission GSM-R radio on CP107 Rolling stock. For this purpose, NS-01 shall develop an interface matrix for all related aspects with CP107 matrix and interface at all stages of the project with NS-01	CP107 shall interface for the development of an interface matrix and interface at all stages of the project with NS-01.

Discipline	MMSP INTERFACE			
	NS-01	**CP106**	**NS-01**	**CP107**
	commission the on-board equipment for CP106. NS-01 will supply, install, test, and commission the Clocks for CP106 at both FTI and Bicutan stations.	Backbone Radio System (CBTC), PABX, PIDS. CP106 will install the GSM-R onboard equipment on their trains.		
Power Supply	**Bicutan Station** No interface with MMSP **FTI Station** No interface with MMSP	**Bicutan Station** No interface with NS-01 **FTI Station** No interface with NS-01	Power simulation will cover CP107 trains running on the NSCR	Train parameters shall be provided for the power simulation.
Power Distribution	**Bicutan Station** NS-01 shall provide complete LV (400V/230V) power distribution to Bicutan station shall be scope of NS-01 **FTI Station** 6.6kV distribution cable from SS No.S5 to FTI station at upper-level Electrical room shall be scope of NS-01	**Bicutan Station** MMSP shall receive a complete LV (400V/230V) power distribution from NS-01. **FTI Station** 6.6kV distribution cable from FTI SS (scope of MMSP) to FTI station at lower level Electrical room shall be scope of MMSP		

Discipline	**MMSP INTERFACE**			
	NS-01	**CP106**	**NS-01**	**CP107**
Overhead Line	Cross over tension length and section insulator to be provided NS-01. This overlap will cross over the MMSP tension length running to the MMSP Bicutan end of the line.	Cross over tension length and section insulator to be provided NS-01. This overlap will cross over the MMSP tension length running to MMSP Bicutan end of line	Dynamic Simulation shall be undertaken by NS-01. This shall include the operation of the CP107 rolling stock,	Train and pantograph parameters shall be provided for the dynamic simulation simulation.
Platform Screen Door	PSD's for both platforms at Bicutan by NS-01	PSD's for both platforms at Bicutan by NS-01		
CMMS/ MMS	NS-01 to provide numbering convention details for MMSP CMMS/MMS system.	CP106 MMS systems to accommodate NS-01 CMMS requirement and implement the standards throughout the project.		
AFC	Reconciliation will be done at Level 4. There will be no direct interface at Level 3 and below between NS-01 and CP106. Tickets purchased on NSCR stations including those for the Limited Express service shall enable passengers to alight at MMSP stations.	Reconciliation will be done at Level 4. There will be no direct interface at Level 3 and below between NS-01 and CP106. Tickets purchased on MMSP stations shall enable passengers, including those taking the Limited Express Service to alight at NSCR stations. The Limited Express tickets		

Discipline	**MMSP INTERFACE**			
	NS-01	**CP106**	**NS-01**	**CP107**
		issued shall be capable of being validated onboarding the Limited Express services as per limited Express tickets issued at NSCR station.		
Training	Train Simulator and Signaling Simulator database exchange.	Train Simulator and Signaling Simulator database exchange.		

End of Section

c) TECHNICAL REQUIREMENTS (ERT)

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1 TRACK WORKS

1.1 Scope of Work

1.1.1 General

1) The trackwork scope covers the MCRP and NSRP- South Sections which run from Malolos Station to the CIA Station in the North and from the Solis Station to Calamba Station in the South. The NSRP-South also includes the spurs from Blumentritt and Solis stations to Tutuban Station. The scope covers the trackwork in Mabalacat and Banlic Depots which are located at either end of the complete NSCR.

2) The works also include the mainline turnouts and a diamond crossing for the future link to New Clark City (NCC) and the direct link between Solis and Tutuban. These turnouts and a diamond crossing shall be installed with a short length of track leading to buffer a stop.

3) For the viaduct section of main line track with continuously welded rail, the double elastic fastenings and the elastic PSC sleeper directly fixed on concrete bed track which will be installed on the formation level and or the drainage slope concrete viaduct surface and the shear connectors provided by the Civil Works Contractor.

4) Sections of the Main Line tracks and junctions on supporting structures subject to possible settlement shall be constructed using FFU sleepers with double elastic indirect fastenings embedded within a ballast track base

5) Depot line tracks, unless specified otherwise shall adopt bolted fishplate joints and elastic direct fastening system fixed into mono-block pre-cast pre-stressed concrete sleepers, embedded in a ballast track base.

6) For the depot inspection tracks and maintenance tracks have special track forms like embedded track on floor level, directly fixed fastener track on top of column type pit or wall type pit track, vehicle washing track and all other tracks shall be adopted in various areas in the depot depending on the functionalities.

7) Turnouts and crossover turnouts shall be installed using FFU sleepers directly fixed on concrete bed in main line, turnouts and crossovers will be installed using FFU sleepers in depot area.

8) The track is the standard width 1435mm gauge with EN60E1 or JIS60 rail for the mainline and JIS-50N rail in the depot line.

9) Maintenance Vehicles, machines and tools shall be provided for track maintenance works.

10) The Contractor shall specify only materials and components proven under standard operating and climatic conditions similar to those in coastal island environment.

11) The track bed/plinth shall incorporate gaps at appropriate intervals to allow access for water drainage and for cables to cross the track.

12) The nominal track center distance in main line is 4000 mm.

1.1.2 Scope of Supply

The Contractor shall be responsible for design, supply and installation of tracks and related items on the viaduct, embankment, tunnel, and depot for the Project. The scope of works shall include, but not be limited to the following works:

1) Design, Supply, and Installation of track bed system, including all components

providing the complete track system. The Contractor shall design and test the elastic sleeper directly fastened track/non-ballasted track system for the elevated/embankment section of this Project. Vertical and horizontal adjustment shall be adequately built into the fastenings and/or adjustable to track bed.

2) Design, Supply and Installation of main line and crossovers applying the direct fixation method, including all turnout parts. The Contractor shall provide and install power operated scissors crossings (double crossover), single crossovers and simple turnouts on the elevated/underground track structure using resiliently mounted FFU sleeper and base plates.

3) In the Depot, the main track structures are ballasted track jointed with short welded rails and fishplates. In the Inspection and Repair bays, the rail is supported on concrete or steel stumps/poles. The Contractor shall provide a track structure in the Workshops and at level crossing in which the top surface of the rail head is flush with the adjacent paved area and the elevation is determined by the rail level. Resilience shall be provided between the rail and the paved area.

4) It is proposed to use 4 types of buffer stops namely Friction sliding buffer stop, fabricated buffer stop, stop block type and Ballast mound type. The Contractor shall provide Friction sliding buffer stops at the ends of the main lines for appropriate speeds. The Contractor shall provide appropriate type buffer stops at all track ends in the Depot. The Buffer stops shall be the insulated type so as not to short-circuit the running rails of tracks.

1.2 Definitions and Abbreviations

Whenever the following terms are used in this Track Works requirements, the intent and meaning shall be interpreted as follows:

1.2.1 Commissioning

The process of setting to work the complete transportation system through a series of integrated tests that demonstrate the installation and performance in accordance with the specified criteria.

1.2.2 Consumables

Consumables means those parts that are not repairable and usually have a relatively short life span.

1.2.3 Drainage System

The system of pipes, ditches, and structures by which surface or subsurface waters are collected and conducted from the Project/ building area.

1.2.4 Equipment

All machinery, together with the necessary supplies for upkeep and maintenance, and also all tools and apparatus necessary for the proper construction and acceptable completion of the Work.

1.2.5 Interface

Interface coordination with Civil & Structural and System wide contracts related to track works like rolling stock, electrification and traction, signal system and telecommunications.

1.2.6 Factory Acceptance Tests

Factory Acceptance Tests means the tests to be performed at the Contractor's factories prior to delivery to the Site to verify compliance with the Specification and quality standards.

1.2.7 Laboratory

The official testing laboratories of the Contractor as required.

1.2.8 Materials

Any substance specified or required for use in the construction of the Contract work.

1.2.9 Maintenance

Maintenance includes Maintenance, Consumables, Training of O&M Company' staff and related works.

1.2.10 Subgrade

The soil, which forms the pavement foundation.

1.2.11 Turnout

Switching and crossing mechanism that allows rolling stock to divert from one track to another. Turnouts may be facing (diverting from the line in the direction of normal running) or trailing (converging to the line in the direction of normal running).

1.2.12 Crossover

Two turnouts connecting one track to another. Crossovers maybe facing or trailing.

1.3 List of Acronyms and Abbreviations

The abbreviation of track work specific used in this chapter are shown below. Common abbreviations for all technical fields are shown in General Requirements (ERG).

AASHTO	American Association of State Highway and Transportation Officials
AC	Alternating Current
ACI	American Concrete Institute
ADR	Alternative Dispute Resolution
AREMA	American Railway Engineering and Maintenance of Way Association
ASCE	American Society of Civil Engineers
ASEP	Association of Structural Engineers of the Philippines
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ATS	Automatic Transfer Switch; Automatic Train Supervision
AWS	American Welding Society
BR	British Rail

BS	British Standard
CRT	Cathode Ray Tube
CWR	Continuous Welded Rail
℃	Temperature in degree Celsius
DC	Direct Current
DCU	Door Control Unit
DID	Detailed Interface Document (DID)
DPWH	Department of Public Works and Highways
EBW	Electron Beam Welding
EED	Emergency Exit Door
EJ	Expansion Joint
E&M	Electrical and Mechanical
EN	European Norms
ERG	General Requirements
ERT	Technical Requirements
FBW	Flash Butt-Welding
FFU	Fiber Reinforced Foamed Urethane
GIJ	Glued Insulation Joint
GIRJ	Glued Insulation Rail Joint
H or h	hour
HB or HBW	Brinell Hardness Number
IEC	International Electro technical Commission
ISO	International Standardization of Organization
JIS	Japanese Industrial Standards
Km	Kilometer
Km/h	Kilometer per hour
kN	Kilonewton
LCD	Liquid Crystal Display
MSS	Material Specification Sheet
MΩ	Mega-ohm
NCC	New Clark City
NSCR	North South Commuter Railway
O&M	Operation & Maintenance
PNR	Philippine National Railways
STM	Small Tamping Machine
Ω	ohm

1.4 Design Requirement

1.4.1 General

The track work designs shall be based on established metro railway practices and to the current state-of-the-art track work technology. Track gauge shall be "standard gauge" 1435 mm.

Maximum operational speed shall be 160 km/h.

Track work designs shall incorporate engineering solutions, standards, materials and components that have been tested and well proven in service under similar coastal environment, traffic and operational conditions in other modern railway/metro rail systems for a period of not less than seven (7) years unless otherwise stated.

The Contractor shall provide certificates, attestations and statements from metro rail or railway organizations, industries, and manufacturers, as applicable, to support the Contractor's compliance with this requirement.

The track work shall be designed to accommodate all the forces and displacements generated at the wheel and rail contact point.

Loading conditions for design purposes shall be based on a gross axle load of 16.3 tons for normal operation.

The calculation of forces used for design shall be based on either Japanese regulations or equivalent national or international standards.

1.4.2 Track works Design Principles

1) To produce track works can be easily maintained during non-traffic hours;
2) To minimize the requirements and costs for carrying out maintenance to both the track works and rolling stock;
3) To ensure the long-term availability of the materials and components for future replacements;
4) To maintain different materials and components to be held by the Employer as spare stock to the minimum possible number. To this end, the contractor shall understand the type, standards and manufacturers of track work materials and components of the existing PNR system. It is essential that there is compatibility between components already installed in PNR and components provided under this contract;
5) To provide adequate track-to-earth electrical insulation, to reduce leakage of traction return currents in order to meet limitations specified in the contract specifications;
6) To ensure compatibility of track work with works and designs of all other systems and disciplines;
7) To ensure compatibility and suitability of the incorporated materials and components to match with the existing track works and other systems which have already been installed in the existing system;
8) To ensure the long-term durability and structural integrity of the track works;
9) To ensure that the designs of the track works and its components shall be to Japanese standards, AREMA, AAHSTO, EN Codes, ISO Standards, and IEC Standards and to other recognized international standard specifications, subjected to Approval by the

Engineer;

10) To ensure that the Contractor shall always select the option that provides a higher degree of quality for the concerned material/component;
11) When codes and standards are quoted in this document, equivalent standards may be proposed by the Contractor which offer an equivalent and/or higher degree of quality for the concerned material/component. Demonstration of this equivalence shall be provided during the design stage to the extent required by the Engineer;
12) Unless otherwise agreed, the edition or issue of all standards or codes whether quoted in this specification, shall be that current at the award of Contract;
13) The designs shall be carried out in the SI units and all the drawings and calculations submitted for approval shall be in SI units. The SI system units and/or ISO metric system such as ISO 31, IEC 60027, ISO/IEC 80000, etc. of dimensions and quantities shall be used unless agreed otherwise by the Engineer;
14) The drawings shall be to appropriate scale, fully dimensioned and showing all tolerances. All drawings and documents shall bear a title block and a reference number and shall be prepared and submitted in accordance with the requirements set in the contract documents;
15) All materials and components shown on the drawings shall be clearly identified and the relevant standard or code and class of material shall, where applicable, be quoted making cross-reference to other design documents, as required;
16) Materials and components shall not be ordered, and track work installation shall not commence until the relevant designs or/and specifications have been given a Notice of No Objection by the Engineer;
17) Reference to standards or to materials and equipment of a particular manufacturer shall be regarded as followed by the words "or equivalent". The Contractor may propose alternative materials, or equipment which shall be equal to, or better than, those specified. If the Contractor for any reason proposes alternatives or deviations from the specified standards, or desires to use materials or equipment not covered by the specified standards, the Contractor shall state the exact nature of the change, the reason for making the change, and shall submit for the Engineer's Approval relevant specifications of the materials and equipment in the English language; and
18) Upon the Engineer's request, the Contractor shall submit any of the design drawings in digital form compatible with the Employer's facilities.

1.4.3 Design Input Documents

These documents will be established with the aim to define and ensure that all constraints/requirements that the track system and the track components will have to comply with, are identified.

Solutions for each interface will then be presented and detailed in separate and independent sheets of a format suitable to the Contractor, allowing to trace the evolution of the design parameters.

All necessary backup documents (drawings, calculation notes, material data sheet) justifying the engineering options selected to fulfill the interface will be referenced and attached to this interface sheet.

1.4.4 General Design Documents

General design documents will be developed for each type of track design. In the first part, these documents will gather the track performance requirements, including those resulting from the design input documents.
The Contractor's selected design will then be presented in all aspects, including all sub-systems (such as the stray current collection system, turnout tracks, rail creep control, track- structure interaction).
Necessary calculations, statistics, certificates, aiming at demonstrating that the proposed design complies with the contract requirements and with the design input documents will be provided.
The Contractor's selected design part will also include main track components.

The Contractor will incorporate in the general design documents a statement that its design is in accordance with the regulations and standards specified in the Technical Requirements, General Requirements, and the other documents.

1.4.5 Component Specification

The completion of the above steps will allow the Contractor to proceed with the development of component specifications for all track system components.

For each track component the component specification shall be submitted for the

Engineer's review as a self-standing document, including at least:

1) The technical properties and characteristics of the components to be supplied;

2) Applicable codes, standards, drawings specifying the product; and

3) Quality accreditation levels to be owned by the suppliers/manufacturers.

4) Service Record

1.4.6 Material Specification Sheet (MSS)

The Material Specification Sheet (MSS) will be prepared by the supplier/manufacturer on behalf of the Contractor.

The MSS will be prepared as a self-standing document detailing the product the supplier/manufacturer intends to provide. The MSS will include at least:

1) The supplier /manufacturer's name and address:
2) The place of manufacture;
3) A description of the product;
4) A confirmation of compliance with the component specification;
5) A copy of the supplier/manufacturer's quality accreditations;
6) An exhaustive list of Factory Acceptance Tests as per relevant codes, standards, and the manufacturer's quality control program, including sampling data, acceptance criteria, etc.
7) The schedule of inspection and testing;

8) Factory Acceptance Test procedures;

9) Place of inspection and/or testing;

10) Agency performing the test and/or inspection;

11) Detailed drawings; and

12) Credentials of proven satisfactory performance.

1.4.7 Installation and Control Procedures / Installation Drawings

1) The installation and control procedures for the track work system shall be submitted to the Engineer for Approval as independent documents representing each of the main activities such as the topographical survey, the track assembly, the track lining, concreting etc.
2) These procedures will provide all relevant staff with the detailed installation and control procedures, the tolerances to be achieved, the particular safety measures to be adopted to safeguard the personnel and the permanent way material integrity.
3) The procedures will form part of the Contractor's quality control plan for track work. The installation drawings will be provided to the Engineer as coordinated drawings broken down into sub-systems installation drawings, in such format and scale to easily depict the geographical location of all type of track design and of all permanent way components.

1.4.8 Quality Control Plan

1) The Quality Control Plan for the executed works will address the responsibilities to execute, supervise and control the works, will sequence and list the installation and tests procedures and forms and will include all final acceptance tests required to verify and document the compliance of the works with the contract performance requirements.
2) In particular, the tests listed in this specification and other contract documents shall be addressed in this Quality Control Plan.
3) Any laboratory intended to be used for testing shall be given a Notice of No Objection by the Engineer prior to use.

1.4.9 Temporary Works

For proposed temporary works required during the construction period, the Contractor shall submit a detailed proposal to the Engineer for Approval prior to the commencement of such works.

This submittal shall include but is not limited to:

1) Method statements;

2) Drawings;

3) Material submissions;

4) Compliance with Local Authorities and amenity Suppliers;

5) Permissions where required from Local Authorities (e.g. Highway Department);
6) Compliance with fire regulations; and
7) Information to the Employer as to where the temporary works shall affect revenue service.

1.4.10 Interface Requirements/ Obligations

1) The Contractor shall, as a matter of course, interface with other railway disciplines and outside authorities in addition to meeting their contractual responsibilities with the Employer.
2) These interface requirements and obligations shall include but are not limited to, the following:
    a) The Employer;
    b) All other railway disciplines i.e. Signaling, Communications, Power Supply/Distribution, Overhead Catenary, AFC, and Depot systems;
    c) Local Authorities (Municipalities, Barangays);
    d) Highway Department;
    e) Meralco and other power utility companies;
    f) Telecom Amenity Suppliers;
    g) Police Authorities; and
    h) Philippine Government Departments (Local and National).
3) An Interface Management plan shall be submitted for Approval by the Engineer.
4) The Contractor shall follow the Interface Requirements for Track Work as specified in the General Requirements and Technical Requirements.

1.5 Particular Track Specification

1.5.1 Scope of Works

1) Two major track system are adopted; firstly, ballast less track on the invert of elevated viaduct, embankment, at grade and stations; and secondly ballasted track in the Depot. The first stage invert concrete support shall be provided by the Civil Contractors. The elastic sleeper shall be directly fastened into concrete track bed provided by the Contractor.
2) Other track systems are adopted within the depot at road crossings and in maintenance buildings.
3) Scissors crossing, crossovers and turnouts conforming to EN or JIS standard shall be installed where running tracks converge, diverge or cross.
4) For the tracks in the Mainline, the Contractor shall set permanent datum track point to maintain accurate track alignment at 10m intervals along the whole line. The Contractors can use the survey control points that is reference the exact horizontal coordinates and elevation used by the Civil Contractors for these track datum points. The contractor shall carry out the track laying accurately based on this datum point.

   The Contractor shall integrate each part of the other railway systems to satisfy the operational requirements and track work layout for the Depot and Depot Access Line to establish top of rail datum for the Workshop Building and other Depot buildings with track work.

5) For the tracks in the Depot and Depot Access, the Contractor will also establish permanent datum points throughout the Depot area. These control points will establish exact horizontal coordinates and vertical elevations based on the project survey grid and datum. The Civil Contractors will construct super-structures to support the track work. The Depot and Depot Access Line track shall comprise of pre-stressed mono-block concrete sleepers on ballast bed. Scissors Crossing, Single Crossover and Simple Turnout shall be on FFU sleepers, on ballasted bed. The sub-ballast layer of crushed stone will be laid by the Civil Contractor on the formation. In paved workshop areas and on level crossings, the rail shall be embedded in a setting pourable elastomer or commercially available embedded rail fastening system where the rail head flush with the surfaces of the paved area.

6) The Glued Insulated Rail Joints, conforming to Signal System being adopted, shall be installed at the section which is required from track circuit of direct fixation tracks, scissors crossings, single crossovers, and turnouts on the main line CWR section.

   The contractor shall provide Glued Insulated Rail Joints at demarcation sections between NSRP-South and MMSP line.

7) The Insulated Rail Joints shall be installed at the section which is required from track circuit of ballasted track, scissors crossings and turnouts in the Depot area, and Depot Access Line.

8) All track components shall have proven performance in operation under similar operating and environmental conditions to this Project.

1.5.2 Standards and Codes of Practice

1) All works shall comply with the relevant standards issued by recognized International Railway standards.

2) An appropriate compatible standard may be adopted from another reputable organization. For convenience, this Specification typically refers to Technical Regulatory Standards for Japanese Railways (Civil Engineering) and its approved Model Specifications (2007) and American standards, but the Contractor may propose to substitute equivalent standards from, amongst others, the International Standards Organization (ISO), the Union International des Chemins de Fer (UIC), AREMA (American Railway Engineers & Maintenance of Way Association) and Japanese Industrial Standards (JIS). Civil construction work for reinforced concrete may follow ASTM or EN.

3) However, the Contractor shall note that the Engineer intends that the standards to be adopted for the contract shall represent the latest and best international practice. The Engineer shall have absolute discretion in deciding whether any particular standard proposed by the Contractor for adoption is appropriate for and/or compatible with the requirements of the Employer. The Contractor shall provide a translation into English of any standard proposed to adopt which is written in other language other than English.

4) All standards shall be those current at the commencement of the contract, including any Amendments and Addendum and made available at the Contractors office for

reference.

1.5.3 Samples of Materials and Workmanship

1) The Contractor, at his own cost, shall, whenever requested by the Engineer, supply to the Engineer for his acceptance samples of any materials or demonstrations of workmanship proposed to be used in the execution of the Works.

2) Where samples or demonstrations of construction work are required for the Engineer's acceptance, all work accepted shall match the sample or demonstrations in material and workmanship.

3) All track work components shall be fit for purpose in a tropical climate and unless otherwise specified shall have a proven record of satisfactory service for at least seven (7) years unless otherwise stated on a similar system with similar environmental conditions. All components of any particular type shall be procured from the same manufacturer.

1.5.4 Test of Materials and Components

1) The Engineer shall have the power to inspect the production of any materials and the manufacture of any components at suppliers' and manufacturers' works.

2) The Contractor shall afford him all the necessary facilities to do so, including the provision of Personal Protective Equipment (PPE) where necessary.

3) Similarly, the Engineer shall have the power to witness any testing being undertaken in any laboratory or in any test track. The Contractor shall afford him all the necessary facilities to do so, including the provision of PPE where necessary.

4) Where testing is required onsite, the Contractor shall provide all the necessary labor, plant, tools, instruments, and materials for carrying out all tests.

5) The costs of carrying out laboratory tests and in-track tests shall be borne by the Contractor, including the collection and transport of test samples and specimens.

6) All laboratories proposed for examine shall be given a Notice of No Objection by the Engineer.

1.5.5 Inspections

The Engineer shall be entitled to inspect the Works at any time. The Contractor shall provide to the Engineer any inspection equipment such as rail thermometers, levels, track gauges, tapes, calipers, gauges and other tools and instruments as required.

1.5.6 Quality

The Contractor shall operate a Quality Management system that complies with ISO 9000 or equivalent.

1.5.7 Site Records

The Contractor's Quality Management Plan shall include details of the compilation of adequate written site records which shall include, but shall not be limited to, the following:

1) Materials testing of all aggregates, cement and concrete identifying the section of works to which they relate;
2) Casting dates for in-situ and precast concrete;
3) Striking of formwork and application of curing compound;
4) Daily ambient air temperatures and rail temperatures;
5) Fire resistance testing of materials, where applicable;
6) Track laying records;
7) Welding Records;
8) Inspection/certification by Contractor's safety officers;
9) Electrical Tests;
10) Destressing records for all track; and
11) A detailed index of the contractors is to be prepared and made available from the contractor for ease of traceability.

1.5.8 Delivery, Storage, and Handling

1) The Contractor shall load, transport, unload, store, and handle materials in a manner, which will prevent damage to the track work materials and supporting structures.
2) Damage caused by the Contractor shall be repaired, corrected or replaced at the Contractor's expense.
3) The Contractor shall recommend to the Engineer for approval what methods and type of protecting manner that shall be applied to all rails prior to shipping to prevent rusting and steel oxidization.
4) The contractor shall supply with the first delivery of rails a lifting device (beam) capable of ensuring that the rails, when lifted with a mobile or static crane, remain Heads up and that no distortion in the rail occurs. This lifting beam shall be capable of lifting a minimum of 2 rails and be equipped with self-actuating rail devices.
5) The contractor must investigate the transportation route from the unloaded port to the rail stockyard, present that route to the Engineer and receive consent.

1.5.9 Housekeeping

1) The Contractor shall maintain his storage area and work sites in a neat and orderly condition.
2) The Contractor shall not allow debris and scrap materials to accumulate.
3) At the completion of each stage of work, the Contractor shall remove all surplus construction material and clean up all debris and dirt from the site. Drainage inverts, sumps, and cable trough shall be thoroughly cleaned. The Contractor shall check the integrity of survey monuments and restate his own expense any which have been disturbed.

1.6 Operational Criteria

1.6.1 Criteria

The following criteria shall be used for the project:

1) Cars per train - 8 (To be upgraded to 10 cars in the future), Total Length 160m (200m in the future);

2) Design speed

- Main Line : 160 km/h and 120km/h (Based on location);
- Depot Access Line : 45 km/h;
- Depot Area : 25 km/h;

3) Maximum axle load : 160 kN;

4) Maximum distance between axle centers of one bogie: 2,100 mm;

5) Maximum distance between bogie centers: 13,800 mm;

6) Maximum applied cant : 180 mm;

7) Maximum cant deficiency : 70 mm;

8) Environmental conditions: Maximum air temperature: 40℃;

9) Environmental conditions: Minimum air temperature: 20℃;

10) Distance of Track center : 4,000mm (Main line, station)

11) Rail inclination: 1:40

12) Track gauge shall be Standard 1,435 mm

13) The track support system shall be resiliently mounted to reduce impact loads on the structure and wheels and axle boxes of the rolling stocks.

14) The track support system shall ensure that the essential track parameters remain within the tolerance range.

15) The track support system shall provide electrical insulation when dry condition of more than 14.0 Ohms per 1 km measured between rail and earth (less than 0.07 Siemens/km) and more than 2.0 Ohms per 1 km (less than 0.5 Siemens/km) under wet condition (or when the system is covered by a fine water mist).

16) This insulation is required to prevent earth leakage currents (stray currents) and to suitable for signal system operations.

17) The rails shall be transported smoothly and protected from wear.

18) In order to give a good riding quality for the passengers, the track work shall be carried out within suitable geometrical and location tolerances.

19) The scissors crossings, single crossovers and simple turnouts at stations shall be designed for train operation through the turnout side lines at:

- 55 km/h for #12SN in 160 km/h section
- 55 km/h for #12 in 120 km/h section
- 45 km/h for #10
- 35 km/h for #8

・20 km/h for #6

20) Rail expansion joints shall be installed where necessary to limit stress in the rails caused by differential thermal movements, creep and braking and traction. It is commonly laid at both ends of long span Bridges and Turnouts.

21) The Depot tracks shall be suitable for train operation at speeds up to 25 km/h and have low maintenance requirement.

1.7 Component Design life

1.7.1 Objective

The objective for track work components to be specified for procurement from sub-suppliers, selection of materials and design shall be for the following technical design life (in years) detailed as follows:

1) Sleepers	
Reinforced /Pre-stressed concrete sleepers	- 40 years
Rail seat pads on sleeper	- 10 years
Elastic rail fastenings	- 10 years
Anti-vibration sleeper support pads	- 30 years
2) Ballast	- 20 years
3) Rails on curves of radius less than 200m	- 7 years
4) Rails on straight track in Main line	- 20 years
5) Rails on straight track in Depot	- 30 years
6) Resilient track fastening viaducts and embankments:	
Resilient support pads	- 10 years
Anchor bolts	- 15 years
Rail fastener	- 10 years
Electrical insulators	- 10 years
7) Scissors crossing, Single crossovers and Turnouts:	
Tongue rail or switch blades	- 7 years
Resilient support pads	- 10 years
Nose of crossing	- 15 years
Anchor bolts	- 15 years
8) Rail expansion joints:	
Resilient support pads	- 10 years
Switch components	- 15 years
Anchor bolts	- 15 years
9) Rails in Workshops, if required	- 40 years
10) Rail Expansion Joints and turnouts	- 30 years
11) Buffer Stops	- 40 years

1.8 Track Work Construction

1.8.1 General Descriptions of Track Forms

1) For the viaduct section, the track structure shall be comprised of continuously welded rails supported on mono-block precast concrete sleepers using resilient fasteners spaced at 625 to 714 mm centers. The standard value is 666 mm. The mono-block precast concrete is mounted on elastic pads in turn supported on the cast-in-situ track bed with a maximum length of 8m. Gaps of 100 mm shall be provided between concrete bed units/slabs.

2) The starter bars (shear connectors) shall be installed by the Civil Contractors. The exposed length of the starter bar shall be more than 70 mm. The exposed portion of the starter bars are to be coated by the Contractor, with a suitable and electrically insulated material which has been given a Notice of No Objection. The reinforced track bed shall provide for stray current isolation.

   a) The shear connectors will be cast into the viaduct and embankment section by the Others (Civil Contractors):

      - At locations that have been coordinated between Civil and Contractors as per Contractor's design, or
      - At both sides approximately 450mm centers along the track center line including Turnouts and Crossovers.
      - In areas where the civil contractor has not been provided by the civil contractor shear connectors shall be installed by the Contractor.

   b) At locations where the shear connector cast into the viaduct/embankment by the Civil Contractors is:

      - Not compatible with the Contractor's design for any reason;
      - Where the other Works Contractor (Civil) cast-in shear connectors are incorrectly located, missing or non-functional; and
      - On some special segments required within the span as per Contractors design which has been given a Notice of No Objection;

   c) The Contractor shall additionally drill and install shear connectors including testing as follows:

      - The detail design; material and installation/testing methods shall be proposed by the Contractor for the Engineers Approval; and
      - Locations for any drilling shall be submitted to Engineer Approval after coordination with the Other Works Contractor (Civil), for a suitable reinforcing- free and embedded- conduit free location.

   d) Remove and grout over any of the Works of the Other Contractors (Civil) cast-in shear connectors that fall too close to the end of the track bed unit/slab, between units/slabs, etc. The method shall be proposed by the Contractor for the Engineer's Approval.

3) For the embankment section, the track bed shall be the same specification as for the viaduct. The track bed concrete shall be laid on a thickness 300 mm for the road bed which is to be installed by the civil contractors.

4) The turnouts or crossovers in the main line shall be installed over FFU sleepers directly fixed to the track bed with rail fasteners.

5) There is to be sufficient space under the rail foot to allow for fitting alumino-thermic welding molds and emergency fishplate clamps.

6) The top of the track bed shall be graded to provide a positive runoff of water to ensure the slab tops remain free from ponding water.

1.9 Procedures

1.9.1 Work Plans

1) Before commencing any work at any work site, the Contractor shall submit a detailed Works Plan to the Engineer for his Approval, describing in detail the construction methods for every element of track work together with a coordinated schedule.

2) The Work Plan shall clearly state how the Contractor intends to achieve the specified tolerances and completion date.

3) The contractor shall co-ordinate with the Signal System discipline in order to identify rail connections and SRJ requirements and shall be responsible for drilling the rail for connections and will be responsible for the SRJ installation in the track.

4) The Contractor shall co-ordinate with the Signal System discipline and include in his Work Plan a full description of the means by which turnout operating machines shall be installed and commissioned. The Contractor shall provide, for each turnout, which needs to be operated for construction trains if used or track trolleys, a temporary manual turnout operating device with temporary stretcher bars and a point clip and padlock.

5) The Contractor shall coordinate with the Traction discipline on any connections that may have to be made to the rail with regards to the current return to the sub-station and relevant testing.

6) The Work Plan shall include a specific section that shall address construction safety.

1.9.2 Preconstruction Inspection

1) Prior to commencing work at any particular work site, the Contractor shall carry out a thorough inspection to satisfy that the Works can be satisfactorily constructed according to his design.

2) The Contractor shall check the integrity of alignment monuments, check the as-built position of the Civil Works, and plan the construction of track work to suit the actual conditions at each particular work site. If in the opinion of the Contractor there are deficiencies of any sort in the Civil Works that will affect the construction of track work, he shall notify the Engineer in writing within one (1) week of taking over the work site.

3) Before starting construction work, the Contractor shall report the findings of his inspections in a Preconstruction Report for each work site.

1.9.3 Compliance Inspection

1) Upon completion of construction at any particular work site and prior to handing over the work site to any follow-on contractors, the Engineer and the Contractor shall conduct a compliance inspection jointly. The inspection shall include, but will not necessarily be limited to, the following items:

   a) The correctness of dimensions, gauge, alignment, and level;

   b) The correct fitting and tightening of all fastenings and bolts;

   c) Material quality test reports;

   d) Weld locations and quality;

   e) Cleanliness;

   f) The correctness of signs and markers;

   g) Electrical insulation and conductivity values;

   h) Turnout throw forces, fitting tolerances, and clearances; and

   i) Completion of rail destressing.

2) The Contractor shall promptly correct any deficiencies at his own expense and offer corrected work for re-inspection.

3) Acceptance criteria shall be set by the Engineer.

1.9.4 Final Inspection (Test Running)

1) Initial rail grinding shall be completed by the Contractor prior to Train Test running as per interface requirements.

2) The purpose of this initial rail grinding is to remove the mill skin, a top surface layer of metallurgical inhomogeneous material and surface irregularities and minor damages that occur during construction.

3) After grinding operations, work trains shall be kept to the absolute minimum required by regular maintenance activities.

4) The grinding shall be done in accordance with an existing approved procedure used on a similar system, using similar machinery.

5) The rail surface after grinding shall be smooth and shiny, the acceptance of initial grinding shall be in accordance with EN13231-3:2012 or equivalent international standards.

6) The Contractor shall propose a machine and method statement that has been used on a similar railway system, with similar rolling stock.

7) At the end of the Project, prior to the contract completion, the Engineer and the Contractor shall conduct a final inspection jointly. Prior to this final inspection, the Contractor shall have satisfied himself that the works are in a fit condition for

acceptance and that he has provided the Engineer with all the test results relative to the length to be inspected.

1.9.5 Alignment and Setting Out

1) The horizontal alignment prepared by the Contractor shall represent the longitudinal centerline of the track at rail level.

2) The vertical profile shall show the level of the centerline of the railhead. On canted track, the level shown on the vertical profile is that of the low rail, the cant shall be applied by lifting the high rail above the low rail.

3) The track gauge shall be 1435 mm measured 14 mm below the top of the rails.

4) Permanent track datum points shall be established along the mainline at standard 10 m intervals. These datum points are set to the exact horizontal and vertical position for the construction and management of the track with reference to the construction survey grid and datum. The "best fit" track with slight modifications to planned alignment must satisfy the running safety and the riding quality of the train, must obtain the approval from the Engineer.

5) The "best fit" alignment along with the check lists shall be submitted to the Engineer, for approval.

1.10 Installation

The Contractor may propose alternative installation methods to those described in this Specification which are subject to Approval by the Engineer. The Contractor must clearly demonstrate that his proposed method will deliver at least the same accuracy and durability.

1.10.1 Concrete Track Bed

1) The Contractor shall review the design of the reinforced concrete track bed to suit the proposed fastening system, including the provision for collecting stray currents, and integrate with the civil contractors on the location of starter bars cast in the viaduct and the embankment areas.

2) The Contractor shall prepare the finished viaduct deck for the installation of the trackwork. The Contractor will be responsible for construction of the first stage concrete to a level 650 mm (minimum) below proposed top of rail level to an unformed concrete finish.

3) The Contractor shall install the track bed throughout the elevated structures, embankment sections and transition zones. This shall provide an accurately generated surface on to which elastic sleeper installation shall be fixed.

4) The track bed in the form of a reinforced concrete bed shall be keyed into the first stage concrete by protruding reinforcement (shear connectors) installed by the civil structure's contractors, such that no relative movement can occur under load.

5) The minimum thickness of the track bed shall be 200 mm under the foot of the rail position.

6) Formwork shall be used to ensure that the second stage concrete is set accurately

to line and level, especially in the region of the bottom of the sleeper. Tolerances on the level of the secondary pour concrete shall be satisfied within the limits described within this Specification. The formwork design shall be given a Notice of No Objection by the engineer.

7) The track bed shall not extend over an expansion joint in the civil structure.

8) The concrete laitance shall be removed from the 'foot print' of the track bed and the surface scraped to increase the bond between the track bed pour concrete and the supporting structure.

9) The minimum strength of concrete shall be 27 MPa.

10) The track shall be adjusted precisely to the correct line and level and shall be securely propped and braced to ensure that it cannot move during the delivery, placing or vibration of the track bed concrete.

11) Track bed concrete shall not be placed until the alignment of the track has been accepted by the Engineer as being within the specified tolerances. The Contractor shall afford unrestricted access to the Engineer for checking the setting-out measurements and the alignment as and when the Engineer requires it.

12) The Contractor shall design the track bed to provide appropriate drainage so that water falls away from the rails and shall form adequate gullies and connections into the drainage pipe laid in the first stage concrete. The Contractor shall take all necessary steps to prevent any concrete or other material from entering and reducing the permanent cross section of any drainage pipes, gullies, manholes, etc.

13) No trains shall run over newly concreted track until the cube strength of the concrete has reached a minimum of 27 MPa.

14) When each section of track bed concrete is completed, the rails shall be released from their fastenings to even out longitudinal stresses and refastened at a designated destressing temperature range when the concrete has assumed sufficient rigidity to carry the loads. The destressing temperature range shall be agreed with the Engineer before starting the process. The unfastening and refastening will overlap into the preceding section by not less than 50 m. Records of air temperature and rail temperature shall be taken at the beginning and end of each operation.

15) After destressing or stress equalization, the track shall be adjusted precisely to its design position and rail joints welded.

1.10.2 Depot

1) The safety guard device is not required in the depot area. It is required only for the depot access track and test track, only if the radius of the curve is less than 200m. In the depot area a cant will not be required. In the test track a cant will be required.

2) The minimum thickness in the ballast area shall be 200mm.

1.10.3 Track Components

1) Fastening assemblies shall be at nominal 667 mm or less centers for straight tracks,

and 625 mm or less centers for curved tracks. They shall be perpendicular to the longitudinal track centerline.

2) Rail shall preferably be handled by mechanical means and shall not be dropped during unloading; dragging of rail shall be kept to a minimum with the Engineer Approving the methodology.

3) Prior to welding, all joints over which a construction train may pass shall be firmly clamped with fishplates and at least two clamps installed.

4) The rail gap shall not exceed 6 mm at neutral temperature and the speed of any construction train shall not exceed 10km/h.

5) All rail borne vehicles shall not pass over welded joints until trimming and rough grinding has been completed and the rail temperature is below 100°C. Speed shall be restricted to 10km/h until grinding has been performed to the specified final tolerances and the weld has been tested, inspected and accepted.

6) Rails shall be cut square and clean by means of either rail saws or abrasive cutting disks. Flame cutting shall not be permitted. Cuts shall be controlled using a purpose-made guide or template and shall be within 0.75 mm of the vertical axis of the rail measured over the overall height or within 0.50 mm of the transverse axis measured over the head width.

7) Records of rail temperature and air temperature shall be taken every one (1) hour as welding proceeds.

1.10.4 Cant

Cant shall be applied by rotation around the head of the lower rail. Maximum actual cant on the main line shall be 180 mm. Maximum cant deficiency shall be 70 mm.

1.10.5 Access for Cables and Drainage

The track bed on viaducts shall incorporate gaps 100 mm wide every 8 m; pipes shall be laid at the lower part to allow crossing for water drainage and power cables.

1.10.6 Viaduct Joints

On completion of the track work concreting screed shall be applied to the deck at the viaduct span end upstands to prevent ponding of water and to ensure water flows to the nearest drainage outlet.

1.11 Construction Tolerances

Regarding the allowable tolerance of track work, the Contractor shall follow the instructions of the Engineer of track work.

1.11.1 Positional Tolerances - Main Running Lines

Allowable construction tolerances shall apply to the static unloaded condition of the track for the concrete bed, after concrete placement.

1) Vertical position of top surface of rail with respect to fixed datum: ±3 mm;

2) Lateral position of rail running edge with respect to marked lateral position on tangent track: ±3 mm;

1.11.2 Acceptance Tolerances – Track in Main Lines

Track irregularities shall be maintained for five items such as: gauge, cross level, longitudinal level, lateral alignment, twist. Geometrical tolerances of finishing track works in the main line shall be as follows:

1)	Gauge	: +0, -3 mm
2)	Cross Level	: ±2 mm
3)	Longitudinal Level	: ±2 mm in 10 m chord
4)	Lateral Alignment	: ±2 mm in 10 m chord
5)	Twist	: ±4 mm at 5 m interval

Any additional tolerances required, shall be proposed by the Contractor for the Engineer's Approval.

1.11.3 Acceptance Tolerances – Turnouts

The following items are examples. The Contractor shall obey instructions of the Engineer of track work.

1)	Straightness of turnout measured along the straight leg:	±2 mm;
2)	Gauge at switch and stock and at crossing nose:	±1 mm;
3)	Gauge at all other rails:	±2 mm;
4)	Flange way of crossing shall be:	45 mm;
5)	Flange way at check rail shall be:	41 mm;
6)	Crossing point protection shall be:	1394 mm -0 + 1 mm;
7)	Toe of switch to stock rail gap:	<0.5 mm;
8)	Squareness of toe	±2 mm
9)	Toe to nose:	±8 mm;
10)	Nose to nose at diamond:	±2 mm;
11)	Switch Flange way opening:	>55 mm;
12)	Toe opening – to be confirmed by point machine supplier.	

1.11.4 Ride Quality

To ensure ride comfort for the passengers, on completion of the trackwork installation the contractor shall carry out geometrical and location tolerances measuring using track geometry vehicle or similar equipment.

The results shall be submitted to the Engineer for review.

1.12 Rail

1.12.1 General

1) The Contractor may propose alternative installation methods to those described in this Specification however this proposal shall be given a Notice of No Objection by the Engineer, the Contractor must clearly demonstrate that his proposed method will deliver at least the same accuracy and durability.

2) Factory acceptance and subsequent material/testing inspections shall be carried out in accordance with the General Requirements.

3) The manufacturer shall carry out all relevant tests in accordance with JIS E1101:2001or equivalent and JIS E1120:2007 or equivalent.

   The manufacturer at his own expense shall supply all templates and gauges, prepare and supply test pieces and samples of steel, sample rails and supply labor and apparatus and equipment for testing which may be required by the inspecting agency for carrying out all tests.

   And the manufacturer shall render reasonable assistance in execution of such tests as desired by the purchase/inspection Agency.

4) All rails shall be produced by one manufacturer.

5) The rail supplier shall satisfy the following requirements:

   a) Shall have experience of manufacture and delivery of the rails over 10 years previously; and

   b) Shall have manufacturing capacity of 15,000 tons or more of rails per month.

6) The Contractor shall submit all the necessary documents for the Engineer's Approval prior to engaging any rail supplier.

1.12.2 Rail Section and Material

1) Rail EN60E1 for mainline, EN60E1or JIS60 for mainline turnout and JIS50N for depot areas compliant to JIS E1101 or equivalent shall be utilized,

2) The production, straightening and testing shall conform in all aspects to EN13674-1 or JIS E1101 or equivalent on receiving a Notice of No Objection by the Engineer.

3) All rails shall be sourced from one (1) manufacturer and rolled from blooms produced by the continuous casting and in-line testing process.

4) No rail rolled before the commencement of the contract shall be used in the permanent works.

5) Rails shall be supplied undrilled.

1.12.3 Standard Rail

1) Standard rails shall be EN Grade R260 rail steel according to table 1 of EN13674-1 with hardness of not less than 260 HBW.

2) Standard rails shall be used in all straight track and in all main line curves of radius greater than 800 m.

3) The standard rail length shall be 25m. Up to 5% of total tonnage will be accepted in shorter length (20 m to 24m). The shorter rails shall be identified in each length at the time of delivery.

4) The appearance of rails shall be according to 7.1 of JIS E1101:2001 or equivalent.

5) The internal soundness of rails shall be according to 7.2 of JISE1101:2001or equivalent.

1.12.4 Head Hardened Rail

1) Head hardened rail shall be compliant to JISE1120 or equivalent. Rail quality shall satisfy hardness of 340HB to 375HB incompliance with JISE1120:2007 or equivalent. The heat treatment process shall be an in-line process delivering the specified hardness to a minimum depth of 25 mm.

2) Head hardened rail shall be used on rail of curves of radius less than 800 meters, including the transition spirals, areas where there will be a high frequency of starting or stopping (station areas), for mainline turnouts and crossings and on grade sections exceeding 4%. In these locations and any other special track work, the rail steel shall be weldable with a minimum equivalent railhead hardness as set out in EN 13674-1 2003.

1.12.5 End Hardened Rail

End hardened rail shall be compliant to JISE1123 or equivalent.

End hardened rail shall be used for jointed section in the mainline with a radius larger than or equal to 800 meters.

1.12.6 Compromise Rail

1) Compromise rails shall be used to join rails of two different cross sections.

These rails shall conform to the Japanese standards or equivalent industrial standards

2) Compromise rails connecting EN60E1 to JIS60 may be laid in the mainline and EN60E1 to JIS50N shall be laid in the depot access line separated from the main line.

1.12.7 Continuously Welding Rails

1) Continuous rail welding shall be made while the rail temperature is within the neutral temperature range.

2) The neutral rail temperature range shall be optimally defined such that rail temperature variations after closure will not exceed ±35°C.

3) Unless the Contractor verifies the maximum and minimum rail temperatures, the following rail temperature limits shall be considered:

a) Maximum rail temperature in open air +60°C; and

b) Minimum rail temperature is +20°C.

4) Regarding the neutral rail temperature range, the Contractor shall decide after discussion with the Engineer.

1.12.8 Dimensions and Tolerances

1) The desirable nominal rail length shall be 25m. Rails shorter than 20m shall not be used in plain line unless their use has been given a Notice of No Objection by the Engineer. Should transport considerations dictate then the minimum length of 20m shall be acceptable.

2) Tolerances shall be in accordance with EN13674-1:2003 and two (2) sets of rail profile gauges shall be supplied to the Engineer upon first delivery of rail.

3) The profile tolerances of rails shall be class 'X' of Table 8 of the above standard.

4) The straightness tolerances of rails shall be class 'A' of Table 9 of the above standard.

1.12.9 Cutting Rails

1) Rails shall be cut square and clean by means of either rail saws or abrasive cutting disks. Flame cutting shall not be permitted. Cuts shall be controlled using a purpose-made guide or template and shall be within 0.75mm of the vertical axis of the rail measured over the overall height or within 0.50mm of the transverse axis measured over the head width.

2) Head hardened rails shall be cut using a suitable coolant. An appropriate cooling regime which is suitable to avoid increases in hardness of head hardened rail by more than 20HBW or diminishing hardness by more than 30 HBW within 10mm of the cut rail end shall be established by laboratory testing prior to any head hardened rails being cut on site. The Contractor shall strictly observe the conditions of this regime.

1.12.10 Minimum Length of Closure Rails

The minimum length of closure rails in the main line shall be 9m, and absolute minimum shall be 6 m. Where the length of closure rails is less than 6m at the turnout area, the Contractor shall present this for the Engineer's Approval. Closure rails should be used sparingly at a few specific locations/turnout zones.

1.12.11 Electric Resistance

The rail must work as a conductor to return electricity to the substation after driving the train in electric railway. The conductor electric resistance of the rail per one meter shall be as follows.

・50kg rail : 31.6μΩ/m

・60kg rail：26.2μΩ/m

1.12.12 Safety Guard Device

1) Guard rails shall be installed in main line on all curves with a center line radius of less than 250m. and in depot on 200m or less radius curves except turnouts.

2) The Contractor shall submit the shop drawings for the Engineer's Approval before manufacturing. Mounting parts shall be suitable to EN60E1 rail in main line for only necessary case, JIS50N rail in Depot of standard gauge track under acceptance of the Engineer.

3) The Contractor shall provide labor, materials equipment, machines, and tools sufficiently for accomplishment of the works complying with the Specifications at the places specified on the drawings or instructed by the Engineer.

4) Materials shall comply with the description below.

a) Angle steel: Angle steel shall comply with JIS G3101 SS400 with method of rolling and forging or casting.

b) Guard block/holder: Material for manufacturing this product shall comply with JIS G5502 FCD400 with method of rolling and forging or casting.

c) Bolts and Nut: Bolts and nuts for connecting angle steel guardrail to guard block/holder shall be heat-treated type in compliance with JIS B1180 and JIS B1181 respectively.

5) The Contractor shall be responsible for determining and providing all necessary supervision, inspection, sampling, testing or controlling the manufacture in such manner that the materials or items supplied shall comply with the requirements of these Specifications.

1.12.13 Identification

1) Identification marks and hot stamps shall be in accordance with Section 1.3 of EN13674-1:2003 or Section 12.1 and 12.2 of JIS E1101:2001.

1.12.14 Delivery, Storage and Handling

1) All new rails shall be shipped in a covered hold; rails shipped as deck cargo are not acceptable. Rails shall not be delivered as bundles, but stacked upright, so that they are unloaded by a self-actuating multi rail-lifting device.

2) All new rails shall be supplied with a protective coating to protect against corrosion. During installation of the new rails, the Contractor shall ensure that the protective coating is continuously maintained to this standard. Immediately prior to running of any train or to handover of the works, the coating on the wheel/rail contact area shall be removed.

3) The Contractor shall reject any rails which, in the opinion of the Engineer on arrival at the Site exhibit pitting of the rail head or are subject to corrosion or mechanical damage beyond that which can be corrected by normal rail surface grinding

required under the contract. The rails shall be stockpiled a minimum of 100 mm clear of the ground and at a sufficient grade to prevent water ponding between and on the rails; also, there is to be sufficient air flow around the rails to allow them to stay dry.

4) The Contractor is responsible for shipping all rail required by the Project from the mill or plant to the storage area. The storage area layout and methods of stacking rails shall be submitted to the Engineer for Approval.

5) Rail shall be loaded and unloaded with the use of lifting devices given a Notice of No Objection by the Engineer. Rail which is damaged during delivery, storage or handling shall be replaced at the Contractor's expense.

6) The Contractor shall recommend to the Engineer for Approval the methods and type of protective coating that shall be applied to all rails prior to shipping to prevent rusting and steel oxidization.

1.12.15 Certification

The Contractor shall submit the following documents:

1) Chemical composition;

2) Heat records;

3) Description of the ultrasonic and eddy current testing equipment, procedure, and certification for the testing personnel;

4) Brinell hardness testing records;

5) Ultrasonic testing records, including equipment calibration results, a listing of rails tested, and hard copy readouts from the ultrasonic testing equipment.

6) The control cooling, vacuum-treating, and heat-treating records if applicable;

7) The name and qualifications of the third-party testing organization;

8) Mill Certificate; and

9) Any additional certification required by the Engineer.

1.13 Rail Fastening System

1.13.1 Rail Fixation Fastening Track System for Ballast less tracks.

1) The rail fastening system shall be designed for attaching the rail to the track bed in elevated, embankment and transition structures using anti-vibration sleepers and fastenings. Vertical and horizontal adjustment shall be adequately built into the fastenings and adjustable elastic materials. The vertical elasticity of the elastic pad/mat of the anti-vibration sleeper shall be 30 MN/m to 80MN/m in the transition section between the anti-vibration sleeper concrete bed and the FFU sleeper for single crossovers, turnouts, and expansion joints. Normal vertical elasticity of elastic pad/mat of the sleeper shall be 25.0 MN/m to 30.0 MN/m. The Contractor shall furnish and install all of the hardware which comprises the rail fastening

system.

2) The rail fastening system shall comprise of a resiliently mounted steel or malleable iron base plate onto which the rail is fastened by two elastic rail clips or plates. A stiff elastomeric pad shall be interposed between the underside of the rail foot and the top surface of the base plate. Insulators shall be placed between the rail clip/plates and the rail foot and fastenings shall be mounted on the resiliently mounted anti-vibration sleepers.

3) Insulators shall be placed between the rail clip and the rail foot. On the mainline ballastless track an in-direct fastening assembly, a defined by EN-13481-1 Clause 3.18 shall be secured to the anti-vibration sleeper by suitable holding down bolts. On ballasted track in the depot cast-in shoulders embedded in the sleepers shall be used.

4) The rail fastening system shall provide support, guidance, resilience and insulation between rails and the track support system and shall incorporate proven state-of-the-art technological developments for all components. It shall be designed to meet the following minimum requirements:

   a) The rail fastening system shall comprise a fixation system as follows:

      i) Elastic steel spring clips;

      ii) Rail pads;

      iii) Rail insulators between the rail and clip;

      iv) Cast iron baseplate;

      v) Tensioned holding down bolts/compression springs;

      vi) Insulating ferrules between the baseplate and holding down bolts;

      vii) Conforming pad between fastener system baseplate and concrete surface; and

      viii) Stray current isolating pad.

   b) Electrical properties:

      i) 100 MΩ DC resistance when dry;

      ii) 1 MΩ DC resistance when wet; and

      iii) 20,000 Ω AC when dry to frequencies from 20-10 KHz.

5) The electrical resistance of the rail fastening assembly system measured between the rail and track bed reinforcement shall be at least fifteen (15) MΩ per baseplate when dry and one (1) MΩ per baseplate when the fastening assembly is covered with a fine water mist.

6) The total fastening system to provide the following:

   a) Lateral rail head movement (head roll and lateral shift combined) ≦ 4.0mm under nominal track loading conditions or tested in accordance with EN13146-4 standard or equivalent international standard.

   b) Vertical rail deflection ≦ 3.0 mm under nominal track loading conditions;

   c) Lateral adjustment (Gauge adjustment) up to ±10 mm;

   d) Vertical adjustment of + 30 mm; and

   e) Vertical rail pad stiffness 40-110 kN/mm @ 10-40 kN.

7) All fastening assemblies to be tested to the relevant European standards, including EN13481-5 2003, or equivalent subject to receipt of a Notice of No Objection by the Engineer.

8) The fastening system components shall be designed and manufactured by the original manufacturer of the rail fastening system. The Contractor shall submit the fastening system components to the Engineer for Approval.

9) The Contractor shall design the rail fastening system and shall submit to the Engineer the results of the design and acceptance tests. The result shall verify that anticipated stress levels based on the effective loads are within the fatigue limit of the proposed material, and projected wear of the extent life under normal operating conditions is within limit.

1.13.2 Rail Fastening Assembly for Concrete Sleepers for Ballast Tracks

1) The rail fastening assembly for concrete sleepers shall consist of a rail pad, cast shoulders, and rail clips, or similar suitable low maintenance elastic rail fastening assembly.

2) The specification for rail seat pads is generally the same as for rail seat pads on base plates.

3) The pads shall have a nominal thickness of 10 mm.

4) Cast shoulders shall be a standard manufactured shoulder to suit the proposed rail clips. The shoulder shall be cast from spheroidal or nodular graphite cast iron meeting the requirements of EN1563:1997 grade EN-GJS-500-7, ASTM A536:1984 grade 80/55/06, AS1831:2007 grade 500/7 or equivalent. The cast shoulder shall be capable of resisting a pull-out load of 50N.

5) Rail clips shall be standard manufactured spring steel rail fastening clip made from hot rolled steels quenched and tempered springs meeting the requirements of BS EN 10089:2002 grade 56SiCr7, or equivalent. Rail clips shall be furnished with sherardized or other corrosion resistant coating which has been given a Notice of No Objection by the Engineer.

1.13.3 Fastener Spacing

1) The Contractor shall submit an analysis to the Engineer for Approval supporting the proposed fastener spacing along tangent track and curved track.

2) In the main line the spacing shall be 666 mm or less on the straight track and curved track with the radius of more than 650 m. The standard spacing shall be 625mm on the curved track with the radius of 650 m or less.

1.13.4 Track Adjustment

1) Provision shall be made for maintenance of the rails to adjust the main line track level locally by maximum +30mm. This vertical adjustment shall be accomplished without having to remove either the baseplate or rail and require only the use of simple track tools.

2) Shims less than 2 mm shall be made from a high-grade corrosion resistant stainless steel; 2 mm and above can be made from a hard-plastic compound, resistant to ultraviolet rays.

3) Lateral adjustment of the rail shall be possible and that shall be done in the fastening system. The Contractor shall supply details of the method it proposes for lateral adjustment either by the use of rail insulator with different thickness, or other methods benefiting construction and maintenance processes and shall state the range of adjustment that it affords and must be in the range of ±10 mm for Gauge Adjustment. Lateral adjustment should be achieved in lockable steps. Use of eccentric bushes as a mean for lateral adjustment shall not be permitted.

4) Requires for adjustment for elevated and embankment sections shall be as follows:

a) Vertical:

Preferable: 0/+30 mm or more

Absolute min: 0/+20 mm

b) Lateral:

Preferable: ±7.5 mm or more

Absolute min: ± 5 mm; Gauge adjustment up to ± 10 mm

1.13.5 Anchorage System

1) Fastenings shall be anchored to the anti-vibration sleeper by two (or more) high tensile bolts or screws. Either stud bolts or glass reinforced nylon inserts with helical steel reinforcement shall be cast directly into the anti-vibration sleeper. Spring washers, helical springs passing through an insulated ferrule, or equivalent system, shall be used to secure the holding down system. For ballasted track system SG Iron shoulders can be embedded into the sleeper.

2) Bolts and nuts or screws shall be provided with either a galvanized, sherardized, or other corrosion resistance coating, as appropriate, which has been given a Notice of No Objection by the Engineer. Sherardizing will be preferred where there is a possibility that the fatigue life of the component will be reduced by galvanizing.

3) In order to confirm the security of the anchor system, the Contractor shall carry out a series of pull-out tests on the anchor bolts/screws. This testing shall comprise applying gradually an upward axial load to each bolts/screw selected for testing. The minimum axial load shall be 50kN and shall be sustained for a period of not less than 1 minute. Bolt, concrete or grout-bond failure by slippage or cracking, meaning the anchor system failed the test, shall require remedial work, the extent of which shall be satisfactory compliance.

4) Baseplates shall be anchored by a minimum of two (2) high tensile bolts at straight sections of the mainline. If necessary due to lateral loadings, four (4) high tensile bolts at curve sections radius less than 500 m may be used. Spring compression washers or helical springs through an insulated ferrule must be used to secure the holding down system. Surface configuration of the pad shall be consistent with the properties of the material offered. The final size of pad shall suit the type of base plates used.

5) High tensile strength holding-down bolts shall conform to JIS B1051/1052, ISO 898-1 or equivalent international standard. Helical compression springs shall be manufactured from high carbon spring steel or an equivalent standard.

6) The anchor bolts and ground/coach screw shall be capable of withstanding a pull-out test appropriate to the insert selected. Requirements of the test shall be according to EN standards for pull-out tests for the inserts.

1.13.6 Rail Seat Pads

1) Pads are to be inserted between the underside of the rail foot and the rail seat area to provide a resilient bearing surface and so that the rail is electrically isolated from the baseplate in the rail area. Pads shall be manufactured from the proven materials and shall be shaped so that they are located permanently in place. The pads shall conform to the conditions of JIS E 1117, or equivalent international standards to be given a Notice of No Objection by the Engineer.

2) The pad material offered shall be suitable for use in the Manila environment of high temperature and high humidity without degradation or significant differences in compression stiffness at the predicted extreme ranges of temperature. Pads shall be resistant to ozone and mold growth and in exposed locations to ultraviolet light also.

3) Rail seat pads shall be of the studded rubber type, with natural rubber being the predominant polymer or equivalent. The pads shall have a minimum thickness of 10 mm.

1.13.7 Baseplate Shims

1) Pads for insertion under the fastener system shall be manufactured from proven materials.

2) Surface configuration of the pad shall be consistent with the properties of the pad material offered. The final size shall suit the type of baseplates adopted and be larger than the footprint of the baseplate.

3) The electrical resistivity of resilient pad material shall be a minimum of BS903: Part C2: 1982, 1×108 ohm-cm.

1.13.8 Resistance of Rail to Longitudinal Movement with Respect to a Baseplate

1) The resistance to longitudinal movement of the rail with respect to a baseplate shall be a minimum 9kN throughout the life of the fastening system. Preference shall be given to a fastening system capable of being adapted to provide both zero and low toe loads to suit requirements for structural flexure and thermal expansion of concrete beneath the rail, where required by the civil structure design.

2) The Contractor shall design into the fastening system, a zero-toe load or variation in toe loads that will allow the viaduct or bridge structure to expand or contract due to thermal and dynamic loading. Viaduct/deck joints are located approximately every 40 m. The Contractor, as part of the design, shall do a study of the viaduct/deck interface with the rail to determine the extent of required Zero Longitudinal Restraint (ZLR) fasteners to accommodate for the longitudinal movement of the viaduct/deck expansion joints.

1.13.9 Electrical Insulation

The electrical resistance of the rail fastening assembly system measured between the rail and earth shall be at least 14.0 Ohms per km (less than 0.07 Siemens/km) under dry condition and at least 2.0 Ohms per km (less than 0.5 Siemens/km) under wet condition (or when the system is covered by a fine water mist).

1.13.10 Clips

1) Rail clips shall be standard manufactured spring steel rail fastening clips made from hot rolled steel quenched and tempered springs meeting the requirements of BS EN 10089:2002 Grade 56SiCr7. The clips shall be heat treated to achieve a surface

hardness in the range of 44-48 Rockwell C.

2) Rail Clips shall have an identifying mark to indicate year manufactured and to provide manufacturing traceability.

3) Rail clips shall be furnished with sherardized or other corrosion resistant coating given a Notice of No Objection by the Engineer.

4) Throughout all mainline and depot line plain track (other than turnout and rail expansion joint) only one type of clip shall be used to avoid multiple stock holding and remove any risk/danger of incorrect clip usage. The proposed clip shall be proposed by the contractor for Approval by the Engineer.

1.13.11 Insulators

1) Insulators shall be an ultraviolet resistant, heat-stabilized high-viscosity nylon66, nylon 6 or glass reinforced nylon 66, to the fastening manufactures' specification.

1.13.12 Baseplates

1) The cast iron baseplate shall be suited to the proposed rail section and rail clips. The baseplate shall be cast from spheroidal or nodular graphite cast iron meeting the requirements of EN1563:2011 Grade EN-GIS-500-7, ASTM A536:1884 Grade 80/55/06, AS1831:2007 Grade 500/7 or equivalent. The hardness of the baseplate shall be 170 to 240 Brinell and shall be tested for hardness before dispatch from the manufacturer's premises at 0.25% sampling rate.

2) The baseplate shall in plan preferably be of a rectangular shape with radiused corners.

3) The baseplate shall be designed to avoid retention of water or other detritus.

4) The baseplate shall have the following identification/marking:

   a) Manufacturing reference;

   b) Year of manufacture;

   c) Baseplate type; and

   d) "G" for gauge side.

1.13.13 Identification Markings

1) Each component part of the fastener assembly shall be permanently marked for identification. The location and method of marking of identification data shall be shown on the shop drawings and given a Notice of No Objection by the Engineer.

2) The following minimum information shall be provided either directly or by means of alphanumeric codes and abbreviations. It is not necessary to display it on clips.

   a) Manufacturer's name;

   b) Part number;

   c) Year of manufacture; and

3) The rail fastening system shall only be supplied by the original system designer and the supplier shall demonstrate the design has proven history of installation for a minimum 10 years.

1.13.14 Installation

The Contractor shall submit to the Engineer a set of instructions defining the procedure to be used to install the fastener system. The instructions shall describe the proper method of assembly and the tools required for installation to ensure optimum performance and longevity of service, including removal and replacement of plastic inserts.

1.14 Prestressed Concrete Sleepers (PSC)

1.14.1 For Main Line Elastic Sleeper

1) PSC mono-block sleeper for the concrete track bed shall be pre-tensioned using high tensile pre-stressing wires on the long line process, or alternatively may be post-tensioned. Sleepers shall be a minimum of 2200 mm in length.
2) Inserts shall be cast into the sleepers to take the requisite rail fastening system where required.
3) The pre-stressed concrete sleepers shall conform to the conditions of JIS E1201, E 1202 or equivalent.
4) The elastic material shall be adhered on the bottom surface of the sleeper beneath the rail position. The coefficient of elasticity shall be 25-30MN/m.
5) Deformable clearance material shall be attached to the bottom surface of the sleeper to avoid adhesion between the sleeper and track bed around the elastic material.
6) Elastic material is attached to avoid adhesion between sleeper and the track bed on the end surface and side surface of the sleeper. The coefficient of elasticity of the material shall be about 250-300MN/m.
7) The Contractor shall provide design calculations based on established design code and test results verifying the structural adequacy of the proposed concrete sleeper section.
8) At locations where a mono-block sleeper cannot be used, a shallow sleeper with the same fastener as the mono-block sleeper or other method shall be used as proposed by the Contractor and given a Notice of No Objection by the Engineer.
9) The Contractor shall propose for Approval by the Engineer, the sleeper:
   a) Production quality tests and inspections;
   b) Handling and transportation procedures;
   c) Stacking and storage procedures;
   d) Concrete design mix; and
   e) Curing details.
10) Acceptance dimensional tolerances for sleepers shall be:
   a) Length: ±5 mm
   b) Depth; +5 mm/-1 mm
   c) Width; ±2 mm.

   All sleepers shall be chamfered, or similar, as proposed by the contractor and given a Notice of No Objection by the Engineer.

1.14.2 For the Depot

1) Pre-stressed concrete sleepers shall be pre-tensioned using high tensile pre-stressing wires on the long line process, or alternatively may be post- tensioned.

Sleepers shall be minimum 2400 mm in length and have rail seat areas tilted inwards at 1:40.

2) Malleable iron or steel shoulder inserts shall be cast into the sleepers to take the required rail fastening system.

3) The pre-stressed concrete sleepers shall conform to the conditions of JIS E1201, E 1202 or equivalent.

4) The Contractor shall provide design calculations based on established design code and test results verifying the structural adequacy of the proposed concrete sleeper section.

5) The Contractor shall propose for Approval by the Engineer, the sleeper:

   a) Production quality tests and inspections;

   b) Handling and transportation procedures;

   c) Stacking and storage procedures;

   d) Concrete design mix; and

   e) Curing details.

6) Acceptance tolerances for sleeper shall be:

   a) Length: ±5 mm

   b) Depth; +5 mm/-1 mm

   c) Width; ±2 mm.

All sleepers shall be chamfered, or similar, as proposed by the Contractor and submitted for Approval by the Engineer.

1.15 Track Ballast

1.15.1 General

1) Track ballast shall be crushed rock from a quarry to be given a Notice of No Objection by the Engineer before being incorporated in the works. The ballast shall consist of crushed granite, basalt, rhyolite, quartzite, andesite or equivalent. Weathered rock shall not be acceptable. The ballast shall comprise clean angular fragments made from hard rock and shall be free from deleterious material and without thin or elongated pieces. The stones shall be produced by crushing rock and shall have a high percentage of fractured faces and be cuboids in shape. In the crushing process, secondary crushing shall be by gyroscopic crusher.

2) The ballast shall also conform to the specification with the following sieve analysis:

   a) Percentage to pass through 63 mm sieve :100%

   b) Percentage to pass through 53 mm sieve :80 - 100%

   c) Percentage to pass through 37.5 mm sieve :35 - 75%

   d) Percentage to pass through 26.5 mm sieve :0 - 40%

   e) Percentage to pass through 19 mm sieve :0 - 5%

   f) The Contractor shall make due allowance in production, transport, placing and compacting to ensure the ballast grading is maintained until completion.

3) Abrasion resistance: Los Angeles Abrasion Test shall be not more than 33%.

4) The Contractor shall also submit the following to the Engineer for Approval:

   a) Name and address of quarries to supply ballast;

   b) Results of initial testing of quarry materials for use as ballast;

   c) Contractor's proposals for source Quality Control;

   d) The Contractor shall submit details of the proposed source of supply prior to the commencement of ballast works, together with the test results of the proposed ballast material stated hereinafter;

   e) The Contractor shall also submit for approval methods of transporting ballast, including equipment to be used, from the proposed source of supply to the final destination; and

   f) Samples shall be submitted at regular intervals during the progress of the works as directed by the Engineer, and whenever the source of material changes.

5) The track ballast shall be laid directly onto the compacted sub-ballast or concrete slabs and shall have a minimum thickness of 200 mm in the Depot area and Depot access line between the bottom of the sleeper directly under each rail and the sub-ballast or concrete slabs/civil structures. The ballast section shall be placed in a trapezoidal shape with the top extending a minimum 400 mm beyond each edge of sleeper and tapering downward at 1:1.8 slope to meet the top of sub-ballast or concrete slab level.

6) When the ballast is laid, it shall be rolled in two stages and be graded to give the required sleeper level.

7) Tracks will be laid on the ballast and additional ballast added to the crib and shoulder.

8) Final adjustment of the track horizontal and vertical alignment shall be done using a tamping machine and equipment.

1.16 Rail Expansion Joints

1.16.1 General

1) The Contractor shall liaise with the Engineer and the other contractors to determine where provision of expansion joints is required to allow for relative movement at structural movement joints and between elements of the works, transition structures and elevated structures.

2) Rail expansion joints shall be provided to accommodate predicted relative longitudinal movements beyond the capacity of the fastener system to accommodate the forces generated.

3) The Contractor shall propose and apply an appropriate factor of safety to limit the risk of damage to the track work.

4) The track and/or joints shall also be capable of accommodating short- and long-term thermal contraction and expansion effects due to temperature changes and commissioning and decommissioning.

5) The rail expansion joints can comprise either a spliced joint between two rail ends or a scarf joint with the two rail ends abutting.

6) The expansion joint shall be supported on resiliently mounted FFU sleepers direct fastened to the concrete bed.

7) The expansion joint shall be designed so that the train wheels running over the joint do not result in impact loading into the rails or structure.

8) The expansion joints shall not be installed on the structural joints such as expansion joints of civil structures; structural moveable joints of civil structures, etc., in any case.

1.17 Turnouts

1.17.1 For Mainline Turnouts

1) In the areas where there are single crossovers and simple turnouts, the Contractor shall install accurately screeded concrete beds, to be overlaid on the concrete slab on top of the viaduct or embankments already previously established.

2) The Contractor shall provide gaps in the turnout slab to allow for drainage and railway circuit cables. The top slab shall be graded to provide a positive runoff of water to either the center or outside, to ensure the turnout slab tops remain free from ponding water.

3) Slots and cut-outs in the track bed shall be provided to accommodate cables, switch operating gear, drainage channels and switch motors.

4) The Contractor shall allow in the design of the turnout slabs for the fitting of signaling equipment by others.

5) The Contractor shall interface through the Engineer and supply all necessary information on the supplied rail profiles to ensure that rolling stock wheel profiles are compatible for all rails.

6) The switches, crossings, switch operating gear and expansion joints shall not be installed on the structural joints such as expansion joints of civil structures; structural movement joints of civil structures, etc., in any case. If the situation arises, where symmetrical turnout is required, the Contractor shall design and install the same. All switches shall be of shallow depth flexible design and incorporate an anti-creep device.

7) Switch preparation and fitting shall be compatible with the interface and operation of the proposed switch machine to be furnished and installed by the signaling Sub-Contractor.

8) All the single crossovers and simple turnouts on the main line, including depot and depot access line, shall have components to reduce maintenance cost. Switches shall use a low friction and lubrication-free slide baseplate system. The Contractor shall propose the slide baseplate details for Approval by the Engineer.

9) The rail fastening system of the most common assembly in the turnouts shall provide track elasticity/stiffness equivalent to the adjacent plain line track.

10) The turnouts shall be preferable with the rail can't of 1:40 when possible.

11) The turnout switch shall have a web of sufficient thickness and the switch entry angle shall be as small as possible.

12) In regions of the crossover and turnouts where track circuit isolation is required between running rails, insulated rail joints shall be used.

13) The single crossovers and simple turnouts in the main line shall be supported on resiliently mounted FFU sleepers and base plates.

14) The single crossovers and simple turnouts shall be based on the appropriate JIS E1301, 1303, 1304, 1305, 1306 and 1307 standards, or equivalents.

15) The Contractor shall design and manufacture all turnouts to incorporate GIRJs at locations coordinated by the contractor with the other systems' e.g. Signaling, Power Supply and OCS of GIRJs are required.

16) The flangeway clearances of the turnout shall be as proposed by the Contractor to suit the wheel diameter, wheel profile (including worn wheels), bogie arrangement and turnout geometry. The wheel profile and bogie dimensions/characteristics shall be as coordinated by the Contractor with the Rolling Stock Contractor.

17) Turnouts and REJ's shall be clearly and indelibly marked in the rail web with their reference number and installation location. The markers shall be as proposed by the Contractor and given a Notice of No Objection by the Engineer.

18) The Signaling Sub-Contractor shall install the switch operating mechanism on the assembled switch under the supervision of the track works Sub-Contractor with the track works Sub-Contractor providing all necessary support.

19) The Track works Sub-Contractor shall contribute information regarding their Track inspection and certification regime into a test plan (to be produced by the Contractor) for the integrated proving test of the switch and the switch operating mechanism. Test reports shall be submitted for the Engineer's Approval.

1.17.2 For Depot Turnouts

1) All track work units in the depot shall be on FFU sleepers on a ballast bed.

2) The rail fastening system for the track work.

3) The #8 turnouts shall be designed for train operation at 25 km/h through the turnout side line.

4) Materials shall conform to the requirements of the Technical Requirements.

5) Turnouts shall be based on the appropriate JIS E 1301, 1303, 1304, 1305, 1306 and 1307 standards, or equivalent.

6) All the turnouts in the depot shall have components to reduce maintenance costs. Depot line switches shall have a lubrication-free, low friction slide surface. The Contractor shall propose the slide baseplate details for Approval by the Engineer.

7) The Contractor shall design and manufacture all depot line turnouts to be compatible with standards on track tamping and lining equipment.

8) The Contractor shall design and manufacture all turnouts to incorporate GIRJs at locations coordinated by the contractor with the other systems (Signaling, OCS and Power Supply), should GIRJs be required.

9) The flangeway clearances of the turnout shall be proposed by the Contractor to suit the wheel diameter, wheel profile (including worn rail profile), bogie arrangement and turnout geometry. The wheel profile and bogie dimensions/characteristics shall be coordinated by the Contractor with the Rolling Stock Contractors.

10) Turnouts shall be clearly and indelibly marked in the rail web with their reference number and installation location. The markers shall be proposed by the contractor for the Engineer's Approval.

11) The Contractor shall install the switch operating mechanism on the assembled switch under the supervision of the Contractor. The Contractor shall provide all necessary support.

12) The Contractor shall contribute information regarding their track inspection and certification regime into a test plan (to be produced by the contractor) for the integrated proving test of the switch and the switch operating mechanism. Test reports shall be submitted for the Engineer's Approval.

13) Test track turnouts shall be compatible with the maximum attainable speed at the test track.

1.17.3 Set off Siding Track Turnouts

Set off sidings #6 turnouts shall be installed on the main line to connect to the siding used for maintenance vehicle stabling. The trackform shall be the same as that used for other mainline turnouts.

1.17.4 Ordinary Rails in Turnouts

1) The running rails of the single crossovers and simple turnouts shall be high strength rails.

2) The main line turnouts shall be tangential in design and constructed from the types of rail listed below with compatible components and proper transition/compromise rails.

- Rail for #10 and #12 Single Crossover - JIS60 or EN60E1;
- Rail for #10 and #12 Simple Turnouts - JIS60 or EN60E1.
- Rail for #6 Symmetrical Turnout – JIS60 or EN60E1

In depot turnouts, JIS 50N rail shall be used with compatible components.

3) All main line turnouts shall be head hardened rail, including the closure rails between crossovers.

4) The Contractor shall install an extra 20-25m head hardened rails at switch and crossing ends to act as a transition between Grade R260 running rails and turnout structure.

1.17.5 Switchblades, Crossings, Noses

1) The switchblades shall be heat treated to strengthen for abrasion resistance.

Heat treatment shall be followed to the slack quenching method on JIS E1303 or equivalent.

2) The switchblades shall be made from S rail specified in JIS E 1101 or equivalent.

3) The heel end of the switchblades shall be forged to the cross section of its turnout rail.

4) Manganese crossings shall conform to the appropriate technical specification for the supply of cast manganese steel crossings for switch and crossing work.

5) All noses of the single crossovers and simple turnouts shall be cast from manganese steel or high strength rails assembled and welded by Electron Beam Welding (EBW).

6) Low-friction roller/slide chairs shall be used which require no lubrication during their service life. Low-friction roller/inserts shall be readily replaceable.

7) Turnouts and crossovers shall avoid free (expansion) ends of structures and a turnout shall not be permitted to span over a structural movement joint. All movable parts of special track work and associated operating equipment shall be prohibited from being positioned over a structural movement joint and shall, wherever possible, encroach no closer than 5m from any such joint.

8) The Contractor, based on the turnout supplier's design, shall establish the detailed positioning of the rail supports and cut-outs where signaling equipment is required to be installed.

1.17.6 Fastening System

In the main line FFU sleepers shall be resiliently mounted on the concrete bed by a direct fixation method with two or more high tensile strength bolts set or screws into holes formed in the concrete bed.

1.17.7 Anchorage System

1) The single crossovers and simple turnouts in the main line shall be resiliently mounted on the FFU sleepers by a fastener anchorage system.

2) The fastener anchorage system to the FFU sleepers shall be with two or more high tensile strength bolts or screws set into holes formed in the FFU sleepers.

3) The FFU sleepers shall be resiliently mounted on the concrete bed by a direct fixation method with two or more high tensile strength bolts set or screws into holes formed in the concrete bed.

4) In order to confirm the security of the anchor system, the Contractor shall carry out a series of pull-out tests on the anchor bolts/screws. There shall be no failure of bolt, concrete or grout bond by slippage or cracking meaning the anchor system failed the test shall require remedial work, the extent of which shall be determined by the Engineer.

5) The base plates of single crossovers and simple turnouts shall have sufficient mechanical performance.

1.17.8 FFU (Fiber Reinforced Foamed Urethane) Sleepers

The FFU sleeper shall conform to JIS E 1203 or equivalent.

1.17.9 Interchangeability

1) The turnouts are constructed using the JIS standard with EN60E1 or JIS60 profile rail, the forms of which are standardized, and spare parts can be delivered by different producers/suppliers.

2) All components of the turnout shall be manufactured to dimensional tolerances sufficient to ensure that all units of the same component parts are interchangeable.

1.17.10 Geometry of Turnouts

1) The Turnouts shall be designed for the following operational speed.

Table 1.17.1

Mainline			Depot	
Turnout Type	Operation speed		Turnout Type	Operational speed Through turnout
	Through straight side line	Through Curved side line		
#12SN	160 km/h	55 km/h	#8	25 km/h
#12	120 km/h	55 km/h	#6	15 km/h
#10	120 km/h	45 km/h		
#6 Temporary	160 km/h	20 km/h		

2) The actual geometry of turnouts shall be based on the appropriate JIS standards, or equivalent.

1.17.11 Tolerances

In turnouts, the following additional tolerances to those previously specified shall apply:

1) Crossing and checkrail flange ways shall be corrected to within ±1 mm. The minimum flange way opening between the back edge of an open switch and the running edge of the stock rail shall under no circumstances be less than the design opening;

2) The switch rail shall fit snugly to the stock rail along its length such that it is not possible to insert a feeler gauge wider than 0.5 mm into the gap between them;

3) When the switch rail is closed to the stock rail, there shall be no gap greater than 0.5 mm between the switch rail web and any distance block; and

4) When the switch rail is closed to the stock rail, the vertical clearances from the underside of the switch rail foot to the non-roller fitted slide plates shall be uniform 0.5 mm and the switch rail foot shall bear evenly on the rollers. The manufacturer shall supply acceptance tolerances for endorsement.

1.17.12 Materials

1) The switch rails shall be manufactured to a shallow depth, with enough thick web asymmetric section forged to standard rail profile near to the heel and shall be heat treated at the head.

2) No welded joints shall be allowed within the entire length of the switch rails.

3) The switch assembly shall comprise a flexible switch and the stock rails fitted with distance blocks. Suitable anti-creep precautions shall be incorporated into the design of the switch and stock rail assembly.

4) Crossings in the main line shall be cast manganese mono-block with factory welded R350HT grade steel weldable legs or equivalent. The wheel contact surfaces shall be fully machined either by planning or milling.

5) The main line turnouts shall use the same holding down bolt system as the plain line rail fastening assembly.

6) The Contractor shall demonstrate that a damaged plastic insert can be removed and replaced with simple tools, without the need to use concrete coring equipment.

7) Each crossing shall be identified by markings in raised letters which shall indicate the following:

   a) Crossing type;

   b) Manufacturer identification;

   c) Month and year of manufacture; and

   d) Project Logo.

8) Adjustment of running rail track fasteners shall be possible without the requirement to remove the check rail.

9) The inside elastic stock rail fastening shall hold down the stock rail at the inside rail base with an equivalent load to the standard fastenings. The spring must be accessible for removal and replacement without disassembly of the baseplate.

1.17.13 Pre-Assembly

1) Factory acceptance for the turnout manufacturer and subsequent material and preassembly testing shall be in accordance with the ERG and ERT.

2) The dimensions of all turnouts' parts and rail shall be checked against the approved turnout design drawings prior to installation at site, then prior to concrete pour, jointly inspected with the Engineer for position, geometry, final survey and tolerance conformity.

1.18 Rail Welding

1.18.1 Permitted Types of Welding

1) Rail for all main line and depot tracks outside the limits of special track work such as turnouts shall be site welded into continuous long strings using either flash-butt or gas pressure welding processes using on-track/off-track equipment that shall have the capability of adjusting rail heads for individual welds. The long strings shall themselves be site welded by flash-butt, gas pressure or alumina thermic methods. Final closure welds at destressing points shall be similarly executed in a manner compatible with the method used to attain the stress-free temperature.

2) Suitable post-weld treatment is required to restore head hardness in the case of welding together two (2) rails of Grade R350HT.

3) All rails to be welded shall be oriented in the same manner such that the brand marks always lie to the same side on all rail strings.

4) It is anticipated that as a percentage of the total welds in the track, gas pressure and/or flash-butt types shall constitute no less than 90% of the total per single rail-km on average, based on plain line only.

5) Rail within turnout limits can be welded using an accepted alumino thermic welding process.

1.18.2 Alignment and Finishing

1) Vertical alignment shall provide for a flat running surface. Any difference of height of the rails shall be in the base.

2) Horizontal alignment shall be adjusted, according to the welding machine type, either center line or gauge face.

3) All welds shall be ground on the full rail head and gauge face, and where required the rail foot. Alumino-thermic welds shall be located midway between fasteners (+/50mm). Flash butt welds shall not locate on fastener, where a flash butt weld inadvertently falls on a fastener, due to the final fastening down operation, the foot of the rail shall be ground by the contractor by a means given a Notice of No Objection to achieve EN60El rail foot profile.

4) The geometrical tolerances, using a 1m straight edge, after final weld grinding are as follows:

   a) Gauge face ± 0 .5 mm; and

   b) Rail Head +0.5, - 0.1 mm.

1.18.3 Flash-Butt Welding (FBW**)**

1) The FBW shall follow EN 14587-1-2007 Railway applications -Track-Flash butt welding of rails.

   The Contractor shall submit for Approval by the Engineer a method statement including full details of the welding machine and welding process he proposes to use. These shall include but shall not be limited to the following:

   a) Welding procedure, equipment description;

   b) Calibration methods, rail shearing method, and rail straightening and grinding method;

   c) Cooling procedure for preserving the hardness of head hardened rails;

   d) Certification of welding machine operators;

   e) Rejection criteria for welds;

   f) Procedure for detecting defective welds;

   g) Procedure for replacing defective welds; and

   h) Confirmation that the flash butt welding machine, associated equipment, and rail stockpile are within the permissible loaded permitted by the viaduct design.

2) Weld Test Samples

   a) Prior to making any welds on Site, the Contractor shall produce evidence of the competence of his welding machine operators in the form of a test certificate issued by the machine manufacturer, and also evidence of a minimum of one (1) years' experience of similar work on a similar machine.

b) In the presence of the Engineer, each welding team shall produce six (6) welds for testing. If the welding machine operators are changed during the course of the Project, repairs are carried out or the machine is relocated, the Contractor shall, in the presence of the Engineer, produce another six (6) welds for testing from the team having the new operator(s), and check repairs or relocation.

c) The six (6) test welds shall comprise two (2) specimens of the each of the following combinations:

i) Two (2) standard rails welded together;

ii) Two (2) head hardened rails welded together; and

iii) A standard rail and head hardened rail welded together.

3) Weld Testing and Quality Check

Weld testing shall follow EN 14587-1-2007 Part 6.4 Approval Tests or equivalent. UT; Magnetic Particle Testing (MPT); alignment and visual check shall be carried out on all Site welds produced.

4) Production Records

During production, a recorder shall be attached to the welding machine which shall record the critical parameters during weld execution. Such parameters shall include but are not limited to:

a) For Flash-Butt Welds:

i) Welding current;

ii) Upset force;

iii) Displacement; and

iv) Time.

b) For Gas Pressure welds:

i) Gas consumption;

ii) Forging pressure;

iii) Distance; and

iv) Time.

c) The Contractor shall carefully examine the recorded parameters after each weld. If it indicates characteristics that depart significantly from the expected process regime, the weld shall be considered defective and shall be immediately replaced.

d) At the end of each machine shift, copies of the recordings for each weld shall be delivered to the Engineer together with the information requested on the specimen Welding Record Form. All welds, including defective welds that have been cut out, shall be included in the daily records.

1.18.4 Alumino Thermic Welding

1) Submittals

The Contractor shall submit for Approval by the Engineer a method statement including full details of the welding process proposed to be used. It is preferred that the Contractor use the 'One-Shot Crucible' process. This method statement shall include, but not be limited to, the following:

a) Details of a third-party independent testing agency for MPT and UT testing;

b) Equipment description;

c) Certification of welding crews;

d) Rejection criteria for welds;

e) Procedure for detecting defective welds;

f) Procedure for replacing defective welds (wide gap welding is prohibited);

g) Minimum and maximum gap between rail ends;

h) Method used for placing, fixing, and maintaining the rails in alignment and position during welding;

i) Method used for preheating, if required, including item and temperature;

j) Tapping procedure including the minimum time required to cool the weld under the mold insulation;

k) Method used, including a description of special tools and equipment, for removing excess weld metal and finishing the weld to the final rail head contour; and

l) Consideration should also be given to the use of the "one-shot cubicle" process.

2) Preproduction Tests

a) Prior to making any welds on the Site, the Contractor shall produce evidence of the competence of the welding crews. In the presence of the Engineer and the welding machine manufacturer's representative experienced in alumino-thermic welding, each crew shall produce six (6) specimen welds for testing. If anyone (1) or more member(s) of a welding crew is changed during the course of the Contract, the Contractor shall, in the presence of the Engineer, produce another six (6) specimen welds for testing from the crew having the new members.

b) The six (6) test welds shall comprise two (2) specimens of the each following:

    i) Two (2) standard rails welded together;

    ii) Two (2) head hardened rails welded together; and

    iii) A standard rail and a head hardened rail welded together.

c) All welds shall be trimmed and ground to profile on the rail head.

d) These shall be subjected to Ultrasonic Testing (UT) to check the integrity of the fusion faces throughout the internal rail section and also to a magnetic particle or dye penetration inspection to detect any surface breaking discontinuities.

e) One (1) of each type of weld shall have a hardness traverse made longitudinally about the weld center line to establish the heat affected zone pattern and minimum hardness values.

f) This sample shall then be cut longitudinally and macro-etched to determine the shape and dimensions of the heat affected zone.

g) For these welds, the hardness of the rail head shall be recorded across the heat affected zone. The loss of hardness shall be not more than 70 HB relative to the parent rail hardness in the case of Grade R350HT rails and not more than 30 HBW for Grade R260 rail.

h) The other specimen of each pair shall be subject to a slow bend test as described in EN 14587-1-2007.

3) Production

a) All welds shall be made under the direct supervision of an experienced welding supervisor;

b) Each qualified welder shall be provided with an identification stamp. After the completion of each weld, the welder shall apply the stamp to the rail web in a way that is readily identifiable. In addition, the alumino-thermic welds shall be identified in a manner compatible with the system adopted for flash-butt or gas pressure welding;

c) The completed weld shall be finished by mechanically controlled grinding;

d) The Contractor shall be permitted to employ post-weld straightening only whilst the surface temperature of the weld is above 260℃;

e) No weld shall be closer than 6.0 m to an adjacent weld; and

f) The Contractor shall inspect every weld by ultrasonic testing in accordance with ASTM E 164; MPT plus alignment and visual check. Each completed weld shall have full penetration and complete fusion and be entirely free of injurious flaws.

4) Test Records

Records of each weld shall be kept containing the information requested on the specimen Welding Record Form. At the end of each shift, copies shall be delivered to the Engineer. All welds, including defective welds that have been cut out, shall be included in the daily records.

5) Inspection and Testing

a) The Contractor shall submit full details of the testing arrangements he proposes to adopt. These shall include but not be limited to the following:

i) Ultrasonic inspection procedure, equipment description and calibration methods;

ii) Daily calibration of ultrasonic inspection equipment;

iii) Name of laboratory and procedure to be utilized in radiographic testing; and

iv) Training and certification of ultrasonic and radiographic test person.

6) Test Methods

a) Ultrasonic testing shall be carried out within twenty-four (24) hours of the weld being completed.

b) The calibration of the equipment shall be checked at the beginning of every day and after every four (4) hours of use thereafter.

c) The equipment shall be fitted with a CRT or LCD screen and scale and shall be capable of generating a calibrated paper tape trace to record accurately the CRT screen indications when a noncompliant weld is suspected.

d) The test procedure shall be in accordance with the instructions of the equipment manufacturer.

e) Where a non-compliant weld is suspected, the Contractor shall make a permanent trace recording and shall paint the rail web on both sides across the weld.

7) Acceptance of Welds

a) In general, welds with test results indicating the presence of internal cracking, lack of fusion or surface breaking cracks shall be rejected.

b) Rail ends showing evidence of electrode burns shall lead to weld rejection.

c) The specific criteria for approval/rejection of welds for the processes proposed by the Contractor shall be determined in due time and endorsed by the Engineer.

d) Welds showing a response at any level that is identified as a crack or lack of fusion shall not be acceptable.

8) Consolidated Welding Reports

For each weld, the welding records and test records shall be presented in a format acceptable to the Engineer.

1.19 Buffer Stops

1) Buffer Stops on the main line and depot test track: The Contractor shall provide friction sliding buffer stops and concrete stop block at the ends of the main lines. These shall be capable of stopping a train with a capacity of 10 car train with axle load 16 ton at 12.5 km/h impact speed; over a distance of 12.5 m, and train weight of empty train at 7.5 km/h impact speed over a distance of 7.0 m respectively;

2) Buffer Stops in the Depot: The contractor shall provide fabricated buffer stop at all track ends in the Depot. These shall be capable of stopping a train with a capacity of weight of empty train at 7.5 km/h impact speed; over a distance of 7.0 m; and

3) The Buffer stops shall be if an insulated type so as not to short-circuit the track.

4) The buffer stops shall be positioned to enable 10 cars trains to be stabled without hindering service operations or protruding beyond fouling points.

5) Buffer stops installed on the mainline shall be equipped lights.

1.20 Insulated Rail Joint Glued Type

1) General

a) All glued insulated rail joints shall be factory made and welded into the track. Each joint shall be fabricated from two (2) rail with each rail not less than 9m long, which that shall be precisely cut perpendicular to the rail line. This technique for matching rail ends shall be strictly applied and any joint discovered to have the jointed ends matched in any other way shall be rejected;

b) The fishplates shall be full contact type for the glued type of joint;

c) The end plate (fiber glassed) shall be 5-6mm thickness; and

d) All the main line insulated joints shall be the 6-hole type of the Glued type (GIJ) that is of a standard design. The insulated joint shall be designed for CWR forces and shall meet a European or AREMA Standard.

2) Installed tolerances, with 1m Straight Edge

a) Vertical Dip Nil.

b) Vertical Peak +0.3 mm.

c) Lateral, gauge face - 0.2/ +0.3 mm no gauge reduction.

3) Materials

a) Fishplates shall be quenched and tempered carbon steel in accordance with UIC Code 864-4/0.

b) Bolts shall be high-strength bolts and shall comply with the requirements of ASTM A490 and UIC 864-2/0 for Strength Category 8.8. Washers shall comply with the requirements UIC 864-3/0 for steel spring washers.

c) Insulating material shall be high pressure, laminated design, impervious to oil, grease, and water, and having electrical characteristics equal to or greater than fiber insulation, meeting requirements of the AREMA Manual 2000, Part 2 Section 2.11 & 2.12 and the electrical resistance test specified herein.

d) The Contractor shall demonstrate that the adhesive to be used for fabrication of the bonded insulated joints has a proven life of not less than fifteen (15) years.

4) Installation

The position of each joint shall be central between rail supports to within 50 mm and, in the case of joints being required in both rails at any particular location, they shall be square to within 50 mm of each other.

5) Pre-Production Testing

Test Specimens: Two (2) specimen joints shall be tested to either a European or AREMA 2000 Standard, and shall include a tensile load test, a joint compression test and stroke rolling load test; parameters to be set by the manufacturer and given a Notice of No Objection by the Engineer.

6) Production Testing

The Contractor shall test the resistance of every bonded insulated rail joint prior to installation and in situ by applying 50 VDC across the joint. The resistance shall not be less than 10 MΩ or whatever higher benchmark value in the standard that the joints are made and tested.

7) Robustness

At the end of the Contract, the installed bonded joints shall be visually inspected. There shall be no evidence of separation between adhesive and steel or movement between the fishplates and the rail. Joints that exhibit any visible movement between the fishplates and the rail ends or at the gap between the rail ends shall be replaced at the contractor's expense.

1.21 Staff Walkway in Depot

1) The Contractor shall lay the walkway for staff in the necessary locations in the depot.

2) Precast concrete board may be used for the walkway. The surface of precast board shall have anti slip condition. That precast board shall be laid on the surface of ballast layer as steady condition.

3) The width of the walkway along the stabling track shall be 400 mm. The width of the walkway across the stabling track as level crossing shall be 600 mm.

1.22 Stray Current Corrosion Control

1) The Contractor shall incorporate into his design precautions to minimize stray current corrosion.

2) The design of the track bed shall provide a positive roll-off in the order of 1 to 2% and ensure that the drainage is adequate to prevent standing water in the vicinity of the rails, which is the possibility of invalidating the insulation between the rails and the track bed.

3) General requirements for earthing and bonding the structures are to be determined in liaison with the Civil Works Contractors.

4) Cross-bonding of the running rails, stray current return cabling, etc. will be carried out by the Contractor.

5) The contractor shall be responsible for providing all earthing connections from track level to earth rods located at ground level as detailed on the drawings.

1.23 Walkway

1) The Contractor shall design, supply and install an emergency walkway system shall run continuously along the whole main line on both sides of the track. The walkway shall incorporate a walking surface and handrail to enable passengers to safely evacuate the train at any point along the viaduct so that they can proceed to the nearest station or other point of safety.

2) The walkway shall be compatible with the walkway design being adopted on other sections of the NSCR project and shall have a design life of 50 years.

3) The walkway shall be designed to withstand the loads shown in the below table. The total weight of the walkway including handrail shall not be more than the weight shown. The design load limit herein is based on the maximum additional load that the viaduct superstructure can accommodate.

Table 1.23: Walkway Loads

Load Case		**Description**
Self-weight	Walkway and Handrail	3.0 kN/m run each side
Self-Imposed loads	Cabling and containment	4.5 kN/m run each side
	Pedestrian loading	5.0 kN/m^2 run each side

4) The: raised walkway shall be designed in accordance with the AASHTO LFRD Bridge Design Specifications-2016 or Design Standards for Railway Structures and Commentary (Steel-Concrete Hybrid Structures)-2016, or any other codes and standards proposed by the Contractor and given a Notice of No Objection by the Engineer,

5) The material proposed for the walkway must have a flame spread rating of 25 or less, as tested in accordance with ASTM-E-84, and meet the self-extinguishing requirements of ASTM D-625.

6) The emergency walkway system shall comprise, as a minimum

   a) Supports;

   b) Walkway;

   c) Ramps;

   d) Walkway earthing

   e) Handrail

   f) Cable containment; and

   g) Provisions for drainage within the walkway

7) The contractor shall ensure that the walkway, in any condition shall not infringe the structure gauge for all tangent and curved tracks.

8) The walkway shall be designed to be independent of the viaduct parapet and shall be fabricated off site for assembly on site.

9) The walkway top surface level shall be set 150 mm below the train vehicle floor taking into account cant of the track.

10) The height and width of the walkway at outside curved sections shall be adjusted to keep the distance which shall be not more than 400mm from the train vehicle door.

11) The height and width of the walkway on curved sections shall be adjusted such that the separation between the construction gauge and the edge of the walkway is more than 100mm.

12) The width of the walkway shall be nominally 1200 mm at the tangent sections. At OCS mast and telecommunication monopole locations the available usable width of the walkway will be reduced.

13) The Contractor shall provide suitable cable hangers underneath the station platform to support the cables.

14) The materials used in the fabrication and installation of the walkway shall be in

accordance of the following;

a) The walkway frame and base plate to support the deck for walk surface shall be made of hot dipped galvanized steel according to ASTM A123/A123M and/or ASTM A153/A153M or an equivalent standard which has been given a Notice of No Objection by the Engineer. The frames shall have base plates which shall be fixed to the viaduct deck using chemically anchors.

b) The Anchor bolts shall meet the requirements of ASTM A307, or equivalent specification that has been given a Notice of No Objection by the Engineer. Any drilling to the viaduct deck shall be given a Notice of No Objection by the Engineer.

c) The walkway deck shall be made of material given a Notice of No Objection by the Engineer. If FRP is used for the deck it shall have high anti-slip rating, and safe for walking in wet surface conditions.

d) The handrail shall be made of hot dipped galvanized steel according to ASTM A123/A123M, aluminum or FRP materials proposed by the Contractor and given a Notice of No Objection by the Engineer.

e) The walking surface or coping shall be yellow or other high visibility color.

15) Where the emergency walkway changes from side to side the Contractor shall design and install pedestrian crossings. Down and up ramps are to be provided with a slope of 1:12 between the emergency walkway and Track crossing. The proposed ramp shall have an anti-slip surface. Walkways shall interface with the stations at platform ends.

16) Provision shall be made for maintenance ladders with retractable handles that shall not infringe the structure gauge. The Contractor shall provide these at both ends of the stations, at turnout locations and at 200m intervals. The positions shall be subject to the Engineers Approval.

17) Pedestrian crossings shall be clear of switch and crossing, switch machine, rodding, drive, and other moving parts. The pedestrian crossings shall be at least 5m away from a switch toe.

18) Walkways shall not block any drainage inlets or cable openings.

19) The cable containment shall ensure suitable separation between the different types of cables. Cable tray hanger/support shall be made of hot dipped galvanized steel to avoid corrosion.

20) The separation of the different types of cables shall conform with Philippine and International Standards.

21) Power cables supported by the cable containment shall be cleated or fixed by a method given a Notice of No Objection by the Engineer. Fiberoptic cables shall be continuously supported by the means of table tray or trunking.

22) Cable tray design shall consider the minimum bending radius of all cables especially power cables of large diameters.

23) There shall be no sharp edges in the entire cable tray system so as not to damage any cables during pulling and installation.

24) The walkway shall support any commercial telecommunication cables and leaky coaxial cables to be installed at a later date. In addition, the cable containment

shall be designed to have 25% spare capacity for future cables.

25) For the at grade areas concrete footings shall be provided for the walkway.

26) The contractor shall design and assemble a mock-up of the proposed walkway system for the worst case of horizontal curvature and applied cant. This mockup shall be prepared during the design phase and before the commencement of manufacture.

27) Emergency lighting shall be provided in accordance with NFPA 130 in tunnel and covered areas and other dark areas where there is no or limited ambient lighting.

28) The Contractor shall provide a suitable earthing system for the walkway taking into consideration safety and stray currents.

1.24 Access Platform and Stairs

The contractor shall design, supply and install access platform for drivers and cleaning staff in the depot stabling areas. These platforms shall be positioned to allow access to the nearest passenger train doors and designed based on the following parameters:

1) A steel structure for the platforms with reinforced concrete foundation plinths adopting I-shaped sections except for bracing and handrails;

2) The structure shall have suitable corrosion protection to meet the design life requirements of this specification.

3) Suitable for uniformly distributed live load of at least 200 kg/m^2;

4) Height of the platform shall be approximately 1m to allow safe access to the train doorway with a width to fit between the trains with adequate clearance. The structure is envisaged as a succession of steel portals 1 m-high, 1 m- wide, spaced 3m between each other, longitudinally connected with lateral beams with diagonal bracing;

5) The walking surface shall be of anti-slip material;

6) '\The parapets stanchions shall be I-shaped columns spaced at 3m with tubular handrails;

7) Provision of LV Power outlets on the platform;

8) The platform shall be suitably earthed to minimize step and touch potential.

9) The platform shall be protected against corrosion to be proposed by the Contractor;

10) Length of the platform should facilitate easy entry and exit into the Trainset for 2 Car length;

11) Platforms shall be located at the buffer end of the stabling yard on both side of the line in U shape; and

12) Suitable ramp access for platform to be made for easy entry of the O&M personals with trolleys/carts.

1.25 Depot Line Load Gauge

1) The Contractor shall design, test, commission and install a construction vehicle load gauge in each Depot to check that the Works Trains are within the 'gauge' before leaving the infrastructure maintenance area.

2) The contractor shall propose for Approval his construction vehicle load gauge design,

which shall be in accordance with the construction vehicle load gauge shown on the Drawings.

3) The Contractor shall propose the installation location for each Depot.

4) The load gauge main frame shall be fabricated from structural steel, e.g., RHS, with a sub-frame and chains or similar, as proposed by the contractor, for the actual load gauge. The load gauge shall be loose to avoid damage to any load that might infringe the gauge and shall be painted in a bright color paint.

5) The main frame shall be made stable in all operating conditions by means proposed by the contractor and given a Notice of No Objection.

1.26 Miscellaneous Track Work Items

All products or component parts of the miscellaneous track work items specified in this section shall have a proven history in service of at least ten (10) years in a railway or a heavy rail transit system.

1.27 Track Maintenance Vehicles and Equipment

1.27.1 General

Track maintenance vehicles shall be provided for the ongoing maintenance of the line. Main track maintenance being considered are replacement of materials, rail grinding, 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 1.27.1 Track Maintenance in Main Line

No.	Maintenance	Length/shift	Maintenance vehicles
1	Measuring Track	25km/track	Motor car, Track Recording Car
2	Rail Grinding	500m/track	Motor car, Rail grind car
3	Rail Replacement	100m/track	Motor car, Flat wagon, Covered wagon
4	Re-Alignment	200m/track	Motor car, Covered wagon
5	Tamping	300m/track	Small Tamping Machine
6	Mobile Flash Butt Welding (FBW)	2000/track	Flash Butt Welding Machine

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.

All track mounted maintenance vehicles (Motor car with crane, Track Recording vehicle, Rail profile grinding vehicle and Mobile flash butt welding machine) shall be equipped with telecommunications and signaling equipment with the exception of Small Tamping Vehicle which is only equipped with onboard radio. In addition, all maintenance vehicles shall have couplers provided by the CP NS-02 contractor. These couplers once received from the CP NS-02 contractor shall be installed on the maintenance vehicles at their place of manufacture.

The Contractor shall provide a back-up software for the equipment wherein software program is required. Track maintenance car or equipment needed to be supplied are described as follows.

1.27.2 Motor Car with Crane

1) Quantity: Two (2) Sets

2) Functional Requirements

A self-propelled, multi-purpose track and infrastructure maintenance vehicle shall be supplied.

3) Design and Performance

The track and infrastructure maintenance vehicle shall be a multi-purpose. Diesel-powered vehicle shall be used as single vehicle as well as towing power for maintenance cars along the main line and depot. That 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 or depot.

4) Performance

a) Traction from depot to main line: total 120 tons freight wagon on rail;

b) Full hauling velocity at least 25km/h at any gradient of the alignment;

c) Full hauling velocity 40km/h on main line;

d) Self-running velocity 60km/h on main line;

e) Running minimum radius 92 m in depot;

f) Equal operation in forward and reverse directions; and

g) Bi-directional cab operation.

5) Vehicle dimensions and features

a) Vehicle length approximately 10 m and to follow the rolling stock and structure gauge.

b) Gauge on rail 1435mm

c) Flange back to back distance between 1359mm and 1362mm.

d) Minimum curve radius 92 m in depot area

e) Max axle load 16t

f) Loading platform with slip-resistant surface, accessible from ground level via steps

g) Platform load capacity 3ton

h) If maximum height of the equipment is over 4.0m, it is subject for the review and approval by the Engineer

i) Connector for pneumatic and electrical control of hauling procedure shall be equipped with needs.

6) Drive Power: All vehicles engines and machines must follow the requirements of the DENR order 2015-04

a) Self-propelled, diesel powered, emission-optimized

7) Cab

a) The cab shall have 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.

d) Two driving cabs each with a fully equipped driving console.

8) Operating Equipment

a) Couplers shall be provided for hauling flat open wagon and covered wagon;

b) Decelerating hydraulic and or pneumatic brakes are applied at track running and road traveling; Suitable onboard compressor of adequate capacity shall be provided for pneumatic brake and horn air requirement.

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.

9) Hydraulic Crane

a) Hydraulic crane, lifting capacity approximately 12 tons, with accessories like lifting tools, personnel basket, and grip tongs etc. with a rotation of 360°. The crane must equip with an overload protection, emergency switch-off and other safety- relevant devices.

b) Outriggers for crane operation

1.27.3 Open Wagon with Side Plate

1) Quantity: Six (6) Sets

2) Functional Requirements

Side covered wagon hauled by motor car, transporting materials of track and infrastructure maintenance shall be supplied.

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:

b) Track works materials, e.g. sleepers, ballast, equipment, etc.

4) Vehicle dimensions and features:

a) Track gauge 1435mm;

b) Flange back to back distance: 1359-1362mm;

c) Vehicle to follow rolling stock and structure gauge;

d) Vehicle overall length approximately 6.0m;

e) Floor level shall be 1.1m or less match to station platform (1.09m) from TOR;

f) Weight of empty car under 15 ton;

g) 2 axles;

h) Couplers shall be identical to couplers on motor car;

i) Wheels monoblock type, with same profile as passenger car wheels and same brake type;

j) Pneumatic brakes and Mechanical parking brake shall be provided, applied via hand from either side of wheel;

k) Fully Load capacity 10 tons;

l) Hauling speed on main line 40km/h;

m) Minimum curve radius 92m in depot area.

5) Operating equipment

a) Loading platform with slip-resistant surface;

b) All sides of the wagon shall have hinged boards (approximately 400 mm high fold down type) around periphery of vehicle; and

c) Two chocks are attached to wheel tread at track working.

1.27.4 Open flat Wagon

1) Quantity: Six (6) Sets

2) Functional Requirements

Flat open car hauled by motor car, transporting materials of track and infrastructure maintenance shall be supplied.

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;

4) Vehicle dimensions and features

a) Track gauge 1435mm;

b) Flange back to back distance: 1359-1362mm;

c) Vehicle to follow rolling stock and structure gauge;

d) Vehicle overall length approximately 13.92m;

e) Floor level shall be around 1.1m or less match to station platform (1.09 m) from TOR;

f) Weight of empty car under 10 tons;

g) Couplers shall be identical to couplers on motor car

h) Coupler between flat wagon vehicles shall be provided with sufficient length

i) Wheels monoblock type, with same profile as passenger car wheels and same brake type

j) Pneumatic brakes and Mechanical parking brake shall be provided, applied via hand from either side of wheel;

k) Fully Load capacity 6 ton;

l) Hauling speed on main line 40km/h; and

m) Minimum curve radius 92m in depot area.

5) Operating equipment

a) Loading platform with slip-resistant surface

b) All sides of the wagon shall have no side cover

c) Motorized crane maximum capacity 1 ton, shall be erected at floor Side

d) Two chocks are attached to wheel tread at track working

1.27.5 Track Recording Vehicle

1) Quantity: Two (2) Sets

2) Functional Requirements

A self-propelled measuring equipment for measuring track irregularity shall be supplied.

3) Design and Performance

Track Recording 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) vertical misalignment of both rail

e) lateral misalignment of track center line

f) wheel off loading,

g) average rail corrugation depth of track segment

h) rail side wear, rail top wear, rail head profile, rail inclination

i) chainage, speed measurement and marker

j) Alignment;

k) Twist; and

4) Equipment dimensions and features

a) Track gauge 1435mm;

b) Flange back to back distance: 1359-1362mm;

c) Machine to follow rolling stock and structure gauge;

d) Machine overall length approximately 15.0m

e) Pneumatic brakes and Mechanical parking brake shall be provided, applied via hand from either side of wheel;

5) Operating performance

a) Measure speed 80km/h;

b) Reproduce measure accuracy all items 0.5 mm

1.27.6 Rail Profile Grinding Vehicle

1) Quantity: One (1) Set

2) Functional Requirements

Self-propelled rail grinding vehicle shall be supplied.

3) Design and Performance

The rail grinding vehicle 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;

4) Vehicle dimensions and features;

a) Track gauge 1435mm;

b) Flange back to back distance: 1359-1362mm;

c) Vehicle to follow rolling stock and structure gauge;

d) Axle load under 16t;

e) Totally 12 Grinding Stones or Discs (6 Grinding stones or grinding discs ×2 sets);

f) Couplers shall be identical to couplers on motor car;

g) Wheels monoblock type, with same profile as passenger car wheels;

h) Pneumatic brakes and Mechanical parking brake shall be provided, applied via hand from either side of wheel; and

i) Grindstone under the floor rotation speed approximately 30m/s.

j) If maximum height of the equipment is over 3.6m, it is subject for the review and approval by the Engineer.

k) A vacuum system shall be supplied with the rail profile grinding car to fully collect rail grinding debris and deposit them in an onboard container. The container shall be removable from the vehicle by a forklift truck for discharging debris.

5) Operating equipment.

a) Hauling or self-running speed on main line 60km/h;

b) Minimum curve radius 92 m in depot area;

c) Rail grinding velocity approximately 0.7～0.8km/h; approx. 500m/track

d) Grinding depth 0.05mm/pass; and the center-line-average roughness of a worn rail is typically 0.5 to 2 microns. However, a ground surface is relatively rough because the grits in a grinding stone (like sand on a sanding disc) cut small grooves in the rail (the value of for a freshly ground rail is typically less than 12 microns).

e) Two chocks are attached to wheel tread at track working.

1.27.7 Ultrasonic Rail Inspection Equipment

1) Quantity: Four (4) Sets

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.

(3) Design and Performance

The rail inspection module(s) shall be mounted on a carriage which is pushed manually.

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.

1.27.8 Surveying Equipment

1) Quantity: Four (4) Sets

2) Functional Requirements

Equipment for track surveying instrument shall be supplied.

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;

e) Horizontal angle 3";

f) Vertical angle 2";

1.27.9 Tie Tampers with Generator Set

1) Quantity: Eight (8) Sets

2) Functional Requirements

Equipment for hand tamping of track ballast shall be supplied.

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) One (1) – Electric power generator to power tampers.

b) Four (4) – Hand-held power tampers;

1.27.10 Field Welding Hardware Sets and Welding Kits

1) Quantity: Four (4) Sets

2) Functional Requirements

Field welding hardware Sets and welding kits shall be supplied.

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 EN60E1 or JIS60 and JIS50N rail; and

b) Ten (10) – Field welding kits.

1.27.11 Rail Heater

1) Quantity: Two (2) Sets

2) Functional Requirements

Rail heaters for field welding shall be supplied.

3) Design and Performance

a) Suitable for pre-heating of rail by gas fired.

b) Include gas containers for preparation for field welding.

1.27.12 Rail Tensor

1) Quantity: Four (4) Sets

2) Functional Requirements

Rail tensor for field welding shall be supplied.

3) Design and Performance

a) Stressing is operated hydraulically with hand pump.

b) Required pulling force 70 ton, pushing force 40 ton.

c) Suitable for EN60E1 or JIS60 rail or equivalent.

1.27.13 Weld Shear

1) Quantity: Four (4) Sets

2) Functional Requirements

Weld shear for field welding shall be supplied.

3) Design and Performance

a) Trimming of field welding unnecessary material.

b) Suitable for EN60E1 or JIS60 rail or equivalent.

1.27.14 Refueling Facility for Maintenance Car

1) Quantity: Two (2) Sets

2) Functional Requirements

Refueling Facility is a facility to refuel diesel oil for track maintenance vehicles.

3) Design and Performance

a) Refueling for track maintenance cars at high speed.

b) Diesel oil injection capacity shall be approximately 400 liters/minute

c) Fuel tanks shall be installed on the ground in compliance with laws and regulations

d) Capacity of tank shall be approximately 5000 liters

1.27.15 Small Tamping Machine (STM)

1) Quantity: One (1) Set

2) Functional Requirements:

   a) The vehicle shall be self-propelled;

   b) The small tamping machine shall be operated by a single ride on operator;

   c) Truck transportable.

3) Design and Performance:

   The Track tamping machine shall be equipped with min 4 tools of tamping heads with positioning and diagonal tamping configuration for maintenance of the plain track and turnouts in the depot. It combines the proven strengths of continuous action plain line tamping machines and the flexibility of turnout tamping machines: continuous forward motion and cyclic tamping for plain track and large parts of the turnout, 1-sleeper tamping unit for absolute flexibility and, if necessary, cyclic working action for complex turnouts. The machine shall be capable of tamping 50m of track per hour and enable the operator to achieve the track geometry through turnouts to the required standards.

4) Vehicle dimensions and features:

   a) Track gauge 1435 mm

   b) Vehicle to follow the rolling stock and construction gauge

   c) Axle load under 160kN

   d) Couplers shall be supplied by the rolling stock contractors and the contractor shall provide the necessary interface point for the coupler.

   e) Wheels mono-block type, with same profile as passenger car wheels

   f) Fuel tank capacity for 6 hours

   g) Flange back to back distance between 1359mm and 1362mm

   h) Fitted with audible warning horn.

   i) Headlight and tail lights.

   j) Equipped with self-loading device for the loading to the truck operation without the need of the crane.

5) Operating equipment.

   a) Hauled self- running speed on main line 60 km/h

   b) Minimum curve radius 92m in depot area

   c) Two tamping tools must cover two sleepers

   e) Driver controlled variable work head depth control.

   f) Tamping head can be lowered and raised.

   g) The tamping work head shall be able to be set in a normal mode of operation on straight-line tangent track, or shall allow the operator to position side-ways (swung in/out to clear obstructions as needed) and to accommodate switch work tamping in turn-outs and cross overs.

h) The tamping head shall enable positioning to precise depths using position sensors located on each head, to provide position feedback to the control system.

1.27.16 Rail Grinding Machine (Hand Operation)

1) Quantity: Four (4) Sets

2) Functional Requirements

Machine equipment operated by track personnel for grinding rail profile shall be supplied.

3) Design and Performance

The Rail grinding machine is handled for grinding rail profile. The rail grinding shall be equipped for:

a) Grinding top of rail;
b) Grinding gauge corner of rail;
c) Grinding inner and outer side of the rail; and
d) Machine dimension and features:
    i. Track gauge 1435mm;
    ii. Machine width maximum 2.6m
    iii. Machine overall length approximately 2.0m
    iv. Max weight of 120kg and can be carried by 2 personnel.
e) Operating performance
    i. Grinding depth 0.02mm/pass or more
    ii. Grinding time is 30min. for one welding point on rail joint.

1.27.17 Tools and Equipment for Track Maintenance

The Contractor shall provide the latest type of the following:

Table 1.27.2 Tools and Equipment for Track Maintenance

Name of Parts/Equipment	**Quantity**	**Specification**
Rail Sawing Machine	4 sets	3000 rpm. EN60E1 or JIS60 rail is cut within 5 min.
Boring Machine for Rail	4 sets	300 rpm. Max travel 100 mm, Max core φ 40 mm
Coach Screwing Machine	2 set	Socket speed 100 rpm. Max torque 12 kNm
Lighting equipment	20 sets	100 lx 10 m from light origin

Name of Parts/Equipment	Quantity	Specification
Puller for rail fastener	10 no.	Requirement subject to fastening system being adopted.
Emergency Rail Clamps	10 sets	interpose "C" type clamp for emergency
Portable generator	4 sets	3 phase AC, 220 V, 4 kVA

1.27.18 Track Work Hand Tools

1) Quantity: Two (2) Sets: Each set including the list of equipment detailed below:

2) Functional Requirements

Each set of hand tools shall include the following:

3) Design and Performance

a) Six (6) – Rail lifting chain jack with standing rack bar, minimum 500 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

l) Two (2) – Track Measure Equipment for portable

1.27.19 Mobile Flash Butt Welding Machine

1) Quantity: One (1) Set

2) Functional requirements:

Self-propelled for road and Track vehicle shall be supplied.

3) Design and Performance:

The Mobile Flash Butt Welding Machine must be equipped with diesel-generator set, hydraulic unit, cooling unit and lifting device. The mobile machines must compromise the function control, the weld processor, and the weld analyzer.

The Mobile Flash Butt Welding Machine must weld short rails of any length to long welded rails up to 500-meter lengths and even longer. The main features shall the exact lateral alignment of the running edge and vertical alignment of the running surface. The web clamping device must be independent from the electrodes and it ensures the rails do not slip during upsetting.

4) Vehicle dimensions and features:

Track gauge 1435 mm

A flexible truck-based system for road/rail operation

30-foot container based.

5) Operating equipment

a) Hauled or self-running speed on main lines tracks 20 km/h and on roads 60 km/h.

1.28 Interfacing Requirements

The Contractor shall make due allowances, during the Initial and Final Design stages, to liaise with other Contractors and to carry out the interface works as necessary to complete the project. The identified interfaces include, but may not necessarily be limited to:

The Contractor shall liaise with the Civil work Contractors in relation to:

1) the alignment of railway, arrangement of structures such as sub/super structures, embankments, stations, etc.;
2) the surveying, provision of datum marks and setting out of the track system;
3) the position and level tolerances of the first stage pouring concrete;
4) the position of rail expansion joints;
5) the arrangement of movable and fixed bearings for elevated station structures such as continuous beams, slabs, etc. to minimize the necessity for installation of rail expansion joints;
6) the formation of holes, chases, rebars, etc. in the track bed for installation of drainage runs, pipes, manhole covers, etc.;
7) the position of scissors crossings, single crossovers and turnouts and its operating gear;
8) the shear connectors in the elevated/embankment sections;
9) the preparation, standard and level of formation onto which the track ballast will be laid;
10) the provision of buffer stops.

The Track work shall liaise with the Rolling Stock Contractors for:

1) the lateral and vertical forces generated at the wheel rail interface;
2) the relationship between permitted train speed, track radius and track cant;
3) the provision of setting friction sliding buffer stops and concrete block stoppers as necessary;

4) the vehicle requirement for reverse curves;

5) the vehicle requirement for a variety of turnouts.

The Track work shall be interfaced with the Signal System and Telecommunication to:

1) the provision and location of insulated joints;

2) the provision of track circuit bonds;

3) the provision of location of switch machines and associated mechanisms;

4) the provision of install cable bonds position to the rails;

5) the position of scissors crossings, single crossovers, and turnouts;

6) the position of buffer stops;

7) the 200 mm diameter pipe hole crossing the track bed when required for the Signaling and Telecommunication works. That agreed positions shall be given a Notice of No Objection by Engineer;

8) the provision of insulation between the running rails and earth.

The Track work shall liaise with the Power Supply to:

1) the provision of cable bonds position for traction current supply and return track bonding;

2) the provision of insulation between the running rails and earth;

3) The pipe crossing the track bed when requested for the Power Supply works. The agreed positions shall be given a Notice of No Objection by Engineer.

The Contractor shall liaise with the civil Contractor closely in respect of the track work in the Depot. If there is a difficulty to perform the construction, the Contractor shall report it promptly to the Engineer.

The noise measurement section during the test running shall be determined by the consultation with the contractor, the vehicle contractor, the civil contractor and the Engineer. Top surface of rail in the measurement section shall be kept in good condition with no damage, less irregularity.

1.29 Maintenance Manuals and Knowledge Transfer

1.29.1 Scope

1) The Contractor shall supply the Engineer with the maintenance program in sufficient detail for the Employer to operate, maintain, dismantle, reassemble, adjust, and repair the installed track form. This maintenance plan should correspond to the three-step maintenance program mentioned in Clause 1.26.2.

2) The Contractor shall supply the Engineer with the inspection and maintenance manuals to carry out the maintenance program.

3) The maintenance plan and manuals must be submitted by the completion of track construction. The works shall not be considered to complete of the purposes of taking over until the engineer has received the plan and manuals.

1.29.2 Maintenance Program

The Contractor shall note as below and provide the Maintenance Program. Maintenance of permanent way includes all activities involved in maintaining and installation in good working condition or to restore it to a given condition to perform a given function in a safe manner. These activities include both technical and administrative functions.

1) Preventive Maintenance

   Preventive Maintenance (PM) of equipment is intended to improve equipment life and to avoid any unplanned maintenance activities. In Track Network and Facilities of Malolos Clark Railway Project includes all such actions to be performed to prevent failures, such as; train riding patrol inspection or walk-through inspection of facilities noting deficiencies for later correction, lubrication, alignment, detailed cleaning, adjustments and minor component replacement to extend the life of track facilities. The Employer's purpose is to minimize breakdowns and excessive depreciation. Fixed time maintenance and condition monitoring are two components of Preventive Maintenance.

2) Corrective Maintenance

   Corrective Maintenance actions are carried out to restore defective equipment to a Specified condition. These include tests, measurements and adjustments made to remove or correct a fault. The purpose is to return the condition of track equipment to the state that will slow down the deterioration process, thereby ensuring running safety and passengers' comfort.

3) Renewal Maintenance

   Renewal Maintenance is implemented when corrective maintenance is technically ineffective, or uneconomic. The renewals involve the massive and mechanical replacement. For example, they are complete change of track panel, ballast, level crossing, all type turnouts. This is scheduled in consideration of safety and savings.

1.29.3 Manuals

1) The Inspection/Maintenance Manuals and a summary (suitable for use at technician level) shall be prepared in English.
2) The Contractor shall provide necessary numbers of copies of Inspection/Maintenance Manuals for the use by the Employer.
3) The Contractor shall maintain Inspection/Maintenance Manuals in an up-to-date condition throughout the Contract Period.
4) The Contractor shall produce Inspection/Maintenance Manual for all track works supplied. These shall include, but may not necessarily be limited to, the following:
   a) Elastic sleeper directly fastened track system
   b) Scissors Crossings, Crossovers, Simple Turnout and Expansion Joints.
   c) Ballasted track
   d) Track maintenance cars and equipment

1.29.4 Training and Knowledge/Skill Transfer

The contractor shall provide training courses in the following fields of track maintenance. Each course is specific and will be implemented using a manual to achieve the goals according to the maintenance plan.

a) Elastic sleeper directly fastened track system

b) Scissors Crossings, Crossovers, Simple Turnout, Expansion Joint with FFU sleeper directly fastened track system

c) Ballasted track

d) Track maintenance cars and equipment

1.29.5 Training Records

1) The Contractor shall keep records on the attendance of all trainees. The Contractor shall devise a system and standards in assessing the level of knowledge, understanding of the course content and proficiency of the trainees.

2) The Contractor shall issue appropriate training certificate to trainees who pass the assessment.

1.30 Testing, Commissioning and Verification

These Employer's Requirements establish the overall procedures to be followed by the Contractor relating to the Track works in the elevated sections, embankment sections, depot and depot access line that form part of the works under this Contract. These requirements relate to manufacturing procurement and delivery of materials and their testing and commissioning.

1.30.1 Manufacturing

1) Management

The Contractor shall establish procedures and controls that govern the procurement integration, manufacture and testing, quality assurance and delivery of materials and spares to be supplied under the Contract. This shall include the administration and supply of spare parts and warranty in accordance with the Contract. The Contractor's Manufacturing Management Plan shall be submitted to the Engineer for Approval.

2) Procurement and Subcontract Management

The Contractor's management systems and procedures shall incorporate a procedure for materials procurement and sub-contracting, sufficient to assure technical, administrative, quality, and contractual controls consistent with those of this contract. The Contractor's management system shall be auditable for materials sources, lot numbers, seriate equipment, etc. Sub-contract amendments shall be employed whenever contractual changes are made either bi-laterally or unilaterally by the parties involved.

3) Manufacturing and Production Management

The Contractor's manufacturing and production management system shall encompass all points of receiving, raw material and components processing, fabrication, assembly, test, and all points of in-process inspections. The Contractor shall submit manufacturing data as part of the Manufacturing Management Plan which shall contain:

a) Brief description of all inspection hold points and test points, and a correlation with the Program Schedule;

b) List of all sub-contractors; and

c) Delivery schedule of each item of equipment to match installation plan.

1.30.2 Quality Assurance and Controls

The Contractor's management systems shall emphasize quality assurance and controls. The program shall be adequate to ensure an acceptable level of quality of the materials supplied. The concept of total quality assurance shall be based on the principle that quality is a basic responsibility of the Contractor's organization and shall be evidenced by

a) Designs for proven production process and inspectional procedure;

b) Firm procurement and job performance specifications;

c) Firm procedures for transmission of information and data to sub-contractors and ensuring their compliance;

d) Adequate testing to ensure repetitive product conformity to design requirements; and

e) Total program of surveillance and verification of physical performance and Configuration accountability.

1.30.3 Testing Program, Cost

1) A comprehensive testing program shall be provided by the Contractor that shall include the complete materials to assure conformance with the applied Specifications. The purpose of the comprehensive testing program shall be to:

   a) Substantiate design and performance characteristics;

   b) Complete materials verification and acceptance requirements; and

   c) Complete all reliability, maintainability, and safety demonstration requirements.

2) The Contractor must bear the cost of all necessary tests performed in and out of the Philippines.

1.30.4 Testing and Commissioning

1) The Contractor shall perform all testing and commissioning activities to satisfactory demonstrate the performance of the Works in compliance with the contract requirements.

2) The Contractor's activities shall include but are not limited to the following:

   a) Provide all labour, and experienced supervision to perform all tests required to demonstrate the performance of the Works;

   b) Prepare the Factory Acceptance Test Plan, Testing and Commissioning Plan, testing procedures, and test reports that applies to the Works in a format and to a level of detail given a Notice of No Objection by the Engineer.

   c) Provide all required testing and specialized materials including consumables required to support integrated testing and commissioning and Trail running activities.

d) The strategy of how the Contractor intends to commission the works and how this relates to the sequence of installation;

e) The interdependency and interaction with other Contractors and their commissioning Programs;

3) Testing and Commissioning Plan

The Contractor shall submit the Testing and Commissioning Plan to the Engineer for Approval 30 days of the test. The Contractor must be responsible for test preparation, implementation, recording and reporting.

The test plan shall contain but not be limited to the following:

a) The plan for the production and submission of the test procedures for Approval by the Engineer;

b) The object, type, and extent of testing to be undertaken and the parts of the works to be proven by that testing;

c) The Contractor's strategy for inspection and Factory Acceptance Tests of all constituent parts;

d) The sequencing and interrelationships of the inspections and tests and how this relates to the sequence of delivery;

e) Organization chart and CV of key personnel in inspection and test team.

f) The Contractor shall provide special and general attendance during the trial operation period such that the persons who conduct the on-site testing and commissioning are available on the site to solve any problem.

No testing or commissioning activities shall be undertaken until the Testing and Commissioning Plan has been given a Notice of No Objection.

1.30.5 Factory Acceptance Test Plan

1) The Contractor shall prepare and submit to the Engineer for Approval a Factory Testing Plan that shall detail and explain how the Contractor will plan, perform, and document all inspections and tests that will be conducted to verify and validate the works prior to delivery to the site.

2) The Contractor shall submit and gain Approval of the Factory Acceptance Plan before the first Factory Acceptance Test is planned to commence.

3) The Contractor shall responsible for re-inspecting and re-testing any failed inspection and Factory Acceptance Test.

4) Inspections and tests that are to be witnessed by the Employer or the Employer's Representative shall be scheduled so that as many inspections and tests as possible may be witnessed during a single visit.

5) No testing activities shall be undertaken until the Testing and Commissioning Plan has been given a Notice of No Objection.

1.30.6 Record and Test Reports

1) The Contractor shall keep adequate records to provide evidence of quality and accountability. These records shall include results of inspections, tests, process controls, certification of processes and personnel, discrepant materials; and other quality control requirements.

2) Inspecting and testing records shall, as a minimum indicate the nature of the observations made, and the number and types of deficiencies found, and action proposed to correct deficiencies.

3) Records for monitoring work performance and for inspecting and testing shall indicate action taken for the correction of deficiencies.

4) The test procedures and checklists shall be submitted Approval by the Engineer.

5) Testing will be undertaken with representatives of the Employer and Engineer in attendance.

6) The Contractor shall submit a certified report of the results of these Tests to the Engineer within 14 days from the date when the Engineer confirmed that the Contractor has passed each of the Tests.

1.30.7 Structure Gauge Clearance Checks

1) The Contractor shall undertake, in coordination with the interfacing contractors, a Structure Gauge clearance check for all areas.

2) The clearance checks shall be undertaken on sections of the Works as they are completed by other contractors.

3) The time and number of Structure Gauge clearance checks shall be as advised by the Engineer, but shall be a minimum of:

   a) After installation of all other works in each section. A minimum section shall be station to station;

   b) Immediately before any rolling stock runs; and

   c) As instructed by the Engineer.

4) The Contractor shall propose his means of undertaking the Structure Gauge clearance checks, which shall be by, in order of preference:

   a) A manually pushed or self-propelled electronic/laser system that does a continuous scan of the whole structure cross section as the system is moved along the Track. The recordings shall be electronically produced with soft and hard copies submitted for the Engineer for assessment/acceptance; or

   b) A suitable adjustable frame fixed to a wagon with flexible and adjustable sides, to replicate the ET horizontal and vertical throw in curves. The wagon shall be pulled through the system/section by the contractor construction plant or Works Train, as directed by the Engineer.

5) The Structure Gauge clearance checks shall be undertaken in the presence of the Engineer.

6) After each clearance check run, the contractor shall produce a 'Structure Clearance

Report' highlighting all infringements. The report shall be accompanied by sketches, diagrams, and photographs of all infringements, including the degree of infringement.

7) The format of the 'Structure Clearance Report' shall be as proposed by the contractor and be submitted for Approval.

1.31 Packing, Shipping, Storage and Delivery

1.31.1 Shipping

The Contractor's Manufacturing Management Plan shall provide for the proper inspection of materials to ensure satisfactory completion of manufacturing and testing / check prior to shipment. All shipments shall be adequately prepared to preclude damage during shipment. The Contractor's quality control personnel shall verify the inspection and preparation for shipment. Handling procedures shall include the use of special crates, boxes, containers, transportation vehicles, equipment, and facilities for materials handling.

1.31.2 Handling, Storage

The Contractor shall be responsible to prepare, protect and store all materials so as to safeguard them against loss or damage from repeated handling, climatic influences and all other hazards arising during shipment or storage on or off the site. The Contractor shall provide secure and covered storage for all materials except with the materials such as being suitable for open storage. Means shall be provided for protection against deterioration or damage to materials in storage.

1.31.3 Materials Protection

The Contractor shall follow the requirements on materials identification of the Track works as specified in the General Requirements. All materials shall be capable of continuous soundness in its normal environment and achieve its stated service life and shall be capable of short-term soundness at the extremes of environmental conditions likely to be encountered.

1.31.4 Compensation for Damage

Damage caused by the Contractor shall be repaired, corrected or replaced at the Contractor's expense.

1.31.5 Rail Transport and Storage

1) The Contractor shall recommend to the Engineer for approval what methods and type of protecting manner that shall be applied to all rails prior to shipping to prevent rusting and steel oxidization.

2) Rail shall be loaded and unloaded with the use of lifting devices accepted by the Engineer. Rail which is damaged during delivery, storage or handling shall be replaced at the Contractor's expense.

3) The contractor shall supply with the first delivery of rails a lifting device (beam) capable of ensuring that the rails, when lifted with a mobile or static crane, remain Heads up and that no distortion in the rail occurs. This lifting beam shall be capable of lifting a minimum of 2 rails and be equipped with self-actuating rail devices.

4) The Contractor is responsible for shipping all rail required by the Contract from the mill or plant to the storage area, must investigate the transportation route from the unloaded port to the rail stockyard, present that route to the Engineer and receive consent. The storage area layout and methods of stacking rails shall be submitted to the Engineer for acceptance.

5) All new rails shall be shipped in a covered hold; rails shipped as deck cargo are not acceptable. Rails shall not be delivered as bundles, but stacked horizontally, so that they are unloaded by a self-actuating multi rail-lifting device.

6) The Contractor shall reject any rails which, in the opinion of the Engineer, on arrival to the site exhibit pitting of the rail head or are subject to corrosion or mechanical damage beyond that which can be corrected by normal rail surface grinding required under the Contract. The rails shall be stockpiled a minimum of 100 mm clear of the ground and at a sufficient grade to prevent water ponding between and on the rails, also there is to be sufficient air flow around the rails to allow them to stay dry.

7) The storage area layout and methods of stacking rails shall be submitted to the Engineer for acceptance.

End of Section

2 SIGNALING

2.1 Introduction

The main purpose of the Signaling System is to ensure that train operation safety is guaranteed throughout the whole system including the Depot areas.

The Contractor shall be responsible for the design, manufacture, supply, factory testing, installation, integration with other contracts, site testing, commissioning, training, defects notification period, and operation/maintenance support.

All stations, Depots and the Operation Control Centers (OCC/IOCC) shall form part of the Signaling system.

2.2 Definitions and Abbreviations

2.2.1 Definitions

In this Technical Requirements, the following terms and definitions are used:

Abnormal Operation	The situation where the Signaling / Train Control System operates in a manner not intended by the design.
Availability	The probability that an item will be in a state to perform a required function under given conditions, at a given instant in time or over a time interval, assuming that the required external resources are provided.
Cab Signaling	Signaling in the train cab which governs the movement of the train by conveying the movement authority (MA) and the authorized speed/ target distance as deduced from the most restricting ATP condition, signaling mode, etc.
Call-on/Push-out	Safe operational movements of train involving a coupled train (rescue train and failed train) during rescue. It is usually performed in manual (SR or OS) Mode.
Civil Speed Limit	The permanent maximum speed limit for all trains upon a section of line. This speed limit shall not be exceeded at any time.
Coasting	An increase of inter-station run time over the maximum train performance time, usually by a specified constant percentage value.
Controller	Any person authorized by the Employer to control the System.
Degraded Operation Mode	Train operation mode that is used in the event of failure of the ETCS system.
Dwell time	The period of time taken from the instant that a train's wheels stop at a station until the point in time when the wheels start in motion again.
Engineering Train	A non-passenger train used for engineering purposes.

Equipped Train	A train with fully operational Signaling / Train Control System equipment installed onboard.
Failure	A failure is an event which causes loss of function or performance within any part of the Signaling / Train Control System and requires a maintenance intervention to restore full functionality and performance.
Fouling Point	The position at the convergence of two tracks where the kinematic envelopes, one on each line, would come into contact.
Gauge	The measurement between the rails of one track.
Graceful Degradation	The transfer in quality or performance from the initial level to a lower operable level.
Headway	Minimum time interval between successive trains at any point on the line.
Human Machine Interface (HMI)	The visual and graphical interface between the controller and the control system. The HMI consists of the computer screens, displayed objects, icons, and equipment as well as the facilities by which the Controller executes control.
Isolation IS	The mode of ETCS when the ETCS system is isolated (disconnected) from the other on-board equipment/systems (including the driver) and physically isolated from the brakes.
Kinematic Envelope	The outline of the space occupied by a rail vehicle when in motion including the effects of tilt, sway and cant.
Latched Alarms	Alarms arising from faults in equipment. These alarms remain active until the equipment fault has been remedied.
Movement Authority (MA)	The point beyond which the train may not safely proceed.
Line Replaceable Unit (LRU)	Equipment that can be replaced as a single complete unit.
Main Line	Lines other than those within the Depot.
Maintenance Block	Taking a section of the line out of service for engineering purposes.
Maximum Safe Speed (MSS)	It is a safe speed lower than the Civil Speed Limit and safe speed required to ensure that the MA is not passed. It is also any Temporary Speed Restrictions in force or maximum permissible train speed (maximum speed set by the current operating mode and train parameters).

Mean Time between Failure (MTBF)	The mean time interval between maintenance interventions being required on a piece of equipment, system or subsystem.
Mean Time to Restore (MTTR)	The mean time to restore a piece of equipment, system or sub-system into full operation.
Mimic Display	A graphical representation of the railway and its global operating status.
Non-Equipped Train	A train without Signaling/Train Control System equipment onboard.
On Sight OS	The mode of ETCS that gives the driver full responsibility for the safe control of his train at an enforced and limited speed (national value for driving on sight) when the ETCS system enables the train to enter into a track section that could be already occupied by another train or obstructed by any kind of obstacle.
Recoverability	The measure of ability of a system to recover from a system failure.
Reliability	The measure of equipment, system or sub-system to perform their intended function.
Route	A part of the line originating at a signal through which the points have been set and secured to enable the safe passage of a train.
Service Affecting Failure	A failure which causes a service delay.
Signaled Headway	The minimum time interval that the Signaling / Train Control System will permit between two following trains.
Staff Responsible SR	The mode of ETCS that gives the driver full responsibility for the safe control of his train at an enforced and limited speed (national value for Staff Responsible) in an equipped area.
Stopping Position	The specified point within a station at which the train is to stop.
Target Speed	The optimum speed at which the train should be driven, as calculated by the Signaling / Train Control System.
Trip Time	The time for a train to travel from the starting terminal to the last terminal on the same line, with 30 second dwell times at each intermediate station. This time does not include any layover time at the terminals.

Turnout	A track assembly comprising a point and a crossing enabling a train to be switched from one track to another.
Train Description	An alphanumeric sequence uniquely identifying a running train.
Unauthorized Roll- back	An unauthorized reverse movement of a stopped train.
Workstation	Special computers designed for technical or scientific applications intended primarily to be used by one person at a time. These are commonly connected to a local area network and run at different operating systems.
Wrong-Side Failure	A failure of a safety-critical system or subsystem which directly leads to a situation with the potential to cause harm, injury, damage to property, plant or equipment damage to the environment, or economic loss.

2.2.2 Abbreviations

ABA	Alarm Browser Application
AC	Alternating Current
ACR	Area of Controlled Region
AFTC	Audio Frequency Track Circuit
AOA	Area of Authority
AoE	ATO over ETCS
ARS	Automatic Route Setting
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATO-OB	Automatic Train operation – Onboard
ATO-TS	Automatic Train Operation – Trackside
ATP	Automatic Train Protection
ATPM	Automatic Train Protection Mode
ATR	Automatic Train Regulation
ATS	Automatic Train Supervision
AW	Passenger Vehicle Loadings

AXC	Axle Counters
BMS	Building Management System
BSC	Base Station Controller
BTM	Balise Transmission Module
BTS	Base Transceivers Stations
CATS	Central Automatic Train Supervision
CBI	Computer-Based Interlocking
CP	Contract Package
CCR	Central Control Room
CCS	Control Command and Signaling
CCTV	Close Circuit Television
CER	Central Signal Equipment Room
CPU	Central Processing Unit
CUR	Central UPS Room
DC	Direct Current
DCS	Data Communication System
DCU	Door Control Unit
DLP	Digital Light Processing
DNP	Defects Notification Period
DOTr	Department of Transportation
DMI	Driver Machine Interface
EB	Emergency Brake
EED	Emergency Exit Door
EI	Electronic Interlocking
EIRENE	European Integrated Radio Enhanced Network
EMC	Electro-Magnetic Compatibility
EMI	Electro-Magnetic Interference

EMU	Electric Multiple Unit
EN	Euro Norm (CENELEC)
EoA	End of Authority
ERG	General Requirements
ERT	Technical Requirements
ERTMS	European Rail Traffic Management System
ESA	Emergency Stop Authority
ESS	Emergency Stop Switches
ETCS Level 2	European Train Control System Level 2
ETSI	European Telecommunication Standards Institute
EU	European Union
EVC	European Vital Computer
FAT	Factory Acceptance Test
FFFIS	Form Fit Function Interface Specification
FEP	Front End Processor
FMECA	Failure Mode Effect and Criticality Analysis
FOTS	Fiber Optic Transmission System
FRS	Functional Requirements Specifications
FS	Full Supervision Mode
GB	Gigabit
GoA	Grade of Automation
GoA2	Grade of Automation 2 – Automated Train Operation with Driver
GUI	Graphical User Interface
HDD	Hard Disk Drive
HMI	Human Machine Interface
IEC	International Electro-Technical Commission
IEEE	Institute of Electrical and Electronics Engineers

IRJ	Insulated Rail Joint
IOCC	Integrated OCC
ISO	International Standards Organization
I/O	Input/Output
JRU	Juridical Recording Unit
LAN	Local Area Network
LATS	Local Automatic Train Supervision
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LRBG	Last Relevant Balise Group
LRU	Line Replacement Unit
MA	Movement Authority
MAL	Movement Authority Limit
MB	Maintenance Berth
Mbps	Megabits per second
MPLS-TP	Multi-Protocol Label Switching - Transport Profile
MSC	Mobile Switching Center
MSS	Maximum Safe Speed
MTBMA	Mean Time Between Maintenance Action
MTBSAF	Mean Time Between Service – Affecting Failures
MTTR	Mean Time to Repair
MVB	Multifunction Vehicle Bus
NFPA	National Fire Protection Association
NMS	Network Management System
NSCR-N1	North-South Commuter Railway Project (Malolos-Tutuban/Solis)
MCRP	Malolos-Clark Railway Project
NSCR-Southern	North-South Railway Project - South Line (Commuter)

NTC	National Telecommunications Commission (Philippines)
OBU	On Board Unit
OCC	Operations Control Center
OFC	Fibre Optic
OMPD	Operating Modes and Principles Document
ORP	Overrun Protection
PA	Public Address
PAT	Partial Acceptance Test
PDB	Permissive Door Button
PED	Platform Edge Door
PID	Passenger Information Display
PSD	Platform Screen Door
PTI	Positive Train Identification
RAMS	Reliability, Availability, Maintainability and Safety
RBC	Radio Block Center
ROM	Read Only Memory
RSSI	Received Signal Strength Indicator
SB Mode	Standby Mode
SBD	Service Brake Demand
SCADA	Supervisory Control and Data Acquisition
SCR	Station Control Room
SER	Station Equipment Room
SIL	Safety Integrity Level
Shift2Rail	A European Body on Research and Innovation in Railways
SRS	System Requirements Specification
SUR	Station UPS Room
TC	Track Circuit

TD	Train Detection
TDG	Time Distance Graph
TFT	Thin Film Transistor
TID	Train Identity Number
TIU	Train Interface Unit
TMS	Train Management System
TORR	Train Operated Route Release
TRM	Train Radio Module
TSI	Technical Specification for Interoperability
TSR	Temporary Speed Restriction
TWC	Train to Wayside Communication
UIC	International Union of Railways
UNISIG	Union Industry of Signalling
UPS	Uninterruptible Power Supply
VDU	Visual Display Unit
V&V	Verification & Validation
ZB	Impedance Bond

2.3 List of Standards

This list is provided solely for the convenience of the Contractor. The reference to any specifications shall be considered as the latest version of the specifications. The Contractor may also propose alternative, equivalent or better standards, which shall be subject for review by the Engineer.

Table 2.1 – CCS TSI Standards

Subject	Organization	Standard
ERTMS/ETCS Baseline	ERA	Baseline 3 release 2 or later
Functional Requirements Specification	UIC ETCS	ERTMS/ETCS FRS
System Requirements Specification	UNISIG	Subset 026

Table 2.2 – IEC Standards

Subject	Organization	Standard
Protection against Lightning	IEC	IEC 62305
Electro-magnetic compatibility	IEC	IEC 61000-1, IEC 61000-2, IEC 61000-3, IEC 61000-4, IEC 61000-5
Conducted immunity level	IEC IEC IEC	IEC 61000-6 IEC 62236 IEC 61992
Electrostatic discharge (ESD)	IEC	IEC 61000-4-2
Fast transient burst	IEC	IEC 61000-4-4
Power surge	IEC	IEC 61000-4-5
Train Control System Equipment Ingress Protection	IEC	IEC 60529 Ed. 2.0 b
Safety and Reliability Requirement of Electronic Signaling Equipment	IEC	IEC 62278, IEC 62279, IEC 62425
Software	IEC	IEC 62278, IEC 62279, IEC 62425
Cable standard and cable installation standard	IEC	IEC 60364-5-523
Grade of Automation	IEC	IEC 62290-1: 2006
Life Cycle Costing	IEC	IEC60300-3-3
Functional Safety of Electrical / Electronic / Programmable Electronic Safety-related Systems	IEC	IEC 61508
Railway applications - Communication, Signaling and processing systems: Safety-related communication in transmission systems	IEC	IEC 62280:2014
Measurement of smoke density of electric cables burning under defined conditions	IEC	IEC 61034
Tests for electric cables under fire conditions	IEC	IEC 60331

Subject	Organization	Standard
Test on Electric Cables Under Fire Conditions, Part 1: Test on a Single Vertical Insulated Wire or Cable	IEC	IEC 60332 - 1
Test on Electric Cables Under Fire Conditions, Part 3: Test on Bunched Wires or Cables	IEC	IEC 60332 - 3
Determination of the Amount of Halogen Acid Gas, Test on Gases Evolved During Combustion	IEC	IEC 60754
Semiconductor converters - General requirements and line commutated converters	IEC	IEC 60146
Classification of environmental conditions	IEC	IEC 60721
Railway applications - Electronic equipment used on Rolling Stock	IEC	IEC 60571
Railway Applications - Wayside and Environmental	IEC	IEC 62498
Rolling Stock Equipment – Shock and Vibration Tests	IEC	IEC 61373
Conductors of Insulated Cables	IEC	IEC 60228
Uninterruptible power systems (UPS)	IEC	IEC 62040

Table 2.3 Miscellaneous Standards

Subject	Organization	Standard
Prevention of inadvertent ignition of flammable atmospheres by radio frequency radiation	PD	PD CLC/TR 50427
Determination of Burning Behavior by oxygen index.	ISO	ISO 4589-2 Method 141
Methods of Testing Plastics Part 1: Thermal Properties 143A and B: Determination of Flammability Temperature of Materials	ISO	ISO 4589-2 Method 143

Subject	Organization	Standard
Quality Management and quality assurance	ISO	ISO 9000
Installation work and lineside assets	Railtrack	GS/IH0001 or an acceptable equivalent
Network time protocol	Network Working Group	RFC 1305
Ethernet Network Standard	IEEE	IEEE Std 802.3
Recommendation Practice for Determining Smoke Generation of Solid Materials	NFPA	NFPA 258

2.4 Scope of Work

2.4.1 General

The scope of work describes the requirements for a Train Control System using ETCS Level 2 (Baseline 3 Release 2 or later) and GSM-R (Packet switched) to constitute an ERTMS signaling system for the NSCR-Ex {Malolos to Clark (MCRP) and Solis to Calamba (NSRP)}(This shall include Depots, which shall be located at Mabalacat and Banlic. The OCC for MCRP shall be at Mabalacat depot and the OCC for NSRP shall be at Banlic depot.

- The Malolos to Clark Railway Project (MCRP) also called NSCR-N2 is northern part of the North to South Commuter Railway Project Extension (NSCR-EX).
- The Solis to Calamba project forms the southern part of North to South Commuter Railway Project Extension (NSCR-EX) and is also called NSRP – South.
- The quantity of Rolling Stock EMU units to be equipped with ERTMS onboard and commissioned by the Contractor are as follows:
  - 7 x 8 Car Limited Express
  - 38 x 8 Car Commuter trains
  - 30 x 8 Car Trains from MMSP line (to be fitted with CBTC and ERTMS systems onboard. CBTC system supplied by others)
- This will interface to an adjacent section; the Malolos to Solis project also called (NSCR-N1) being done by a separate team. The depot and OCC for NSCR-N1 is located at Malanday. NSCR-N1 is in the middle of MCRP and NSRP.
- NSCR-N1 project will interface with the adjacent Solis to Calamba project that forms the southern part of (NSCR-EX) also called NSRP - South.
- All three sections described above form a single railway line.
- It also interfaces to the MMSP project, A CBTC Signaling project being undertaken by others.
- The Works to be executed under the Contract include the design, manufacture / procurement, verification, delivery, installation, testing, commissioning and

technical support for a complete, integrated ERTMS / ETCS Level 2 system with GSM-R as the Radio sub-system, including a new control center, trackside, and train borne equipment, accessories and fixtures and fittings necessary to deliver the requirements of this Technical Requirements.

- In addition, use for ETCS data transmission, GSM-R radio system shall also provide for train operational communications including Railway Emergency calls, broadcast calls, group calls and packet data. Users will include train drivers, dispatchers, operational controllers, shunting groups. Fixed terminal devices and mobiles phones will need to be provided. Further details specify by train operations.
- There is an Option for ATO. The ATO sub-system to be designed, tested and installed as part of this project based on the UNISIG standard for ATO over ETCS. This will consist of an onboard and trackside sub-system. Implementing ATO will increase the capacity of the line, ensure time-table adherence and reduce energy consumption. If ATO is not implemented, normal train operating mode will be ATP with manual driving by the Driver.
- Any clauses for ATO in this document will not apply if this Option is not exercised. With ATO, normal train operations on the main lines and depot access shall be automatic providing speed control, accurate stopping, door opening and closing at a grade of automation 2 (GoA2) - semi-automated train operation with Driver in the cab. The Contractor shall co-ordinate with NSCR-N1 Contractor for effective and efficient interoperable Automatic Train Operation (ATO). The Contractor shall supply all the necessary onboard ATP/ATO software updates/modifications needed for interoperable operation with NSCR-N1.
- This scope also covers the provision of all onboard equipment for all track mounted maintenance vehicles and Depot engine (refer Chapter 8, Depot Facilities). Please refer to chapters ERT 1. Track works and chapter ERT 6. Overhead Contact Line System for details of maintenance vehicles. The contractor shall develop interface between Signaling and these vehicles and obtain Notice of No Objection from the Engineer.
- The Contractor shall provide the equipment's and support for the Rolling Stock mock-up activities of MMSP Package CP 107 at the CP 107 Rolling Stock Contractor's facilities. Further detail shall be developed by the Contractor and submit to the Engineer for review during the interface activities between the Contractor and CP 107 Rolling Stock Contractor.
- This scope also covers the signaling interface with MMSP line that will be signaled with CBTC and the provision of all onboard ERTMS equipment for the MMSP rolling stock to enable train running on the NSCR-South.
- The contractor shall supply and implement Key Management system (with at least 25% spare capacity) for ETCS system complying to UNISIG subset 037, 038, 114, 137 and other relevant subsets for complete line from Clark to Calamba including NSCR section being constructed by CP04. For this purpose, the contractor shall interface with CP04.
- The demarcation of the work shall be as provided in the Track work drawings (in ERD) and as defined in clause 2.26.10, Interface between NSCR-EX and MMSP projects.

2.4.2 Performance Characteristics

There are several considerations which are of utmost significance in the implementation of the ETCS System; these include:

1) The ETCS Level 2 System shall be designed to operate up to a speed of 160 km/h in NSCR-N2 and up to a speed of 120 kmph in NSCR-SC section by the Contractor to smoothly support headway operations whilst being capable of recovering from perturbations;
2) The attainment of the reliability, availability, maintainability and safety requirements of the System shall be verified by analysis, simulation, testing and commissioning, and system demonstrations as required in this ERT;
3) The accomplishment of the operating performance requirements, e.g. signaled headway and line capacity; and
4) The Contractor shall provide a life-cycle cost plan in accordance with IEC 60300-3-3 or equivalent with the objective to optimize the overall life-cycle cost whilst satisfying the safety, quality and reliability requirements of the specification.

2.5 General Requirements

2.5.1 Performance

The ERTMS / ETCS system shall be designed, manufactured, supplied, installed, tested and commissioned by the Contractor in accordance with the Contract and shall meet all performance and functional requirements as defined in the EU Directives for CCS TSI and other relevant specifications.

2.5.2 Salient Features of the Project

The Traction Power System will utilize a 1500VDC OCS Traction system. The track shall be standard gauge (1435mm).

The Signaling system shall be capable of providing an operational headway of 5 minutes initially but shall reduce to 3-minutes in the future. The Signaling system shall be designed for a 3-minute operational headway.

Train Operations shall normally be performed using ATP (non-automated) in accordance with Grade of Automation 1 (GoA1) as specified in IEC 62290-1. However, the system shall be upgraded to GoA2 when ATO over ETCS (AoE) standards are introduced. Therefore, the Contractor shall only supply proven systems that fulfil these requirements. Substantiated proof of successful implementation of such systems shall be necessary.

The Contractor shall only supply proven systems that fulfill these requirements. Substantiated proof of successful implementation of such systems shall be necessary.

2.6 Scope of Supply

2.6.1 Systems and Equipment

The system shall fulfill the full requirements of ERTMS / ETCS Level 2.

The Contractor shall supply all equipment and facilities necessary to meet the requirements of this ERT plus the applicable specifications.

The Contractor shall supply of the following sub-systems or equipment as a minimum in accordance with the specification. The Contractor shall also supply any additional equipment required to supplement the system not indicated below.

1) Control equipment; including:

   a) Complete GSM-R Train Control Radio system for secure transmission of voice and data including the Signaling Data Communication System (DCS) Radio Modems, cabling, accessories, fixtures and fittings for an ETCS Level 2 system;

   In addition, use for ETCS data transmission, GSM-R radio system shall also provide for train operational communications including Railway Emergency calls, broadcast calls, group calls and packet data. Users will include train drivers, dispatchers, operational controllers, shunting groups. Fixed terminal devices and mobiles phones will need to be provided. Further details will be specified by train operations.

   b) Radio Block Center (RBC) equipment that will be the central point for processing ETCS logic. This will interface with onboard ETCS system on trains, Computer based Interlocking and signaling control and indications systems at the OCC.

   c) Computer Based Interlockings (CBI) shall be SIL 4 system and be configured as triple-modular redundant or equivalent. The CBI should be approved for an ETCS Level 2 system. It shall interface with trackside signaling, the RBC and the ATS at the OCC

   d) Computers / workstations required for NMS systems;

   e) Train borne equipment (EVC, JRU, TIU, TWC, Doppler Radar, DMI, Antennae, Tacho-generators, accelerometers, redundant GSM-R voice and data Radio Equipment inclusive of all cabling, accessories, fixtures and fittings required for the ETCS system);

   f) Train Detection System; and

   g) Signals and Marker Boards (where applicable) inclusive of buffer stop signals.

2) In addition to use for ETCS data transmission, GSM-R radio system shall also provide for train operational communications including Railway Emergency calls, broadcast calls, group calls and packet data. Users will include train drivers, dispatchers, operational controllers, shunting groups. Fixed terminal devices and mobiles phones will need to be provided. Further details will be specified by train operations.

3) An ATO sub-system that shall consist of the onboard ATO-OB and trackside ATO-TS. The ATO will be an add-on to the ETCS system in accordance with the (ATO over ETCS) system requirements specification (subset 125) and the ATO-OB / ATO-TS interface (subset 126).

4) Servers and computers for ATS including LAN at OCC, stations, Depot and other locations and fiber optic links; Workstations; Overview Video Screen. Train real time Display aid in Drivers' offices.

5) Trackside equipment inclusive of Balises, Base Transceivers Stations (BTS), switch machines, signals (where applicable), and train detection system.

6) Concrete or metallic bases / fixtures / supports for Indoor and trackside equipment;

7) Enclosures and supporting brackets for housing and affixing equipment;

8) All cables (excluding fiber-optical backbone), cable terminations and cabling support / protection pipes / accessories necessary for the Works except those specifically excluded from scope of supply;

9) Power supply distribution panel, circuit breakers, and isolators and earth leakage detectors for both AC and DC supplies;

10) Station equipment, including:
    a) Station Control Room equipment workstations and emergency point handles (where necessary);
    b) Train Control Equipment Room: interlocking (where applicable), ATC equipment, relays (if required), power supply, cable termination racks etc.);
    c) Train Control Maintenance Room equipment; and
    d) Emergency Stop Switches
11) All equipment associated with any interfaces required to ensure safe operation within the performance requirements;
12) All equipment necessary to allow the installation, testing and introduction of services;
13) All special test equipment and tools;
14) Maintenance tools;
15) All equipment necessary to carry out on-site testing and commissioning;
16) Spares as covered in Employer's Requirement.
17) All software and hardware, appropriately safety validated, verified and certified, to meet the requirements of the Specification;
18) All software and hardware required for data logging;
19) Testing platform; and
20) Any other apparatus required to provide a complete ETCS Level 2 system.

The Signaling system shall be designed and constructed in conformity with internationally recognized standards including International Union for Railways (UIC) standards.

The Contractor shall design the Signaling system for right-hand running on the main line. The Signaling system shall also comply with the System Operation Plan.

The Service Life for the Signaling system shall ensure a life cycle of at least 20 years, the exception being for workstations, VDUs, keyboard, DMIs, etc. which shall have a life-cycle of 7-10 years, as a minimum.

Any updated components shall be fully backward compatible with the originally installed component.

The Contractor shall notify the Engineer in writing prior to deleting any component of the System from general availability and submit written assurances that it can provide functionally identical replacement units. The notification period for the deletion of the component and written assurances shall not be less than the lead-time for ordering or manufacturing the component plus six months.

The Contractor shall prepare a plan that identifies in detail the sequence of testing that must include at least the evaluation of the equipment at the Contractor's premises. Prototypes of equipment shall not be allowed.

All cables required for the Signaling and Train Control system shall be supplied by the Contractor. The fiber optic cables used for the Signaling and Train Control transmission network shall be supplied by the Communications system.

The Contractor shall ensure the availability of a sufficient quantity of spare parts to ensure replacement is easily obtainable. The quantity of spares required shall also consider the predicted MTBF or similar calculations. The Contractor shall submit a detailed list with supporting calculations including the source of MTBF data for the Engineer's review. Also, the Contractor shall provide sufficient spare parts for critical function as identified by FMECA. Furthermore, the Contractor shall inform the Operator if any equipment might be discontinued. Any new equipment shall be backward compliant with the existing equipment.

The Contractor shall provide all necessary training, the duration, materials, curriculum and location of the training. Also, Operation and Maintenance manuals shall be supplied by the Contractor. The number of hard and soft copies to be provided by the Contractor is stipulated in the applicable specifications.

A Maintenance Shop with sufficient space shall be constructed by others in the Mabalacat Depot Workshop Area for the repair and maintenance of Signaling equipment. The contractor shall incorporate Test benches/worktables with suitable test instruments for Signaling (also for radio Communications and other electronic equipment) and ergonomically arrange so that repair technicians and the test equipment interact safely and efficiently. All the test instruments for signaling equipment and the furniture for the Signaling workshop shall be provided by the Contractor.

2.7 Services

2.7.1 General

The Services to be performed by the Contractor shall include, but not be limited to, the following:

1) Design, manufacture, supply, system assurance, installation, testing and commissioning of the ETCS Level 2 System and GSM-R radio constituting ERTMS.
2) Design, manufacture, supply, system assurance, installation, testing and commissioning of the ATO over ETCS sub-system as per the AoE standards.
3) Presentations, reviews and audit support as specified;
4) Assist and provide all information, documents required by an Independent Safety Assessor (if appointed);
5) Interface management as specified;
6) System operations and maintenance support services;
7) Training for operations and maintenance staff;
8) Preparation of Operation, Maintenance and Training Manuals;
9) Decommissioning, removal and/ or disposal of Temporary Works;
10) Design, manufacture, delivery and installation of foundations/ fixtures for Indoor and Outdoor equipment;
11) Warranty period and Defect Notification Period support after commissioning;
12) Providing necessary support and documents (SIL certification documents, Safety case, Type test result, etc.) required including compliance for the attainment of safety worthiness of the sub-systems of the ERTMS system, and the ATO system. certified from the relevant statutory authorities;
13) Supervised maintenance;
14) All equipment necessary to allow the installation, testing and introduction of services on these lines; and

15) Any other service needed to provide a complete GSM-R based ETCS Level 2 system

16) The Contractor shall supply furniture i.e. chairs, tables, cabinets, etc. (the design and quantity of the furniture shall be submitted by the Contractor and for review by the Engineer) in the following rooms:

    a) OCC Control Room;

    b) Station Control Room;

    c) Signaling Maintenance Room;

    d) Signaling Equipment Room;

    e) Both Depot Signaling equipment rooms;

    f) Signaling Training rooms in Mabalacat depot; and

    g) Signaling equipment repair and maintenance shop in Mabalacat Depot Workshop Area.

2.7.2 Work Excluded from this Contract

The Contractor shall refer to the relevant Interface Specifications in the Appendices for the specific demarcation of responsibility and supply with other Interfacing Contractors.

Services to be provided by other Interfacing Contractors shall include:

1) Equipment Rooms: All equipment rooms will be provided by the Civil Works Contractors;

2) Earthing Pits: Shared main earth shall be available for shared use by the Contractor. The Contractor shall set up an earth busbar in the Signal Equipment Room (SER) and other locations where Train Control equipment are located;

3) Rolling Stock Equipment: See Appendix A1 for details;

2.7.3 Outdoor Cables

The main fiber Optic backbone cables shall be supplied by the Communications system. The Contractor shall provide their Input / Output requirements and agree the quantity of fibers required as part of the interface plan as necessitated by both systems. The requirement shall be submitted in writing accompanied with any calculations / supporting details / cable plans.

2.8 Performance Requirements

2.8.1 General

1) The ERTMS / ETCS System shall achieve all performance requirements as provided in the relevant technical specifications.

   All the sub systems, equipment to be used for ERTMS / ETCS Level 2 System (including but not be limited to ATP, ATS, CBI, GSM-R, RBC and ATO) shall be of proven design, ratified by Independent Safety Assessor and shall have been successfully implemented in transit systems currently in operation.

2) Trackside signaling systems including point machine, train detection, signals (where required), balises, Input/output modules, associated adapters and power supplies shall

be of proven design and shall have been successfully implemented in transit systems currently in operation.)

3) The Contractor shall provide documented evidence from end-users of transit systems that the proposed sub-systems / equipment has been performing satisfactorily and no unsafe failures have been encountered.

4) The Built-in diagnostics and remote monitoring functions for each microprocessor-based equipment module of the ETCS System shall be provided by the Contractor.

5) The maintenance processes and procedures shall be planned, integrated and developed in conjunction with the operating environment, and the design, development and production functions to permit the most cost- effective achievement of the system and equipment design objective.

6) The system shall meet or exceed the requirements specified in ERT and clause 20 of ERG in accordance with IEC 62278, IEC 62279 and IEC 62280 or equivalent standards for Reliability, Availability, Maintainability and the Safety of signaling equipment.

7) The calculation of RAM requirement will take into consideration only relevant failures. A relevant failure of an item is an independent failure which results in a loss of function of that item caused by:

   a) A fault in equipment or a sub-system while operating within its design and environmental specification limits; or

   b) Improper operation, maintenance or testing of the item as a result of Contractor supplied documentation;

2.8.2 Reliability Requirements

The Reliability requirements of this ERT shall be subsidiary to the Availability requirements of the applicable specifications. If higher figures are required to achieve the Availability requirements, then these higher figures shall become the Reliability requirements for the ETCS System.

The Reliability measure for the ETCS System shall be Mean Time between Maintenance Action (MTBMA) and Mean Time between Service Affecting Failures (MTBSAF) (delay of 5 minutes or more).

The Train Control System shall achieve a MTBMA in accordance with the following:

1) The Contractor shall state the reliability figures of all LRU's whose failure shall have a potential safety impact to the system;

2) The Contractor shall state the reliability figures of all LRU's whose failure would have a significant impact on the system;

3) The Contractor shall state the reliability figures of all failures, which would have a major influence on the system; and

4) The Contractor shall state the reliability figures of all failures that would have a minor effect on the system.

An LRU considered as being related to Safety shall be defined through Safety activities. The Contractor shall provide the reliability figures for their particular equipment.

The Contractor shall develop a failure mode and analysis inclusive of an assessment in order to determine which Reliability requirements are applicable for all LRU's.

A definitive RAMS study of the ETCS System shall be demonstrated by the Contractor in accordance with the processes defined in IEC 62278 or an equivalent standard.

2.8.3 Availability Requirements

The Contractor shall be responsible for providing a signaling system design that is fail-safe. The system shall also employ redundancy (for example in transmission) and graceful degradation to minimize the impact of failures. The contractor shall provide maintenance procedures, and define the spares to ensure that the Availability requirements of the ETCS System shall be achieved.

A single point failure shall not cause failure of the overall system.

The availability of the ETCS System shall be demonstrated by the Contractor in accordance with the processes defined in IEC 62278 or an equivalent standard.

For the purposes of availability calculations, the Contractor shall assume that the service should operate 19 hours per day (05:00 to 24:00) 365 days a year.

The availability of the Train Control System shall be demonstrated by the Contractor in accordance with the processes defined in the relevant documents and specifications.

The Contractor must develop the ETCS/ERTMS system to comply 99.98% Availability requirements.

2.8.4 Perturbation Analysis

A detailed System perturbation analysis shall be performed stating the types of failures that could cause service interruptions.

Operational actions, System design features or maintenance strategies that can reduce the impact of potential service interruptions shall be submitted to the Engineer for review.

2.8.5 Maintainability Requirements

2.8.5.1 Systems and Equipment Design

The System shall be designed to maximize availability during traffic hours and minimize the amount of maintenance required. Maintenance tasks should be optimized and simplified for minimal time, reduced skill levels and cost where applicable. Consideration should be made to locate equipment in position of safety away from the running line where applicable. Line access points should be established as part of the project and maintenance hazards designed out where possible.

2.8.5.2 Mean Time to Repair

The maintainability measure for the ETCS System shall be Mean Time to Repair (MTTR).

The required MTTR shall be achieved for failures of the whole System or any part of the System, whether service affecting or not.

The following MTTR shall be achieved:

1) 15 minutes for train-borne equipment;

2) 30 minutes for trackside equipment; and

3) 15 minutes for equipment located in equipment rooms or control rooms.

The MTTR time measurement shall include on-site diagnostics and rectification of the failure (including software re-boot) up to the point that the System is restored to full functionality. In the event that the failure cannot be rectified, this time measurement shall include the time necessary to remove the failed piece of equipment from the System and replace it with a functioning one.

The MTTR does not include the time taken for designated personnel to arrive on site (access time) to begin local diagnostic activities, neither the time taken for the replacement parts to be delivered to site, especially in the event of point machine failure, where hand operation may be required until the machine is repaired.

The maintainability requirements of the ETCS System shall be demonstrated by the Contractor.

2.8.6 Line Replaceable Unit Exchange

All line replaceable units shall follow maximum weight restrictions such that these can be easily handled manually by a single person (with the exception of point machines and impedance bonds).

The design of the system shall avoid as far as possible maintenance operations along the track. Consequently, the Contractor shall minimize as far as possible the amount of track equipment that requires regular maintenance / servicing.

2.8.7 Safety Requirements

The ETCS System shall provide for the safe routing, spacing, movement and control of trains.

The Contractor shall establish and maintain complete responsibility of the system safety through a compliant design and the application of engineering and management principles, criteria and techniques to optimize all aspects of safety throughout all phases of the system life cycle. This shall apply to all systems supplied under this Contract.

The safety level of the ATP system, Interlocking, RBC and Train Detection system shall satisfy SIL-4 requirements.

An unsafe condition shall not occur to the ETCS System when a plug-in module / card or equipment is removed for replacement or any other matter.

The probability of Wrong Side Failure shall be 10^{-9} per train operating hours or better for the complete ETCS System supplied, installed and commissioned under this Contract.

2.8.7.1 Safe Train Movement

1) Operating Envelope

The ERTMS / ETCS Level 2 system shall ensure safe movement of all trains under all operating conditions by continuously generating a safe operating envelope defined by the MAL and the MSS.

The MAL shall be the furthest point to which the train may safely proceed taking into account margins for error in speed and distance measurement, calculating braking distances and equipment reaction times.

The speed measurement apparatus shall be provided by the Contractor in accordance with the Interface Specification for Rolling Stock in Appendix A1.

The MSS shall be the maximum speed at which the train is permitted to travel without intervention by the ETCS System. It shall be continuously calculated such that;

a) Civil Speed Limits are never exceeded;
b) The speed limits for the type of train are never exceeded;

c) Temporary Speed Restrictions are never exceeded; and

d) The train shall always stop without passing the MAL.

Should the train be required to be driven in manual mode a Target Speed shall be calculated for display to the train operator to provide advance warning of changes in MSS whilst in ATP mode.

If the train is being driven in a manual mode and a new MSS is lower than the current MSS, the Target Speed shall be calculated and displayed to the train operator in advance, such that the train may be braked to the new MSS with a normal service brake application.

Where the new MSS is higher than the current MSS, the Target Speed shall reflect this change immediately. The ETCS shall ensure minimum safe train separation. Braking distance shall be derived from a safe braking model that shall consider worst case system response times and failure conditions, consistent with railway industry practice. The safe braking model shall be submitted as part of safe braking calculations. The Contractor shall submit this information to the Employer's Engineer for review.

2) Prevention of Movement Outside Safe Operating Envelope

The ETCS Level 2 system shall always prevent train movement outside of the safe operating envelope by application of the service brake.

The ATO system shall normally drive the train providing traction and brake control while staying within the Maximum Safe Speed (MSS) monitoring and avoiding ETCS intervention.

The ATO driving features shall include:

a) Timetable Speed Management (TTSM)

b) Supervised Envelope Speed Management (SESM)

c) Automatic Train Stopping Management (ATSM)

In manual driven mode, if the actual speed exceeds the permitted speed, a warning must be given to the train operators to enable them to react and avoid intervention from train borne ATC equipment at least 2 seconds before the intervention of the full-service brake until the actual speed does not exceed permitted speed, then the train operator must be capable of selecting release of full service braking. The warning must continue until actual speed does not exceed permitted speed. The full-service brake intervention and emergency brake intervention must be recorded. If the full-service brake fails or is not adequate to stop the train at the target point, the train borne equipment must apply the emergency brake.

2.8.7.2 Safe End of Track Approach

The ERTMS / ETCS System shall ensure that the train shall be brought under control and not overrun the end of track buffers even under the worst failure conditions.

2.8.8 Equipment Response Time

The response time for all equipment, with the exception for point machines, irrespective of the location shall not generally be greater than 500ms.

Equipment response times for all OCC/IOCC, SCR, CER and SER equipment shall be inclusive of all processing time, display time and transmission propagation delays.

Response time in this context is time taken for the equipment to process the commands (or input) and generate a signal at the output (or user display).

The time necessary for the initialization of a sub-system (trackside ATC, train borne ATC, interlocking, track to train transmission) shall be as short as possible.

The Contractor shall provide variances that fall outside the normal expectation for parameters of ERTMS/ETCS standards regarding speed, distance and equipment response times, and justify any such deviation and impact on overall performance.

2.8.9 Service Capacity

2.8.9.1 Service Capacity Requirements

The ERTMS / ETCS system shall have the capacity for the sustained operation of the total number of EMU's in both directions per hour with no cumulative delay between the stations, including turn-back operation at the terminal stations. This includes operations with respect to any pocket lines used throughout the System.

The ETCS shall be able to support different rolling stock and their particular characteristics.

2.8.9.2 Service Capacity Conditions

The per-hour-per-direction service capacity requirement shall be achieved based on the following conditions:

1) Train station stops with 30-second dwells;
2) Nominal train layover of 120 seconds at all terminals to fulfill headway requirements;
3) All merges, diverges, and conflicting moves; and
4) Train characteristics and performance as indicated in Appendix A1 of this ERT.
5) This will include PSD operation time.

2.8.9.3 Signaled Headway

Notwithstanding the service capacity requirement above, the ETCS shall provide a minimum operational headway of 5-minutes but shall reduce to 3-minutes in the future. The Signaling system shall be designed for a 3-minute operational headway.

This headway shall be measured on the line using the respective EMU performance for 8-car trains (possibly 10-cars in the future) with a 30-second dwell at intermediate stations and a nominal layover at terminal stations.

The Signaled Headway requirement of the ERTMS / ETCS system shall be demonstrated by the Contractor. The Contractor shall furnish the Employer with design data, formulas, calculations and computer simulation logic, results and printouts to demonstrate that both safe braking and the specified theoretical headways have been provided by the design. These shall be submitted to the Engineer for review.

2.8.9.4 Recoverability

In the event of failure of one operating mode, there shall be graceful degradation to another mode, which shall optimize service capacity while maintaining safety.

The Contractor shall demonstrate, during the on-site test and commissioning period that the Automatic Train Supervision (ATS) shall recover a delay to service by utilizing all available margins obtained from the difference between 5% and maximum performance for all inter-station runs and the difference between the nominal and minimum values for all station dwells.

The Contractor shall demonstrate that the ETCS can recover delays to the scheduled train service.

The Contractor shall demonstrate that the ETCS System can recover the train service to constant service headway. Recovery, in this context, shall be defined as all trains operating to a constant required headway, within the configurable tolerance, subject to review by the Engineer.

The normal operational mode for trains will be ATO over ETCS, the Contractor shall demonstrate the benefits of improved capacity, on-time performance (timetable compliance) and energy efficiency.

2.8.9.5 Train Types

The ETCS shall provide for the safe operation of all train types including:

1) EMU passenger trains; and

2) Empty Trains

2.8.9.6 Ride Quality

The normal operational mode for trains will be ATO over ETCS and should result of better ride quality.

The ERTMS / ETCS Level 2 system shall control the movement of trains to avoid frequent occurrences of acceleration and braking. This function shall not compromise the headway and line capacity capabilities.

The ERTMS / ETCS level 2 system shall ensure that the jerk limit specified for the EMU's is not exceeded. Detail is provided in Signaling/Rolling Stock Interface Specifications and attached in Appendix A1.

2.9 Electromagnetic Compatibility

This statement defines the minimum Electro-magnetic compatibility (EMC) requirements for all electronic and electrical equipment supplied under this Contract. For 1500VDC OCS traction power, the Contractor shall comply with IEC 62236 or an equivalent standard.

An EMC strategy shall be submitted by the Contractor to Engineer for his review.

The EMC control plan shall include measures to reduce conducted, induced and radiated emissions to acceptable levels as specified by relevant international standards. The plan shall specify measures to increase immunity of the Train Control System.

The plan shall specify basic protective measures proposed for all electrical and electronic subsystems and components and specific measures to be adopted for the selected subsystems and components.

The plan shall analyze EMI/EMC impacts on the design of the ERTMS / ETCS Level 2 system including train-borne equipment, trackside equipment and bi-directional train to wayside data communication as well as the general environment. Particular attention should also be paid to additional requirements in grounding, bonding, shielding, filtering and cabling.

The Contractor shall coordinate with other Interface disciplines as well as external interfacing parties to ensure that the frequency ranges employed by the ERTMS / ETCS Level 2 system will be free from interference. The system shall also not infringe on the frequencies of other systems.

The Contractor shall ensure that the fundamental frequencies, harmonics and any other potential sources of interference produced by the ERTMS / ETCS level 2 system will not impede those of other systems in the Project.

The Philippines National Telecommunication Commission (NTC) has confirmed via a letter to DOTr regarding reservation of GSM-R frequencies for rail use. Previous allocation to commercial GSM Entities has been amended and affected entities instructed to re-configure their systems to ensure the 876-880 MHz and 921-925 MHz frequency ranges are reserved for Railway use for the NSCR projects from Clark through Manila to Calamba. Please refer to the Telecom Bidding Documents with regards to the "Co-use of Frequency" as approved by NTC which can be found on Appendix 2- Radio System under Section 1.1 of the General Requirements.

2.9.1 EMC Tests

The Contractor is required to conduct full EMC tests. The tests shall satisfy the requirements of standard IEC 62236 or equivalent.

2.9.2 Specific Standards

1)	Electrostatic Discharge	IEC 61000-4-2
2)	Radio Frequency field	IEC 61000-4-3
3)	Electrical fast transient/burst	IEC 61000-4-4
4)	Surge	IEC 61000-4-5
5)	Conducted RF	IEC 61000-4-6
6)	Power Frequency magnetic field	IEC 61000-4-8
7)	Pulse magnetic field	IEC 61000-4-9
8)	Damped oscillatory magnetic field	IEC 61000-4-10
9)	Voltage dips, short interruptions	IEC 61000-4-11
10)	Oscillatory waves	IEC 61000-2-12
11)	Harmonics and Inter Harmonics	IEC 61000-4-13
12)	Voltage fluctuation	IEC 61000-4-14
13)	Conducted disturbance	IEC 61000-4-16
14)	Ripple of DC power supply	IEC 61000-4-17
15)	Variation of power frequency	IEC 61000-4-28
16)	Digital Radio Phone	IEC (Latest draft)

The Contractor may use equivalent standards which apply to the various EMC tests indicated above.

The following specific EMC requirements shall be met by the design of the ERTMS / ETCS Level 2 system:

1) Radiated Emissions

As a minimum requirement, the maximum levels of radiated electro-magnetic interference (EMI) of the installation shall not exceed the levels specified in IEC 61000-6(or an equivalent standard);

2) Conducted EMI

The maximum levels of conducted EMI of the installation shall not exceed the levels specified in IEC 61000-6(or an equivalent standard); and

3) Induced EMI

The Contractor shall ensure that any cables supplied under this Contract other than power cables used by the System are properly screened, earthed and terminated to prevent noise and/or electric shock from exceeding levels defined by the International Telecommunication Union-Telecommunication (ITU-T).

2.9.3 Radiated Immunity Levels

1) Any sensitive electronic equipment supplied will operate in an environment with a substantial amount of radiated interference present. The equipment may be subject to radiated energy from hand-held transceivers and other communications systems.
2) As a minimum requirement, the equipment must be immune to field strength defined in IEC 62236(or an equivalent standard) for the adopted frequency range.

2.9.4 Conducted Immunity Levels

The equipment supplied shall continue to operate correctly with no degradation in performance, when subject to the levels of conducted interference set out in IEC 61000-6(or an equivalent standard) in the frequency range of 150 kHz to 30 MHz.

2.9.5 Electrostatic Discharge

Any equipment which contains sensitive electronic components and is likely to be handled or touched by personnel or customers shall be protected against electrostatic discharge and shall be tested to 6 kV with contact discharge or 8 kV with air discharge as defined in IEC 61000-4-2 (or an equivalent standard).

1) Fast Transient Burst

In regard of fast transient burst, equipment supplied shall be tested to 2 kV peak in accordance with IEC61000-4-4 (or an equivalent standard).

2) Power Surge

In regard of power surge, equipment supplied shall be tested to 2 kV (common mode) and 1 kV (differential mode) in accordance with IEC61000-4-5 (or an equivalent standard).

3) Magnetic Field

The Contractor shall ensure that any static or alternating magnetic fields generated in the environment shall not interfere with correct operation of any equipment to be supplied.

CRT Monitor: CRT monitors shall not be used, and all monitors supplied as part of this Contract shall be of the LCD or LED type.

The Contractor shall conduct a preliminary EMI Hazard analysis at the conceptual design stage to identify sources of EMI likely to affect other system equipment and equipment sensitive to EMI; likely consequence in the event of failure and the proposed EMC measures.

4) Off-the-Shelf Products

EMC test certificates shall be submitted to the Engineer for review for any standard off-the-shelf products.

2.9.6 Inter System EMC

The Contractor shall ensure that all the train control equipment is designed and constructed in accordance with the latest issues or versions of internationally recognized EMC standards including, but not limited to IEC 62236, IEC 61992, IEC60571, IEC 61000 (or equivalent standards) to ensure correct functioning.

2.9.7 Intra System EMC

The Contractor shall ensure that all intra system EMI are taken care of through proper design and other special measures. All major subsystems shall be tested for emissions and immunities in accordance with the appropriate standards for equipment operating in a similar Railway environment.

Where testing is not applicable due to factors such as size of subsystem or availability of test facilities, written approval shall first be obtained from the Authority for waiver of such tests. In this circumstance, an applicable technical construction file shall be developed in accordance with appropriate EMC directives and be certified by an appropriate Competent Body for the compliance of such mandates.

2.9.8 Safety-Related Systems Interference

Special attention shall be given to the immunity of the ERTMS / ETCS Level 2 system to inter-system EMI due to its safety-related operations. Special tests shall be designed to ensure that the emissions from other apparatus, whether conducted, induced, of radiated conform to the specific requirements of the Signaling system. Adequate safety margins between the immunity levels of these safety-related systems and the emission levels of other electrical and electronic equipment shall be adopted. Measures shall be taken to improve the immunity of the Train Control system. These measures shall include, but shall not be limited to the following actions:

1) Correct grounding to reduce ground-loop coupling;
2) Correct cable shielding to reduce common-mode coupling;
3) Correct use of twisted-pair cable to reduce differential mode coupling;
4) All cable pairs in multi-pair cables shall be twisted;
5) Correct magnetic shield to reduce low-frequency magnetic field interference from the traction system;
6) Use steel cable supports (trunking, trays, etc.);
7) All cable supports shall be grounded;
8) Correct choice of operating frequency;

9) Use of a filter to reject out-of-band noise;
10) Correct use of surge arrestors;
11) Use of high-level modulation technique to improve the immunity of the system;
12) Use of redundancy codes/checksum, etc. to improve the immunity of the system;
13) Use of parallel-check technique to improve the immunity of the Train Control system; and
14) The probabilities of various conditions, which could lead to an unsafe operation, shall be determined. An appropriate technical construction file suitable for safety audit shall be developed to demonstrate EMC compliance.

2.9.9 Environmental EMC

The train-borne electronic and electrical equipment shall not produce significant interference with radio, television, tape recorders/players, heart pace makers, radar, computer systems, magnetic media, portable and cellular telephones, pagers, etc. in the passenger saloon or externally. This includes potential interference generated by both static electricity and electro-magnetic fields.

Additionally, protection from external sources such as Bluetooth and commercial Wi-Fi must be assured by adopting appropriate security layers and/or advanced encryption or other methods as prescribed in the relevant standards.

Effect of emission on explosive or volatile/flammable material must be considered. The standard PD CLC/TR50427(or an equivalent standard) (Prevention of inadvertent ignition of flammable atmospheres by radio frequency radiation) and any other related standards must be adhered to.

Effect of the magnetic field produced by traction on grounding system in addition to electrolytic weakening of underground structures should be considered wherever applicable.

2.9.10 Installation and Mitigation Guidelines for Cabling

The cables used in the Train Control system shall be adequately protected against external interference. Additional protective measures, including but not limited to the use of metallic conduit, armor, ferrite choke, EMI filters shall be used to reduce such external interference wherever required. Covered conduit is preferred.

The cables shall also be installed at a safe separation from potential interfering sources, including power cables, etc. A cable routing plan shall be designed so that there is the least likelihood of coupling between the Train Control cables and the potential sources of interference. The Contractor should refer to guidelines recommended by IEC61000-5-2 (or equivalent standards) wherever possible.

2.9.11 Signal Trunking

For protection against electrostatic capacitance coupling, direct electrical connection between ducts of power cables and signal cables shall be avoided. For protection against electromagnetic induction, the latest versions of IEC61000-5 or any other equivalent standards shall be referred to wherever practical.

2.10 Functional Requirements

1) ERTMS / ETCS Level 2 shall be defined to support various trains and driving modes in order to guarantee line capacity and headways. The standard is defined in CCS TSI (Technical Specification for Interoperability) of EU Directive. In addition, standards have been set for each device and are harmonized to which the Contractor shall comply.

2) The ETCS Level 2 will require GSM-R radio transmission system to enable RBC to train data communication as well as GSM-R voice communications.

2.10.1 ETCS On-board Configuration

The Contractor shall provide on-board units (OBU) and all accessories at each end of the train. The EVC of the OBU shall be redundant. The Contractor shall propose the configuration of the redundant EVC. The ETCS equipment required within both train cabs shall be connected to the OBU by Ethernet, train lines or similar systems.

2.10.2 Principle of ERTMS / ETCS Operation

1) ETCS Level 2 requires radio for the transmission of signaling data, both constituting an ERTMS system. The National Telecommunications Commission (NTC) of the Philippines has confirmed the use of a 900MHz band (uplink: 876-880 MHz; downlink: 921-925 MHz) as designated by the EU regulations. Please refer to the Telecom Bidding Documents with regards to the "Co-use of Frequency" as approved by NTC which can be found on Appendix 2- Radio System under Section 1.1 of the General Requirements.

2) ETCS Level 2 is a fixed block control system and will use track circuits that are fail-safe and have been proven reliability for train detection.

3) The train position shall be confirmed by programmed trackside balises that the train passes over and track circuit boundaries separating ETCS block sections. Position reports will be transmitted to the RBC. The RBC will take as input, status of route setting as communicated by the by the CBI and will issue movement authorities (MA) to trains based on route set, track circuits clear and other conditions. The RBC is the center for processing ETCS Level 2 logic and will contain the route-map.

   Within the RBC, the MA for a train is calculated up to the next stop position (end of authority). The Movement Authority is calculated using the distance from the last relevant balise group (LRBG) reported from the train.

   The EVC on the train calculates the brake pattern based on the distance between front end of the train and the End of Authority (end of Movement Authority). The front-end position of the train is determined by tachometer and radar as a trip distance from the LRBG.

   The MA request from the onboard ETCS to the RBC and MA issue from the RBC to the train shall be transmitted via GSM-R system.

4) The Signaling system shall supply the GSM-R system liaising with the communications system for provision of infrastructure. This shall include a complete radio survey to determine the number and distances between Base Station Transceiver Stations. Additionally, a MSC (Mobile Switching Center) and BSC (Base Station Controller), shall form part of the Train Radio infrastructure.

5) Ideally 100% radio coverage is required. An assessment of radio coverage over the entire line shall be made and actions taken to address any radio holes identified to

ensure a functioning ERTMS system.

The Radio system shall be preferably a closed system unless it can be justified by the Contractor that using commercial public sites or a hybrid version of the Radio system can be proved to have significant benefits.

6) The ERTMS / ETCS system shall operate in a fail-safe manner and shall continuously supervise the safe running of the train in accordance with ERTMS / ETCS subset-026. In the event of dangerous situation arising, the system shall warn the train operator (in manual driving mode) to apply the brakes as necessary. The ETCS-OB provides the safety function when the train is driven by ATO. sub-system.

7) The ETCS system shall be capable of supporting a mixed fleet of trains (if required for future operations), where specific trains, and/or classes of trains, have different performance characteristics.

8) The ETCS shall be designed to support degraded modes of operation in event of failure and to continue to provide ATP with minimum reliance on adherence to operating procedures. This shall be achieved through functional elements of the ETCS system.

9) The ETCS train-to-wayside communications interface shall be sufficient to support all required ATP and ATS functions. The data link shall provide continuous coverage within ETCS territory to sustain train operations. The data link shall support bi-directional data transfer and shall exhibit sufficiently low latency to support defined performance requirements. The data link shall include a protocol structure to maintain safe, timely and secure delivery of train control information.

10) All trains managed by the ETCS shall transmit their position and direction at all times (unless under failure conditions) and shall have a detailed knowledge of the line.

11) The wayside train control system using inputs received shall determine the position of all trains within the operational network. The location of all trains in the system shall be monitored by the ATS. By the use of this process, line capacity shall be maximized.

12) The ERTMS / ETCS Level 2 system shall as a minimum be capable of the following:

   a) Advanced and High-Performance Functionality to support Operations, including:

      i) Automatic Train Protection (ATP) and Automatic Train Supervision (ATS)

      ii) ATO shall be introduced as part of this project based on the approved ATO over ETCS subset 125 (SRS) and subset 126 (ATO-OB / ATO-TS interface).

   b) High Performance

      i) Energy Saving; and

      ii) Door Opening Sequence.

   c) Availability

      i) Fault tolerant and resilient to external influences.

   d) Safety Engineering processes in accordance with proven standards.

   e) Flexibility

      i) Ability to include Rolling Stock and their particular characteristics when the system is fully expanded to include future operations

f) Optimum Life Cycle Costs
   i) Procurement;
   ii) Operations; and
   iii) Maintenance.

2.10.3 Data Transmission System

1) The Data Transmission System shall provide a bi-directional, reliable, and secure data exchange system between the base transceiver stations (BTS), Radio block center (RBC), computer-based interlocking (CBI) and wayside equipment.

2) A data transmission between the trackside balise groups and the on-board equipment shall provide relocation information and various ETCS messages and telegrams. In some instances, switchable balises may be required (where signals are retained).

   The Communication system infrastructure equipment shall be provided by the Communication system.

2.10.4 Radio Block Centers (RBC)

The Contractor shall calculate the number and configuration of RBC's required to efficiently operate the system. The RBC(s) shall be capable of communicating with the RBC on adjacent section NSCR-N1 (Malolos to Solis project).

The communication between RBCs shall adopt rules in accordance with ERTMS standards (Subset 98 and Subset 39). Appropriate encryption/cryptography algorithms in accordance with ERTMS Key Management principles (Subset-038, Subset-114 and Sub-set 137) shall be implemented to ensure security of transmitted data.

The RBC equipment shall be configured to ensure high reliability and availability. The Contractor shall indicate the configuration of the redundant RBC platform. The RBC shall conform to SIL 4 and be capable of managing the following safety-critical related functions in real time:

1) Calculation of the end of movement authority of each train; Transmission of ETCS data to / from each train.
2) Interface with the CBI for the exchange of data regarding track equipment status, route proving and train positioning; and
3) Interface with the CBI and the ATS for the exchange of system information, e.g. train location, train regulation, train hold, change of ends, etc.

2.11 Operating Criteria

2.11.1 Normal Operation

The maximum allowed speed of trains will be 160 km/h in MCRP section and 120 km/h in NSRP section. The ATP system shall enforce civil speed restrictions, temporary speed restrictions that may be affected and diverging speed restrictions over turnouts and crossovers. Any speed restrictions in effect shall apply for the entire train.

2.11.2 Operating Modes

The operation modes are classified as train operation mode and system operation mode. Each mode has several degraded modes dependent upon the failure mode. It should be noted that the driving modes differ slightly from those indicated within the ETCS specification. However, in order to unify the driving modes with the rolling stock specification, these modes shall be adopted.

The following operational modes shall be adopted:

1) ATO Mode (FS mode));
2) ATP Mode;
3) On Sight Mode (OS)
4) Staff Responsible (SR) Mode;
5) Reversing Mode; and
6) Isolation Mode

2.11.2.1 ATO Mode

In ATO mode, the train shall operate without intervention by the train operator except when starting from a station stop. ATO mode shall operate under the supervision and control of the ATP subsystem.

ATO mode shall be the normal mode of operation.

Trains capable of automatic operation shall be entered into service in ATO Mode.

In ATO mode, the ATO function controls the train braking and traction systems under the supervision of the ATP system.

In ATO Mode, the Train Control System shall:

1) Accelerate and decelerate the train by applying traction power, coasting, and applying and releasing the brakes;
2) Automatically control speed and acceleration thereby preventing unnecessary braking, stopping and starting;
3) Automatically stop the train at the correct stopping point within stations;
4) Provide all indications necessary to operate the train;
5) Continuously control the speed of the train within the Maximum Safe Speed (MSS) and Movement Authority Limit (MAL);
6) Open train doors on the correct side when the train is docked if permitted by the ATP door release and
7) Prevent the train from starting if train doors are not detected closed.

Train re-starting from a signal stop shall be automatic.

Train starting or re-starting from a station stop shall be initiated by the train operator.

When a train is stationary, the train operator shall apply a Full Service brake.

The train operator shall have the capability of taking over control of the train any time while degrading the mode appropriately.

2.11.2.2 ATP Mode

In ATP Mode the train will be driven by the train operator obeying cab signals. ATP Mode shall be the normal mode of operation in the event of failure of ATO.

In ATP Mode, the Train Control System shall:

1) Provide cab signals and all other indications necessary to operate the train including current speed;
2) Determine continuously the MSS and MAL;
3) Prevent train operation in excess of the MSS or MAL;
4) Provide audible and visual warning if the train speed exceeds the MSS;
5) Enable train doors when the train is docked, enabling only the doors on the platform side of the train; and
6) Prevent the train from starting if train doors are not detected closed.

ATP Mode shall be available on all trains.

2.11.2.3 On Sight Mode (OS Mode)

This mode enables the train to enter into a track section that could be already occupied by another train or obstructed by any kind of obstacle. The authority to use this mode shall come from trackside only (this mode cannot be selected by the driver). It remains in operation until sufficient conditions have been met to allow for a transfer to the Automatic train Protection/Full Supervision Mode. Maximum operating speed under this mode shall be 25 kmph.

2.11.2.4 Staff Responsible Mode

Staff Responsible-This mode allows the driver to move the train under his own responsibility in a ETCS system equipped area under certain situations e.g., after the ETCS on-board equipment starts up, to pass a signal at danger etc. It remains in operation until sufficient conditions have been met to allow for a transfer to the Automatic train Protection/Full Supervision Mode. Maximum operating speed under this mode shall be 25 kmph.

2.11.2.5 Reversing Mode

The mode of ETCS when the ETCS system allows the driver to change the direction of movement of the train driving from the same cab (the train orientation remains unchanged).

2.11.2.6 Isolation Mode

In Isolation Mode, the train will be operated by the train operator in accordance with procedures and instructions from the Traffic Controller.

Isolation Mode is intended for use in case of complete train borne ETCS failure preventing release of the emergency brake. The emergency brake will be held off by the train. The train-borne equipment supplied by the Rolling Stock Contractors will limit the speed at 25 km/h (Refer to the Signaling/ Rolling Stock Interface Specification in Appendix A1).

The ATP By-pass Mode shall be initiated by the train operator operating a Safety Cut-out

Switch (SCS). The operation shall be recorded by the On-board TMS. The SCS shall be provided by Rolling Stock Contractors. In this mode the train doors shall only be enabled and controlled manually.

Isolation Mode shall be available at all times, on all trains.

2.11.3 Speed Regulation

The maximum train speed for particular train operation modes are as follows:

a) ATP Mode - Max. 160 km/h in MCRP section and 120km/h in NSRP section;

b) ATP OS Mode - 25km/h;

c) ATP Staff Responsible mode - 25km/h;

d) Reversing Mode – 10km/h; and

e) Isolation Mode – 25km/h

2.11.4 Call-On and Push-Out

The ETCS shall allow for call-on or push-outs to be safely performed in the event of operational need to rescue a failed train using a functional train.

Coupling of trains for call-on or push-out shall normally be performed in SR or OS Mode. Additionally, it shall be able to couple consists together whilst in service. This may be performed at stations, turn-backs or sidings. The train shall then be returned to the depot at the earliest opportunity.

2.11.5 Unauthorized Roll-Back

The ETCS System shall prevent an unauthorized reverse movement of the train by applying the emergency brake after a pre-determined distance.

2.11.6 Reverse Running

It shall be possible to operate trains bi-directionally at main line operational speeds. Full ATP (no ATO will be provided for reverse running) protection shall be provided for bi-directional running on all main line tracks and spur lines. Reverse running shall be performed in the event of the unavailability of any track section, or in an emergency scenario (e.g. derailment, train failure, etc.).

2.11.7 Train Operation Mode

The normal train operation mode is ATO (Automatic mode). For the other operation modes, the Train Operation procedures between modes shall be detailed by the Contractor.

2.11.8 Degraded Operation Modes

The normal mode of operation for trains shall be ATO.

If a failure of the ATO mode occurs, the ATO-OB shall enter a failure state and a failure indication displayed to the Driver. The train control system shall revert to ATP mode.

A failure of the ATP system shall prevent the train to be driven in ATP Manual mode, reverting to SR Mode. In this mode, the speed of the train shall be limited to 25 km/h.

A complete malfunction of the on-board ATP system will require that the system is overridden. To override the ATP system, a sealed switch shall be provided by the rolling stock contractors. Operation of this switch shall be logged within the TMS and the speed restricted to 25 km/h by the Rolling Stock system.

An indication shall be provided within the train operator cab to indicate the type of degraded mode of operation.

The degraded operation performance requirements shall be demonstrated by the Contractor.

2.11.9 Mode when entering a depot on the depot transfer line

As the train approaches the depot access line, the train operator must manually transfer from ATP (or ATO) mode to manual shunting mode to switch the operational mode. Thereafter, manual operation of the train is performed in the Depot. All movement in the Depot shall be achieved in this mode and by observance of the Depot signals. In this mode the speed is limited to a maximum speed of 25 km/h.

2.11.10 Transition between Modes

The Contractor shall state and describe in detail which transition modes may be achieved automatically and which must be performed manually by the train operator.

This shall be done in accordance with operational moves required for each depot and must be detailed on signaling layout and route tables.

2.12 System Architecture

2.12.1 General Requirements

The achievement of the system architecture and management of the line operation depends upon the fiber optic Communications Network (supplied by the Communications system) which encompasses the whole line and allows bi-directional communication between each sub-system.

The system comprises of the following infrastructure sub-systems; these being:

1) ATP (Automatic Train Protection);

2) ATO (Automatic Train Operation);

2) CBI (Computer Based Interlocking);

3) ATS (Automatic Train Supervision);

4) RBC (Radio Block Center);

5) Backbone Communications Network;

6) Bi-directional digital Radio Network; and

7) Network Management System.

The Contractor shall indicate which of the above systems shall be centralized and which could be distributed throughout the project area. Conversely, the Contractor may wish to propose an alternative method of configuration of the sub-systems. The Contractor shall justify any alternative method of configuration asserting the enhancements to the overall project and any other notable benefits to for the review of the Engineer.

All main sub-systems shall be configured with redundant constituents to achieve hot-standby mode such that a failure will have no impact on operations.

The Contractor shall provide a GSM-R system for transmission of bi-directional ETCS information between the RBC and the trains and the EVC. The Contractor shall state details the transmission of ATO data between the ATO-TS and the ATO-OB subsystem.

Where required for transmission of radio signals between wayside equipment and the train, the Contractor shall state whether free space propagation, waveguides, or a combination of the various methods for the transmission of the radio signals. The Contractor shall propose the frequencies in which the transmission shall operate and whether licenses to operate at such frequencies shall be required.

The Signaling system shall coordinate with the Communications system to confirm requirements and responsibilities for interconnections between the Base Transceiver Stations (BTS) distributed throughout the line, to enable full radio coverage.

The Contractor shall conduct a survey to ensure that all sections of the line are covered by the GSM-R radio system for ETCS. The Contractor shall identify any areas that may be problematic and propose suitable methods to overcome this situation, while noting that the Spectrum Committee composed of DOTr-PNR, Contractor and Public Telecommunication Entity, under the supervision of the NTC, will take all responsibility to remove any frequency interference.

The GSM-R radio-based system shall not be affected, degraded, or influenced by the simultaneous passage of trains on any given section of the line.

2.12.2 Safety Characteristics

The Contractor shall ensure safety by the use of approved standards, which shall certify that the safety-critical systems of the ETCS shall comply with SIL-4. These safety-critical functions pertain to the Automatic Train Protection sub-system, Computer Based Interlocking, Radio Block Centers and relevant sub-systems of the wayside and EVC. Communications between these sub-systems shall adopt appropriate techniques and shall only allow fail-safe exchanges of information. A safety analysis of the line configuration shall be performed by the Contractor, which shall form the basis of the project safety case.

2.12.3 Station Stopping

The ATO system shall ensure accurate station stopping though its Automatic Train Stopping Management function (ATSM). It shall provide train door opening commands after interfacing with the ETCS to ensure train stopped. An interface with the Platform Screen Doors System is required for ATO-OB to provides door opening and close commands in accordance with the subset 125 (SRS).

If the train stops within safety conditions for door opening i.e., door opening authorization window, the ETCS system shall provide the door enable signal to the train operator to open the doors manually on the correct side of the platform. If the train does not stop within door opening authorization window, the ETCS system shall not provide the door enable signal to the train operator (when in driving mode). If the train is not positioned correctly and it is desired to open the train doors, then a special door control signal must be sent to the door operating apparatus. The door controls shall be supplied and installed by the Rolling Stock manufacturer. Specific criteria for accuracy of stopping and for door control are given in this Technical Requirements.

2.12.4 Automatic Train Control (ATC) Function

The ATC Function shall be responsible for implementing train movements in accordance with the requirements established by the ATS Function, within the constraints established by the Interlocking Function.

The ATC integrates the safety and non-safety functions that enable safe operation of trains. It consists of the ATP, the ATO and the ATS.

2.12.5 Calibration of Train Data

Train-specific data are to be set by means of a fail-safe input procedure; examples of such data include:

1) Train type;
2) Maximum permissible train speed;
3) Train/train length;
4) Wheel diameter;
5) Service braking rate;
6) Guaranteed Emergency braking rate;
7) Brake response time;
8) Full-scale speedometer deflection; and
9) Any other information.

2.12.6 ATC Wayside Function

The ATC wayside equipment shall acquire and communicate in a safety critical manner, information about the track, which is needed on board to calculate the safe speed-distance curves. The information to be transmitted to the train as a minimum, but not limited to the following:

1) Track profile (Curves, gradient etc.), speed restrictions, switch/point locations and any other necessary information;
2) Dynamic train location, overlap status etc.; and
3) Train Regulation Commands.

2.12.7 Transmission of ATC Information

The communication provided between various ATC equipment and between ATC equipment and interlocking system shall comply with the requirements for transmission of vital safety information conforming to ERTMS standards.

The on-board ATC equipment shall conform to IEC 60571-1, and IEC 61000(or equivalent standards).

The system shall as a minimum shall be capable of transmitting data from train to track, such data as operating data, train number, destination and crew number etc., control information for automatic train routing, odometer readings etc., registration data and fault indications of the train data recording facility for the purpose of positive train identification and any other requirements.

No single failure of any component/board/module in the Trackside ATP and Onboard ATP subsystem shall cause complete failure of the respective subsystem.

The ATP wayside equipment and on-board ATP equipment shall be based upon fail-safe microcomputer system principles.

The Wayside ATP equipment and On-board ATP equipment shall have a fault tolerant equipment design using redundancies or other design features to ensure that a high level of train service is maintained in the presence of single point failure and also ensure achievement of availability as specified.

The wayside and on-board ATP equipment shall be configured in a fail-safe arrangement with suitable redundancies conforming to Safety Integrity Level-4 respectively as defined in IEC 62280 (or an equivalent standard):

1) Wayside ATP Equipment

   a) Single Electronic Structure based on reactive fail-safety with diverse software. The system shall work with on-line and hot standby configuration with facility of automatic changeover in case of fault of working system without affecting train operation; or

   b) Dual Electronic structure based on composite fail safety with fail-safe comparison (the configuration shall comprise of either 2x2 out of 2; 2 out of 2; or 2 out of 3 processors) with common or diverse software. The system shall work with on-line and hot standby configuration with facility of automatic changeover in case of fault of working system without affecting train operation.

2) On board ATP Equipment

   a) Two out of three hardware architectures with identical hardware and identical or diverse software; or

   b) Two out of two hardware with identical or diverse hardware and common or diverse software or Single Electronic Structure based on reactive fail safety with diverse software. Redundancy shall be provided so that failure of one onboard ATP equipment does not prevent the train from being operated in ATP mode. The changeover in the event of failure of one unit shall be automatic, without train operator's intervention, with an indication in the cab.

The train to wayside radio communication network architecture should use GSM-R radio-communication system. Failure of single network element, e.g., Radio switch, media converter, etc. shall not cause any deterioration in ETCS performance. The system shall employ countermeasures against interference and should use various techniques, e.g., directional antenna, space diversity of the antenna, etc. to achieve the performance requirements.

The Contractor shall use designated GSM-R frequencies for the ETCS radio network. The GSM-R radio system shall comply to EIRENE SRS 16.00 and FRS 8. The Contractor shall liaise with the relevant authorities for obtaining all necessary approvals of wireless equipment in the proposed frequency band.

The radio design shall be submitted for review by the Engineer before deployment.

The Contractor shall submit their preferred methodology for the positioning of Wayside ATP equipment including RBCs / CBIs, etc. to the Engineer for review.

2.12.8 Diagnostics

The system shall perform internal diagnostics. Internal self-test should be performed every system cycle and should verify the proper operation of CPU hardware and software as well as the health of other system PCB's. The failure shall be logged.

The system shall have the facility of interfacing with a portable test unit to retrieve data logs and system status information. The Contractor shall provide the portable test unit with the associated software to the Employer.

2.12.9 On-Line Data Logging Facility

The system shall log all events, commands, functions etc. which should be date and time stamped, for enabling complete analysis of safe and proper functioning of the system. The duration of logging shall be for a minimum of 24 hours.

The system shall interface with the on-board Train Management System (TMS) of the Rolling stock for online data logging of all events, commands and functions including on board Train control system failures, operating modes, current track section identification, etc. The duration of logging will be 24 hours.

Event logging facility for minimum 100,000 events shall be provided for the Wayside ATC equipment.

The Contractor shall provide laptop with debugging software for both on-board and wayside ATC equipment for failure diagnosis at site.

The system shall be suitable for working on sections having 1500VDC OCS traction power system and where cars will be propelled by IGBT VVVF controlled three-phase induction motors.

2.12.10 Automatic Train Protection (ATP) System

This system shall be a "proven in operation" ETCS fixed block ATP system. The Contractor shall provide substantiated evidence of successful operation on other similar types of Rail systems.

The sub-system shall as a minimum, but not be limited to, the following elements or similar proven equipment:

1) European Vital Controller (EVC) which controls the train's safety-critical and other functions; and
2) Radio Block Center (RBC) which supervises trackside equipment data and train positioning throughout the line, which is received from the CBI to provide Movement Authority (MA) to the trains.

The ATC shall comprise of a comprehensive ATP system, which shall perform the following high-level functions:

1) The accomplishment of headways as specified in the ERT, with trains being separated on the basis of their real positions plus an additional safety margin. This is made possible by continuous bi-directional track to train communications via the ETCS GSM-R radio system;
2) The inclusion of an advanced screen display (DMI) for driving modes, providing enhanced driver assistance functionality;

3) The continuous monitoring of trains, including the management of alarms and events, which can be downloaded on a reliable and regular basis;

4) The ATC system (ATP) shall safely perform safety-critical functions at SIL-4 level, inclusive of wayside and train-borne equipment; and

5) The ATP system shall provide the safety functions when the train is running in ATO mode, the normal mode for train operations.

6) When the ATO fails, the train will run in ATP mode. Its functions include supervision of running of train while remaining within the safety envelope calculated by ATP, train speed control, and protection point.

The train doors shall be authorized by the ATC system to be opened once the train reaches the correct stopping point at the station. The ATC system shall execute programmed stops and control, in conjunction with the ATS/ATP equipment, and shall execute dwell times in accordance with the timetable/ headway.

7) Automatic Train Protection is considered a "vital" system and shall comply with 'fail-safe" principles using state-of–the-art techniques in conjunction with recognized railway standards acceptable to the Employer. The system shall be configured for it and associated subsystems meet availability objectives.

8) The ATP system should be modular in design for installation on-board of vehicles, wayside equipment rooms or apparatus enclosures and for ease of replacement in the event of malfunction. The equipment (hardware and software) must be of proven design and application.

9) Automatic Train Protection shall be provided on all main line running sections inclusive of turn-back facilities at terminal stations and at specific locations situated on the system. As a minimum, the ATP shall provide the following functions:

    a) Prevents a train from entering a non-permitted area without invoking an irrevocable emergency brake application;

    b) Roll back detection;

    c) Wheel diameter compensation;

    d) Wheel slip and slide detection; and

    e) Self-diagnostic and health monitoring.

10) The ATP shall also be capable of ensuring observance of temporary or permanent speed restrictions in addition to the provision of safe stopping profiles for all train movements.

11) The ATP equipment shall be of fail-safe design with high availability and designed in accordance with Safety Integrity Level 4 (SIL 4) requirements as stipulated in standards indicated in the applicable specifications. The Contractor shall provide valid substantiation of implementation of the proposed system and associated equipment together with references of successful in-service operation on similar rail networks. This shall be supported by full technical details and description of equipment and system operating philosophy, including failure modes.

12) The ATP system design and equipment shall be capable of maintaining a safe braking distance between following trains at all times. The Contractor shall explain in a separate document the method and all parameters adopted for use in the calculation of overlap distances. The braking distances shall assume worst case braking with vehicles crush loaded at AW4, other variables including equipment

reaction, poor rail/wheel adhesion and other imprecise characteristics shall also be taken into consideration. The Contractor shall identify and quantify all tolerances and assumptions, the measures adopted in the calculations and their subsequent evaluation and submit them for approval by the Engineer/Employer. The Contractor shall stipulate and provide a copy of any computer-aided simulation software package used for this purpose.

13) The design of the signaling system shall be based upon a train-braking rate used by the Rolling Stock.
14) The ATP speed profiles are to be determined in conjunction with the signaling interlocking, which shall ensure that sections are unoccupied by vehicles, and points are in the correct position and detected & the route ahead is set and locked.
15) The Contractor shall document in detail the effect of ATP wayside transmission failure of single or multiple balises or similar devices as prescribed by the Contractor's system, and its potential consequences to the safety of the ATP system inclusive of maintaining safe braking distances.

2.12.11 Automatic Train Operation (ATO) System

ATO mode shall be the normal mode of operation.

In ATO mode, the train shall operate without intervention by the train operator except when starting from a station stop. ATO mode shall operate under the supervision and control of the ATP subsystem.

Trains capable of automatic operation shall be entered into service in ATO Mode.

In ATO mode, the ATO function controls the train braking and traction systems under the supervision of the ATP system.

In ATO Mode, the Train Control System shall:

1) Accelerate and decelerate the train by applying traction power, coasting, and applying and releasing the brakes;
2) Automatically control speed, acceleration, preventing unnecessary braking, stopping and starting;
3) Automatically stop the train at the correct stopping point within stations in conjunction with the Platform Screen Door positioning;
4) Provide all indications necessary to operate the train;
5) Continuously control the speed of the train within the Maximum Safe Speed (MSS) and Movement Authority Limit (MAL);
6) Open train doors on the correct side when the train is docked if permitted by the ATP door release command; and
7) Prevent the train from starting if train doors are not detected closed.

Train re-starting from a signal stop shall be automatic.

Train starting or re-starting from a station stop shall be initiated by the train operator.

When a train is stationary, the train operator shall apply a Full Service Brake.

The train operator shall have the capability of taking over control of the train any time while degrading the mode appropriately.

2.12.11.1 Station Stopping

In ATO Mode, the Signaling/Train Control System shall ensure that the trains stop within the accuracy specified. A visual indication shall be provided to the train operator when the train has docked.

2.12.11.2 Stopping Position

Stopping Positions shall be provided for each direction of travel and shall be designed to position the train within the parameters indicated below. The train stopping position shall be optimised for platform screen door (PSD) entry/exit locations.

2.12.11.3 Stopping Accuracy

All trains in ATO mode shall have a stopping accuracy within ± 300 mm for 99.95% and ± 500 mm for 99.98% of station stops. When a train is stopped within these tolerances of the Stopping Position and proved to be stationary, it is said to be "docked".

2.12.11.4 Train Doors

An enable doors signal shall be provided for train doors, indicating left-side, right-side or both-side, as appropriate for the station, when the following conditions are met:

1) The train is stopped within the performance limits; and
2) Train speed is lower than 1 km/h.

This signal shall be available to the train within 0.5 s of this condition being achieved.

In ATO Mode, the Signaling/Train Control System shall initiate door opening when the enable doors signal is sent. In ATP Mode, the doors will be opened by the train operator. Provision shall be made for the train operator to prevent door opening in ATO Mode.

2.12.11.5 Cab Side Door Interlock

In ATO Mode only, the train shall be prevented from departing unless all the train cab doors are closed.

2.12.11.6 Door Opening Authorization in ATP Mode

The ATP system shall prevent unsafe opening of train doors by providing the train with an appropriate control signal when the train has proved to be stationary, with the service brakes applied and the Train is correctly positioned within its designated stopping location (±500 mm) at a station platform with the train doors aligned with the Platform Screen Doors. The ATP system shall only enable the opening of the Train doors on the side of the Train that is immediately adjacent to the platform edge. To achieve this function, a normal stopping marker board shall be provided to ensure the Train stops within the defined stopping point.

If the train stops within safety conditions for door opening authorization, the ETCS will provide the door enable signal to open the doors on the correct side of the platform. If the train does not stop within the door opening authorization window defined above, the ETCS shall not provide the door enable signal to open the doors on the correct side of the platform.

If the train has stopped outside the door opening authorization window, the System shall provide the Train operator with the following three alternatives:

1) To attempt, in ATP mode, to reposition the train in case the train stops short of stopping position subject to a maximum creeping speed of 10 km/h;
2) To attempt, in ATP mode, to reposition the train in case the train overrun the stopping position subject to a maximum total reversing distance of 10 m; and
3) To proceed to the next station (except terminal station) in ATP Mode in case the train overrun the stopping position more than 10m. In this case, an alarm shall be activated by ATC system to indicate this condition.

It should be noted that this maneuver can only performed in ATP mode and only with the permission of the traffic controller.

A stopped train shall not be permitted to move until all doors (including Platform Screen Doors) of the train are proven closed and locked.

2.12.11.7 Permissive Door Operation

The Rolling Stock Contractors shall provide a permissive door button (PDB) in the driver's console. The permissive door button function (PDB function) shall be possible on the main line as well as in the Depot.

The PDB shall provide the following functionality:

1) The PDB when activated shall override the on-board signaling system's door release signal and shall provide door authorization on either side of the train regardless of the train's position; and
2) In the event of the on-board signaling unit not releasing the train doors at standstill, the permissive door operation shall force authorization on either side of the train door and the train operator can open the selected side train doors.

Train door operation shall be normalized after train doors are closed and locked again.

Activation of the PDB shall be logged by the event recorder.

2.13 Emergency Stop Switches

1) These shall be located on each side of each platform. On each platform, there shall be 3 Emergency Stop Switches provided and in the Station Control Room.
2) Operation of the switches shall have the following effect:
    a) If a train's approach is more than its service braking distance from the platform, it shall stop with a service-brake application;
    b) If a train's approach is less than its service braking distance from the platform or any part of a train is in the platform area, it shall stop with an emergency brake application;
    c) If train is stopped at the platform, it shall not be allowed to leave until the emergency switch has been restored to its normal position;
    d) Any departing train, where no part of the train occupies the platform area, it shall be allowed to proceed as normal; and
    e) If the train has started to depart from the platform and part of the train still occupies the platform, the train shall be stopped with an emergency brake application.

3) An indication of which 'switch' has been activated shall be provided at the site and on the workstation and an audible alarm shall be raised at the OCC/IOCC and SCR.

2.14 ATP Functional Requirements

The ATP system shall work on the principle of target distance, target speed and Movement Authority using ETCS Level 2 system based upon fixed block principles. The transmission from track to train will be continuous through the transmission of data by GSM-R radio.

All the functions under ATP shall be vital functions and shall govern the overall functioning of the ATC system. The ATP system is to permit supervised runs in the forward direction with respect to the occupied cab only.

The ATP component of ATC system shall ensure safe movement of trains and shall have as minimum, but not be limited to the following functions:

1) Reception of data and line information;
2) Track-related Speed Profile Generation: The ETCS Level 2 system shall compute the track-related speed profile from the line data and train data continuously along the track which shall be controlled and monitored by the ATP system. The permitted speed shall be computed separately for each of the monitoring functions. The maximum safe speed shall be the minimum of these speeds;
3) Output data for the cab display;
4) Monitoring and enforcing the change in Target Distance/Speed;
5) Maintaining the safety distance between trains: Train separation shall be maintained by ATP system. The movement authority to a train shall be given as per fixed block principles;
6) Continuous supervision of maximum permitted speed on the line;
7) Monitoring of maximum permissible train speed;
8) Monitoring for constant speed;
9) Monitoring of maximum speed set by the current operating state of the on-board unit (e.g. permissive speed);
10) Continuous monitoring of a braking curve with respect to a defined target point. Monitoring of braking curves shall be provided for a target point with respect to a stopping point or a speed restriction section etc. The braking curve is to be computed continuously along the line, so as to enable a minimum safety distance to be maintained. This computation shall be based online characteristics as well as the parameters of the train;
11) Stopping point monitoring: The ATP system is to regard the stopping point as a fail-safe stopping point with the target speed of Zero (0) km/h. The system shall comply to release speed requirements of relevant ERA/UNISIG standards. The stopping point monitoring function must ensure that a train does not run into the hazard point located beyond
12) Monitoring of train stop in the target area of a station, to ensure that scheduled trains stop at stations. The train must be supervised to stop within the stopping window;
13) Monitoring of speed restriction sections: A train or train length is to be taken into account when the train leaves speed restriction section. The train must observe the permitted speed within the speed restriction section until the tail end of the train has

passed the speed restriction section;

14) Entering and cancelling speed restriction sections: It shall be possible to add temporary speed restriction in a safe manner from both Operation Control Center and local control depending on the existing level of control. Any temporary speed restriction shall be in effect for the entire train;

15) Monitoring direction of travel and backward rolling. The unauthorized reverse movement of train shall be prevented by the application of the emergency brakes after a pre-determined distance;

16) Initiating emergency braking when safety limits are exceeded;

17) Automatic braking of the train shall be initiated in the event of missing or incorrect information from the wayside equipment or a fault in on-board equipment;

18) Releasing doors on the correct side at stations when the train has come to a stop within the door opening authorization window;

19) Releasing doors on both sides at stations having double discharge platforms when the train has come to a stop within the door opening authorization window;

20) To ensure that no movement of train is possible until all train doors are closed;

21) Entry to and Exit from the ERTMS / ETCS Level 2 Area;

22) Starting trains in ATP mode after Turn-back operation;

23) Activation of the on-board emergency stop button/handle shall result in the following:
    a) Immediate emergency braking; and
    b) Emergency braking, once initiated, shall remain active until the train comes to a complete stop. After the train has stopped, the emergency brake shall be required to be reset by the train operator.

24) The ATC shall detect train integrity and any parting of the train shall ensure the emergency brake shall be immediately applied;

25) In the event of the emergency brake being initiated by the Rolling Stock system or otherwise, the train-borne ATC shall withdraw any propulsion order; and

26) The ATP shall ensure that the train will be controlled to a stop before reaching the end of track buffer under worst case failure conditions both in the Depot as well as on the mainline.

2.15 ATP On-board equipment

2.15.1 General

1) In ETCS Level 2, the ATP on-board equipment shall calculate a braking control pattern for the MA based upon data received from the RBC and the train's speed and direction determined by the tachometer/radar and with position correction by wayside Balises. To achieve such functions, the EVC shall contain within its memory, the vital data of the track configuration (gradients, curves, Permanent Speed Restrictions, stopping points, relocation balise positioning, etc.) and constantly receives real-time track status (Movement Authority status, point position, Temporary Speed Restriction, etc.).

2) The ATP on-board equipment shall consist of an EVC (European Vital Controller), BTM (Balise Transmitting Module), TIU (Train Interface Unit), Redundant TRM (Train Radio Modems), DMI (Driver Machine Interface), Pulse generator, Doppler

Radar, JRU (Juridical Recording Unit), TMS (Train Management System). The ATP on-board equipment shall manage and control both two cabs (the front cab and the rear cab).

3) The ATP on-board equipment shall be based upon the standards as indicated in CCS TSI sub-sets. The ATP on-board equipment shall comply with SIL-4 requirements.

4) The train-borne ATP equipment shall be of a well-proven design, highly reliable and capable of operation in the electrically disturbed environment produced by traction motors and train control systems (e.g., inverters, choppers, etc.). It shall also be capable of withstanding vibration and oscillations produced by the interaction of the vehicle and track.

5) Fail-safe principles shall be adopted for the vehicle speed measuring system. The speed measurement indication on the speedometer shall denote true train speed within a tolerance of ± 2km/h. This is subject to calibration for wheel diameter; therefore, the system shall be adjustable to compensate for wheel diameter parameters. The Contractor shall determine, justify and submit for approval the design tolerances on the nominal speed profiles.

   The ATP system shall measure train speed in a fail-safe manner. This shall be derived from at least two independent sensors. Any fault in the speed measurement system shall either be detected as a fault or result in a higher than actual speed indication. The speed measurement system shall be able to measure the true speed of the trains and there should be no measurement errors due to wheel slip or slide. The distance measurement, which may be falsified by sliding and skidding, shall be synchronized regularly. The error in the speed measurement due to wear in wheel diameter shall be mitigated by automatic means or other safe methods.

6) The ATP system shall provide the driver with an audible warning should the maximum allowable speed be violated. Should the driver not respond to this warning by reducing the vehicle speed to the correct limit within a predetermined period, an irrevocable operation of the emergency brakes shall be invoked.

7) Errors in speed measurement due to excessive wear and usage of the speed measuring device shall result in an indication, which is higher than the actual speed. Wheel wear shall be taken into account for correction within the measuring device.

8) The on-board ATP system shall be provided with health monitoring, which will continuously examine the integrity of the system. In the event of a malfunction, which affects the integrity of the system, the train shall be required to be brought to a complete stop. An ATP bypass switch shall be operated to allow the train to continue during ATP on-board equipment failure. The use of the bypass switch shall be logged and time-stamped by the on-board Train Management System.

9) Additionally, equipment failure to on-board equipment shall be indicated to the driver in the form of an audible and visual alarm. Error codes may also be provided, which will assist the driver in deciding what further action is required.

10) The on-board ATP system shall also include self-diagnostics and data recording to assist in faultfinding; this information may be then downloaded to a portable device for further analysis and maintenance purposes.

2.15.2 Locked Axle Detection

Locked axle detection shall be provided.

2.15.3 ATC Auto Tests

Before allowing the train into revenue service, the system shall perform an ATC auto test to ensure that the on-board system equipment is correctly and safely operating. The system shall test the integrity of the embedded equipment (built-in-tests). The on-board system shall perform ATC auto tests which comprise of examining the integrity of the on-board hardware equipment and software, inclusive of safety outputs and emergency brake system. This shall be performed prior to the train entering revenue service.

2.15.4 ATP Wayside Equipment

The wayside equipment comprises of ATP wayside units and bi-directional GSM-R radio-data communication system and other necessary equipment. The ATP component of ATC system shall ensure safe movement of trains and shall have as minimum, but not be limited to the following functions:

1) Extracting driving instructions;
2) Long-term storage of line parameters (line gradient, curve, track section length, civil speed restriction sections, temporary speed restriction sections, Station stopping points, etc.);
3) Interface to ATS system;
4) Interface to the interlocking (operating states of routes and route elements);
5) Communication with adjacent wayside units (fail-safe communication);
6) Train location determination shall safely and accurately establish the location of the train;
7) Interface with peripherals (service and diagnostic computer, contact inputs, emergency stop inputs etc.); and
8) Generation and transmission of necessary data in fail safe manner for safe train movement.

2.16 Computer Based Interlocking

The Contractor shall indicate whether the interlocking(s) shall be centralized or distributed throughout the line and located at certain stations. The configuration of the interlocking(s) shall ensure high reliability, availability and cost-effectiveness. The Contractor shall justify their selection of the configuration of the interlocking(s).

The Computer Based Interlocking system indicated in this ERT shall be a microprocessor-based equipment used for the operation of points, signals, and other controls through a VDU based control panel. It shall interface with the RBC, ATP and ATS systems.

2.16.1 General Requirements

The System shall provide all the interlocking, control and indication functions as per approved Train Control plan, selection table (i.e., control/ route table) and panel diagram/HMI layout of the station.

The CBI shall adopt the Entry-Exit system, when manual route setting is required.

The System shall work in conjunction with trackside Signaling equipment. Signaling cables and outdoor power supply arrangements as stipulated within the ERT.

The System shall be capable for working in non-air-conditioned environment and ambient temperature range between -10 ºC to 70 ºC and Relative Humidity up to 95% at 40 ºC.

The System shall be provided in a dust protected cabinet. If force cooling is required, the cooling fans shall operate on the system power supply with an over current protection arrangement. The failure of any one of the fans shall generate an alarm to the operator or an appropriate fan redundancy arrangement shall be provided.

The equipment shall be constructed as to prevent unauthorized access to the system.

Necessary provision shall be made in the hardware and software for modular expansion of the system. For large stations, which cannot be covered by one CBI, it shall be possible to connect another CBI if necessary, preferably through a serial channel.

Both hardware and software of CBI shall conform to SIL-4 as defined in the standards indicated.

The Contractor shall give details of all modifications carried out in the system after initial validation/approval. Date of each modification with brief reasons for undertaking modifications shall be given. All modifications must have got approval of original validating agency/approving agency.

The CBI shall log of all safety related commands with counters provided e.g. Emergency Route cancellation, Emergency Point operation, Emergency Takeover Control, Un-blocking operations etc. so that in the event operation commands are given through the VDU, then correct working of counters shall be possible and readings of all counters can be read as and when required.

2.16.2 System Configuration

The CBI system shall consist of the following:

1) A Microprocessor based interlocking equipment to control and monitor inputs, outputs, process them in a fail-safe manner as per the selection table and generate required commands;
2) The cycle time and response time to read and process the input shall be fast enough to ensure safety and avoid any apparent delay. Cycle time and response time of the system shall be clearly indicated;
3) VDU terminal workstations to set routes and to perform other signaling control and monitoring functions;
4) The Maintenance Terminal (MT) inclusive of display, keyboard, and event logging facility for minimum 1,000,000 events;
5) Electronic Actuators/Object Controllers or Relay racks inclusive of the required number of approved type of relays; and
6) The system shall communicate with Operation Control Centre. Dual serial links in hot-standby mode or Ethernet links shall be used for this purpose.

The object controllers or similar devices shall be such that it can operate/receive status information from outdoor train control equipment without any modification/change in the design of outdoor train control equipment. The object controllers will be centralized in the Station Equipment Rooms.

For the Depot, the object controllers or similar devices shall also be located within the OCC Signaling equipment room to directly or through relays to drive train control equipment and/or to reduce the requirement of train control cable and interface relays.

2.16.3 Control Terminal with VDU Display

The control terminal with VDU displays (Workstation) shall consist of the following:

1) Color VDU monitor of 22" LCD/TFT, inclusive of appropriate equipment to operate the VDU;
2) A keyboard and mouse; and
3) Suitable interface to continuously display the current position/status of various field equipment and track sections.

A flashing or similar indication shall be provided on the VDU to indicate healthy condition of the main system, communication channel and panel processor. The Contractor shall propose the type of health monitoring to be included.

The health indication shall be prominently displayed at a conspicuous location on the VDU terminal.

The current position/status of various field equipment and track sections shall be displayed on the VDU using different colors/symbols. The HMI design shall be submitted for review by the Engineer.

The system shall have suitable interface to receive and process the information for displaying the status of field equipment on the control terminal. This interface shall be of standard type such as RS 232 or any other appropriate protocols.

The availability of communication channel shall be indicated by a constantly flashing indication. Whenever the serial channel is faulty, a suitable error message shall be displayed on the terminal.

2.16.4 Hardware and Fail-Safety

2.16.4.1 Components

The Components used shall comply with relevant clause of latest version of the specifications and should be commercially available.

2.16.4.2 Protection against Electromagnetic and Electrostatic Interference

The Contractor shall comply with the requirements as stated in the relevant clauses of latest version of the respective specifications. The equipment housing or chassis shall be connected to earth.

2.16.4.3 Printed Circuit Board

The Contractor shall comply with all requirements as stipulated in the relevant clauses of latest version of the respective specifications.

All cards shall be marked with running serial numbers for identification of individual cards.

2.16.4.4 Fail-Safety

Hardware and software redundancy shall be provided to ensure that any single fault does not lead to an unsafe failure.

The Mean Time Between Wrong Side Failures shall be a minimum of 10^9 operating hours.

The system shall have provision for accommodating an additional 25% of I/O cards.

2.16.5 System Composition

The Contractor shall propose the composition of the Computer Based Interlocking and shall justify their selection indicating the benefits. The configuration shall adopt one of the following architectures:

1) Two out of three hardware architectures with identical or diverse hardware and common or diverse software; or

2) Two sets of two out of two hardware with identical or diverse hardware and common or diverse software. Failure of hardware shall invoke an automatic changeover in a fail-safe manner without affecting train operation; or

3) Two out of two hardware with identical or diverse hardware and common or diverse software.

2.16.6 Maintenance and Diagnostic Aids

Maintenance terminal consisting of a PC with sufficient memory, a VDU terminal, printer, external media for retrieving and storage of data and a dedicated keyboard shall be used for following:

1) Display of the current status of the system;

2) Storage of minimum one month of data or 1,000,000 events;

3) Display of recorded events; and

4) Data transfer to CD / Memory or any other storage media

The command of train control functions shall not be possible from the maintenance terminal.

Facility of annunciation and display of faulty card / module for easy fault diagnostic shall be provided on the system. Suitable alarms shall be displayed for this purpose.

A trouble-shooting visual aid shall also be provided to indicate the step-by-step actions to be taken in case of failure of the equipment. It shall be possible to rectify the fault by replacement of PCB card by the maintainer at site.

The system shall log all events, commands, functions etc. which should be date and time stamped, for enabling complete analysis of safe and proper functioning of the system.

2.16.7 Software Requirements

The software of system should comprise of two layers; these being:

1) Executive Software

This Executive Software shall define what the system is capable of and how the various parts of the system operate together. It shall include all start up and operational safety tests (including checking the Executive Software itself) that comprise of the logical elements of the processor for continual assurance of safety operation. It shall not be possible to modify Executive Software.

2) Application Software

This software contains the logic that defines how the inputs and outputs for a particular station are related. This shall be station and system specific.

The Executive Software and Application Software shall be programmed into Read Only Memories (ROM) by the Contractor. Both the ROMs shall be separate and isolated from each other. The contractor may propose alternative method compliant to ETCS L2 requirements.

Software used in the CBI should have been developed in conformity with software engineering standards with special relevance to safety critical applications.

The selected CBI Software shall have been independently verified and validated. As specified in the software Engineering Standards, full documentation on Quality Assurance Program; this is especially pertinent to the Verification and Validation (V&V) procedures performed in-house or by any independent agency.

The results shall be made available to the Engineer to check their conformity to the standards. If the procedure and documentation for V&V is considered inadequate, the Employer reserves the right to obtain the verification and validation of the software and hardware. This shall be performed by an independent agency at the cost of the Contractor.

The system shall conform to software requirements and self-check procedures as laid down in relevant clause of latest version of the respective specifications.

2.16.8 Self-Check Procedures

The self-check of the associated functional hardware as required by the hardware design should be performed periodically as laid down in relevant clause of the latest version of the respective specifications. Sufficient self-checks should be accommodated into the system to detect possible hardware faults.

2.16.9 CBI Signaling Functions

Each CBI shall be provided with VDU workstations which will be provided at the SCR's of interlocking stations with points and crossing. These VDUs shall be used as a backup in case of failure of the Central ATS.

Interlocking shall normally provide for an overlap for all the routes, which shall be proven in the MSS and MAL transmitted to the train. In the normal running direction, the MSS and MAL shall be transmitted to the train based upon the Safe Braking Distance (SBD) in all cases. This shall also be achieved in reverse running direction, where simultaneous movements are possible. In other situations, or where such track section free of points is not feasible due to the track layout, points in the overlap shall be set and locked with the route.

The area of jurisdiction of the interlocking units on the main line shall be so configured as to cover the entire section. The Contractor shall confirm whether the configuration adopts centralized or distributed equipment according to the system feature. Separate Interlocking units shall be provided for the Depot.

The Contractor shall develop and submit the system configuration drawing, train movement specifications, (Train Control plan) signaling scheme plan and route table to the Engineer for approval. All turn-backs permitted by the track layout shall be provided and shall be fully ATP protected. Turn backs in ATP mode of operation shall also be provided at each platform in both directions at stations with points. Sequence Mode/Cycles shall be provided at terminals, at intermediate terminals and at stations with points. All such possible sequences/cycles shall be allowed for trains arriving in the normal running direction.

A maintenance workstation shall be provided with each CBI, which shall have the capability of displaying any fault, error or log. The maintenance workstation shall log the change of status of all elements, notably; points, route etc. The centralized maintenance workstation at OCC/IOCC shall receive information of all the interlocking units.

The equipment shall have door-locking arrangement.

The interlocking shall provide Approach Locking, Route Locking, Route Releasing, Fouling Protection, flank protection where required etc.

2.16.10 Route Control Modes

The Interlocking System shall make available the following three operating modes for route control:

1) Manual Mode (Automatic release mode): the route will be set on command from the Controller and will be automatically released after the passage of the first train or at reception of a route cancellation request, and a new request has to be sent for another train passage;

2) Fleet Mode: the route once set in fleet mode remains set, (unless cancelled by the operator), irrespective of the passage of train; and

3) Sequence Mode at termini: trains shall enter and leave platforms in a predetermined sequence with routes being set automatically.

The conditions to permit a particular route to be set are described as follows:

1) The route must be set, and the route locking must be in effect (all the sub-routes/ elements locked;

2) All the points in protection must be set, locked and detected in the protection position (flank and trap protection);

3) Opposing routes not set;

4) The timing release of the route is not in process; and

5) Overlap is set and locked.

A route is defined by its entrance and its exit or destination. Routes may be set if all the following applicable conditions are fully met:

1) Any conflicting routes are not set;

2) The route locking section/ route elements must not be locked in the opposite direction of the considered route; and

3) The opposite overlap must be free, if it is in the same section of track of the last switch of the considered route.

<u>Route locking section (sub-route/elements)</u>: When the route is set, all the sub-routes /elements of the considered route are locked if points have been set in the correct position. It is a condition for locking a route.

<u>Route locking</u>: A route is locked only if the route is controlled and all sub-routes/ elements are locked, and all overlaps are eventually locked.

<u>Application of Train Operated Route Release (TORR)</u>: Train operated route release (TORR) is the release of a route after the passage of a train without further action from the Controller. TORR must be inhibited if a route is set to work in fleet-mode.

<u>Route locking release by manual control</u>: If the Controller decides to release a route, they must select "route cancellation". There is such a control for each route. When this process is engaged, the interlocking realizes the following actions:

1) If the approach locking is free, the route is immediately released; or

2) If the approach locking is locked, the route is released after time delay.

Approach locking shall lock all switches when a route is set and will not allow the route to be released for a period not less than 180 seconds on the mainline and not less than 30 seconds in the Depot under certain circumstances (or time periods as decided during design stage). If a route is set but no train is within the approach distance (to be verified by the Contractor), the route will cancel immediately.

A route shall ordinarily be released by the passage of trains over the route in a sequential manner. Sectional release of route (elements) shall be provided as necessary.

The overlap is the distance between the Point to protect and the Operating Stopping Point. The point to protect shall always be ensured by the ETCS system for the safe braking distance.

Once a route has been set, the infringement of the Fouling Point of any point or crossing in the route by any train shall cause an emergency stop command to be sent to any train approaching or within the set route.

2.16.11 Terminal Control

Automatic turn-back (Cycle mode or Sequence mode) shall be provided in the interlocking logic at terminal stations including interim turn back stations, to automatically operate more than one route one after the other in a sequential manner. All such possible modes shall be provided for the trains arriving in the normal running direction.

2.17 Automatic Train Supervision (ATS)

The Automatic Train Supervision (ATS) System is the principal core of the control and monitoring system. The ATS receives and manages all operational railway data in real time coming from apparatus located at the wayside, at stations, and on-board trains. The ATS shall conform to SIL2.

The ATS system shall adopt proven hardware and software using generic COTS architectures. These architectures shall be modular in order to provide suitability or the inherent combinations of sub-systems and Employer expectations as required for the project.

The ATS shall also provide a Human Machine Interface (HMI), using graphical based user-friendly menus. It shall also offer a complete alarm management system, which enables the system to create a history of events, required for on-line analysis.

The ATS network architecture shall be centralized within the Operation Control Centre unless the Contractor proposes a different configuration, which is considered beneficial to both the project and the Employer. The Contractor shall justify any arrangement, which does not adopt the centralized method of control and monitoring.

All Workstations, printers and the Overview Mimic Display System shall be located within in the Central Control Room. All ATS central Servers, FEPs, workstations and archiving servers shall be located in the Central Equipment Room, notwithstanding any alternative arrangements proposed by the Contractor.

The ATS system shall have data processing facilities and achieve the minimum following main functions, but shall not be limited to:

1) Monitoring of ETCS equipment (Interlocking, Train Detection, Signals, switch machines, etc.);
2) Perform automatic route setting, automatic train regulation etc.;
3) Train Describer, Monitor and regulate train movement continuously;
4) Initiate information for PIDS and PA systems;

5) Generation of the schedules;
6) Playback and Recording Facility;
7) Training facilities for operators; and
8) Operation assistance including generating alarms and store system-operating data.
9) The ATO trackside (ATO-TS) sub-system will be an important part of the ATS system. It will communicate with the onboard ATO-OB via GSM-R radio system as per UNISIG subset 126. It will provide the Journey Profiles (JP) and Segment Profiles (SP) that ATO-OB requires for traction / brake control, with stopping points, timing points and other details.

The ATS functions shall be implemented in a way to derive benefit from the characteristics of an ETCS system namely:

1) Train location information to a high precision;
2) Continuous wayside to train and train to wayside data communications link; and
3) Train borne and wayside data processing capabilities.

The ATS sub-system is divided into three categories:

1) Category 1: Central Operation: Automatic train control operation from the Central ATS server at OCC;
2) Category 2: Communication with external systems and Local train control operation. Automatic train control operation from Local ATS server at station; and
3) Category 3: Off-line operations.

The ATS sub-system component of Category 1 shall be composed of a Local Redundant LAN at the OCC, and Operator workstations. The Communication system shall provide redundant IEEE 802.3 Giga-Bit Ethernet channels from the Operation Control Centre to the Signaling equipment rooms (provided with Interlocking logic) within the mainline and depot. The Communication system shall also provide redundant Gigabit Ethernet channels from OCC to each station including the Depot. These channels will be used for transmitting signaling controls and indications for the ETCS level 2 system. Interface between software components of Category 1 and external sub-systems shall include Central server to the Radio System, Central server to PA/PIDS, Central server to PAS, and the Central server to the Master clock system. The Central server shall also have redundant link to Local server(s).

The ATS sub-system component of Category 2 shall be composed of a Local Redundant LAN, redundant server(s), Field Interfaces and Operator workstations. The interface between software components of Category 2 and external sub-systems shall include a Local Server to CBI, Local server to ATC and a Local server to PA/PIDS.

The ATS sub-system component of Category 3 shall comprise of:

1) Off-line workstations;
2) Playback system; and
3) Training Simulator.

The ATS system shall provide as a minimum the following functions:

1) Monitoring of train control equipment;

2) Control of train control equipment;
3) Train detection;
4) Train identity;
5) PTI management;
6) Inter-station train stop detection management;
7) Automatic route setting;
8) Delays and departure/arrival times of scheduled trains management;
9) Dwell and inter-station running times management;
10) ATS train hold management;
11) Skip stop station management, keep doors closed;
12) Online timetable management;
13) Delay distribution management;
14) Passenger information management;
15) TSR management;
16) ATS sub-system supervision;
17) Alarms and Events management;
18) Time management;
19) Operating System Administration;
20) Off-line timetable management;
21) Quality of service;
22) Playback management;
23) Training Simulator and Trainee positions;
24) All functions (operating modes including all trains stop function); and
25) Human Machine Interface (HMI).
26) Automatic Train Operation

A Redundant LAN, including optical fiber cables, shall be provided and shall be connected through redundant optical switches to form a redundant network. The bandwidth shall meet all the functional, performance and redundancy requirements. Redundant optical switches shall be provided at all stations.

Communication redundancy shall ensure at least two physically distinct communication media shall be available between sender and receiver throughout the entire communication path, no matter how many intermediate nodes the message must go through. The redundancy shall be incorporated within the LAN, Ethernet switches, FEPs etc.

There shall be dual redundant communication medium between any two-computer units of the OCC/IOCC, between the CATS/LATS servers and the operator and maintenance workstations.

The system hardware shall be based on proven design philosophy and shall be fault tolerant and modular. Redundancy shall be built in the hardware both in the external equipment interface and also in the OCC network equipment interfaces/ link such that no single point failure will precede the shut-down of the ATS.

Route diversity for cable entry points from the field shall be provided in order to provide better reliability and availability of the system. The software shall be based on open system concept and shall have portability and interoperability across multi-vendor environments.

The Contractor shall submit the hardware specifications of the servers to meet the functional and performance requirements as specified in this ERT. The specifications of the server shall be based on latest configuration available at the time of supply. There shall be external redundant links to CBI, ATC and redundant link to LAN.

A screen, keyboard and mouse shall be available for server administration purpose only and it shall be integrated inside the cubicle.

The cubicle for the ATS shall integrate:

1) The redundant local server;
2) The redundant LAN;
3) The field interface equipment;
4) All cables between integrated equipment; and
5) Appropriate connectors for external links: power supply, links to CBI/ATP, links to operator workstations, links to network, etc.

The Contractor shall submit the hardware specifications of the Operator Workstation to meet the functional and performance requirements as specified in this ERT. There shall be redundant link to Ethernet LAN (2 single Ethernet port boards in the PC, with appropriate software to operate these boards).

The Ethernet network shall be based upon IEEE 802.3 Giga-Bit standards.

The ATS functions shall be available in the OCC and SCR(s). The ATS facility for the Depot shall be available in the OCC.

The ATS user profiles shall be finalized on completion of the ergonomic study of the OCC, which shall ensure maximum efficiency of the system.

The ATS system shall ensure central control from Operation Control Centre, local control from each main line Station Control Room, and the Depot control from the OCC. The ATS networking shall guarantee fault tolerance, transfer of controls between control levels, hot-standby redundancy ensuring transparent switchover, ATS scalability and without loss of data.

The ATS hardware and architecture are described comprehensively hereunder.

2.17.1 Control Locations

Workstations for control shall be provided in the following locations:

1) Operations Control Centre (OCC);
2) Depot Control from the OCC; and
3) Station Control Room (SCR);

All Workstation functionalities shall be independent of the Workstation's location. The available functionality for a particular Workstation shall remain subject to the Controller's assigned Area of Authority (AOA).

The workstations shall be capable of displaying any of the screens available at the OCC.

2.17.2 Levels of Control

There shall be three levels of control:

1) Central Control from the OCC;
2) Local Control from the SCR; and
3) Interlocking VDU.

2.17.3 Local Control from Station

An ATS Workstation with appropriate quality printer shall be provided in each SCR.

Station Control shall provide all the functions under authorization of OCC, and verbally under OCC authorization upon failure of OCC if is not in operation.

In addition to ATS workstations in each SCR, the station with an interlocking shall be provided with an interlocking VDU display as a backup. The SCR controller shall be able to operate the interlocking area under their jurisdiction from the interlocking VDU.

2.17.4 Technician's Workstation and Technician's Laptop

The SMR (or any designated place in the station/depot for technician) of stations having Computer Based Interlocking shall be provided with an ATS workstation and a Laptop with diagnostic software. Each station SER shall have facility to connect the maintenance laptop.

The Technician's workstation shall have following:

1) Indication of the position of all trains in the area and approaching the area of control;
2) Indication of all local equipment and route states;
3) Alarm conditions and status;
4) Acknowledge alarms; and
5) Analysis of fault logs and data log

2.17.5 Transfer of Control

The ETCS System shall provide a mechanism to transfer train control from the OCC to a specified station and vice versa. This mechanism shall be cooperative; the OCC and SCR must both agree to the change in control. Stations under local control shall be clearly displayed as such upon the line overview display.

The system shall also provide a cooperative mechanism to transfer train control from the ATS to interlocking VDU and vice versa.

It shall be possible to take Emergency control of any CBI at the SCR without any cooperative mechanism. All such events shall be logged with time stamp and an inbuilt increment counter.

Simultaneous operation from the ATS workstation and interlocking VDU shall not be possible.

2.17.6 Degraded Operation

Constant Headway regulation and manual regulation shall be available to regulate the train in the event that a failure causes the loss of Central Control functionality.

The Central ATS server will hold the timetable for the trains to run as per schedule. The

Central ATS shall send the actual schedule type for the day to the Local ATS server at each location every morning when the system is started. In this way the trains can run normally, receive dwell, coasting and departure information in the event of failure of central control. If the station is in local operation mode the information handled by the Local ATS shall be sent to the Central ATS on restoration of Central Control functionality to keep track of trains.

ATS functions of central control shall be available for first level of degradation to automatic operation from Local ATS. Local control from the station shall operate for the first level of degradation work degradation (constant headway mode), second level of (manual mode) from the ATS workstation.

The system shall be operated with the interlocking VDU in the event of failure of the Local/Station ATS.

2.17.7 Control Equipment Status

The status of all control equipment shall be monitored and displayed on all Workstations such as Controller Log-On and Area of Authorization (AOA).

The Train Control System shall require Controllers to execute a log-on sequence before any commands are available on a Workstation.

The log-on sequence shall, as a minimum, require the Controller to enter both a unique username and password.

The System shall enable immediate access to all authorized indications and commands following log on and allocation of AOA.

The AOA granted to a Controller shall define the functions and commands that are authorized and accessible by the Controller on the Workstation.

The System shall provide the facility to modify, add, regroup, and remove AOA's in conjunction with the Chief Controller.

The Chief Controller shall have the capability of logging in to any workstation. Upon logging in to that workstation it shall become the Chief Controller's position.

Only one Chief Controller's position shall be operative at any given time.

2.17.8 Workstations

The Workstation shall consist of all equipment necessary to provide the specified display and command functions for each Controller.

Workstations for traffic controllers' desk shall have three monitors each, with a facility to run them concurrently and independent of each other.

Each Workstation shall be equipped with only one keyboard, and one pointing device regardless of the number of screens or processors used.

All Workstation displays shall support high-resolution (1600*1200) color graphics or better. All the workstations (in OCC, stations, Depot, maintenance room etc.) shall be with 22" LCD screens.

All workstations shall be provided with suitable printer ports.

2.17.9 Workstation Display

The System shall provide, as a minimum, the following displays on all Workstations:

1) Line overview diagram;
2) Available and assigned AOA;
3) System alarms history and alarm management;
4) Available and assigned timetables;
5) System equipment connection status;
6) ATR tools - performance graphs;
7) ATR related screens/pages;
8) Data logging viewing and management;
9) Correspondence between Train ID, Train Radio ID, Train Operator number;
10) All alarms / display functions available on SCR CBI control workstation shall also be available in OCC workstations; and
11) Status of station control mode (Local/ Central/ VDU).

2.17.10 Mimic Overview System

The Contractor shall provide mimic overview system at OCC in Banlic Depot and OCC at Mabalacat Depot. There shall be a number of mimic display panels to ensure full coverage of the system inclusive of all sidings. The mimic projection system shall adopt DLP (Digital Light Processing) technology.

The resolution shall be of High Definition and the matrix shall be configured using 70-inch cubes. The Contractor shall perform an ergonomic study for the OCC to provide an aesthetic, environmentally, efficient and user-friendly solution.

The Mimic panel shall have as a Minimum 8 Visual Display Unit/Rear Projection Module at the OCC. The exact number of Visual Display Unit/Rear Projection Module shall be assessed by the Contractor to meet the performance requirements.

The mimic panel shall display minimum, but not be limited to the following:

1) Real time train movement geographically on the track layout using train detection;
2) Display train ID of stationary and moving train;
3) Position of points (locking and detection) and status of routes; and
4) Signal Status.

In addition, the following alarms shall be displayed on the mimic panel:

1) Station equipment failure – CBI and RBC;
2) Power failure (No power supply to SER equipment);
3) UPS failure;
4) Train Ready;
5) Blocking / unblocking of points, route, signals and maintenance block;
6) Cycles in the terminal stations and intermediate turn back station; and
7) Alarms pertaining to the ATP operation

The Contractor shall provide and organize mimic display mock up demonstrations at the manufacturer's premises for review before implementation.

Redundant processors and redundant controller with auto testing facility shall be used in the design of projector system so that no single failure of any of the modules shall result in the failure/blinking of a zone on the display board.

The large video screen will be used for the display of additional video digital streams from other subsystems namely CCTV, SCADA, etc. Each video stream shall be displayed in separate windows. The window position and size shall be configurable.

Therefore, it shall be the responsibility of all Contractors to coordinate to ensure that the large video screens in the control room are constructed in a manner to support a cohesive and uniform appearance.

2.17.11 Line Overview Diagram (On Workstations)

The line overview diagram shall provide a concise, uncluttered and logical view of the track layout for each corridor including train movement and equipment status by employing different colors. The color scheme shall be submitted to the Engineer for approval.

The line overview diagram shall consist of, but not be limited to, permanent, detailed and dynamic indications.

1) Line Overview Diagram - Permanent Display

The line overview diagram shall permanently display, as a minimum, on all magnification levels, the following:

a) All tracks and turnouts;

b) Stations, station names, platforms and platform identities;

c) All points; and

d) Bridges (if applicable).

2) Line Overview Diagram - Detailed Display

The magnification feature shall not only magnify the line overview, it shall add additional information and details at higher magnifications levels as follows:

a) Point identities; and

b) Maintenance blocks and temporary speed restriction zones.

The line overview diagram shall display, on all magnification levels, as a minimum the following dynamic indications:

a) Train position and identity;

b) Signals status;

c) Route status including overlap status;

d) Point detection status;

e) Point lock status;

f) Direction of train travel;

g) Platform hold status;

h) Train hold status;

i) Central / Station control status;

j) Traffic mode status;
k) Sequence mode status;
l) Dwell countdown clock;
m) Point block status;
n) Signal Block status;
o) Maintenance Block, Route Block, and Point Block information;
p) Platform Emergency Stop Switches status;
q) Train Delay;
r) Non-Descriptive train status for a train without a run number;
s) Alarms;
t) Train ready;
u) Cycles in the terminal stations and intermediate turn back station; and
v) Any other indication required by the specifications.

2.17.12 Human Machine Interface

The Contractor shall provide and organize HMI prototypes in Manila for demonstration and submission for review prior to their implementation. These prototypes shall demonstrate the facilities and capabilities of each type of Workstation.

Colors chosen for distinguishing between different functions and alarms displayed on each of the Workstations and mimic panel shall be of high-quality contrast, easily distinguished by the average person.

Controls shall be provided from the OCC to the field. Appropriate controls shall also be provided from the SCR to the field.

Indications shall be provided from the field to the OCC. Appropriate indications shall also be provided from the field to the SCR.

The HMI shall be user-friendly and menu driven. Whenever information is required, it shall prompt the operator and shall guide them to give the correct input/information. In the case of safety critical commands such those of remote control or removal of blocking restrictions, a double-checking facility shall be available for ensuring the correctness of the command that has been input by the operator. Various help levels shall be available for assisting the operator. It should be possible to select the required option with minimum number of operations.

The system shall be designed so as to achieve the overall objective of providing instant information. The vital response times of time between a change of state at a remote station and its display at OCC, the time taken between initiating of a command and its display on the OCC etc. shall be considered in the design to incorporate the overall equipment response time.

2.17.13 Temporary Speed Restrictions

The Train Control System shall provide for temporary speed restrictions to be applied from the ATS workstation, and from interlocking VDU at station depending upon the level of control at the time of implementation.

No loss of power supply shall cause the loss of an imposed temporary speed restriction.

It should be possible to apply temporary speed restrictions in steps of 5 km/h up to the maximum civil speed.

Temporary speed restrictions shall be capable of being imposed over any track segment. For point track segment it shall be possible to impose speed restriction separately for straight movement and diversion movement.

Temporary speed restrictions shall be in effect for the entire train. A train or train length is to be taken into account when the train leaves the speed restriction section. The train must observe the permitted speed within the speed restriction section until the tail end of the train has passed the speed restriction section.

Temporary speed restrictions shall only be capable of being removed in a safe manner.

The ATS System shall ensure that no one can inadvertently remove or modify a temporary speed restriction.

2.17.14 Maintenance, Route and Point Blocks

The ATS System shall provide for means to restrict movements or physical state of a point equipment to facilitate safety during maintenance activities.

It shall be possible to impose and lift Maintenance block (movement not possible towards the blocked area from either direction), Route block (particular route is blocked), and Point block (throwing of point blocked) from the ATS Workstations and from interlocking VDU at station depending on the existing level of control. The logic shall be implemented in the interlocking.

The ATS shall be capable of preventing train entering areas where works may be ongoing during major failures or other significant malfunctions. The ATS shall provide an Emergency Stop Authority (ESA) to ensure this functionality.

Commands for the lifting of blocking restrictions shall require a second command confirmation from the operator.

Loss of power shall not release any blocking restrictions.

2.17.15 System Alarms and Alarm Management

Controllers shall have the ability to view and take action upon alarms incoming from the System.

All incoming alarms shall be time and date stamped. The ATS system clock shall be synchronized with the Central Master Clock system at OCC respectively. In case of failure of Master-Clock the ATS system shall operate on its own internal clock. The ATS system shall distribute the clock to the interlocking and ATC system including on-board the ATC system.

Each incoming alarm shall be classified within an alarm priority level, depending upon the severity of the alarm condition and the urgency of Controller response required.

Priority levels shall be allocated by the Contractor for the Engineer's review.

All alarms shall remain on the alarm display list for each Workstation until they have been acknowledged by the Operator.

Alarms resulting from equipment faults shall be Latched Alarms. The alarm list shall be updated on real time basis with the occurrence. Un-acknowledged alarms shall flash.

All alarms removed from the alarm display list shall automatically be inserted into the alarm history list upon acknowledgement by the Controller.

2.17.16 Alarm Displays

Alarms shall be directed to Workstations dependent upon the AOA granted to the Controller logged onto the Workstation. Alarms shall be displayed upon the Workstation in two ways:

a) Using a specifically positioned alarm bar, displayed at all times. This would normally include higher priority alarms, which will be decided in consultation with Engineer; and

b) Adopting a detailed full screen Alarm Browser Application (ABA). The ABA shall be one of the System display screens and shall provide a form in which multiple alarms and alarm history can be managed.

The overriding principle of the ABA display shall be to allow a concise, uncluttered view of alarm information to the Controller, with a clear emphasis upon higher priority alarm information.

The Contractor shall provide as a minimum the following general capabilities and characteristics for the ABA for alarm display list and alarm history:

a) The ability to quickly filter the alarm display to view alarms generated from a particular subsystem (Train related, interlocking related/ trackside related, ATR related) or by geographic region;

b) A scrollable interface, to allow the Controller to view more alarms than directly fit upon the display;

c) The facility to acknowledge alarms; and

d) The facility to clear alarms from the display.

2.17.17 Audible Alarms

In conjunction with the alarm display upon the consoles, incoming alarms of the higher priority levels shall each be accompanied by an audible tone.

Highest priority alarms shall be accompanied by a periodic sound that will not stop until the Controller has taken positive action to address the alarm.

The volume of all audible alarms shall be sufficient to alert the Controller within the Control Center environment.

A command shall be provided to disable the audible alarm.

2.17.18 System Administration

A supervisor administration function to be exercised by a single nominated person shall be available to control, as a minimum, the following:

1) Allocation of passwords;

2) Creation and deletion of users;

3) Administration and housekeeping functions; and

4) Creation, deletion and modification of AOA.

The functions of supervisor administration shall be allocated by the Chief Controller.

2.17.19 Timetable Compilation and Proving

A timetable compilation and proving system shall be provided such that timetables can be compiled and tested off-line and loaded directly to the System when ready.

The timetable compilation and proving system shall enable the creation and modification of timetables through an HMI.

1) Editor

The timetable compilation and proving system shall provide an editor for editing inter-station running times, platform dwell times, terminus turnaround times and train description for each of the timetable blocks (timetable periods) defined.

2) Block Generation and Connection

The timetable compilation and proving system shall provide for the automatic generation of a timetable block, given only the headway, number of trains, duration of the block and dwell times used.

The timetable compilation and proving system shall provide the ability to connect timetable blocks to generate a complete timetable.

When connecting timetable blocks, the timetable compilation and proving system shall:

1) Match trains in the different blocks;
2) Introduction/removal of trains during peak and non-peak service; and
3) Highlight any conflicts with suggested corrections.

2.17.20 Types of Trains in Timetable

The timetable compilation and proving system shall provide the facility for scheduling train paths for the following train types:

1) Passenger trains; and
2) Empty trains.

Provision shall be made for trains having different run-time during revenue hours for purpose of varying dwell time or energy saving.

2.17.21 Train Identification

The ATS System shall uniquely and positively identify every train. The train description shall consist of Alphanumeric characters. The train ID consists of first two digits to identify the current destination and last two digits to identify the service. The Service identification remains constant during the service, the Destination identification changes at each trip or turn back. Undetermined trains should be numbered outside the above normal range. Such a train identity is attributed manually from the Depot ATS or Central ATS in accordance to location of this train respectively either in the Depot or main line. The attribution is automatically cancelled when the train terminates its current service.

During switchover from Central ATS to Local ATS or from one CATS server to the redundant CATS server there should not be any loss of Train ID.

2.17.22 Timetable Adjustment

The timetable compilation and proving system shall adjust the timetables automatically under the following circumstances:

1) Global adjustment made to one timetable block;
2) Adjustments made to only a particular train through the day; and
3) Local adjustments to a particular train trip

Provision shall be made for manual adjustment of the timetable by manipulation of the time-distance graph.

2.17.23 Generation of Timetable

The timetable compilation and proving system shall generate the following different parts of the timetables:

1) Working timetable;
2) Distances between stations and different sets of run time and dwell times; and
3) Summary of train frequencies.

2.17.24 Crew Roster Facility

The timetable compilation and proving system shall provide a facility for the Controller to enter the crew roster information attached to the timetable.

2.17.25 Plot Train Movements

The timetable compilation and proving system shall plot train movements in the form of a time distance graph utilizing a suitable color scheme on A0 size graph. The time distance graph should have the capacity to capture the train movements for an entire day operation. Contractor shall supply high-resolution graphic plotter.

2.17.26 Timetable Verification

The timetable compilation and proving system shall simulate the running of a timetable to verify the viability of the timetable, including, but not limited to:

1) Non-conflicting movements; and
2) Interchange matching.

The timetable compilation and proving system shall simulate the effect of perturbations to test the robustness of the timetable.

2.17.27 Generate Summary Information

The timetable compilation and proving system shall calculate and generate number of train trips and train kilometers for all timetable trains.

On-line timetable system shall have redundant communication links with Off-line timetable and ATS system.

The Timetable system shall have the capability to define the line characteristics of the project, additional type of trains or the configuration of vehicle types.

2.17.28 Daily/Weekly/Holiday/Special Timetable Selection

The Train Control System shall automatically select the correct timetable for application at the start of each traffic day based upon a pre-defined schedule. The Controller shall be able to override the automatic selection at any time and select a different timetable for the day.

2.17.29 On-line Timetable Modification

After a timetable has been loaded, the following on-line timetable modification commands shall be available:

1) Cancel a train trip;
2) Insert additional train trip;
3) Turn a train short at a specified track section or station platform;
4) Reschedule a trip (i.e., modify timetable departure times);
5) Modify origin, destination, station dwell time, station arrival time, station departure time, inter-station run time, revenue/non-revenue service, last service train and terminal station layover time;
6) Shift the time of train schedule for all the trains before or after a stipulated time;
7) Exchange the order of appointed trains after appointed station;
8) Export timetable to other file formats;
9) Suspend timetable;
10) Resume suspended timetable from current time through a single command with automatic train assignment and operations; and
11) Load new timetable;

The timetable modifications shall be taken into account by the ATS function but the reference timetable shall not be affected. All operator's actions and parameter changes shall be logged.

For a particular train, a Timetable change will be taken into account by the trackside ATO-TS and updated Journey Profile transmitted to the ATO-OB.

2.17.30 Train Movement Control

2.17.30.1 Automatic Route Setting

The ATS System shall provide Automatic Route Setting. The ARS with the PTI function shall be provided for use in all regulation modes. When the Train ID received from the PTI and the Train ID in the Central ATS does not match, an alarm shall be raised to the operator.

Automatic Route Setting shall ensure that trains are routed according to timetable and train ID when the ATS is running in scheduled regulation mode.

Automatic Route Setting shall be the normal mode of operation on the mainline.

The ATS System shall provide commands to disable automatic route setting on specific routes and manually set routes in various modes. The following modes shall be available for route setting:

1) Fleet and manual modes (including shunt route setting); and
2) Sequence mode for turnarounds.

2.17.31 Train Dispatch

Trains shall be dispatched from reception tracks, sidings and stations automatically, as determined by the ETCS System or by Controller command.

The ETCS System shall provide a train-ready signal, initiated by the train operator (only in train operator/driven mode) which shall place a train into service from any track section on the running lines, including, but not limited to:

1) Depot departure track;
2) Turn back platform; and
3) Turn back track.

The train shall be dispatched automatically or by manual intervention upon receipt of the train ready signal.

The System shall distinguish between a train ready signal in ATP driven mode and a train ready signal in ATO/ATP Mode.

2.17.32 Inter-Station Stop Detection

The ATS System shall detect trains that have remained stationary between stations for more than a predetermined time interval, which shall be user configurable. This condition shall be treated as an alarm and shall be shown on the workstation and mimic panel by flashing the train's ID.

2.17.33 Train Hold and Release

A command shall be provided on Workstations to hold a specific train at a designated platform, preventing departure of the train until a release command is issued. The hold command shall be capable of being issued at any time before the train arrives at the platform or subsequent to its arrival at the platform.

An indication shall be provided to the train operator when this command is operational on his train.

2.17.33.1 Platform Hold and Release

A platform hold/release command shall be provided on Workstations to hold or release all trains arriving at the specified platform.

An indication shall be provided to the train operator when this command is operational on his train.

2.17.33.2 System Hold and Release

The ATS System shall provide a command on Workstations to hold all trains at their nearest platform along the whole line by the chief controller or within ACRs by respective traffic controllers. The OCC shall be able to release the command either for a single train, group of trains, all trains in a section of track or all trains on the line. An indication shall be provided to the train operator when this command is operational on the train.

2.17.34 Dwell Time

A command shall be provided on Workstations to allow the Controller (at the OCC as well as the SCR) to modify the dwell time at a particular station for all trains. The dwell time at each station shall also be modified by the ATR function.

At each station, the System shall generate an indication (the dwell countdown clock) to the train operator and Controller of the dwell time remaining, in units of one second.

The System shall generate an audible alarm to the train operator when the dwell countdown has reached zero.

The nominal dwell time shall be 30 seconds.

For each platform, the dwell countdown clock for each train shall be automatically calculated and displayed on the appropriate Workstations and to the train operator.

The dwell countdown clock time shall also be adjusted to include 2 seconds for the train operator to react to close the train door and approximately two (2) to five (5) seconds for the train door to physically close.

The minimum value for the dwell shall be configurable by the Controller.

2.17.35 Skip-Stop

The ATS System shall provide a command on Workstations to cause specified trains to run through specified stations (one or more than one) without stopping.

The train operator shall be provided with an indication that this command is in force. The same shall also be transmitted to PIDS and PAS.

When a train has been commanded to skip a station, it shall not enter that station until it is cleared to proceed past the station. The fact that the next train shall pass the station shall be shown on the PIDS.

The ATC system shall allow trains to pass stations being skipped at the maximum authorized speed.

2.17.36 Automatic Train Regulation

The ATS System shall provide Automatic Train Regulation (ATR).

The major function of ATR should be as below;

1) Regulate Schedule; and
2) Regulate Constant Headway.

ATR shall regulate train movements in order to optimize the regularity of service and to recover from disruptions.

The ATR shall be designed to dynamically regulate train services to ensure that delay is distributed in a linear fashion over trains in the immediate vicinity of the delay. This shall be put into effect whenever a delay is outside of a configurable range defined by the Contractor.

The ATR shall have the capability to manage a major train delay (a configurable time delay) by performing a best-fit schedule re-determination or timetable reformation. The ATR shall allow the Controller to confirm the new schedule prior to actually carrying out the reformation by the ATR.

2.17.36.1 Regulation Modes

The ATR shall offer the following regulation modes:

Full: Schedule (timetable) and Headway Adherence simultaneously active. This is the standard default mode.

Schedule (timetable) Adherence Only: Only Schedule Regulation is active:

1) In timetable regulation mode, the ATR algorithm shall regulate trains to schedule to minimize overall delay with respect to the timetable; and

2) The ATR shall maintain the timetable sequence of trains.

When the ATR timetable mode is selected, a train is considered early/late if it is operating outside of a time window which shall be user configurable. If a train is early or late then the ATR shall regulate the train to timetable using the following ATR functions:

1) Train performance regime adjustment to meet the scheduled arrival time at the next station;
2) Station dwell optimization; and
3) The Schedule regulation strategy should include accelerate, slowdown, dwell time calculation and optimization, use of minimum dwell time and speed.

Constant Headway Regulation: Schedule time pattern from trips are disregarded.

In headway regulation mode, the ATR algorithm shall regulate trains to a selected headway, aiming to produce a balanced headway throughout the line.

The headway regulation mode shall utilize the following ATR functions:

1) Train performance regime adjustment; and
2) Station dwell optimization.

In case of service disruption, the trains shall turn short at intermediate stations, creating one or more short loop operations. The ATR shall be capable of operating trains in headway regulation mode within these loops.

Manual Regulation mode: In manual regulation mode, each train shall be dispatched from each platform by a manual action of the Controller.

Monitoring Only: ATR only monitors the trains, computes delays, raise alarms, update the expected trip plan, but does not initiate train circulation.

ATR OFF: ATR component is disabled.

2.17.36.2 Regulation Strategies

If the station dwell optimization for the train is not sufficient to regulate it to the operator defined service headway, the ATR shall adjust the performance regime of the train based on the regulation strategies as outlined in Table below to achieve the on-time arrival at the next station.

Table 2.4 - Regulation Strategies

	Train is Early	**Train is Late**
Service Recovery	Increase the % coasting of the performance regime	Reduce the % coasting of the performance regime
Energy Optimization	Increase the % coasting of the performance regime	No change in the % coasting of the performance regime

The ATR shall further adjust the current station dwell if the new arrival time at the next station does not match with the timetable resulting from the adjustment of the coasting level of the performance regime.

The ATS System shall provide facilities for the Controller to select through the

Workstations the regulation strategy and the time window within the current Operating hours that the selected regulation strategy will be enabled. Only one regulation strategy shall be enabled at any one time.

2.17.36.3 Junction/Reverse Running Management

The ATS shall provide junction management for all merging and diverging junctions.

The ATS shall provide for the following junction management modes:

1) First come first serve;
2) Priority for late trains;
3) Priority for selected train types or individual trains; and
4) Priority for selected routes.

The junction management mode and associated parameters shall be selectable by the Controller for individual or sets of junctions.

The movement of train running in reverse direction shall be controlled and monitored by ATS but without automatic route setting.

When a train is approaching a platform at an Intermediate station or a Terminal Station for turn back, all the track section ahead up to the platform track must be proved unoccupied.

2.17.36.4 ATR Support Tools

1) Punctuality Analysis on daily weekly, monthly and yearly basis;
2) Analytical reports of various unusual occurrences e.g., signal failures, OCS faults, train failure, etc., on a daily, weekly, monthly basis;
3) Analytical report of train utilization;
4) Total Traffic Blocks granted/refused including with locations, time blocked, time cleared;
5) Sectional running times by trains;
6) Delay report of trains along with train numbers, delayed time, etc.;
7) Difference between actual and scheduled running times in tabulated as well as graphical form; and
8) It shall be possible to add remarks on the display of the workstations.

The performance-monitoring tool shall make use of logged data allowing for on-line and off-line performance analysis as well as for incident investigation.

The ATR performance monitoring tool shall be capable of producing the following:

1) Train performance line graph - actual performance versus timetabled performance taking the form of station platforms versus deviation in seconds;
2) On-time train performance graph – comparison of actual trains departure times compared with the timetable at each station;
3) Headway interval graph – headway interval in seconds versus time in minutes;
4) Inter-station stopping chart – a plot of the number of stops in between stations;

5) The capability to produce on-line and off-line graphical analysis with hard copies of the outputs from the performance monitoring tools;

6) The capability to produce a train graph for a particular train;

7) The capability to give complete information about a selected train e.g., Train number, train details, etc.; and

8) The capability to produce interactive train graphs/time table in off-line mode where it will be possible to alter the running times of any train interactively to observe the effect instantly, simulate and monitor the effect graphically of various parameters such as speed restrictions, dwell time, coasting, etc. on headway.

   Time Distance Graph (TDG): The graphical representation of the line traffic shall provide for the screen consultation on a specific workstation and for printing on a plotter. The printing should be in A0 size preferably in manageable portions for the entire previous day operation.

   The Time Distance Graph shall represent:

   1) The scheduled traffic - the data on the scheduled traffic imported from the daily Timetable; and

   2) The actual traffic - the data on the actual traffic defining the current train movements on the line.

   The performance of the System shall not be degraded by the use of the on-line ATR performance monitoring tool.

2.17.36.5 Arrival and Departure Time Prediction

The ATR shall continuously update the estimated arrival/departure time for all trains to all platforms.

The arrival and departure time predictions shall be shown on Workstations.

The arrival and departure times shall be transmitted to Communications System for the PIDS/PAS interface.

2.17.36.6 ATR Indications

The ATR shall provide the following indications on all Workstations:

1) Line overview: train punctuality status, dwell counter at each individual station; and

2) Terminus departure showing the latest train departing from each terminus, the actual time of departure, timetable time and deviation.

2.17.36.7 Performance Strategies

The ATS System shall provide different performance regimes for each train, selected from Workstations and by the ATR.

Each performance regime shall select different levels of acceleration, braking and coasting.

The minimum performance regimes to be provided by the ETCS shall be as follows:

1) A maximum train performance regime;

2) Full coasting regime;

3) Energy Saving Regime;

4) 5% coasting performance regime; and
5) 8% coasting performance regime.

The Contractor shall propose any other performance regime as per the interface.

2.17.37 The System shall log and retain: Event and Fault Logging

2.17.37.1 Data Logging

1) All train movements;
2) All alarms and failure events;
3) Alarm acknowledgements;
4) All System commands; and
5) Data communication between:
   a) ATS, CBI, ETCS subsystems; and
   b) ATS, GSM-R Radio and Rolling Stock.

The data logging requirement in this clause is in addition to the requirements for health status, reporting and diagnostics.

Each item recorded shall be date and time stamped.

Equipment shall be provided to download and analyze this log.

The System shall have a minimum data storage capacity to maintain one month's data logs on-line at the OCC.

The Contractor shall supply permanent off-line storage for data logs.

The Contractor shall provide a facility similar to that of the ABA so that the data log can be retrieved, filtered, viewed and managed for on- and off-line analysis and for incident investigation at both OCC as well as local station. The System performance shall not be degraded by the use of this facility on-line.

Power down or reset shall not cause any logged data to be lost.

The system shall provide for automatic retrieval of data logged at the local station in the event of re-establishment of link between the OCC and local station after such failure.

The System shall provide facilities to replay the captured data log on all Workstations.

2.17.37.2 Train-borne Log

The Rolling Stock Contractors will provide a data log to record all train-borne Train Control and Signaling System faults. All train-borne System faults shall be transmitted to the train for recording in this log.

The train-borne ETCS System shall continuously record, under all modes of operations, except in Isolation mode, as defined in Signaling/Rolling Stock Interface Specifications in Appendix A1.

The event data downloaded from trackside ATC, train-borne ATC, Interlocking, Radio controller, ATS equipment etc., shall be capable of being analyzed so as to reproduce an incident in accurate detail and identify the cause of any failure. The analysis will enable a complete recreation of a sequence of events to be reproduced in a variety of reports including lists, graphs, tables and other charts. Trackside system event recorded material shall also be capable of reproducing in a geographical layout format (that is a representation of the track layout), a sequential replay of all train movements. Any special equipment and software required to generate the reports and the replay feature shall also be supplied.

The full scope of recorded train-borne ATC events shall be reviewed by the Engineer. The events recording shall take place at all times in any part of the track except when in standby mode and shall include the following functions as a minimum:

1) speed direction;
2) time;
3) location;
4) mode of operation;
5) propulsion and brake demands;
6) movement authorities;
7) door enable;
8) over speeds;
9) emergency brake demands;
10) driving control commands;
11) train ATC bypass if applicable;
12) ATC reset; and
13) Non-communicating trains.

2.17.38 ATS Training Simulator

2.17.38.1 General

The training facility shall comprise of a separate training server with additional hardware and software as necessary to simulate train movements and emulate the trackside equipment. This simulator maybe integrated with the Troubleshooting and Maintenance Workstation.

Software shall be provided to allow the equipment to act as a training simulator and a development facility. The training simulator shall provide for the training and testing of Controllers in an environment as similar as possible to the operating railway for complete line including NSCR-N1 section.

2.17.38.2 Training Simulator Architecture

The training simulator shall be independent of the System hardware and software used for running and supervising the revenue service, driven by a train movement model to simulate the full functionality of the System.

The System shall provide two trainee positions, each having three monitors. Each position shall be independently configurable to any one of the Depot Controller, Traffic Controller, Station Controller and Crew/Attendant Controller Workstations.

The System shall provide one Employer's Training Instructor position to interactively control and monitor both trainee positions concurrently and independently.

The training simulator shall be physically isolated from the active control equipment.

All simulator software shall be separate from System software.

1) Train Movement Model

The model shall provide for train movements, per hour per direction and for simulation of a typical 24-hour timetable. It shall be possible to simulate perturbations and observe its impact.

It shall be possible for the end-user to modify the model.

2) Trackside Emulation Software

The trackside equipment emulation software shall reside on the System. The emulation shall support all ETCS System functional capabilities. The emulator shall be able to run up to 10 times faster than real time if required.

It shall be possible for the Employer to modify the emulation software.

3) Training

The training facility shall provide for both Employer's Training Instructor run training sessions and Controller tutorial sessions where the trainee undertakes pre-programmed exercises with results stored for review by the Employer's Training Instructor later.

The training facility shall permit as a minimum, the Employer's Training Instructor to:

a) Set up, load and save initial conditions;

b) Run the training sessions;

c) Freeze training sessions;

d) Generate, modify and select pre-defined exercise scenarios for training exercises;

e) Introduce service perturbations and System malfunctions; and

f) Record and playback trainee actions.

2.18 Operations Control Center (OCC)

The OCC operation will be based on 24 hrs x 7 days a week (365 days/year) with staff shift operation; therefore, system equipment, rooms and E&M facilities design for the OCC shall meet these operational requirements.

The OCC System equipment, rooms and E&M facilities design and installation shall also be in line and in compliance with the RAMS Project requirements as defined elsewhere in the Technical Requirements.

The functionality of the operating systems shall be driven by operational requirements.

This Technical Requirements for OCC systems equipment have been developed to international norms and standards. Other Equivalent standards shall also be allowed subject to review by the Engineer.

The Contractor shall propose all designs and functionality required to effectively operate the line.

The Contractor shall submit suitable designs and plans for undertaking this work, at detail design stage, for the review of the Engineer.

Furthermore, the systems from the NSCR-N1 and NSCR-South which initially are controlled from their own OCC's will eventually be transferred to an Integrated Control Center located in Mabalacat Depot, the Contractor shall allow provision for the seamless switchover of control from the OCC. The Contractor shall submit in their design how this will be achieved as required by ERT Section 12 IOCC and DCC.

2.18.1 Standards

The Table below, although not exhaustive, contains standards, codes and reference documentation applicable to the Operations Control Center in Depot.

Table 2.5 Standards

ISO 11064 Parts 1-7	Ergonomic Design of Control Centers
IEC 60964	Control Room Design
ISO 9241 Parts 1-17	Ergonomic requirements for office work with visual display terminals (VDTs)
ISO 9355 Parts 1 and 2	Ergonomic requirements for the design of display and control actuators
ISO 13407	Human centered design process for interactive systems
ISO 14738	Anthropometric requirements for the design of workstations and machinery
EN 547 Parts 1-3	Safety of machinery - Human body measurements
CIBSE	Code for Interior Lighting, 1994, ISBN 0900953640
ISO 13406-2	Ergonomics Requirements for work with visual displays based on flat panels - Part 2: Ergonomic requirements for flat panel displays
BS 5459-Part 2: 2000	Specifications for Performance Requirements and Tests for Office Furniture - Part 2: Office pedestal seating for use by persons weighing up to 150kg and for use up to 24 hours a day including type-review tests for individual components
DIN EN 985:2002	Textile Floor Coverings: Castor Chair Test
BS ISO 2094: 1999	Textile floor coverings. Determination of thickness loss under dynamic loading

2.18.2 Design Requirements

The Contractor shall assemble an interdisciplinary team, including competence in ergonomics and shall ensure an appropriate balance and representation of skills. The ergonomics input shall encourage a user-friendly approach within the Control Room Design Process.

Suitable time and resources shall be made available for iterative ergonomics input throughout the Control Room Design Process lifecycle.

Task Analysis of comparable operations shall be conducted by competent personnel at an early stage of the design programme.

Functional Analysis covering user and systems shall be conducted by competent personnel during the early stages of the design programme.

Consideration shall be given to accommodating the needs of employees with disabilities.

A system for documentation of ergonomics input shall be developed and maintained throughout the Control Room Design Process lifecycle.

2.18.3 Functionality

The OCC functionality can be summarized as 'The ability to direct train operations in order to provide a scheduled service under normal operating conditions and to maintain the best possible service in the case of disruptions.' Routes will normally be called automatically by the Train Control system in accordance with the assigned timetable. Train Control/Operator interaction will normally only be required to manage perturbations and failures. The Contractor shall provide the following:

1) Graphical user interfaces to assist the control operators to monitor and optimize train operations;
2) The means to prepare, store and activate timetables;
3) The capability to display train performance versus the active timetable and the facility to alert the operators to any excess service interval arising at any point on the Line;
4) The capability for the Operator to modify the timetables in response to disruptions; and
5) The facility to graphically display the status of the Signaling system to the control operators on polychrome video display units.

Implementation of the OCC Human/Machine Interface (HMI) as well as OCC Room Design (Operator's Furniture/Consoles/Chairs, Layout, Wall Display, etc.) according to proven International Ergonomic Design Principles as a minimum in accordance with the standards indicated in Table 2.5 or equivalent Standards.

In addition to the above, the OCC shall be, but not be limited to undertake the following tasks:

1) Control of the train service via the Signaling system;
2) Power SCADA;
3) Building Management System (BMS);
4) Passenger communications;
5) General staff communications;
6) Emergency and cab-secure communications;
7) CCTV monitoring activities; and
8) General alarm management.

2.18.4 Control Center Layout

The Contractor shall undertake Human Factors, Ergonomics and Human Machine Interface studies, in order to optimize working arrangements and design of the OCC layout in accordance with relevant standards. The study reports and designs shall be submitted to the Engineer for review, prior to implementation.

The studies shall address, but shall not be limited to, the following issues:

1) All activities in the OCC relating to the operation of the line;
2) Efficiency of operation of the OCC;
3) Ensuring optimum arrangements to minimize fatigue and stress and to maximize the equality of working conditions; and
4) Task analysis covering human/machine interaction both for normal operating conditions and in the event of emergency situations e.g., breakdown, fire, derailment etc.

Following submission and review of these studies and assessments, detailed designs shall be submitted to the Engineer for review.

The Contractor shall submit both 2D and 3D analyses of their proposals for the design for the OCC room for review by the Engineer prior to commencement of the construction activities and, if required by the Engineer, a walk-through software simulation of the OCC room designs.

The final configuration of the workstations and OCC manning/layouts shall be agreed in conjunction with the appointed Operator.

2.18.5 Workstation General Functionality

Workstations shall be designed according to human capabilities, limitations and needs. Workstation dimensions shall support the user population ranging from 5th percentile Philippine female to 95th percentile Philippine male.

Workstation design shall consider the five postures commonly adopted by Control Room Operators:

1) Bent forwards;
2) Erect;
3) Relaxed;
4) Reclined; and
5) Standing.

The layout of Workstations shall take account of maintenance access requirements. Workstations shall be safe, taking account of electrical safety, stability and heat conduction.

The design of workstation-mounted display equipment shall take account of the greater viewing distances to be found in Control Rooms when operating with multiple displays, compared with workstations where a single monitor is used.

Workstation design shall be suitable for right and left-handed users.

When using one-handed control devices, there shall be adequate workstation space and cabling facilities to place devices to the left or right of the user.

Seats shall, as a minimum, meet requirements for the type of task required to be performed.

Workstations shall take into account the needs of employees with disabilities, where appropriate.

Human abilities, characteristics, limitations, skills and task needs shall be taken into account when designing the human-machine interface (HMI).

The operator shall at all times be the highest authority in the human-machine interface with the exception of when in automatic mode. However, the operator may take manual control at any time.

The user shall at all times be provided with the necessary information such that they are able to have a comprehensive and robust understanding of the system and its associated sub-systems. All workstations, printers, voice and data facilities within the OCC shall be provided the Contractor.

2.18.6 Control Room Design, Materials Finishes and Facilities

The Depot Contractor shall be responsible for the supply and installation of all finishes and E&M services in the Control Room.

2.19 Depot

Depots shall be provided for the overall system at Banlic (South Depot) and Mabalacat (North Depot). The Depot shall be under the control of a Depot controller located within the OCC. Additionally, the yard master room has been provided in the Depot for visual monitoring of trains and vehicles movement and to operate the point machine manually, if required. However, the departure movement of trains from the Depot into revenue service shall be achieved at the Depot transfer track using Automatic Route Setting (ARS) in conjunction with the timetable.

2.19.1 Manual Route Setting within the Depot

In the event the automatic route setting is unavailable for departure from the Depot, the Depot Controller shall be capable of setting routes into and out of the Depot manually.

The Manual control of equipment within the Depot includes, but shall not be limited to the following:

1) Route setting and cancelling, route barring and releasing;
2) Switch setting Normal and Reverse, switch blocking and unblocking;
3) Maintenance blocking and unblocking;
4) Traffic direction set and cancelling (into and out of Depot);
5) If manual route setting is requested and the route is not set within a predefined time, the route setting is cancelled, and an alarm is raised to inform the Depot Controller of the unsuccessful route request;
6) When a route cancellation is requested, the route shall automatically be released if no train has entered the approach locking area. However, if a train has entered the approach locking area, then the route shall cancel after a pre-defined time-out. This shall be represented specifically on the Depot HMI;
7) When a route is set, the system shall automatically release the route after the passage of a train on that route (TORR);
8) The route shall be released when the train has cleared the switch area. Additionally, the system shall automatically release switches upon the passage of the train that may be involved in that route; and

9) The system shall allow the Train Controller to activate a route cancellation request or by an auto route cancellation request through different commands (by screen touch, mouse or keyboard command). The cancellation of an already interlocked route shall not be allowed while there are trains in the route area unless predetermined interlocking rules have been fully satisfied.

The system shall ensure that every control and indications are updated in accordance with equipment response times by transmitting the latest status of wayside equipment to the interlocking system. If control has failed, the system raises an alarm to the Depot Traffic Controller.

The Depot design shall provide for transition for switching into and out of ATP mode from the Depot operation mode, whilst entering or leaving the Depot on the transfer track. It shall be the responsibility of the Contractor to provide all of the design, manufacture, installation, testing, and commission of the Signaling apparatus to be installed in the Depot.

Train detection within the Depot shall be achieved using either axle counters or single rail track circuits. This will eliminate the use of impedance bonds. However, broken rail detection will not be available; this can be mitigated by the fact that the speed of the train within the Depot is low (25 km/h) and no passengers are on board the vehicle.

Shunt and buffer stop signals, route indicators shall be rugged, reliable, aesthetic, of proven industrial quality and design, and be of the high-performance LED type in accordance with International Standards. The Contractor shall submit a copy of standards and specifications for review of the Engineer. Route indicators (if used) shall be of the LED type and shall be constructed not to infringe the structure gauge.

The switch machine within the Depot shall be of the trailable type and electrically driven and shall preferably adopt the commercially available power supply where possible. The switch machine shall be immune to the traction power supply inclusive of stray and fault currents.

The Contractor shall supply balises to ensure low speed approach to buffer stops and ensure that the trains shall stop before the buffer stop.

2.19.2 Depot Test Track

Equipment for test tracks within the MCRP North Depot shall be provided as part of the Train Control System.

The test track shall be equipped with full trackside ATP and ATO system for train tests to be conducted within the limitations of the test track.

The Depot test track shall provide the ability to dynamically test the train-borne system.

The test track as a minimum shall provide the following facilities:

1) Testing of the train borne system;
2) Checking calibration of the speed and positioning sub-systems;
3) Testing stopping accuracy;
4) Testing of the Bidirectional Train Wayside communication; and
5) Testing of the train operator DMI.

The tests shall include, but not be limited to, testing the following functions:

1) Reception of Telegrams;

2) Speed trajectory determination and regulation;
3) Train speed and speed limit detection;
4) ATP braking and propulsion control; and
5) Door opening authorization on either side.

The Contractor shall provide a comprehensive description of all functional interfaces and equipment tested by the interactive dynamic test. The Contractor shall indicate which tests were not or could not be performed.

Dynamic testing of the train on the Depot test track shall be under the command of a train operator.

2.19.3 Level Crossing in the Depot (Mabalacat and Banlic)

The Contractor shall supply, install and integrate a level crossing system at the Depots comprising of sliding gate barrier, visual and audible warning devices (e.g., flashing lights and a siren). The crossing would form protection for the road traffic crossing over the (i) test tracks (for which the contractor shall provide sliding gate barrier) inclusive of (ii) any other access roads where this may occur (to be provided with audio visual warning devices).

2.20 Wayside Equipment

2.20.1 General

All wayside equipment shall be verified clear of the structure gauge and designs should go through inter-disciplinary check and submitted for the Engineer's review.

The outdoor junction boxes shall be made of stainless steel for rust protection. The Contractor shall submit the specifications of junction boxes for review by the Engineer.

2.20.2 Points and Crossings

Point machine on the main line shall be electric, shall conform to international and local standards and shall be proven in use. The maximum operating time, which includes the controlled status of the point, shall be compatible with the headway requirements. The ingress protection of all point machines shall be IP 65. The Contractor shall submit the point machine specifications for review by the Engineer.

Main line point machines shall be non-trailable. Main Line Machines shall be electric, and where possible operate on commercially available voltages.

Point machines shall be capable of operating points with curved/thick web section with EN 60 (60 kg/m) stock rail and JIS 50 within the Depot. Turnouts used shall comprise of 1:6, 1:8, 1:10 and 1:12 radii. Nominal switch opening at toe will be 160mm.

Locking detection shall be provided to detect that the points are locked in the respective position before authorizing a train movement over the points.

It shall be possible to operate trains through all points and crossings in all directions of travel. Loss of electrical power shall not cause a change of physical point status and the points and lock shall remain in the last operated position.

The Contractor shall provide point machine and all mechanical rail connections except those fittings explicitly stated in the interface specifications to be the responsibility of the track system. Supplementary drives and detection shall be provided as required by the length of the point.

Point detection shall be provided to detect that each switch is positioned with sufficient accuracy to ensure safe travel through the points before authorizing a train movement. The limits of Go and No-Go test shall be 2 mm and 5 mm respectively at 150 mm from toe of the switch.

Where the points form a crossover, independent detection and indication shall be provided for the points at each end of the crossover to mitigate failure of one end. The relative position between the point machines and the stock rail shall be fixed such that independent movement is prevented.

Provision shall be made for individual manual operation of each point. Electrical power shall be disconnected from the point drive under manual (crank handle) operation. The number of crank handles shall be minimized by suitable grouping such that the operational impact is minimal when a handle has been removed.

The point machines shall be designed to be immune from traction power and other electromagnetic interference sources.

2.20.3 Train Detection

All trains and vehicles shall be positively detected, whether moving or stationary, under all modes of operation.

Train detection shall be provided on the main line, sidings, reception lines and within the Depot (except the workshop and maintenance area tracks).

The ETCS Level 2 system shall adopt Track Circuits on the main line to acquire the status of track occupancy. The Contractor shall ensure that track circuits are unaffected by traction power short-circuit currents flowing through the rails.

All connections to the rails for train detection shall be carried out by the Signaling system with close coordination with Track system.

Track circuits located on the main line shall be capable of detecting broken rails.

Impedance bonds shall be provided by the Contractor wherever required. However, the Contractor shall as far as practicable adopt track circuits which do not require the use of impedance bonds. Where impedance bonds are required, they shall be mounted between the rails, provided adequate space is available. If adequate space is not available, the Contractor shall propose the locations of the impedance bonds.

The Contractor shall work with the Traction Power system to assure that the impedance bonds provided meet the requirements for traction return current without compromising train detection. Inter-disciplinary check required with electrification engineer regarding cross-bonding that may be required on traction return rails.

2.20.4 Balises

The Contractor shall supply balises, which comply with ETCS systems. The passive type but switchable balises may be required in sidings/depots with signals. They shall be located within the center of the track suitably affixed and aligned to ensure that data is easily transferred when read by the on-board ATC equipment. They shall be installed at areas to serve as overrun protection, train position correction and other locations as may be required in accordance with ERTMS / ETCS subset 026 (SRS)

2.20.5 Signals and Signage

The provision of any sign or signal shall be submitted for review by the Engineer.

Lineside signs shall include, but not be limited to:

1) Entering/Exiting ETCS Territory Marker for level transition;
2) ETCS location marker
3) Stopping / Reverse Marker Board;
4) Speed restriction signs;
5) Change operating mode for example shunting (if applicable);
6) Depot Transfer Track stopping point;
7) Point number plates;
8) Normal stopping marker board (Stopping Position);
9) End of Block marker board; and
10) Any other signage as required by the ERTMS standard or the Employer.

2.20.6 Lineside Signals

The Contractor shall develop a numbering scheme for signal equipment for the review of the Engineer.

Whilst no line side running signals are required for the Project, the Contractor shall supply signals (shunting signal) at turnouts and within the Depot. The Contractor shall also provide signals for Buffer Stops. All signals shall be LED with a minimum 5-year life and shall include health monitoring. These signals are provided as trains will be required to be driven in manual mode to the stabling areas in the Depot. Route indicators shall be provided where signals have multiple route destinations. Furthermore, the signal shall not be capable of indicating the destination unless the route indicator is proven illuminated.

A numbering scheme is also required for ETCS block marker boards that are provided.

All signs and signals that are proposed should be designed to be structurally clear of the gauge and electrically clear of the overhead traction supply. Sign sighting forms and signal sighting forms should be produced and be subject to Inter-disciplinary check.

2.20.7 Rail Connections

The Contractor shall coordinate as part of their interface requirements with the track system to ensure that any connection e.g., holes drilled into the rail web, welding, etc. are satisfactorily resolved prior to any work commencing.

Prior to the selection of the connection, the Contractor shall demonstrate the reliability and maintainability of the connection required. In meeting these criteria, the Contractor shall provide evidence typically in the form of the following:

1) Mechanical test results;
2) Evidence of their reliable service on other railways; and
3) Maintainability in terms of removal, refitting and testing.

2.21 Environmental

All ERTMS / ETCS level 2 equipment shall be suitable for the prevailing environmental conditions of the project area.

All ERTMS / ETCS level 2 system equipment shall be provided in accordance with ISO 14000 (environmental management) and other specifications herein.

The Train Control System shall conform to IEC 60529 Ed. 2.0 b (or an equivalent standard) to the following levels:

1) Trackside equipment: IP code 66;
2) Internal train borne equipment: IP code 52;
3) External train borne equipment: IP code 67; and
4) CER/SER internal equipment: IP code 52.

The ETCS System shall be able to withstand following the environmental conditions stipulated below:

2.21.1 Temperature

1) Train borne equipment	0°C to 70°C
2) Trackside equipment	0°C to 70°C
3) CER and SER equipment 4) Control room equipment	Shall be capable of working in a non-air-conditioned environment up to 40°C without any degradation in performance of the equipment.

2.21.2 Humidity

1) Train borne equipment	0 to 99 % relative (condensing)
2) Trackside equipment	0 to 99% relative (condensing)
3) CER and SER equipment	0 to 95% relative (condensing)
4) Control room equipment	0 to 95% relative (condensing)

2.21.3 Shock and Vibration

All ETCS equipment both wayside and internal shall be protected from damage or reliability degradation due to shock or vibration in accordance with IEC 62498 or an equivalent standard.

Vibration and Shock (sinusoidal and random): The vibration and shock requirements for on-board equipment will conform to the ranges and classification contained in IEC 61373 or an equivalent standard.

2.21.4 Equipment Cabinet and Equipment Enclosure

All indoor equipment cabinets and equipment enclosures used for housing the Train Control equipment shall be provided with lock and key. Padlocks shall not be used.

The Contractor shall provide to the Employer, as a minimum, 3 keys per cabinet or equipment enclosure.

Sufficient ventilation shall be provided for the indoor equipment cabinets and enclosures in which active equipment are housed.

All outdoor equipment cabinets and equipment enclosures used for housing the ETCS equipment shall be provided with suitable locking or protection arrangement. The key or opening arrangement for identical equipment shall be the same. The key or opening arrangement for different equipment should be the same as far as possible.

All metallic cabinets/parts shall be earthed in accordance with the Philippine Electrical Code and Standards.

2.22 Power Supply Requirements

The power supply for the Signaling should be derived from a highly reliable source. For this purpose, the Employer shall provide a single source supply of three-phase 400 VAC supply. The Contractor shall supply all transformers and auxiliary/protection equipment to provide the correct power supplies for their equipment. The system shall comply with all regulations of the Philippines Electrical Code (2017 edition).

The Contractor shall additionally provide an Uninterruptible Power Supply (UPS) to complement the main power source. The UPS shall be suitably rated to ensure the Signaling system's (including point machine) continuous operation for a period of not less than three (3) hours in the event of failure of the main supply. The Contractor's design shall rationalize the power system in order to minimize the number of UPS units required, yet ensure all equipment is supplied under main power failure conditions.

All Signaling equipment at main line shall derive their power supply from the UPS.

A UPS for Signaling equipment shall also be required at the OCC. Depot outdoor Signaling equipment will be connected to the Depot UPS, except point machines which shall be fed directly. It should be noted that OCC/IOCC UPS could be shared with other systems such as communications and AFC (for IOCC) if necessary. The UPS shall also be designed for loads of systems being transferred (if any) from Banlic depot (SC) and Malanday depot(N1) to Mabalacat Depot IOCC

The input of the UPS shall be protected from over voltages and surges of current. Additionally, it shall be protected from the effects of lightning. The UPS shall also function as a filter in order to remove transients and other noise, which may affect the operation of electronic equipment.

A bypass switch shall also be provided to enable maintenance to be undertaken and to circumvent the UPS unit should a malfunction occur.

Batteries where possible, shall be contained within the unit and shall be maintenance free. If this is not feasible the batteries may be installed in a dedicated room with the UPS unit. Cabling between the batteries and UPS shall be sufficient to carry the full load.

The design and performance of the UPS shall be in accordance with the latest edition of IEC 62040 or an equivalent standard and with the following criteria:

2.22.1 Main Supply

1) Voltage three phase 400VAC ±10%, and
2) Frequency 60 Hz ±3%.

2.22.2 Output

1) Three phase 400VAC or Single phase 230VAC (dependent upon Contractor's equipment requirements),
2) Voltage variation ±2%,
3) Frequency 60/50 Hz ±3% (If the Contractor's equipment predominantly operates on 50 Hz this will be considered),
4) Harmonic distortion ±3%, and
5) Ambient temperature Operation 15°- 40° C.

The UPS shall be equipped with fans and filters for air-cooling. The Contractor shall indicate whether any forced-air cooling or constant temperature control is required.

The UPS shall be provided with output current limiters, which afford short–circuit protection. The overload capacity of the inverter shall be 150% for one (1) minute and 125% for the next ten (10) minutes.

In addition to the above, the UPS shall be capable of monitoring and detecting potential malfunctions; these include:

1) Overload;
2) Over voltage and current;
3) Under voltage; and
4) Temperature.

Should the battery temperature exceed the specified maximum during charging, the inverter shall terminate the charging to prevent thermal runaway of the batteries.

An alarm shall be generated for each of the above-mentioned features should they occur.

The operational status of the UPS shall be capable of being exhibited using a Liquid Crystal Display (LCD) or similar device. The differing features of the UPS shall be selectable using a keypad; these would include but not be limited to the following:

1) Input voltage;
2) Input current;
3) Power factor;
4) Frequency;
5) Battery voltage;
6) Battery and rectifier current;
7) Output voltage and current;
8) Inverter kW; and
9) Temperature.

The UPS shall be capable of providing information to the ATS system. An alarm shall be generated for failure or malfunction of items indicated above.

The UPS mechanical construction shall allow for maintenance from the front of the equipment.

The UPS proposed by the Contractor shall be subject for review by the Engineer.

The UPS and other power supply equipment shall be designed with a spare capacity of 25% of the nominal load.

No power supply, transformer, rectifier, battery or other power source, which is used to directly supply fail-safe circuitry, shall be used to supply non-Signaling equipment and circuits.

2.23 Design Requirements

2.23.1 General

The design shall be in accordance with the specifications relating to ERTMS / ETCS Level 2 system and other requirements of this Technical Requirements. In case of conflict between any of them the Contractor shall seek the advice of Engineer.

The following design requirements shall be adopted by the Contractor and are in addition to those specified in the ERG.

The Contractor shall submit a list of all design review documents for the review of the Engineer, as per the submission schedule given in General Requirements.

The ERTMS / ETCS Level 2 system and its sub-systems shall survive the occurrence of Single failures.

2.23.2 Design Process

The Contractor shall adopt a structured design process, including, but not limited to the following:

1) Conceptual, preliminary and final design reviews with the Engineer, including, but not limited to, requirements capture and decomposition, system architecture, logic flow diagrams, RAMS allocations, Standards to be followed, Safety integrity levels, operation and maintenance philosophy, verification and validation, and test approach; and
2) Conceptual, preliminary, and final software design reviews with the Engineer, for the software design, including but not limited to: the software requirements specifications, software architecture, requirements decomposition, logic flow diagrams, Standards to be followed, Safety integrity levels, HMI prototypes, and verification and validation, and test approach.

2.23.3 Design Documentation

The Contractor shall, in addition to the documentation requirements specified in the ERG, supply, as a minimum, the following hardware and software design documentation:

1) Conceptual design specifications, details and drawings;
2) Preliminary design specifications, Software and system verification and validation standards, signaling plans with final location of signals, specifications for Indoor and

lineside equipment. The Preliminary design shall include, but not be limited to:

a) System and Subsystem Overview;

b) System requirement specifications, System traceability specifications;

c) System safety plan;

d) System Verification and Validation Plan;

e) System Assurance Plans consisting of EMC Management Plan, RAMS Plans, Software Quality Assurance Plan and Quality Plan; and

f) ATC interface with Rolling stock, including the design of the Driver's HMI for ATP etc.

3) Final design specifications, details and drawings including complete specifications for various sub-systems e.g., CBI, ATP, ATS, ATO, Trackside equipment, Train Detection, bi-directional communication devices, GSM-R Radio and Data Communication network, etc. and their configuration for required headway, which shall include as minimum the following:

a) Design reviews, Design Verification Table;

b) Failure mode effect and criticality analysis (FMECA);

c) Project risk management plan, Hazard Analysis;

d) Hardware adaptation report;

e) Result from simulation studies including Design Data, formulas, calculations, and computer simulation logic, results and printouts for demonstrating that both safe braking and the specified theoretical headways have been provided by the design and subject to review by the Engineer.

f) Approved Signaling layout and numbering plan;

g) Interlocking Control tables;

h) Data preparation validation report;

i) Train Control principles;

j) Overall Train Control principle report;

k) Installation design;

l) Systems Engineering Plan; and

m) Final System Assurance Plan;

The submission of the above documentation shall be included in the Programme submission as specified in General Requirements.

2.23.4 Software Requirements

All software shall be designed, developed, tested, verified and be validated in accordance with the General Requirements.

2.24 System Safety Design Requirements

2.24.1 System Safety Objectives

The Contractor shall define a systematic approach to ensure that:

1) Safety is consistent with sub-system and the functional requirements are designed into the system in a timely, cost-effective manner;
2) Hazards associated with each system/sub-system are identified and evaluated, and the necessary mitigation measures are introduced to ensure potential hazards are eliminated throughout the entire life-cycle of the system/sub-system;
3) Historical safety data generated by associated systems are considered and used, where appropriate;
4) No risk is involved in accepting and using designs, materials and production and testing techniques;
5) Retrofit actions required to improve safety are eliminated through the timely inclusion of safety features during development and acquisition of a system; and
6) Modifications do not degrade the inherent safety of the system.

2.24.2 System Safety Design

The system safety design requirements shall include, but shall not be limited to, the following items:

1) Eliminate identified hazards or associated risk through design, including material selection or substitution;
2) Isolate hazardous substances, components, and operations from other activities, areas, personnel and incompatible materials;
3) Locate equipment so that access during operations, servicing, maintenance, repair, or adjustment minimizes personnel exposure to hazards (e.g., hazardous chemicals, high voltage, electromagnetic radiation, cutting edges, or sharp points);
4) Minimize risk resulting from excessive environmental conditions (e.g., temperature, pressure, noise, acceleration and vibration);
5) Design to eliminate risk created by human errors in the operation and support of the systems; and
6) Protect the power sources, controls and critical components of redundant subsystems by physical separation or shielding.

2.24.3 System Safety Engineering

Safety shall be the primary consideration in the design and performance requirement for the system. To meet these requirements, all safety critical equipment shall be designed to fail-safe and check redundancy principles. Structured and systematic approach shall be employed to identify, analyze and resolve potential system hazards.

All safety critical equipment shall be designed, manufactured and validated to Safety Integrity Level 4 as defined in the standards IEC 62278, IEC 62279, and IEC 62425 (or equivalent standards). The Contractor shall submit a report stating that the safety of the Train Detection, ATC, Radio Block Center and CBI system all fulfill SIL-4 requirements.

The development process of ATS shall be designed, manufactured and validated to Safety Integrity Level 2 as defined in the standards IEC 62278, IEC 62279 and IEC 62425 (or equivalent standards). All potentially unsafe effects of safety-related functions performed by ATS shall be mitigated by mandatory interaction with SIL-4 subsystems such as ATP and CBI.

Critical commands such as unblocking a blocked point/route/maintenance area, emergency operation of a point or releasing a temporary speed restriction shall be implemented in a safe manner.

Train Control system shall enable the Traffic Controller to take train movement decision based on the indications available with them (e.g., ATS HMI/Mimic Panel/Interlocking VDU) in the event of failure.

The ERTMS / ETCS operator interfaces for different modes of operation shall be included in the hazard analysis. The hazard analysis shall as a minimum take into consideration the following:

1) Probability of safety related commands not being executed when initiated by the train operator;
2) Probability of the ERTMS / ETCS system prematurely removing safety-related commands initiated by a train operator;
3) Probability of the ERTMS / ETCS system executing safety-related commands that were not initiated by a train operator; and
4) Probability of incorrect information being displayed by the ERTMS / ETCS system to the end-user.

2.24.4 Deliverables

A list of project deliverables shall be submitted as part of the System Safety Management Requirements. The deliverables shall include but not limited to the following:

1) Safety Assurance Plan as defined in the applicable specifications.
2) Hazard Analysis and safety risk assessments conducted for the various phases of the whole life cycle of the system as defined in this specification.
3) Identification of the Employer's requirements and operating rules and procedures required to ensure safe operation and maintenance of the ETCS system.
4) All documents for all the subsystems including but not be limited to Trackside equipment, On-board ATP, CBI, ATO, Train detection system, Bi-directional train to wayside data communication system, ATS, Radio Block Center, etc.
5) Proof of final safety report containing detailed analysis of software and hardware; and the assessment report of an ISA (if appointed) for the same as required by the relevant standards (or their equivalent standards) indicated in this Technical Requirements for both Hardware and Software for the following:
    a) All the subsystems including but not limited to Trackside equipment, on-board ATP, CBI, ATO, Train detection system, Bidirectional train to wayside data communication system, ATS, Radio Block Center, etc.; and
    b) The ERTMS / ETCS Level 2 system as a whole.

2.25 Quality Assurance

All materials and workmanship shall be of good quality.

Since the quality of the equipment espouses a direct relationship to the manufacturing process and the environment in which the equipment is manufactured; the manufacturer shall ensure the QAP is in full accordance with the General Requirements.

Validation and the system of monitoring of QA procedure shall form a part of type approval. Any necessary Plant, Machinery and Test instruments shall be available with the manufacturer.

2.26 Interfaces

The purpose of the Interface Specifications is to provide Contractor involvement in the interface with a clear overview of the purpose and functionality of each interface. It provides a framework such that Contractors can set to work in a co-operative way to produce the interfacing standard. Details of the interfaces with the Signaling System are found in the Interface Specifications in Appendix A1 to A6.

The Interface Specifications detailed below are used as the key documents for the interface definition and also to define the scope of each Interface Contractors.

Interfaces required between the individual sub-systems shall be worked out by the various sub-contractors/project partners of this contract so as to meet the functional requirements of the ETCS systems.

The Interface Specifications shall be read as an integral part of the General Requirements and contain the functional requirements for the interfaces.

The following paragraphs provide a brief overview of each Interface Specifications along with key details provided within the documents.

Various matrices given may be used as the basis for the Contractors CDIM however they are not to be regarded as exhaustive and the data given is to be updated by the Contractor as the requirements and circumstances of the Project dictate.'.

2.26.1 Signaling/Rolling Stock Contractors Interface Specifications (A1)

The Train Control / Rolling Stock Contractors Interface Specifications shall describe the interface requirements between the ERTMS / ETCS System and Rolling Stock Contracts. The primary interface is with the on-board ETCS System. It also covers the material and equipment to be supplied for the installation of the ETCS System on the Rolling Stock.

2.26.2 Signaling/Civil/E&M Contract Interface Specifications (A2)

This shall describe the interface requirements between this Contract and Contracts for Civil, Architectural and E&M works.

2.26.3 Train Control / Telecommunications Interface Specifications (A3)

The Train Control system and Communication system Interface Specifications shall describe the interface requirements between ERTMS / ETCS Level 2 System and Telecommunications system providing the telecommunications optical fiber-based network and the GSM-R Radio network.

2.26.4 Train Control/Track Works Interface Specifications (A4)

The Train Control /Track contract Interface Specifications describes the interface requirements between this Contract for ETCS System and track work.

2.26.5 Train Control/Traction Supply Interface Specifications (A5)

The Train Control/Traction Supply Interface Specifications shall describe the interface requirements between the Contract for ETCS System and Traction Power System.

2.26.6 Train Control/Depot Construction Contractors Interface Specifications (A6)

The Train Control/Depot Construction Contractors. This shall describe the interface requirements between this Contract and Construction Contracts for Civil, Architectural and E&M works for the Depot. Please refer to ERG for this interface.

2.26.7 Train Control/Platform Screen Door (PSD) Interface

The point of Physical interface between PSD and Signaling is PSD Control panel/termination box in PSD Room of each stations. All required cables and cabling infrastructure (support, trays, and conduit) from Signaling equipment room to PSD room at each station will be provided by the Contractor.

A voltage limiting device shall be provided to prevent the occurrence of any over-voltages.

2.26.7.1 Platform Screen Door Interface with the Train Control System

Distinctive signals and commands shall be exchanged between the Train Control System and the PSD system. The detailed design will confirm all required inputs / outputs between signaling system and PSD system. The following indicates the basic principle of this interface.

1) Vital Signals

a) Signals from the Train Control System to the PSD System

Door Enable signals for an 8-car train – The Train Control System shall provide a vital Enable Door command when the train is berthed on the platform.

Door Open/close command for 8 car train -When the train operator Operates the Door open/close button on the driver console, the Door Open or Close command shall send to the PSD.

The PSD system shall utilize these signals to authorize the corresponding the DCU's of the PSD to activate the doors. Should the train stop outside the berthing parameter, the Train Control system shall not provide any door enable command.

b) Signals from the PSD System to the Train Control System

All Doors Closed and Locked – When all of the doors (Sliding Doors and EED's) are detected Closed and Locked, the PSD shall send the All Doors Closed and Locked signal to the Train Control System.

Interlock Release – The PSD system shall provide an interlock override (Bypass) signal to the Train Control System, which is the same in functionality as All Doors Closed and Locked signal. These commands and signals shall be agreed with the Train Control Contractor.

For safety reasons, all these signals shall be considered and designed in a safety-critical manner and shall be redundant. Only if both signals indicate the same status the signal is considered valid and the PSD Enable and Door Open commands are activated. The doors shall only then be allowed to open. Furthermore, only if both signals are indicating All Doors Closed and Locked, then the train shall be allowed to depart or enter the platform.

2) Interface with the ATS

The PSD system shall send the alarm and status to the Local ATS and OCC; these include the power failure, interlock override, sliding doors closed and locked status, PED and EED door status. The interface shall also include commands as required by the Train Control and PSD system as indicated above. All commands and indications shall be agreed by the Train Control and the PSD system.

Status of PSD shall be monitored from the ATS. Door downgraded operation modes (alarms, faults, shunt, locking, etc.) shall be Available in OCC and SCR, ATS Workstation. If for any reason, any platform sliding door fails to open or close as commanded, an alarm shall be sent to the OCC/SCR.

2.26.8 Train Control/Tunnel Ventilation System (TVS) Interface:

The physical interface between the two systems will be done at OCC/IOCC level. All required cables and cabling infrastructure from Signaling equipment room to TVS room will be provided by the Contractor.

A voltage limiting device shall be provided to prevent the occurrence of any over voltages.

Distinctive signals and commands shall be exchanged between the Signaling System and the TVS system.

The contractor in consultation with interfacing contractor shall propose Operating rules for the interface based on capacity, relevant standards and operational requirements, for approval. The detailed design will confirm all required inputs /outputs between signaling system and TVS system.

2.26.9 Interface between NSCR-EX and N1 Section Signaling projects

The Contractor shall co-ordinate with NSCR N1 Contractor/supplier for effective and efficient interoperable operation. The Contractor shall supply/coordinate all the necessary onboard ATP/ATO software updates/modifications needed for interoperable operation with NSCR N1 section.

For the track side works, the contractor shall follow demarcation of the track work. However, the contractor shall extend and terminate all data and control cables up to the nearest equipment rooms of North side and South side of CP04 contract.

The contractor shall design and co-ordinate with the Contractor/supplier of N1 section for effective integration of ATS for N1, N2 and SC sections at IOCC to establish centralized control of entire network.

2.26.9.1 Signaling in the Solis-Blumentritt-Tutuban (SBT) Junction including Tutuban and Blumentritt Station

The Contractor's scope is to provide efficient and safe train operation in the SBT junction area (including Tutuban and Blumentritt station) sustaining the requirements of ETCS Level 2. The Signaling works demarcation shall follow demarcation and layout of track works. The Contractor shall provide all sub-systems or equipment necessary for the seamless operation of NSCR-N1 including the SBT junction, Tutuban and Blumentritt in accordance with the Technical Specifications. The Contractor shall supply the following and any other additional equipment as necessary including interfacing equipment to implement an efficient signaling system.

Track circuits

- Balises
- Signals and signages
- Point machines (as necessary)
- Onboard Radio modems
- Interlocking/Object controller (if necessary)

The Contractor shall be responsible for the provision of interconnections of all signaling wayside equipment to the interlocking and Radio Block Center (RBC) including additional intermediate cable termination and distribution where necessary.

The Contractor shall design, install and commission a complete Signaling system for SBT including Tutuban and Blumentritt station.

The Contractor shall also coordinate with other systems for the interface requirements of other facilities such as:

- Track works System for the provision of buffer stops insulated rail joints and additional turnouts at specified location acceptable to both parties;
- Power Supply System for the location of impedance bonds; and
- Communications System for the coverage of radio.

2.26.9.2 Turnouts at SBT Junction

For shunting purposes of various routes along the SBT area, that are critical to the operation of Clark to Calamba, a number of turnouts shall be provided between Solis, Tutuban and Blumentritt. These turnouts shall be controlled from interlocking/s.

For the shuttle operation between Tutuban and Blumentritt, it is composed of a single track that runs under the southbound viaduct of Solis-Blumentritt segment and connects to the platform of Blumentritt at center track.

Additionally, the crossovers at SBT including Blumentritt shall be controlled and monitored by the central and local ATS equipment.

2.26.10 Interface between NSCR-EX and MMSP projects

2.26.10.1 An interface between the NSCR-EX line that will be signaled with ERTMS / ETCS Level 2 system and the MMSP line to be signaled with CBTC is required at Bicutan. The Contractor will need to clearly establish the signaling interface.

1. Trains moving from the MMSP line to the NSCR-EX line will need to register with the RBC, establish a radio connection and transition to ETCS Level 2. The trains shall be fitted with both ERTMS equipment and CBTC equipment.
2. Trains moving from the NSCR-EX line to the MMSP line will transition to CBTC after passing over the transition announcement balises and registering with a Zone Controller for the system. The trains shall be fitted with both ERTMS equipment and CBTC equipment.

Bicutan Station will act as interchange for the two lines. Interface specification to detail interoperability and operational arrangement for changeover of systems shall be developed by the Contractor along with MMSP line contractors and submitted for the Engineer's review.

No through-operation from MMSP to NSRP-South or from NSRP-South to MMSP. All train shall stop at Bicutan Station for turnback and for changeover to continue operation to NSRP-South and vice versa.

3. The Contractor is required to equip MMSP trains with ETCS Level 2 system. The contractor shall interface with MMSP Rolling Stock Contractor for design, supply, placement, fixing, installation, testing and commissioning ETCS Level 2 system for MMSP trains for bi-directional train movement for NSCR-EX line.
4. The contractor shall ensure that the MMSP train is protected by the trackside equipment at all times, including in the event of switchover failure from CBTC to ERTMS L2 or vice-versa.
5. In order to make inter-operability and interfacing effective between MMSP line and NSCR line, the contractor shall also be required to install, test and commission equipment on MMSP tracks/platforms at Bicutan.

2.26.10.2 The ETCS Test Track at MMSP Depot:

1. The Contractor shall design, install, test, and commission the ETCS Test Track on the MMSP Depot (at Valenzuela). This ETCS Test Track is required and will be used by the MMSP operators to test the ETCS onboard equipment with MMSP rolling stock.
2. To achieve this requirement and its objective, the Contractor shall interface with the CP106 Contractor for the shared Test Track infrastructure. MMSP's test track will be equipped with a CBTC test setup by CP106 contractor as part of their Rolling Stock test for their Signaling system.
3. The requirements for the ETCS Test track are to set up to install, test, and commission the wayside equipment, and to arrange the switching over mode from CBTC to ETCS and vice-versa. The Contractor shall extend alarms and warnings to MMSP's OCC and DCC located in MMSP Depot. The Contractor may connect ETCS test track infrastructure to the central facilities for switching, certification, validation etc., available at OCC/IOCC at North Depot (at Clark) of NSCR line via Optical Fiber back bone.
4. The Contractor shall also interface with MMSP 's Civil Depot contractor for the requirement of space and power for ETCS and GSM-R infrastructure.
5. The overall scheme shall be submitted to the Engineer for approval.
6. The Contractor shall identify and supply the testing and diagnostics equipment for the ETCS Test Track needed by the MMSP operator for the downloading logs, diagnostics of equipment, testing of Signaling and Radio equipment, and propose these sets of equipment to the Engineer for approval.

2.26.10.3 The Contractor shall also interface with the O&M Concessionaires for NSCR and MMSP Lines for effective interfacing with the MMSP project and propose solutions to the Engineer to obtain Notice of No Objection.

2.26.10.4 The Contractor will make all such arrangements within the contract price and no separate payment shall be made for the above-mentioned works; all associated costs shall be included in the CP NS 01 Contractor's bid.

2.27 Installation

2.27.1 Construction and Installation Plan

The Contractor shall submit a Construction and Installation Plan for the review of the Engineer. Activities shall be categorized as such that all works that are considered significant will require separate method statements outlining how the work will be carried out safely and risk assessments.

The Contractor shall provide their installation specifications, which shall ensure that installation work and quality conform to best-accepted railway Signaling practices. The installation specifications shall be submitted to the Engineer for their review.

Special attention shall also be paid to all equipment whose correct functioning is essential to the safe and efficient operation of the railway. In particular, the Contractor shall comply with the following requirements:

1) Tail cables running to the trackside equipment shall not be jointed;
2) All trackside equipment shall be installed sufficiently clear of the high voltage and heavy current equipment so that maintenance risk is reduced to a minimum;
3) All trackside equipment shall be installed clear of any stair or door access;
4) All trackside equipment shall be installed not to cause any infringement to the schedule of fixed and moving dimensions;
5) Trackside equipment such as disconnection boxes, etc. shall be installed at appropriate locations for ease of maintenance;
6) Appropriate fixed means of access shall be provided for easy and safe maintenance of Trackside equipment;
7) All train control Cables on the tracks shall cross the rails at right angles; and
8) Where train control cables are required to cross the power cable or traction return cable, this shall cross the power cables at right angles and where possible at a minimum separation of 600 mm.

The Contractor shall ensure that sufficient personnel are available in order to fulfill the overall program requirements.

2.27.2 Temporary Works

The design of the Temporary Works shall be submitted to the Engineer for review.

All Temporary Works shall be removed prior to Employer's taking over of the works or section, or as reviewed by the Engineer. All Temporary Works shall be clearly distinguishable from the Permanent Works.

2.27.3 Work on Safety Critical Sub-systems

The Contractor shall ensure that all safety critical activities are identified prior to the commencement of the installation.

Procedures for safety critical activities shall be submitted to the Engineer for review.

2.27.4 Installation Implementation

The Contractor shall undertake installation in accordance with the Contract. Installation, testing and commissioning of later stages shall not impact revenue operation.

2.27.5 Site Supervision

In accordance with the safety aspects of the specifications, the Contractor shall ensure that the Works are adequately supervised by properly trained and competent supervisory staff in accordance with the requirements of the ERG.

2.27.6 Equipment Locations

All equipment shall be located and positioned such that the environmental, maintenance and operational requirements are met. These shall include as a minimum:

1) Safety;
2) Impact on other Interfacing Contractors; and
3) Access and egress.

The Contractor shall not place any materials, plant, tools or equipment, whether permanent or temporary, within 2 meters of the nearest running rail or the platform edge unless permitted to do so by the Engineer.

2.27.7 Cable Installation

All cables shall be installed as per the ducting plans shown in the Employer's drawings. Wherever such ducts are not provided the cables shall be laid and installed in accordance with the standards contained in this Technical Requirements.

Cables shall be installed such that they are accessible for maintenance purposes.

The Contractor shall ensure that the cabling design minimizes the number of cables running adjacent to or across the running rails.

Each cable and the circuits therein shall be identified.

All Cables shall have 20% or 2 cores, whichever is the greater, as spares after completion of the Works.

No jointing of cables will be allowed, except with the prior review of the Engineer.

2.27.8 Cable Protection and Immunization

All cables outside equipment rooms shall be armored.

All cables shall be protected from extraneous voltage and interference sources, the cables shall be protected at least from the following:

1) Lightning;
2) EMI; and
3) Transient voltages.

The Contractor shall submit to the Engineer for review the earthing and bonding schemes of all the self-screened and separate screened cables.

2.27.9 Track Crossing

All cables that cross the running rails must be protected in suitable protection pipe (HDPE or similar) that must not affect the track formation. The pipe must be of sufficient strength to resist accidental damage to the cable from track maintenance.

2.28 Cables

This specification covers the broad guidelines for design and construction requirements for cables. The Contractor shall be responsible for ensuring adherence to relevant specifications wherever applicable, sizing, procurement, installation, wiring and testing of all single and multi-core cables and wires required for the ETCS system. All cables shall conform to the Philippine Electrical Code (2017 Edition) where applicable.

2.28.1 Manufacturing and General Performance Requirements

All train control cables shall have continuous operating life of at least 30 years.

Cables shall be to the latest standards for railway Signaling cables. The Contractor shall submit the standards and specifications to which the proposed cables shall comply.

All outdoor cables shall be of the armored type and shall be able to withstand the environment in which they shall be installed; this shall include rain and ultraviolet ray exposure. The cable insulation shall be moisture and heat resistant and be able to withstand temperature up to 70 ºC.

The cables shall be resistant to any kind of corrosion due to environmental conditions and shall be suitable for use and also be immune from degradation under the following atmospheric impurities:

1) Total immersion in water, acidic solutions with low concentration, salt laden media, etc.;
2) Exposure to toxic materials, dirt, dust, grease, oil, hazardous gases, etc.; and
3) Exposed to atmospheric conditions including indirect sunlight.

2.28.2 Manufacturing

The Employer or their Engineer shall have access to the works of the manufacturer and shall be given facilities by the manufacturer to inspect the manufacturing of the cables during any stage of manufacture provided reasonable notice is given. They shall have right to reject the product in whole or in part of any work or material that does not conform to the provisions of this ERT and/or may order the same to be removed/replaced or altered at the expense of the manufacturer.

Tests shall be performed by the manufacturer as indicated in the relevant specifications. However, this shall not preclude any test as desired by the Engineer to determine the quality of the cable. The Contractor shall satisfy the Engineer regarding the quality of cable supplied, by production of a certificate from either a recognized testing laboratory or otherwise that the materials used and the cable fulfils the required standards and meet with all the testing requirements of the relevant specifications.

2.28.3 Tests

Following tests as a minimum shall be included in the FAT/Type tests:

1) Propagation;
2) Tensile strength;

3) Conductor diameter / area, resistance, capacitance;

4) Screening Factor;

5) Armor thickness;

6) Corrosive and Acid Gas Emission;

7) Fire resistance/ Flammability; and

8) Smoke Emission.

Test results and certificates shall be submitted for review by the Engineer.

2.28.4 Main and Subsidiary (Tail) Signaling Cables

Main and Tail cables for Signaling and train control trackside functions shall be of individually insulated copper conductor. Protective armoring and sheathing suitable for direct burial or laying at ground level in the open, viaduct or on the bridges under the ambient conditions prevailing in the project area shall be provided.

All tail cables from trackside equipment boxes and junction boxes to equipment installed on the track shall have a fully flexible core and sheathed to absorb track vibration. Approved type of crimping and termination shall be used. The location boxes and junction boxes shall have removable links to facilitate testing and isolation during fault-finding. The links shall be of a design, which shall prevent short-circuiting.

2.28.5 SER and Equipment Box Wiring

Wiring of circuits inside SER and location boxes shall be fire retardant/resistant cables.

Non-vital and vital wiring and cabling shall be kept physically apart and, in Signaling equipment rooms and location cases, in separate wire trees and runs. Full details shall be supplied by the Contractor. Specifications shall be reviewed by the Engineer before being incorporated into system designs.

2.28.6 Train-borne ATC Equipment Cables

All Train-borne ATC equipment cables used by the Contractors shall be flame retardant, halogen free and low smoke emission type. Cables shall be subjected to large-scale flammability test specified in IEC 60332 Part 3 (or an equivalent standard).

2.28.7 Cable and Wire Terminations

The use of soldering in cable connections shall be minimized and it shall be used only for terminating conductors. Cables and wires shall be terminated by more flexible means such as clamp type terminals or similar products.

The Terminal Blocks for Signaling cable terminations shall conform to international specifications and shall be submitted to the Engineer for acceptance.

All wire and cable conductors used in the Contract shall be identified at each end, using durable shrink-on or tag type labels firmly fixed to the wire ends, with descriptive nomenclature clearly and permanently marked. Labels shall be tied at both ends, at entry and exit points of cable trays, ducts and trenches and at appropriate locations where necessary. A record shall be provided to indicate clearly the type of cables, the sizes of cable, the use of each core or pair, and termination as well.

All wire and cable terminals used in the project shall also be numbered, identified in the nearest vicinity, using appropriate type labels firmly fixed and clearly described with their functional purposes.

All cables used by the Contractor in underground section/tunnel/station shall be flame retardant, halogen free and low smoke emission type.

2.28.8 Laying of Cables

Primary cable containment for train control cables is provided as per the Contract and Interface Management Plan.

The Contractor shall provide all necessary secondary cable containment and supports in addition to the primary cable containment provided, if necessary, to complete the connection to the Contractor's equipment.

The Contractor shall submit the working drawings with the following details to the Engineer for review:

1) Cable routes; and
2) Details of the cables to be laid along the proposed cable routes including cable types, number of cables, cable diameter, core count and estimated cable section length.

All cables shall be neatly run in ducts or conduits, laid in trunking, or troughs, or supported by trays, hangers or cleats as appropriate.

Conduits and ducts shall be thoroughly cleaned by a mandrel of diameter slightly less than the conduit or duct being drawn through. After the mandrel has been drawn through the conduits, a draw wire of galvanized steel shall be left in each conduit or duct, if required by the Engineer, to facilitate the drawing in of cables. The duct ends shall be sealed temporarily to prevent the entry of foreign matter. The conduits and ducts shall be cleaned again immediately before the cables are drawn in.

Where cables are to be laid in concrete troughs, the Contractor shall remove and re-instate trough lids prior to and after cable installation.

The Contractor shall use suitable protection pipes for track crossing of cables and at locations where other means of protection are not available.

The installation and handling of cables shall be undertaken at all times by adequate staff suitably trained and supplied with all necessary plant, equipment and tools.

The arrangement of the cables and all methods of laying the cables shall be submitted to the Engineer for review and shall be planned to provide an orderly formation, free from unnecessary bends and crossings.

At no location shall the cable be bent with a radius lower than the minimum bending radius recommended by the manufacturers. Sharp edges shall be avoided.

Every precaution shall be taken to ensure that cables and equipment are not installed in a manner or under conditions likely to cause electrolytic or other corrosive action or damage to, or be detrimental to, the performance of the cables and equipment during operation.

All cables and wires inside cabinets shall be housed in appropriate cable trunking or tied neatly along the side of the cabinet. They shall not cause any obstruction to the access of equipment within.

All cables shall be adequately rated for their duties. All power cables shall be able to withstand full load current for peak operation when the equipment is at its ultimate capacity.

Cable ties shall be made only from corrosion-resistant materials. They shall be further resistant to ultra-violet radiation if they are to be used at locations exposed to sunlight. In areas of significant vibration, cable ties shall be of metallic construction and coated further with a corrosion-resistant material.

Wherever possible, standard multi-pin plug/socket shall be used to terminate multi-core cables for connecting to equipment. Locking mechanism shall be integrated in the connector to secure the connection.

Heat-shrinkable sleeves shall enclose exposed terminated contacts in multi-pin connectors.

Any unconnected socket shall be covered up and properly labeled to avoid exposure for short-circuit and making wrong connection by mistake.

Connectors shall be suitably configured to avoid the possibility of wrong mating.

Connectors at cable ends carrying high voltages or current sources shall invariably use female contacts.

Cables entering enclosures shall utilize suitable cable glands or grommets for protection of these cables over the service life of the System.

Where cable containment is not provided by others then cable containment shall be supplied by the Contractor which shall have 25% spare capacity for expansion works. All cable containment material, fixing methods, and routing shall be Approved by the Engineer.

2.28.9 Fiber Optic Cable

The optical fiber cable backbone network shall be formed by two outdoor single mode optical fiber cables, one laying along the up-track and the other along the down-track. The normal and protected routes shall be routed through different fiber cables with path diversity.

The optical fiber cables shall be installed by the Communications system. Refer to Appendix A3 for details of the respective interfaces.

2.29 Identification

Descriptive labels shall be provided for all cabinets, enclosures, panels, assemblies and sub-assemblies.

Labels shall be of engraved type, with durable markings and shall have character size not less than 6 mm high.

The details of the labels including the material and size of the characters and sample of the labels shall be submitted to the Engineer for review.

Labels and notices on equipment shall be fixed with roundhead brass screws or self-tapping screws. Stick-on labels or fixing by adhesive shall not be accepted.

All enclosures containing terminals or exposed live parts where a voltage exceeds 120 volts shall have a label with lettering indicating the maximum voltage present in the enclosure. Warning signs shall be provided with graphical symbols and wordings in red for hazardous electrical equipment.

2.30 Drawings and Records

The Contractor shall provide 3 copies of all as-built drawings in A3 size, bound into circuit books. All drawings for use in trackside environment shall be durable and weatherproof.

The Contractor shall ensure that, at each equipment location, an as-built copy of the Site documentation is provided. This documentation shall include as a minimum:

1) Interlocking control tables;
2) Circuit diagrams;
3) Train control plan and track plan;
4) Installation Drawings; and
5) Operation and maintenance manuals.

2.30.1 Circuit Diagrams

The circuit wiring books containing the circuit diagrams shall include as a minimum the following information:

1) Point circuits;
2) Interlocking circuits;
3) Cubicle and rack profiles;
4) Room layout;
5) Interface and boundary schedules with Interface Contractors;
6) Power supply arrangement;
7) Earthing and bonding arrangement;
8) Circuits of interface of ATC with Rolling stock; and
9) Radio/OFC information.
10) Track plan

2.30.2 Cable Records

The Contractor shall ensure that the as-built cabling infrastructure is fully documented and accurate at the time of Employer's taking over of the works or section. The documentation shall include:

1) Schematic of the cable routes;
2) Location of cable joints;
3) Cable types;
4) Installed dates;
5) Test data; and
6) Core plan indicating the circuit and function of each core.

2.31 Earthing and Transient Protection

All earthing and lightning protection shall be in accordance with the Philippines Electrical Codes (2017 edition).

Earthing shall be provided for all indoor and outdoor ETCS installations to achieve the following objectives:

1) To provide the safety to the operating and maintenance personnel against the electric shock on account of any potential (voltage) appearing on exposed parts with respect to earth or due to electromagnetic or due to electrostatic induction;

2) To ensure safe and reliable operation of the equipment by limiting or eliminating the induced voltages and transients in the ETCS equipment;

3) To protect the equipment against build-up of unduly high voltages that may cause dielectric (Insulation) breakdown or damage to the equipment or their components; and

4) To serve as common voltage reference point wherever required.

2.31.1 Stations Area (Indoor Equipment)

Main Earth: Shared main earth riser (<1Ω) will be provided to the Contractor by the interfacing Civil/Depot Contractors. The Contractor shall extend main earth from this location and install an earth bus bar in the SER, UPS and other locations (if requires). The Contractor shall be responsible for any other activity required for earthing of his equipment in accordance with the specifications contained in this ERT.

2.31.2 Outdoor Installations

Following outdoor installations are required to be earthed:

1) Metallic sheath and armoring of all main cables at regular intervals;

2) Equipment Housings;

3) Point Machines; and

4) Any other installation as may be necessary to cover the complete scope of works.

The Contractor shall design earthing requirements for his own use and implement them to suit requirements of various sub systems of the train control system. The Contractor for the Signaling grounding may make use of the embedded conduit for the OCS grounding cables inside the structure column. If the Contractor wishes to utilize the OCS grounding cable for the Signaling system, this shall be included within the interface plan in conjunction with the OCS. The common grounding plan both for Signaling and OCS shall be reviewed by the Engineer.

2.32 Transient and Lightning Protection

Despite the provision of earthing as specified above, sometimes failures of Solid- state electronic equipment do occur on account of finite earth resistance, particularly high voltage transients and also due to lightning.

2.32.1 Requirements for Effective Transient and Surge Protection

Suitable electronic devices having high surge handling capability, fast response time, low clamping voltage, etc., shall be incorporated in the ETCS equipment and sub-systems offered, to ensure that the latter withstands the conditions mentioned above without any damage or permanent degradation in performance throughout the system life-cycle. The selection criteria for such devices shall include, but not be limited to, the following:

1) Reverse Standoff Voltage: At least twice the maximum operating voltage and allowing operation over the temperature range –65 ºC to +175 ºC; and

2) Pulse Power Rating: This shall have a value to handle the peak pulse power of the

transients and ensure their decay in less than 10% of the rise time for the worst pulse likely to be encountered from all possible sources including lightning and transients from traction power system;

2.32.2 Lightning Protection

While the station buildings will be provided with the lightning protection arrangements, the protection against lightning surges travelling through conductors into equipment's side shall be done by the Contractor using appropriate devices.

Earthing and other protective measures in preceding paragraphs are given only as indicative guidelines. The Contractor shall design, manufacture, install and be responsible for safe and correct working of all equipment/subsystems under the scope of the Contractor. To achieve this objective, the Contractor shall submit their proposals requiring any changes/modifications in above. The Contractor shall also submit their proposal for protection devices for power lines, data communication lines and equipment parts.

2.33 Verification, Testing and Commissioning

The Contractor shall provide a comprehensive testing regime to demonstrate that all the requirements of the specifications are fulfilled.

Dynamic tests shall be carried out by the Contractor as an essential part of the ETCS System Completion Tests. The Contractor shall devise Integrated Testing and Commissioning plan to verify the system in all modes of operation and with all interfacing system. Test programmes, methods and results shall be documented and submitted to the Engineer for the review.

The Contractor shall supply documentation showing how system safety and reliability are ensured. It shall be a single consistent document.

Possession requirements for installation, testing and commissioning of all sections and their integration with commissioned section(s) shall be reviewed by the Engineer.

The Contractor shall include in Integrated Testing and Commissioning plan, methodology of ensuring safety during Integrated Testing and Commissioning, and Service Trials.

The Engineer may conduct independent safety audits and will therefore require access to all the relevant design and product information. The Contractor shall provide all necessary assistance for this to the Engineer.

All the tests shall be carried out by the Contractor and shall be witnessed by the Engineer.

The Engineer reserves the right to carry out any additional tests they consider necessary to conclude that the System meets the requirements of the Technical Requirements.

The Contractor shall support the Engineer's additional tests as necessary. The Contractor's support shall also include, but not be limited to:

1) Provision of test equipment;

2) Attendance of competent staff; and

3) Provision of test procedures.

The Engineer may request that repeat tests be carried out to simulate the failure mode of any critical hardware/software component that is deemed to have a significant effect on the safety or reliability of the system.

The Contractor shall provide any simulation equipment, required for testing or commissioning.

The Contractor shall submit a Testing and Commissioning programme and details of the testing activities for the Engineer's review as indicated in the General Requirements.

All alterations to equipment, systems and designs shall be performed within the scheduled time prior to installation and commissioning.

The Contractor shall support any additional testing as required by relevant authorities in order to obtain approval for revenue operation.

The Engineer reserves the right to access at any time the records of all pre-installation and post installation inspection and testing of equipment. In the absence of good recording, the Engineer shall have the right to request the Contractor to repeat tests to avoid problems being accumulated at the subsequent phases. Testing and commissioning will not be allowed to start until the Post Installation Inspection and Testing phases are completed.

The Contractor shall make available technically qualified personnel for different systems (radio based ETCS, ATP, Interlocking, ATS, etc.) at the site to perform the activities listed in this chapter.

2.33.1 Sequence of Tests

The sequence of tests shall be as follows:

1) Type Tests;
2) Factory Acceptance Tests (FAT);
3) Pre-Installation Inspection
4) Post-Installation tests and Inspection;
5) Partial Acceptance Tests (PAT):
6) System Acceptance Tests (SAT);
7) Integrated Testing and Commissioning; and
8) Trial Running.

2.33.2 Type Tests

Type Tests shall be performed prior to full production and before FAT.

Type Tests shall be used to confirm that the proposed equipment is fit for purpose in the environmental conditions specified and meets the requirements of the specifications including the EMC.

The Contractor shall provide a schedule of type tests required for the various components such as ATP equipment, Bidirectional Train to wayside communication equipment, CBI equipment, Point machines, Cables, etc. All Sub-systems, components, modules, etc. requiring type testing shall be listed and submitted to the Engineer for review.

The Contractor shall provide detailed Type Test specifications in respect of tests to be performed for individual sub-systems, components, modules, etc., as listed out by the Contractor in the above-mentioned clause.

Equipment that has been tested and approved for unconditional and unrestricted use on any passenger-carrying railway by any Railway administration may be exempted from fresh type approval test by the Engineer. However, for this exemption a viable certificate issued by the concerned Railway administration must be submitted to the Engineer for verification and acceptance. The Engineer's decision will be final.

2.33.3 Factory Acceptance Tests

The Factory Test Plan shall be submitted to the Engineer for review as per the ERG. The plan shall adopt a top down approach and describe the FAT strategy as regards to methodology, procedures to be followed and records to be submitted. The Contractor shall submit the comprehensive list of specifications to be followed.

The FAT plan/submission shall include the appropriate testing and inspection items for approval. The FAT shall demonstrate that each subsystem meets its functional specifications.

No equipment or software should be delivered to the Site until the Contractor has demonstrated to the satisfaction of the Engineer that the equipment or software conforms to the specifications.

The FAT shall combine all subsystems to demonstrate that the requirements of the specifications are fulfilled.

The FAT shall demonstrate the correct operation of the ETCS System working together with all other systems with which it interfaces, as specified in the ERG. Interface protocol tests shall be completed prior to the commencement of the FAT for each interfacing system with the respective designated contractors. Any failed test shall be repeated after rectification. The Contractor shall develop and agree with the Designated Contractor for the test procedures and submit for the review of the Engineer.

The Site for FAT of the train borne ATP and Rolling Stock equipment shall be advised to the Engineer in accordance with the requirements of the General Requirements.

All simulations shall as a minimum cover a complete weekday service operating at the minimum service headway.

The simulations shall include failures and disruption to service to fully demonstrate correct operation of the System under these circumstances.

The FAT shall demonstrate that 72 hours continuous service has been achieved with no fault occurring that would prevent the equipment from operating as per this Technical Requirements.

The Employer/Engineer reserves the right to witness all FAT.

2.33.4 Pre-Installation Inspections

Prior to installation, the Contractor shall ensure that equipment delivered to Site has not been damaged in transit. Inspection and testing shall be conducted by the Contractor to determine that the equipment has not been damaged or the performance impaired in any manner subsequent to shipment.

Installation procedures shall be carefully planned to ensure that the work can be completed in the time available. If the time available is restricted, this planning shall include contingency plan to be implemented if installation proceeds slower than anticipated or defects are identified, which cannot be corrected.

2.33.5 Site Preparations

The Contractor shall submit to the Engineer a site preparation plan before installation.

The Contractor shall prepare the site in all respects required for installation of ETCS System equipment.

2.33.6 Post-Installation Tests and Inspections

Pre-Power up checking, power up, customization and configuration of equipment: The Contractor shall submit a plan for Pre-Power up checking, power up, customization and configuration of equipment for review and approval to the Engineer. The necessary test shall be carried out by the Contractor based on the approved plan and shall be witnessed by the Engineer.

Post Installation tests shall be carried out by the Contractor for each subsystem following Installation but before Functional Tests to demonstrate that the installation has been carried out correctly.

The Contractor shall submit a Post Installation Inspection and Testing Plan prior to the commencement of the post installation inspection and testing.

The inspection shall verify that equipment has been installed in accordance with the specifications and design that have been reviewed by the Engineer and that equipment is correctly located and labeled.

The inspection shall verify that any false feed, temporary wiring and redundant items have been removed and that equipment is correctly protected against interference, damage and deterioration.

The Contractor shall maintain inspection records to demonstrate that each item of equipment has been inspected and found to be satisfactory and attach to this record a detailed list of any discrepancies found and remedial work carried out. Inspection records shall be kept for all installed equipment and a detailed list attached of any discrepancies.

As the discrepancies are rectified, the record sheets shall be amended to record the corrections.

The Contractor shall provide detailed Post-Installation test specifications for each category of tests and these are listed, but not limited to the following for review by the Engineer:

1) Indoor Equipment
    a) Equipment Check;
    b) Layout and equipment profile check;
    c) Voltage measurements;
    d) Continuity test as per the wiring diagrams;
    e) Cable insulation tests;
    f) Power Cubicle function tests;
    g) Wire continuity tests;
    h) Earthing system tests;
    i) "Null Count" to visually inspect and ensure that there are no additional wires or circuits on contacts or terminals;
    j) Software is correctly installed with the correct version and checksum;
    k) Circuit board is of correct version and is correctly installed;
    l) Interlocking Control tables test;
    m) Through circuit function tests of the equipment;
    n) Interfaces tests with other equipment;

o) Radio Communications System; and

p) Network Management System.

2) Trackside Equipment

a) Equipment Check

b) Cable Insulation test;

c) Wire continuity test;

d) Earth test;

e) Point Machines tests;

f) Structure gauge checks; ensure the installations are within the structure gauge limits;

g) Local Test of ATP/CBI/Radio Block Center, Balise, Train Detection, etc.;

h) BTS equipment test; and

i) Remote test of equipment.

3) Train-Borne equipment

a) Equipment Check;

b) Cable Insulation test;

c) Wire continuity test;

d) Static and dynamic tests of the ATO-OB and ATO-TS sub-systems

e) Static and Dynamic tests of ATP equipment; and

f) GSM-R Radio equipment (ETCS).

4) Computer Based Interlocking Equipment

a) Cable Insulation and continuity tests;

b) Data Links tests;

c) Complete control table tests initially performed using a Simulator system prior to testing trackside equipment; and

d) Remote testing – Internal data links and external functions.

Before commissioning tests at site, all the interlocking and controls shall be functionally tested at the Contractor's factory. The Contractor shall provide test certificates on the functional tests performed at the Contractor's factory for the Engineer's acceptance. The Contractor shall, prior to final functional/simulation test, have carried out all preliminary testing of the system, including a full functional test to control tables, track plans and other design requirements. The Engineer shall witness the final functional/simulation tests that shall be carried out by the Contractor at site.

2.33.7 Post Installation and Site Acceptance Tests

Site tests shall be carried out by a separate test team independent from the installation and the design team in order to verify that the installation is correct and that when the system as a whole are connected together, they function safely as an integrated system.

The tests to be performed shall cause each system and sub-system to be sequenced through all required operations and shall include simulated conditions to prove that the installation is in compliance with control logic tables and vital safety requirements. This also involves test of components/equipment, system and sub-systems to prove functionality and compliance with the performance specifications specified in this ERT.

Testing shall progress in a systematic, sequential and logical manner from an established starting point to predetermined completion points of whole systems, sub-systems or stated segments.

All tests shall be documented, tests results recorded and signed by the testing engineer.

Test certificates with completed test records, which demonstrate equipment and components meet the performance requirement of the ERG, shall be submitted for information.

2.33.8 Partial Acceptance Tests

Installation work shall be completed and inspection records submitted to the Engineer for review before the commencement of each PAT.

The PAT Plan shall be submitted for the Engineer's review at least 120 days before the commencement of each PAT.

2.33.9 Functional Tests

The functional tests of the PAT shall be carried out on installed equipment before System Acceptance Tests (SAT) to demonstrate that the Section of the Works operates correctly in accordance with the ERG.

The functional tests shall sequence through all required operations to prove that the System performs in accordance with the ERT and the applicable specifications and that the local configuration data (for example, control tables) are correct.

Where necessary, input conditions shall be simulated.

The Contractor shall provide detailed Functional test specifications for review and acceptance by the Engineer and shall be carried out by Contractor's personnel independent of design and installation.

The functional test specifications for all the sub-systems, including the following categories but not limited to, shall be provided for the acceptance by Engineer:

1) Indoor Equipment including CBI, ATC, ATO, RBC and ATS;

2) Trackside equipment including Point machines, Radio network equipment;

3) Train Borne ATC equipment; and

4) Radio network test containing as a minimum:

   a) Train to Radio Block Center, RSSI (Received signal strength indicator) and Link Quality verification;

   b) Train to wayside packet loss verification (ping loss, etc.);

   c) Train to wayside latency verification;

   d) Single point of failure of radio nodes;

   e) Single point of failure of switches;

   f) Coexistence with other wireless system operating in the same frequency band (simulated); and

   g) Simulating testing (at site) to establish countermeasures against interference.

The functional testing of CBI Equipment shall contain as a minimum, the following, but not be limited to:

1) Input and Output Telegram tests;
2) Technicians control tests;
3) Functional Tests of the CBI;
4) Fault reporting tests;
5) All controls in the CBI area;
6) Cross boundary tests to adjacent Interlocking;
7) Simulation of all vital and non-vital Inputs and Outputs;
8) Total System monitoring of commands and controls implemented by the system;
9) Interlinked design workstation simulation systems.

2.33.10 System Acceptance Tests

System Acceptance Tests shall comprise comprehensive testing of the completely assembled installation to ensure that every item has been installed and adjusted and that all systems operate in every respect in accordance with the requirements of the ERG and are ready for Integrated Testing and Commissioning.

Prior to System Acceptance Testing, the Contractor shall submit a System Acceptance Plan to the Engineer for review. The plan shall adopt a top down approach and describe the System Acceptance strategies and processes.

The System Acceptance Plan shall identify a comprehensive list of specifications, standards, method statements, procedures, drawings and records to be submitted to the Engineer for Approval. The Plan shall also include a programme, which identifies the dates for system acceptance submission and tests.

Any tests carried out which are deemed as System Acceptance Tests shall be identified. If these tests have been carried out earlier or form the part of earlier carried tests, the same need not be repeated unless desired by the Engineer. However, these tests should be identified and included in the System Acceptance Test Plan.

These tests shall be conducted in the presence of the Engineer.

Any defects which become apparent in the course of these tests shall be made good and modifications as approved shall be implemented and recorded. All affected equipment shall be retested and certified before the system is accepted.

2.33.11 System Acceptance Test Requirements

The SAT Plan shall be submitted to the Engineer for review in accordance with the requirements indicated in the ERG.

It shall be the Contractor's responsibility to conduct all tests and record data, and restore the ERTMS / ETCS Level 2 System to full operational use following SAT.

During SAT, all interfaces with external systems other than those pertaining to the designated contractors to the ETCS System shall be tested.

A SAT of the train-borne equipment on each and every train shall be carried out on the Main Line test track facility.

System Acceptance Tests shall include but not be limited to the following:

1) Functional test of all Points and route operations;
2) Test of acceptance signal level under worst-case conditions for ATC transmission;
3) Functional test of the remote-control link and system in respect of both controls and indications;
4) Check of system voltages and loads and a system check under low voltage conditions. Test of system response to the loss of one incoming power feed and to the transfer from normal to standby supply. Additional system tests shall be conducted for all equipment, including changeover and redundant equipment under high voltage conditions to ensure that no function, sub-system, system remains in an unsafe state due to the high voltage settings of the power supply equipment;
5) Demonstrate that the system shall automatically re-initialize upon restoration of power following a complete power failure or reboot of any sub-system or system; and
6) EMC and Environmental testing of all the sub-systems, equipment.

The SAT tests for the ATC System shall be carried out to test all ATP functions and shall include the following but not be limited to:

1) Verification of the safe braking distances;
2) Testing of Control lines to verify that trains receive only the correct speed information according to the locations of other trains, the setting of routes ahead, the imposition of temporary speed restrictions, the operation of emergency stop plungers, and inputs from the control system;
3) Transmission of the correct side train door enable door closed information at each station by the vital ATP link;
4) Testing of emergency stop devices for stopping trains in emergency by the station staff;
5) All hardware non-availability and loss of signals from the equipment does force the sub-system, system to respond to a safe state. (i.e., loss of ATP antenna, loss of radio signal at the on-board, tacho-generator signals);
6) Fault monitoring facilities and also check that loss of supply and restoration does not generate erroneous data; and
7) Verification of the headway.

The ATS System Acceptance tests shall include but not be limited to:

1) Verification of correct implementation of operational commands and indications;
2) Demonstration of alarm responses and display format;
3) Verification of response to each input status change;
4) Correct implementation of various train hold functions;
5) Performance statistic report and failure report;
6) Compilation of timetables of various headway and operational requirements with normal service and special service;
7) Changeover of Control under failure conditions and manual operation;
8) Train dispatching under timetable and train description operation;

9) Dissemination of system information to sub-systems;

10) Control operation with station and depot; and

11) Train regulation under normal and traffic disturbance conditions.

12) ATO sub-system testing consisting ATO-OB and ATO-TS functionality

The CBI System interface acceptance tests shall include but not be limited to the following:

1) Interface with ATP;

2) Interface with ATS;

3) Interface with adjacent CBI's; and

4) Interface with ETCS equipment e.g., Radio Block Center.

The checking of System operation under partial fault condition e.g., computer changeover to hot standby or alternative routing capability of remote-control system.

Check that equipment response time complies with specified requirements.

2.33.12 Integrated Testing and Commissioning

On completion of testing and commissioning of the Contractor's own system to the satisfaction of the Engineer, the Contractor shall carry out all tests necessary to integrate the ERTMS / ETCS Level 2 System with all other systems such as Rolling Stock, Track, Communications, etc. and demonstrate correct operation of all internal and external interfaces.

The Integrated Testing and Commissioning Plan containing the schedule of integrated tests in coordination with the other designated contractors and test procedures shall be submitted to the Engineer for review and acceptance in accordance with the applicable specifications. The tests shall be carried out in coordination with the relevant Designated contractors.

The Contractor shall be required to lead in certain Integrated Testing and Commissioning where such tests are required to prove the performance of system provided by the Contractor.

All defects and shortfalls in the Contractor's system discovered in the course of Integrated Testing and Commissioning shall be corrected and retested to the satisfaction of the Engineer before the dates of correct Trial Operations for service trials.

The Contractor shall be responsible for Integrated Testing and Commissioning of the train-borne ATC equipment in cooperation with the Rolling Stock Contractors.

2.33.13 Static Tests

1) ATC faults to activate the alarms;

2) The Train's Emergency Brake Relays (EBR) and Zero Velocity Relays (ZVR) tripping (if used);

3) Checking of antenna (ATP and Radio) signal strength; and

4) Other tests necessary for the safe and proper operations of the train before the Dynamic test.

2.33.14 Dynamic Tests

Dynamic tests shall be performed on a section-by-section basis. Dynamic tests shall, as a minimum, demonstrate the following:

ATP data transmission and track to train transmission link and vice-versa and Interface between on-board ATC and trackside equipment;

ATO data transmission tests: ATO-OB to ATO-TS, ATO-OB to ETCS-OB

2) Correct interface between track and train equipment up to the Civil Speed Limit;
3) Ability of the ETCS System to stop the train within the allowed safety distances from Civil Speed Limit;
4) Correct operation of the ETCS System in all modes;
5) Verify the speed profile attained against the speed profile received;
6) Verify that the train stops within the designated braking distance for various speeds;
7) Verify that the audio-visual warnings are activated and brakes are applied, if required when the maximum safe speed is exceeded;
8) Verify the activation of EBR and ZVR under required conditions;
9) Verify the train stopping accuracy with respect to station stops;
10) Verify that the train doors open at the correct side of the train when stopped at station; and
11) Verification of the signaled headway.

Low speed dynamic tests shall be carried out on the Depot test tracks and the Main Line where available and as appropriate.

High-speed dynamic tests shall be carried out in maintenance block (where applicable).

The Contractor shall submit the test specifications and procedures for integration of all subsystems of ETCS System with the Communications system for review and acceptance by the Engineer such as:

1) Fiber Optic Transmission System;
2) Passenger Information Display System (PIDS);
3) Public Address System (PA System);
4) Train Radio Communication System; and
5) Master Clock System.

All necessary tests shall be performed for fulfilling interface requirements with other systems such as Track, Traction systems etc. for the purpose of integrated testing and commissioning.

2.33.15 Trial Operations

On completion of the Integrated Testing and Commissioning to the satisfaction of Engineer and System Acceptance Test, the Contractor shall confirm in writing to the Engineer that the works provided by them under the Contract is suitable and ready for the purpose of Trial Operations. During trial operations, the relevant system wide Contractors will run trains and simulate the operating condition of the Railway system.

The objective of Trial Operations is to ensure that the functions and operations of the various systems are satisfactorily integrated and shall be conducted in accordance with the General Requirements.

2.34 Reporting

2.34.1 Failure Report Forms

All failures shall be recorded on a failure report form which shall contain as a minimum the following information:

1) Identification of the equipment, including nomenclature, serial number, manufacturer's part number and location;
2) Operating time of each system including each shut-down and its cause;
3) Date and time of each incident;
4) Failure indication, mode, cause and effect;
5) Classification of the incident (relevant independent failure or dependent failure);
6) Corrective maintenance or operational procedures required to restore the System to operation;
7) Time to restore System to operation and active repair time; and
8) Environmental conditions and supply voltages.

2.34.2 Failure Investigation Reports

The Contractor shall maintain a failure database throughout the execution of the Works. This database shall be reviewed by the Engineer at the expiry of the Defects Notification Period.

2.34.3 Performance Demonstration

The performance demonstration shall take place over the Defects Notification Period. A performance demonstration plan shall be submitted for review by the Engineer in accordance with General Requirements.

2.34.4 Detailed Safety Case

The Contractor shall submit a Safety Case conforming to IEC 62425 (or an equivalent standard) for each section and certify for revenue operation which shall include as a minimum the safety features and safety standards of the ERTMS / ETCS Level 2 system and ATO sub-system after System Acceptance Tests. The Contractor may be required to issue updated Safety Case conforming to IEC 62425 (or an equivalent standard) after Test Running and Trial Operations.

2.34.5 Safety Certificate

The Contractor shall submit the safety certificate for each section in the approved format after Completion of System Acceptance Tests, certifying that the ETCS System is safe for the opening of Revenue Operation.

2.35 Operation and Maintenance Support

The Contractor shall ensure that the design of the software and hardware of the ETCS System is supportable throughout the service life of the System to address, as a minimum, the following:

1) Design errors in the System;
2) Operational changes;
3) Environmental changes; and
4) Changes in infrastructure.

The Contractor shall immediately inform the Engineer upon it becoming apparent that the quality or supply of materials and components is or is likely to be affected, and without delay submit to the Engineer for review of their proposals for alternative sources of supply.

2.35.1 Maintenance During Defects Notification Period (DNP)

During the DNP the Contractor shall support the Employer with competent personnel.

Such personnel shall have their generic competence established and must demonstrate their specific competence and knowledge in the particular systems, environment and procedures.

2.35.2 Defects Notification Management Plan

As part of the Defects Notification Management Plan the Contractor shall detail the management and organization to be provided during the DNP.

2.35.3 Testing and Re-commissioning of ETCS Equipment

In the event of a failure requiring modifications to the System, the Contractor shall undertake any testing and re-commissioning required. Any such modification shall be submitted for review by the Engineer.

2.35.4 Temporary Alterations to Restore Service

The Contractor shall undertake any temporary modifications necessary to maintain service. Any such modification shall be submitted for review by the Engineer.

2.35.5 Communications

The Contractor shall ensure that adequate communications facilities are provided to their staff during the DNP.

2.35.6 Location of Staff

The Contractor shall be responsible for locating on-duty staff at any given time such that the Contractor meets their obligations.

2.35.7 Storage of Equipment and Materials During the Maintenance Period

The Contractor shall ensure that no equipment is to be stored along the trackside.

The Contractor shall satisfy themselves and the Engineer that the storage locations for equipment and materials are suitable and secure.

2.35.8 Failure Investigations

Failure investigations shall be conducted by the Contractor.

The Employer will determine priorities in the event of a conflict between the Contractor and other Interface Contractors during failure investigation.

2.35.9 Software Support

The Contractor shall submit to the Engineer for review, the software and control management plans which shall be in accordance with the applicable specifications.

2.35.10 Support Documentation

Routine and corrective maintenance procedures shall be supplied for all equipment. The format shall be as follows:

1) Uniform format and layout irrespective of equipment supplier;
2) Cross referenced to the Operation and Maintenance Manuals; and
3) Document control information.

The procedures shall be submitted for review by the Engineer; the following shall be included as a minimum:

1) Frequency of maintenance;
2) Type of maintenance;
3) Equipment identification;
4) Safety precautions to be observed;
5) Step by step guide to the maintenance required; and
6) Explanatory diagrams.

The Contractor shall supply the configuration and customization data, parameters and settings in both hard copy and electronic format.

2.35.11 Manuals

The Contractor shall provide three kinds of manuals, Operation, Maintenance and Training manuals, to the Employer for use by supervisory, training and technical staff of the Operator.

All manuals shall be submitted and produced in accordance with the General Requirements for the review of the Engineer.

2.36 Spare Parts, Special Tools and Test Equipment

The Contractor shall provide spare parts, special tools and test equipment in accordance with the requirements the General Requirements.

2.37 Training

Training shall be provided for Employer's staff such that the ETCS System can be operated and maintained in accordance with the General Requirements.

2.38 Appendix A1: Signaling/Rolling Stock Interfaces

2.38.1 Definitions and Scope

This Appendix describes the interface requirements between the Contractor and Rolling Stock Contractors and also with Communications system.

The Contractors shall ensure that all requirements of the specifications pertaining to interfaces are properly satisfied.

The requirements specified herein are by no means exhaustive and it remains the responsibility of the Contractors to develop and execute an interface plan during execution of the work to ensure that:

1) All interface issues between the contracts are satisfactorily resolved;
2) Supply, installation and testing of equipment and software are fully coordinated;
3) All equipment supplied in the contracts are fully compatible with each other; and
4) All modes of operation are achieved with all their inherent features.

The ATP system shall issue the braking commands to the Rolling Stock when safety limits are exceeded or when over-speed is detected. The removal of traction power and the correct application of brakes shall be the responsibility of Rolling Stock Contractors. The ATP system shall be responsible for monitoring of speed and the issuing of braking commands when safety speed limits are exceeded.

Parking brakes shall be provided by the Rolling Stock Contractors. The parking brakes shall be capable of holding a fully loaded stationary train on a 3.5% gradient under all track conditions, indefinitely.

The ATO sub-system traction and brake control will output commands that the train will use to apply traction and brakes.

2.38.2 Interface Management

The Contractor shall establish a structured process to integrate with other systems to ensure safe, reliable and efficient operations under both normal and degraded conditions to the satisfaction of the Engineer.

The Contractor shall ensure that the equipment supplied under this Contract are properly interfaced and integrated with other systems.

The Contractor shall appoint a competent and experienced person with no fewer than 8 years of railway project experience who shall be the single point of contact for all interface design and testing works with the interfacing contractors and the Engineer.

The Contractor shall be responsible for interface identification, establishment, construction and testing works either in the capacity as the Lead Contractor or Participating Contractor.

For this interface the Contractor shall be designated as the Lead Contractor. The Lead Contractor will be responsible to initiate, plan, coordinate and produce jointly with the Participating Contractors all the required interfaces and interface design documents and interface progress reports for submission to the Engineer for acceptance. The Lead Contractor will also prepare and submit all interface meeting minutes and interface progress reports to the Engineer for information.

The costs for all interface design and testing works shall be deemed to be included in the respective Contract sum regardless of the actual extent of effort required or expended by the Contractors.

The Contractors shall be fully responsible for the management and control of their subcontractors in relation to all interfacing activities performed under the Contract.

2.38.3 Interface Requirements Between Signaling and Rolling Stock Contractors

The Contractor shall provide the Rolling Stock Contractors with the final list of equipment to be provided on the Rolling Stock. The size and weights of the ATP and radio on-board cab equipment and antenna, etc., to be mounted on the Rolling Stock shall also be provided as applicable. The location of the onboard cab equipment shall be mutually agreed between the Signaling and Rolling Stock Contractors. However, the on-board cab equipment shall not be placed in the under frame on account of maintainability issues. The Rolling Stock Contractors shall provide supplementary space to allow an additional ATC rack to be fitted.

The Contractor shall deliver to the Rolling Stock Contractors factory, all train-borne ATC and radio equipment, as applicable and data to enable fitting and testing.

The Contractor shall supply at Rolling Stock Contractors' premises pre-wired equipment racks with appropriate connectors for all wiring terminating inside ATC enclosures, including wiring between ATC racks.

For all relay contact interfaces, the Contractor shall provide auto-contact jam detection and contact bounce elimination function to ensure proper operation of the system. Relays for safety functions shall comply with the appropriate internationally accepted standard specifications.

The Contractor shall provide the Rolling Stock Contractors with the number of wires/ Ethernet connections required between cars to transmit signals from one end to the other end of the train through an electrical coupler. Provision of redundancy and spares shall be catered for by the RS Contractors for Train lines/Ethernet connections.

Vehicle control circuits shall be developed by the Rolling Stock Contractors. All the vehicle control circuits incorporating the identified interfaces shall be provided to the ETCS system. The Rolling Stock Contractors shall suitably incorporate these observations in the design. These shall include:

1) A train system failure which prohibits correct functioning of the fail-safe capability of trains, including loss of position, this train shall be immediately stopped; and
2) An application of the service brake either automatically or manually is determined by the ATP if the distance is determined to be insufficient to stop the train short of an obstruction.

Screened cables for train-borne Signaling equipment shall be properly terminated so as to ensure that no return loops are formed to cause electrical noise.

The Rolling Stock Contractors shall ensure that all signal inputs received from ATC equipment and output signals exported to the ATC system shall be recorded and shall be available for retrieval for analysis/record. All signals (input/output between RS and ATC) shall generally be routed through the TMS.

The Rolling Stock Contractors to ensure that all doors related and other safety/train control related signals including brakes, train parting, position of safety cut out switches, direction related relays, suspensions, etc. are communicated to the Contractor.

The Contractor shall define as a part of interface, the signals that will be provided by the ATC train-borne equipment.

There shall be redundant radio systems for communication between train and wayside. The system will broadly cater to Train Radio traffic and ETCS Data. The details of sharing of the redundant radio systems for sending control and data information, levels and protocols thereof, will be jointly agreed by Signaling, Communications and Rolling Stock Contractors. The GSM-R voice and data radio onboard system for transmitting ETCS information, and other data pertaining to control, alarm, events, etc., shall be provided by the Contractor.

The interface plan shall address the procedures to be adopted for rescuing the immobile train on the line by coupling the failed train with a healthy train and subsequently clearing the line in either Pull/Push mode with a healthy train.

2.38.4 Interface Testing and Commissioning

The Rolling Stock, ERTMS / ETCS Level 2 and Communications system shall perform System Integration Test and the tests shall include but not limited to traction and braking control, precision stopping, jog function, door operation, and PA/PIS functioning test, remote command and control for Rolling Stock monitoring and troubleshooting from OCC to train and safety related test, etc.

The Contractor as the lead Contractor shall prepare a comprehensive Operating Modes and Principles Document (OMPD). The Rolling Stock Contractors and the Communications system will assist the Signaling system in preparation of the document. The Traction and power supply system shall also assist the Signaling system in preparation of the document. The Rolling Stock Contractors will provide the necessary inputs such as standard operating procedures, etc. The document shall establish the principles related to system and interface design under normal, degraded and emergency modes of operation. For each operating principle the document shall describe the scenarios, action to be taken by the Operator and system in a structured process flow chart.

A Train Event Recorder shall be provided by the Rolling Stock Contractors, it shall be designed to resist tampering, and shall monitor and record data on train speed, direction of motion, time, distance, propulsion position, brake applications and operations (including service brake, emergency brake) equipped, cab signal indications, etc. The Contractor shall provide the requisite interface signal to RS for this purpose.

2.38.5 Rolling Stock Characteristics to be used by the Contractor.

The ERTMS / ETCS Level 2 system will work on fixed block principles and the system shall be so designed to meet the headway requirements based on the characteristics of the vehicles to be furnished and the track geometry. The Rolling Stock Contractors shall provide traction and braking characteristics of the actual vehicles and the Contractor must coordinate with RS Contractors to fine-tune the system design based on the traction and braking characteristics of the actual vehicles furnished. Acceptance tests of the ETCS system will use the actual vehicles supplied.

When operating in ATP Mode, a delay of 3s (programmable) shall be provided for the train operator to acknowledge a reduction in speed and begin to apply the brakes.

The model for calculating the safe braking distance (SBD) shall identify and take into account various systems' response times and train operators' reaction times. The design of ETCS system shall also take into account the effect of track geometry on the traction and braking characteristics. The Rolling Stock Contractors shall furnish the guaranteed braking rate at the normal braking efficiency, and at the lowest braking efficiency permitted in service, including brake deterioration, to the Contractor. Rolling Stock Contractors shall provide the speed/acceleration and speed/ tractive effort curves, for all loading conditions.

The Rolling Stock Contractors shall furnish as a minimum the Rolling Stock parameters to be used by the Contractor for designing the ETCS system. The Rolling Stock Contractors shall also furnish a reasonable tolerance band for the identified performance parameters. The Rolling Stock Contractors shall ensure that all the trains supplied perform within the tolerance band.

For any other information required by the Contractor, they shall coordinate with the Rolling Stock Contractors.

The Rolling Stock Contractors shall provide facilities to detect any coupling, detachment and/or separation of detachable units of a train consist. Upon detection of an unexpected uncoupling, detachment or separation, an immediate emergency braking to stop shall be invoked on all units of the connected train.

The on-board ATP shall detect the unexpected uncoupling and establish appropriate limits of authority to prevent following trains from entering the area where the uncoupling has occurred. Consequently, an immediate alarm shall be raised and forwarded to the OCC.

2.38.6 ATC and Radio Equipment Cubicles

The Rolling Stock Contractors shall supply the ATC and Train Radio equipment cubicle enclosure(s) inclusive of additional space for future on-board ATC equipment. All supports, braces, mounting holes, cabling apertures, etc. required for mounting the cubicle and its equipment shall be properly coordinated between the Signaling system and Communication system and Rolling Stock Contractors to ensure secure mounting and access. The cubicle(s) shall be suitably protected to the requisite IP level as indicated in this Technical Requirements.

To achieve the ATC control functions, the Contractor shall identify any interfacing circuits specifically required for ATC operation and liaise with the Rolling Stock Contractors. These include but not limited to start, door control, propulsion, coasting, braking and emergency brake commands. Door control circuit design shall allow opening of doors in the standby position of mode selector under manual driving in the event of non-availability of door opening authorization from the ATP.

For train control circuits, the Contractor shall identify the voltage free contacts to be provided by the Rolling Stock Contractor, including the number and type of electrical signals required between the ATC equipment and the equipment provided by the Rolling Stock Contractors. The Contractors shall coordinate to agree on levels and protocols for each signal.

As a minimum, all electronic equipment to be mounted on Rolling Stock, including those provided by Signaling system and Communications System shall comply with IEC 60571 (or an equivalent standard). Electronic Equipment used on rail vehicles for design, manufacture and testing shall use components purchased against an internationally recognized quality assurance and reliability certification procedure.

2.38.7 Antenna

The Contractor shall identify roof, bogie and under frame-mounted antennae, and associated disconnection box mounting brackets and location requirements to identify cable and conduit routes required to antenna as applicable.

The Contractor shall supply the necessary disconnection boxes, terminal blocks, cables adaptation mounting brackets, flexible conduit assemblies complete with connectors and cables from antenna to the junction boxes.

The Rolling Stock Contractors will provide the antenna mounting brackets, conduits, support or clamping arrangements to ensure security and reliability.

The antenna system shall not impact upon the vehicle kinematic envelope both for normal and any reverse directions of any train(s) running and fully meet the radio coverage requirements.

2.38.8 Speed Measurement Devices

For each ATC equipment set (per driving cab), the Contractor shall supply to the Rolling Stock Contractors for installation, axle mounting speed measurement devices and couplings, to be configured, and the data from them processed in such a way to achieve the objectives of obtaining the true speed of the train in a fail-safe manner. The speed measurement devices shall be mounted on axles which preferably shall be non-powered.

The speed sensor shall transmit speed signal which is generated by axle rotation to signaling control system. The speed sensor shall have fitting interface with the end part of boogie journal box and be able to fit to journal box end cap by bolts. Pin or gear shall be used for transmitting the rotation of axle to the sensor and those shall be fitted to axle end by bolts. The Contractor shall adapt the speed sensor to fit the axle as manufactured by the Rolling Stock Contractors.

Additionally, Doppler Radar shall be implemented for speed measurement and direction of travel.

The Contractor shall supply the necessary disconnection and terminal blocks, device mounting brackets and plates, flexible conduit assemblies complete with connectors and cables from speed measurement devices to the junction boxes. The Contractor will supply all the mechanical fixing items such as radar, odometer, accelerometer, radio antennas, and cables required for ATC such as cables for radar, odometer, accelerometer, radio antennas, etc.

The Rolling Stock Contractors shall provide for each speed measurement device mounting brackets, support or clamping arrangements to ensure security and reliability.

The Contractor shall provide the zero-velocity detection apparatus (ZVR relay or equivalent).

The Contractor shall furnish the Rolling Stock Contractors with full mounting details, apertures, fixing holes, etc.

2.38.9 Train Operator's Display

The equipment on driver's console used for all operating modes shall be ergonomically located. The layout of the console shall be agreed with the Rolling Stock Contractors.

Indications to the train operator (when in driven mode) shall be displayed on the ATC Cab Display supplied by the Contractor. The train operator's display shall be composed of an integrated display screen. It shall incorporate as a minimum, but not be limited to:

1) Operating Mode;
2) Train description (ID);
3) Target Distance;
4) Target Speed;
5) Service and Emergency Brake Initiation;

6) Train docked;
7) Train hold status;
8) Station dwell time available;
9) Departure order;
10) Within ETCS territory or otherwise;
11) Operating modes failure indications;
12) Skip Stop indication;
13) Door Open Indication;
14) Maximum Permissible Safe Speed (MSS) in ATP and degraded modes;
15) Train stopped outside of expected stopping window;
16) Depot indication, when the train is identified as being in the depot;
17) Axle locked indication, for axles on which ATC speed sensors are mounted; and
18) Door release available; indicating on which side(s) of the train the doors may be opened.

During design stage, the RS contractors and Contractors may have to interface to integrate TMS/DMI inputs as it is considered necessary to optimize the driving console in the cab for operation under GoA-1.

2.38.10 Interface between TMS and Train

The Rolling Stock Contractors shall provide an on-board Train Management System (TMS) to log the information from the AT and Train Radio equipment supplied by the ETCS and Communication Systems, in addition to the information to be indicated in the Rolling Stock specifications.

Ethernet or Serial Interfaces shall be agreed between the two Contractors. Software for downloading the data from TMS to maintenance terminal shall be provided by Rolling Stock Contractors.

The Contractors shall provide Windows compatible software for maintenance terminals for viewing the data logged in TMS.

All the commands by the on-board ATP system, to Rolling Stock equipment and the responses of the Rolling Stock equipment shall be recorded in the TMS. This shall include any operation of the cut-out mode switch.

The signals to be supplied from the TMS to the equipment of the Signaling and Communication systems shall be decided jointly between the two Contractors.

The interface shall ensure that TMS receives necessary inputs from the on-board ATC system to enable TMS to synchronize its clock with the system master clock.

2.38.11 Power Supply and Earthing Arrangements

An independent 100 VDC power supply circuits, for the ATC and Train Radio Equipment shall be provided by the Rolling Stock Contractors and there shall be no physical or electrical links between these power supply circuits.

The Rolling Stock Contractors shall provide dedicated earthing arrangements for the train-borne ATC equipment. The Contractor shall specify the earth impedance requirements.

The power supply cable between the train power supply and the ATC and radio train-borne equipment power equipment shall be as short as possible and directly connected to the supply without any intermediate connection.

2.38.12 Factory Installation and Testing

All the special equipment associated with the train-borne ATC and radio system including the interface cables/wires between the train-borne ATC and train radio shall be designed and supplied by the Contractor, as applicable to the Rolling Stock Contractors' factory. Each Contractor shall be aware of the locations of manufacturing plants, which could concurrently be manufacturing cars.

The Contractor shall be responsible for providing all data and training of Rolling Stock Contractors' staff in all aspects of ATC and train radio installation and testing where applicable. The Contractor shall install first set of equipment and Rolling stock contractors will actively participate.

The ATC equipment and also train radio equipment shall be installed by the Rolling Stock Contractors, under the supervision of the Contractor including the wiring for the interface of the ATC equipment with Rolling Stock.

The RS Contractors will be responsible for installing wiring and equipment, and its testing on each car to the functioning standard agreed with the Contractor.

Testing of each car shall comply with the accepted international standards agreed between the Contractors and the Engineer. Initial Integration tests (static and dynamic) shall be done at the Rolling Stock facility and carried out by the test personnel of both Contractors jointly. Furthermore, main line integration tests will be required to be performed to ensure all train control functions between the OCC and Train jointly by the Rolling Stock Contractors and Contractors at site. Test certificates for the on-board equipment will be issued jointly by Rolling Stock Contractor and ETCS Contractors. The certificates will pertain to the respective areas of the Contractor's responsibility and shall be decided during the interface.

The Rolling Stock Contractor shall provide facilities for comprehensive static, dynamic and interface tests between the Rolling Stock and ETCS systems at his premises. The Contractor shall be responsible for the provision of special test equipment and instrumentation.

Should the need arise for modifications in the configurations of respective equipment or systems as a result of the integration test or otherwise, the scope of work and division of responsibility shall be jointly agreed amongst the two contractors and detailed procedure shall be developed. Rolling Stock Contractors shall provide the requisite manpower to monitor and/or implement the modifications to the Rolling Stock.

The Rolling Stock Contractors and the Contractor shall fully associate and submit all necessary support during type testing of the respective systems. Rolling Stock type tests may require all out mode of operations in GoA-1 as per the approved test specifications. The Rolling Stock Contractors and the Contractor will jointly finalize such test plans and schemes/operational modes and ensure the satisfactory completion of the type tests.

2.38.13 EMC/EMI Interface

The Contractor shall provide a list of frequencies and other sensitive requirements to the Rolling Stock Contractors, to enable them to avoid such frequency bands in his design, and to provide devices to isolate the source of emission wherever required. The Contractor will have first right of use for radio frequencies as required for ETCS application.

The Rolling Stock and the Contractors shall ensure that the emission and immunity level of their respective equipment meet the requirements of IEC 62236(or equivalent standards).

Rolling Stock Contractors shall ensure that the return current in the track at the specified frequencies does not exceed the values specified by the Contractor.

The Contractors shall jointly develop a test plan detailing how the electromagnetic compatibility of traction and ETCS systems will be verified.

The Contractors shall coordinate activities to ensure that all electronic and electrical equipment on the Rolling Stock works properly without interfering with ETCS subsystems.

The cable layout of the ETCS systems in the cable ducts provided by the Rolling Stock Contractors shall be jointly agreed. The separation between ETCS cables and power cables of 1500 VDC, 400 V three phase AC, 230 VAC single phase, 100 VDC rating shall be in accordance with international/national practices and jointly agreed.

The cable ducts should be earthed every 2 m and also at the ends and shall be in accordance with accepted international practices.

2.38.14 Train Operation Simulator

The Contractor shall provide the necessary onboard Signaling equipment and relevant information to the Supplier of Train Operation Simulator for reproducing all Signaling functions (please refer ERT Training Facility at Training Center).

2.38.15 Scope of Interface

The Signaling and Rolling Stock Contractors shall co-ordinate interactively in order to achieve the functional and operational requirements of the system. The roles and activities of all the relevant Contractors shall as a minimum include, but not be limited to the following:

Table 2.6- Signaling and Rolling Stock Interface

Interface Item ref.	RS Contractor	NS-01 Contractor	Location	Purpose of Interface
SIG. RS.1	To provide space in the vehicle design for fixing and installation and interfaces at the manufacturers facility by the RS Contractor under, the supervision of Train Control Contractor to achieve overall system functionalities. The speed measuring sensor and odometer for non-Signaling mode will be provided by RS Contractor	The Contractor to supply the equipment to the RS contractors' Works.	In the Vehicle	On-board ATC equipment. Antenna for ATP, ATS and TWC Speed measuring sensors and Speedometer for non-Signaling mode. Signaling Cab Displays (Train Operators DMI) including any special cables
SIG. RS.2	To provide, in an agreed format as per the requirements of Train Control, space (inclusive of additional space for the provision of additional on-board Signaling equipment in the future) in the vehicle design for fixing and installation at the manufacturer's facility, by the Rolling Stock Contractor, under the supervision of the Contractor.	The Contractor to supply the equipment to the Rolling Stock Contractors Works		On-board radio equipment Antennas for ETCS and train radios inclusive of all special cables Train lines / Ethernet connection
SIG. RS.3	To provide the required voltages and earthing.	To provide required voltage values and earthing requirements to	Vehicle	Power supply and earthing for on-board ATC and Train Radio equipment

Interface Item ref.	RS Contractor	NS-01 Contractor	Location	Purpose of Interface
		RS Contractors.		
SIG. RS.4	Provide the on-board data logger TMS. All to and from signals shall be logged in the TMS.	The Contractor to co-ordinate with RS Contractor for signal levels and protocols.	Vehicle	Logging of on-board information from ATP and Train Radio
SIG. RS.5	RS Contractors shall co-ordinate with the Contractor to agree on levels and protocols for interface signals. There shall be no delay in braking from RS during the transition from electric brake to friction brake at slow speed.	ZVR and redundant EBR relays to be supplied by the Contractor.	Vehicle	Interface between ATP with train braking and propulsion systems for automatic braking, acceleration and deceleration.
SIG. RS.6	RS Contractors to synchronize TMS clock with system master clock. All subsystems clock in RS shall be synchronized with the TMS clock.	The Contractor to provide necessary inputs.	Vehicle	System master clock
SIG. RS.7	RS Contractors shall provide for necessary hardware interface, display for on-board PA/PIS system inside the cars.	Contractor shall provide necessary signals on-board to RS Contractor.	Vehicle	On board next station information to the passengers
SIG. RS.8	RS Contractors to provide Cab Air Conditioning to all relevant train control and communications installations to maintain a nominal temperature of 25°C. Suitable ventilation	The Contractor to specify at an early date, the total heat load wattage, and maximum permitted operating temperature	Vehicle	Climatic requirements for on-board ATC and Radio cab equipment.

Interface Item ref.	RS Contractor	NS-01 Contractor	Location	Purpose of Interface
	shall be provided by the Contractor for the backside area of the console. Conditioned air ventilation all be provided by the RS Contractors for the console.			
SIG. RS.9	RS Contractors shall ensure the compliance of the requirements of Contractor for on-board Signaling and Radio equipment.	The Contractor shall advise EMI/EMC plan for ATC and Radio equipment to RS Contractor at an early date.	Vehicle	EMI/EMC interface between the RS and Contractor
SIG.RS. 10	Provide all necessary equipment for commissioning of the Train Simulator	The Contractor shall provide necessary materials installation of the Train Simulator	Training Center within the Depot	Train Simulator

2.38.16 Train Characteristics

Typical Train characteristics of trains in various contracts; MMSP (CP107), Limited Express and Commuter train (CP NS-02, CP NS-03) as in Tables below:

Table 2.7 - CP107 (MMSP) train

Item	Specification, Performance
Train	Commuter Train, 8 cars
Performance	Acceleration (Design):3.3km/h/s (0.91m/s^2)(starting) Deceleration (Design):4.2km/h/s (1.17m/s^2)(Max service brake, Instantaneous deceleration) 4.7 km/h/s (1.31m/s^2)(Emergency brake, Instantaneous deceleration) Design operation Max speed:120km/h Jerk limit: 1.1 m/s^3 Full service brake application response time: 1.5 s Emergency brake application response time: 1.5 s (max) Full service brake release response time: 2.0 s Emergency brake release response time: 3.0 s
Carbody	Standard:19,500mm (Length)×2,950 mm (Width)×3,655 mm (Height) Driver unit: Center of cab The length of leading cars may be longer than the above (Overhung)
Bogie	Max axle weight:16t Wheelbase: 2100mm Bogie to bogie center: 13800mm Maximum wheel diameter: 860mm

Item	Specification, Performance
	Minimum wheel diameter: 780mm Wheel back to back: 1359-1362 mm
Traction Motor	3-phased totally enclosed high efficiency induction motor 4 units / M car
Door system	Door fully opened: 2.0 – 2.5 s Door fully closed:2.5 – 3.0 s

Table 2.8 – NS 02 Train

Item	Specification, Performance
Train	Commuter Train, 8 cars
Performance	Acceleration (Design):3.3km/h/s (0.91m/s2)(starting) Deceleration (Design):4.2km/h/s ($1.17m/s^2$)(Max service brake, Instantaneous deceleration) 4.7 km/h/s ($1.31m/s^2$)(Emergency brake, Instantaneous deceleration) Design operation Max speed:120km/h Jerk limit: 1.1 m/s^3 Full service brake application response time: 1.5 s Emergency brake application response time: 1.5 s (max) Full service brake release response time: 2.0 s Emergency brake release response time: 3.0 s
Carbody	Standard:19,500mm (Length)×2,950 mm (Width)×3,655 mm (Height) Driver unit: Center of cab The length of leading cars may be longer than the above (Overhung)
Bogie	Max axle weight:16t Wheelbase: 2100mm Bogie to bogie center: 13800mm Maximum wheel diameter: 860mm Minimum wheel diameter: 780mm Wheel back to back: 1359-1362 mm
Traction Motor	3-phased totally enclosed high efficiency induction motor 4 units / M car
Door system	Door fully opened: 2.0 – 2.5 s Door fully closed:2.5 – 3.0 s

Table 2.9 – NS 03 Train

Item	Specification, Performance
Train	Commuter Train, 8 cars (with future configuration capability of 10 cars)
Performance	Acceleration (Design):3.0km/h/s (0.83m/s)(starting) Deceleration (Design):4.2km/h/s ($1.17m/s^2$)(Max service brake, Instantaneous deceleration) 4.7 km/h/s ($1.31m/s^2$)(Emergency brake, Instantaneous deceleration) Design operation Max speed:160km/h Jerk limit: 1.1 m/s^3 Full service brake application response time: 1.5 s Emergency brake application response time: 1.2 s (max) Full service brake release response time: 2.0 s Emergency brake release response time: 3.0 s
Body	Standard:19,500mm (Length)×2,950 mm (Width)×3,655 mm (Height) Driver unit: Center of cab

Item	Specification, Performance
	The length of leading cars may be longer than the above (Overhung)
Bogie	Max axle weight:16t Wheelbase: 2100mm Bogie to bogie center: 13800mm Maximum wheel diameter: 860mm Minimum wheel diameter: 780mm Wheel back to back: 1359-1362 mm
Door system	Door fully opened: 2.0 – 2.5 s Door fully closed:2.5 – 3.0 s

The contractor shall interface with Rolling stock contractors (MMSP (CP107), Limited Express (CP NS-03) and Commuter train (CP NS-02)) and obtain information on train characteristic and other related information and exchange his information for designing interfaces.

2.39 Appendix A2 –Station and Depot Civil and E&M, Contractors Interfaces

2.39.1 Definitions and Scope

This specification describes the interface requirements between the Contractor and Civil Contractors.

This document shall be read in conjunction with the relevant paragraphs of the General Requirements. The Contractors shall ensure that all requirements of the General and Technical Requirements pertaining to the Contracts are fully resolved and implemented.

2.39.2 Contractor's Responsibilities

2.39.2.1 Coordination and Interfacing

This specification outlines the Contractors' interface requirements. However, the requirements herein specified are by no means exhaustive and it remains the Contractors' responsibilities to develop, update and execute jointly Interface Management details during design and throughout the execution of Works, to ensure that:

1) All interface issues between the two Contractors are satisfactorily resolved;
2) Supply, installation and testing of equipment and software are fully coordinated; and
3) All equipment supplied in the contracts are fully compatible with each other.

2.39.2.2 Scope of Work

Interface between Signaling and Civil contractor for Stations, via-duct and tunnel: Please refer to ERG for this interface.

2.40 Appendix A3 – Train Control/Communication system Interfaces

2.40.1 Definitions and Scope

This specification describes the interface requirements between Signaling and Communications system.

This document shall be read in conjunction with all relevant paragraphs of the General Requirements. All interfaces shall comply with ETCS protocols and relevant ERA/UNISIG standards The Contractors shall ensure that all requirements of the ERT pertaining to the Contracts are fully resolved and implemented.

2.40.2 Contractor's Responsibilities

2.40.2.1 Coordination and Interfacing

This specification outlines the Contractors' interface requirements. However, the requirements herein specified are by no means exhaustive and it remains the Contractor's' responsibilities to develop, update and execute jointly Interface Management details during design and throughout the execution of Works, to ensure that:

1) All interface issues between the two systems are satisfactorily resolved;
2) Supply, installation and testing of equipment and software are fully coordinated; and
3) All equipment supplied in the contracts are fully compatible with each other.

2.40.3 Scope of Work

2.40.3.1 Interface of Train Control with Public Information Display System (PIDS)

The Contractor shall interface for automatic display of train related information including train arrivals/departures and train length on pre-designated display boards.

For all lines, the central ATS and local ATS for a specific sector of the ETCS System shall send data to the PIDS to display train related information including train arrivals and departures and train length on pre-designated display boards throughout the platforms and the concourse of all stations.

Based on the information received from the ETCS System, PIDS system shall initiate and coordinate Train arrival/departure related PIDS message with the Public Announcement System.

The PIDS will carry out time countdown based on the estimated time data sent by the ETCS System and display the estimated train arrival and /or departure particulars. The estimated time to arrive and/or depart of the train(s) as shown on any display board will be updated automatically and will be corrected if necessary, following a data update from the ETCS System.

The pre-defined message displays will be triggered by the data sent by the ETCS system including message displays of non-stopping trains passing through the stations, train not in service and user defined message displays.

The ETCS equipment at each station shall invoke the station PIDS control equipment to clear the designated row of the train arrival/departure information on the corresponding PIDS display boards subsequent to a train departure.

The format of the PIDS display shall be consistent with that used on NSCR and MMSP. The contractor shall coordinate with the CP04 and CP106 Contractors regarding this interface.

The Contractor shall jointly develop detailed interface document covering the hardware interface, list of messages, type and format of message to be displayed and the protocols to be followed for exchange of data between the two systems. All interfaces shall comply with ETCS protocols and relevant ERA/UNISIG standards. The detailed interface document shall be submitted for review of the Engineer.

2.40.3.2 Interface of Train Control System with Passenger Announcement System (PAS)

The Contractor shall interface for automatic announcement of train related information including train arrivals/ departures on the designated station platforms.

Data shall be sent by the ETCS system to the PAS System in a coordinated manner to broadcast predefined train information including train arrivals and departures on pre-designated display boards throughout the platforms of all stations.

PAS announcements will be made to alert passengers of the following:

1) Time schedules and deviations thereof; and

2) Non-stopping trains based on the information received from the ETCS System.

The PAS will carry out the time countdown based on the estimated time data sent by the ETCS System. The estimated time to arrive and/or depart of the train(s) will be stepped down automatically every minute and will be corrected, if necessary, following a data update from the ETCS System.

The time countdown will be paused when a train stops proceeding to the next stopping station, due to circumstance detectable by the ETCS System and relayed to the PAS.

The pre-defined announcements will be triggered by the time countdown functions of the PAS or data sent by the ETCS System including announcement of non-stopping trains passing through the station.

The contractor shall jointly develop detailed interface document covering the hardware interface, type and format of message to be displayed and the protocols to be followed for exchange of data between the two systems. The detailed interface document shall be submitted for review of the Engineer.

2.40.3.3 Interface of Train Control System with Radio System

The ETCS system shall interface with Train Radio for Dynamic Registration of Train identity numbers (TID) using the information provided by the ATS system.

As a minimum operation indication shall appear on the Traffic Controller's Radio Dispatcher Console and shall contain the Train Identity Number (TID), location from which it is originated (in terms of which Radio Base Station the alarm message was originally routed). The alarm message shall be time and date stamped. Radio Dispatcher Console shall be able to send an acknowledgement and initiate a call, both voice and short data message to the Train. This service shall operate regardless of whether the Train operator or the target user is engaged in a voice or data call. Train Radio System may be used to achieve the PTI if requires, however the Contractor may propose alternate solution to achieve PTI.

Failure of the radio equipment shall not interrupt the normal operation of the train-borne ATC equipment.

The Contractor shall jointly develop detailed interface document covering the hardware interface, list of messages, type and format of message to be displayed and the protocols to be followed for exchange of data between the two systems. The detailed interface document shall be submitted for review of the Engineer.

2.40.3.4 Fiber Optic Transmission System Channels (FOTS)

The Communications System shall provide two redundant Ethernet Ports from every station and Depot to the OCC (subject to the maximum required by the Contractor). The FOTS and Signaling system shall jointly develop the channeling plan based on the bandwidth required for these systems. Additionally, Contractors shall agree on the number of fibers required for operation of the ETCS inclusive of any dark or spare fibers.

The point of interface for these channels will be CER at stations and CER at OCC.

2.41 Appendix A4 – Train Control/Track Interfaces

2.41.1 Definitions and Scope

This specification describes the interface requirements between the ETCS and Track System.

This document shall be read in conjunction with all relevant paragraphs of the General Requirements. The Contractor shall ensure that all requirements of the General and Technical Requirements pertaining to the Contracts are fully resolved and implemented.

2.41.2 Contractor's Responsibilities

2.41.2.1 Coordination and Interfacing

This specification outlines the Contractor's interface requirements. However, the requirements herein specified are by no means exhaustive and it remains the Contractor's responsibilities to develop, update and execute Interface Management details during design and throughout the execution of Works, to ensure that:

1) All interface issues between the two Systems are satisfactorily resolved;
2) Supply, installation and testing of equipment and software are fully coordinated; and
3) All equipment supplied in the contracts are fully compatible with each other.

The interface between the Signaling and Track System (s) will be for both ballasted (Depot) and ballast less tracks.

The interface requirements detailed in this ERT are not exhaustive and shall be read in conjunction with all other requirements of the Contract.

2.41.2.2 Physical Interface

The minimum scope of the interface of Signaling and TRW shall be in accordance with table below:

Table 2.10: Physical Interface between Signaling and Tracks

Interface Item Ref.	By Signaling	By Track	Location	Purpose of Interface
SIG.TRW.1	Determine the location of the cross-track cables and Signaling equipment (e.g. point machines, beacon, impedance bond and bonding cables). Supply and install the Signaling equipment.	If required, provide recess/pedestal/foundations for equipment and slot/cut-outs in the Ballast-less track concrete slab for all cross-track cables in Ballast-less track-	Track-form	Mounting of Signaling equipment on track-form i.e. point machine, impedance bond

Interface Item Ref.	By Signaling	By Track	Location	Purpose of Interface
		form.		
SIG.TRW.2	Provide Rail bond cables, drilling of the holes/ exothermic welding in rail web and terminate to the rail Web. Shall bolt/rivet Rail Bond cables to the sleepers on the ballasted track so as to prevent damage during tamping.	Co-ordinate with Signaling for required holes/welding for rail bond termination.	Rail	Ensure the continuity of signal rail and Traction return
SIG.TRW.3	Determine the position (LHS or RHS), dimension, supply and install the point machines with all the associate mechanism.	Provide the supports, hole drilling in track-form and rails as required for the installation of point machines.	Turnout	Installation of point machine.
SIG.TRW.4	Supply and install the first drive rod (including first stretcher bar), all rodding and back-drive including their connections / bars with all their fittings and point locks.	Incorporate all the drilling and fixing requirements in the turnouts for installing point drive mechanisms. Supply and install all stretcher bars except the first drive rod with first stretcher bar.	Turnout	Switch operating mechanism connection.
SIG.TRW.5	Determine the location of Insulated Rail Joints (IRJ) at plain track and turnouts.	Supply and install the IRJs including in-situ type at the location as determined by Signaling.	Rail	Bonding requirement.
SIG.TRW.6	Confirm the location of cable route from wall/ able trough/cable tray to track-bed equipment including the dimensions of the opening required for cable crossings. In case of any specific additional requirement, signaling shall indicate	Provide the required openings in the track bed for cable crossings duly embedding PVC pipes of required dimensions (as provided by Signaling) in the concrete track bed	Track-form	Cable route from track to trackside-mounted beacons / trackside box / Signaling installations

Interface Item Ref.	By Signaling	By Track	Location	Purpose of Interface
	the requirement and shall provide necessary pipes for providing the same under the track.			
SIG.TRW.7	Confirm the rail to earth insulation provided is acceptable.	Propose and provide the rail to earth insulation.	Rail	Rail to earth insulation
SIG.TRW.8	Shall review the methodology and Confirm the locations and extents where reinforcement insulation is required. Further shall ensure that the same is provided before the track bed is cast.	Track installation methodology in terms of insulation requirements for longitudinal/ transverse reinforcement bars and holding down bolts/dowels shall be proposed and adhered to during track installation according to Signaling requirements.		Track-form reinforcement insulation
SIG.TRW.9	Determine the track length required at all terminus, sidings, turn back facilities and stabling tracks for accommodating the trains.	Provide sufficient track length for accommodating the trains as required by Signaling.	Overrun	Overrun protection
SIG.TRW.10	Shall incorporate the same in Train Control design.	Track system shall provide the same for corridor giving the details of curves & gradients and also details of speed restrictions.		Final track alignment and Profile Plan details of curves, gradients etc.
SIG.TRW.11	Shall co-ordinate with Track System for installation of Buffer Stop Signals	Shall supply and install the buffer stops at terminal stations and other locations in co-ordination with Signaling.	Tracks	Buffer Stop Signals
SIG.TRW.12	Shall furnish the final sizes of trackside equipment and co-	Shall co-ordinate with signaling to ensure full compliance of	Tracks	Installation of trackside equipment and

Interface Item Ref.	By Signaling	By Track	Location	Purpose of Interface
	ordinate with Track System to ensure compliance of schedule of dimensions.	schedule of dimensions.		signal posts.
SIG.TRW.13	Jointly test with TRW during installation and while commissioning of points machines and during integrated testing and commissioning.	Jointly test the points with signaling during installation and commissioning of points machines and during integrated testing and commissioning and rectify all defects pertaining to track, if any, identified during the testing & commissioning of points.	Tracks	Testing of points and crossings
SIG.TRW.14	Provide Rail bond cables and terminate to the rail Web. Shall bolt/rivet Rail Bond cables to the sleepers on the ballasted track so as to prevent damage during tamping.	Drilling of the holes in rail web as per requirements of the Signaling.	Rail	Ensure the continuity of signal rail and Traction return

2.41.3 Exchange of Design Information

The Signaling and TRW shall liaise directly in undertaking the interfacing in accordance with the project programme. The Contractor shall keep the Engineer apprised in writing of all such discussion, arrangement and conclusion.

The Signaling shall provide the TRW with locations and detailed requirements for installation of rail and track-bed mounted equipment, location of insulated rail joints, point machines, method of mounting point machines and their positioning in track-bed. The Contractor shall ensure that the attachment of stretcher bars, drive rods, lock rods and detector rods to the rails shall be accommodated in the rail drilling locations as shown on the detailed/final drawings.

The Contractor shall inform the Engineer and agree with TRW of any special requirements for insulation or other special considerations with respect to running rails and track-bed.

The Contractor shall furnish the electrical requirements to the TRW and the TRW shall provide the same.

The TRW shall provide the details of the curves, gradients, chainages, turn outs and assemblies to the Signaling system who shall incorporate the same in their design.

2.41.4 Point Machines

The Contractor shall provide the details of the layout, fixation arrangements required on the concrete bearers/on the viaduct for installation of point machines to the TRW. All required main cable routes which require ducts/cut-outs across concrete track bed shall be marked up in both location and section on drawings and provided to the TRW system.

2.41.5 Special Attendance

During the fitting of the "driven stretcher" bars by the TRW the Signaling system shall provide attendance.

During the installation of the 'the first stretcher bar' and 'drive rodding to the driven stretcher' bars by the Signaling and the TRW shall attend to assist in the adjustment of the switches.

During the installation of Trackwork, the Signaling system shall provide attendance to verify that the insulation requirements are adhered to by the TRW before casting the track bed.

During the testing and commissioning/proving tests of the switch operating force by the Contractor, the TRW shall provide attendance until complete testing of the Signaling equipment.

2.42 Appendix A5 – Train Control/Power Supply (including Traction, Substation, Power Distribution & OCS) Interfaces

2.42.1 Definitions and Scope

This specification covers the interface requirements between the Signaling and Power Supply system.

This document shall be read in conjunction with all relevant paragraphs of the General Requirements. The Contractor shall ensure that all requirements of the General and Technical Requirements pertaining to interfaces are fully resolved and implemented.

2.42.2 Contractor's Responsibilities

2.42.2.1 Coordination and Interfacing

This specification outlines the Contractor's interface requirements. However, the requirements herein specified are by no means exhaustive and it remains the Contractor's' responsibilities to develop, update and execute jointly manual details during design and throughout the execution of Works, to ensure that:

1) All interface issues between the systems are satisfactorily resolved;
2) Supply, installation and testing of equipment and software are fully coordinated; and
3) All equipment supplied in the contracts are fully compatible with each other.

2.42.3 Physical Interface

The Contractor shall co-ordinate for ensuring the minimum safe distance between any train control installation and the traction power for the purpose of personnel safety and apart from the requisite EMI/EMC considerations. Similar minimum safe distances between traction power cables and Signaling cables/wires within the station premises shall also be ensured by both the systems.

2.42.4 Electrical Interface

2.42.4.1 Traction Return

The Traction Power System shall advise the Signaling system of the normal and worst short circuit current levels. This is to ensure that insulation for wayside equipment (where applicable) is adequate.

The Signaling system shall advise the Traction/Power Supply system of the locations of the track circuits. The Contractor shall agree on the final location of cross bonds/impedance bonds and other rail connections related to traction return current to ensure overall system safety and functionality. The two systems shall interface regarding use of Buried Earth Conductor or Structure Earth Cable, if provided along the line, for earthing of outdoor train control equipment.

The two Systems shall interface to achieve an integrated Earthing and Bonding plan for the line.

2.42.4.2 Air Gaps

The Power Supply system shall provide the Signaling system with the length and location of all traction air-gap sections.

The Contractor shall design the System such that no train or a part of a train stops within an air-gap section. This shall apply for 8-car consists, whilst in both normal or in degraded operations.

2.42.5 Functional Interface

2.42.5.1 Protection Characteristics

The Traction Power system shall provide the Signaling system with the OCS feeder circuit rating, the protection tripping setting, the OCS traction system current carrying capacity, transient and surge protection and the protection relay setting.

The Contractor shall ensure that the System makes allowance for the settings when planning for simultaneous start-up of several trains. The Contractor shall ensure that there is no degradation with respect to the performance requirement as indicated in the respective specifications.

2.43 EMC Management Plan

2.43.1 Joint EMC Management Plans and Testing Strategy

The Traction Power Supply and the Signaling system shall perform a joint study and develop the Electromagnetic Compatibility Management Plan using data such as the emission characteristics, susceptibility levels, filter characteristics, physical layout and construction of their equipment, taking into consideration variation in component characteristics with frequencies. The study shall demonstrate compatibility or highlight areas of potential problems with a view to implement remedial measures in time to achieve compatibility.

The Traction Power Supply system and the Signaling system shall co-ordinate for any information concerning EMI/EMC in the OCS and other structures.

The Contractor shall develop a test plan detailing how the electromagnetic compatibility of the traction system and the ETCS System will be verified.

End of Section

3 TELECOMMUNICATIONS

3.1 Introduction

The Telecommunications System covers the following two sections:

1) The Malolos-Clark Railway Project (MCRP)

2) The North-South Railway Project-South line (Commuter) (NSRP-South)

These two (2) sections in conjunction with other systems provided under the NSCR Contract CP04 will be combined to provide a complete interoperable Telecommunication system for the North-South Commuter Railway (NSCR) Project.

3.2 Scope of Work

3.2.1. General

The works comprise of the railway systems from CIA to Malolos and Solis to Calamba and Tutuban including Depots at Banlic and Mabalacat. In addition, the telecommunications system shall be supplied and installed on the different rolling stock fleets that will operate on the MCRP and NSRP South.

The Integrated OCC and Training Center is located at Mabalacat Depot. The temporary server at Banlic Depot used for the partial operation will be migrated to Mabalacat Depot after the Integrated OCC is commissioned. The Contractor shall perform the necessary works for Sectional Completion and Partial Operation as the railway is commissioned in phases.

The Contractor shall be responsible for the design, manufacture, supply, delivery, installation, testing, commissioning, integration with other contracts, training, defects notification period, and operation/maintenance support.

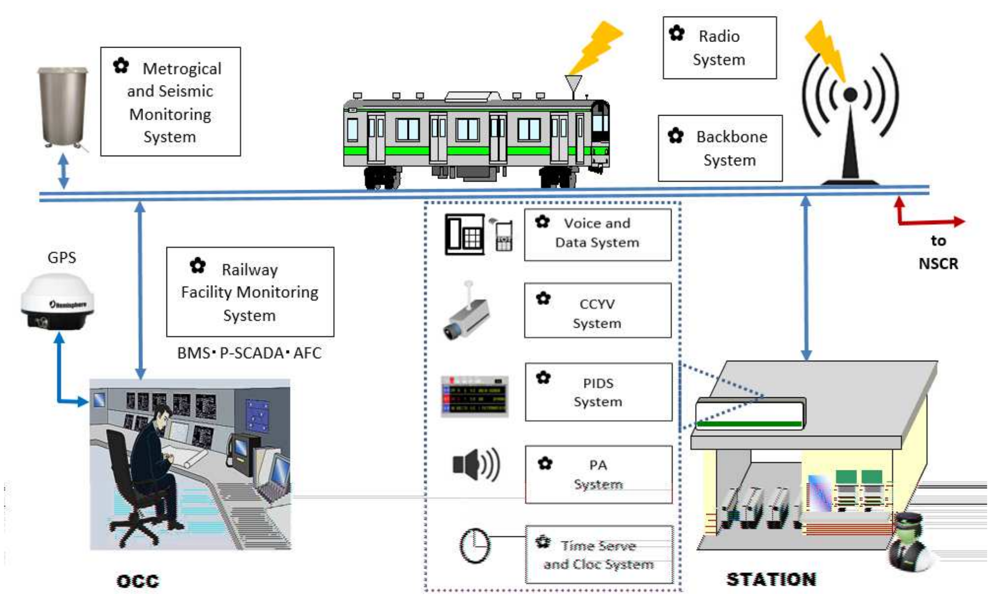


Figure 3.2.1 System Overview

The Telecommunications System is a Design-Build Contract based on the Employer's requirements. If any defects and/or faults are found on the above works, they shall be rectified, at no extra cost to the Employer, with the cost being borne by the Contractor.

Contemporary technologies may be adopted so far if they have been confirmed to be proven and safe in existing Rail Systems.

The communication subsystems shall be flexible to adopt additional stations and extension of the line in the future.

3.2.2. Telecommunication Systems

The telecommunication system scope of work covers the following Ten (10) Subsystems:

1) Backbone System

The Contractor shall provide a Backbone system for the following subsystems: Radio System, Voice and Data System, Public Address System, Closed Circuit Television System, Passenger Information Display System, Centralized Clock System, and Network Management System. In addition, other systems shall be interconnected using the BTS infrastructure as BMS, Signaling, P-SCADA, and Automatic Fare Collection.

The Backbone system shall be high speed, large capacity, and full redundancy with optical fiber cables laid in the cable trough on both sides of the railways, and connected to the downward via L3 switches at the CER in the OCC and stations. Any of the works after the L3 switches shall be the scope of each subsystem.

The Contractor shall be fully responsible for the interface coordination, configuration, modification, and test of the different phases of operation

2) Radio Systems

The Contractor shall provide a GSM-R Radio System comprising of voice communication between drivers, Station staff, Depot staff, Maintenance staff, Shunting staff, and OCC. Packet Switched data communication for the ETCS-level 2 Signaling system including data communication required for Automatic Train Operation and non-vital (non-signaling) data transmission.

The GSM-R Radio System shall include all control equipment, software & licenses, equipment power supplies, control units, interfaces, equipment cabinets and enclosures, base stations, antennas, leaky feeders, all cabling between respective items, and all cabling to the interfaces to other systems.

The GSM-R Radio shall be fully compliant with the EIRENE Radio System specifications. The Contractor shall supply the necessary repeaters or additional antennas based upon the link budget calculation.

The radios shall be fully compliant with Radio System specifications. The Contractor shall supply the necessary repeaters or additional antennas based upon the link budget calculation.

At the project boundaries, the Radio System shall interface with the other Radio System of the adjacent projects. The Radio System shall be fully redundant.

Also, the Contractor shall provide emergency train and/or train operation information (TIS) in this system. Countermeasures for radio interference and redundancy scheme shall be furnished as essential functions.

The Contractor shall provide radio equipment for the trains and in the track-mounted maintenance vehicles, rolling stock, and maintenance vehicles.

The contractor shall deliver the onboard radio equipment to both rolling stock contractors manufacturing facilities. The first and second trainsets shall be installed by CP NS-01 contractor and supported by rolling stock manufacturers. The subsequent trainsets shall be installed by respective contractors. The Contractor shall supply and install radio equipment on all maintenance vehicles.

3) Voice and Data System

The Contractor shall provide Voice and Data system which includes IP telephone, common LAN, and Telephone systems inside OCC, stations, Depots, and the other railway facilities including a Wi-Fi system for staff. Exclusive lines between/among OCC and train crews, station staffs, and shunting staffs together with a digital voice recorder shall be furnished as essential functions.

The system shall be configured with a router, server, IP-PBX, and L2/L3 network switches over the protocol of SIP, RTP, QoS, and the other necessary ones.

Incoming lines from Land Line (Telephone) and ISP (Internet) shall be received and integrated at the OCC and distributed to each station via the Backbone System.

4) Closed Circuit Television System (CCTV)

The Contractor shall provide a CCTV System for the monitoring and surveillance of the trains, stations, and Depots configured by controller, recorder, and various cameras for safety and security. The power for Fixed and PTZ (Pan, Tilt, Zoom) cameras shall be supplied via UTP with PoE without additional power. The cameras shall be made available in strategic locations in OCC, Depots, and Stations.

5) Passenger Information Display System (PIDS)

The Contractor shall provide a Passenger Information System for train operation status notification for the convenience of passengers. The PIDS shall be placed at strategic locations in each station.

The PIDS shall be a LED Display connecting to work stations, control units, and display boards through the network system. For train status notifications, operation information shall be updated by Automatic Train Supervision (ATS) and the time information shall be obtained from the time server.

6) Public Address System (PA)

The Contractor shall provide a Public Address System for train operation status, precaution against train approaching, and accidental information announcement from OCC and each station for the safety and convenience of passengers.

The PA system shall consist of amplifiers, line selectors, speakers, and microphones strategically placed within the stations. Speech generating devices shall be used for prerecorded messages as needed.

7) Time Server and Master Clock System

The Contractor shall provide a Time Server and Master Clock System for accurate time synchronization to relevant sub-systems, the clock system, and also through GPS at the OCC.

The Master Clock system receives the time signal from the server system and displays it on the slave clocks via the sub-master clock in each station building. The power to the slave clocks is supplied via UTP with PoE without additional power.

8) Meteorological and Seismic Monitoring System

The Contractor shall provide a Meteorological and Seismic Monitoring System for the prevention of possible damage occurring from natural disasters that may affect the railway facilities and safety of passengers.

The system shall provide the disaster prediction information from respective sensors mounted at the OCC and station for the protection of facilities and safety of personnel.

The natural disaster shall be predicted by information from the sensor of Rain Gauge, Seismograph, and Water Level. The information shall be sent to the OCC on the IP network for support of train operations.

9) Power Supply for Telecommunications System

The Contractor shall provide Power Supply and Distribution to the Telecommunications System through exclusive UPS. The cables from the UPS to the equipment and devices in OCC, stations, and along the viaduct shall be included in the Telecommunications System scope of work.

Related grounding works to the common grounding plates provided by the power supply system shall also be included in this scope work.

10) Flight Information Display System (FIDS)

The Contractor shall provide a Flight Information Display System in all stations displaying the flight arrival and departure information of Clark International Airport (CIA).

The Flight Information Display System (FIDS) is a computer system to display flight information to passengers, in which a computer system controls electronic display boards or TV screens to display arriving and departing flight information in real-time.

3.3 Definitions and Abbreviations

3.3.1. Definitions

The Definitions used in this section are listed below.

Availability	The probability that an item will be in a state to perform a required function under given conditions, at a given instant in time or over a time interval, assuming that given external resources are provided.
Backbone	The multilevel distributed network, providing communication services for the rest of the network
Console	An MMI device with a video display, keyboard, mouse, and switch panel for train dispatchers /System operators in OCC and station controllers.
System	The telecommunication equipment and systems.
Sub-system	A part of the telecommunication systems.
Supervise	To check the various condition and keeping normal condition Address Resolution Protocol

3.3.2. Abbreviations

The Abbreviations used in this section are listed below.

AC	Alternating Current
AC/DC	Alternating Current/Direct Current
ADM	Add Drop Multiplexer
AFC	Automatic Fare Collection
ANSI	American National Standards Institute
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
ATC	Automatic Train Control
ATS	Automatic Train Supervision
BASE-T	IEEE 802.3 Standard for Ethernet Local Area Network
BER	Bit Error Rate
BIM	Base Interface Module
BMP	Bitmap
BMS	Building Management System
BTS	Backbone Transmission System
B/W	Black and White
CAD	Computer-Aided Design
Cat5e	Twisted Pair Cable used for Computer Networks
CCD	Charged-Coupled Device

CCS	Control Command & Signaling
CCTV	Closed Circuit Television
Cd/sqm	Unit of Luminous Intensity
CD	Compact Disk
CER	Communication Equipment Room
Ch	Channel
C/I	Channel Interference
CIF	Common Intermediate Format
CISPR	Comité International Spécial des Perturbations Radioélectriques
CMMS	Computerized Maintenance Management System
CMSS	CCTV Management System Software
CNR	Channel to Noise Ratio
COTS	Commercial Off-the-Shelf
CPU	Central Processing Unit
CSS	Communications System Supervisor
CTF	Cable Termination Frame
DANS	Dynamic Ambient Noise Sensors
DAS	Distributed Antenna System
DC	Direct Current
dB	Decibel
dBμV/m	Measurement of Radio field intensity

DHCP	Dynamic Host Configuration Protocol
DLT	Direct Line Telephone
DMO	Direct Mode Operation
DNP	Defect Notification Period
DTN	Delay Tolerant Network
DTS	Data Transmission System
DTMF	Dual Tone Multi-Frequency
DVAS	Digital Voice Announcement System
DVD	Digital Video Disk
DVI	Digital Visual Interface
DVRS	Digital Voice Recording System
E2E	End to End
EHS	Event Handling System
EIA	Electronic Industries Alliance
EMC	Electro-Magnetic Compatibility
EMI	Electro-Magnetic Interference
E&M	Electrical & Mechanical
EPS	Electrical Pipe Shaft
ETSI	European Telecommunication Standards Institute
FAT	Factory Acceptance Test
FC	Ferrule Connector

FEXT	Far End Cross Talk
FO	Fiber Optic
FOC	Fiber Optic Communication
Fps	Frame per Second
FRMCS	Future Rail Mobile Communication System
FRU	Field Replaceable Unit
Gal	Unit of Ground Acceleration (Seismic)
GE	Gigabit Ethernet
GHz	Gigahertz
GOP	Group of Pictures (I or P Frame)
GoS	Grade of Service
GPS	Global Positioning System
GSM-R	Global Systems for Mobile communication for Railways
GUI	Graphical User Interface
HCS	Hundred Call Second
HDD	Hard Disk Drive
HDMI	High Definition Multimedia Interface
HMI	Human Machine Interface
HTTP	HyperText Transfer Protocol
H.264	Video Compression Format
HV	High Voltage

H x V	Horizontal / Vertical (CCTV)
Hz	Hertz
ICMP	Internet Control Message Protocol
IGMP V2	Internet Group Management Protocol, version 2
ID	Identification
IEC	International Electro-Technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IPxx	Ingress Protection (xx indicate a level of protection)
IPX/SPX	Internetwork Packet Exchange / Sequenced Packet Exchange
ISI	Inter System Interface
ISO	International Standards Organization
ISP	Internet Service Provider
ITU-R	International Telecommunication Union – Radio Communication Standardization Sector
ITU-T	International Telecommunication Union-Telecommunication Standardization Sector
JPEG	Joint Photographic Expert Group
kHz	Kilohertz
km/h	Kilometers per hour
kbps	Kilobits per Second

kVA	Kilo Volt Ampere
L2	Layer 2 switch
L3	Layer 3 switch
LAN	Local Area Network
LCD	Liquid Crystal Display
LCX	Leaky Coaxial Cable
LED	Light Emitting Diode
<	Less Than
LSOH	Low Smoke Zero Halogen (LSZH or LSFH)
Mbps	Megabits Per Second
MDF	Main Distribution Frame
MHz	MegaHertz
MIL-HBK	Military Handbook
MM	Multi-mode
mm	Millimeter
mm/h	Millimeters per Hour
MPEG-4	Moving Picture Experts Group (Audio/Video Data Compression)
MPLS-TP	Multi-Protocol Label Switching – Transport Profile
ms	Millisecond
m/s	Meters per Second
MSN	Multi Services Network

MTBF	Mean Time Between Failures
MTTR	Mean Time to Repair
NAS	Network Attached Storage
NEMA	National Electrical Manufacturers Association
NEXT	Near End Cross Talk
NMS	Network Management System
NSCR	North-South Commuter Rail
NTC	National Telecommunications Commission
NTP	Network Time Protocol
NVMS	Network Video Management System
NVRS	Network Video Recording System
OAM&P	Operational, Administration, Maintenance, and Provisioning
OCC	Operations Control Center
ODF	Optical Distribution Frame
OFC	Optical Fiber Cable
OSI	Open System of Interconnection
PA	Public Address
PAGASA	Philippine Atmospheric, Geophysical, and Astronomical Services
PAS	Public Address System
PBX	Private Branch Exchange
PDG	Packet Data Gateway

PEC	Philippines Electrical Code/ Philippine Electronics Code
PEI	Peripheral Equipment Interface
PIDS	Passenger Information Display System
PLMN	Public Land Mobile Networks
PMR	Portable Mobile Ratio
PNFC	Philippine National Fire Code
PoE	Power-Over-Ethernet
PSNEXT	Power Sum Near End Cross Talk
PSTN	Public Switched Telephone Network
PTE	Public Telecommunications Entity
PTT	Press-to-Talk
PTZ	Pan-Tilt-Zoom
QoS	Quality of Service
RAID	Redundant Array of Independent Disks
RAMS	Reliability, Availability, Maintainability, and Safety
RASTI	Room Acoustic Speech Transmission Index
RAU	Radio Access Unit
RCH	Radio Control Head
RCW	Radio Control Workstation
RCP	Radio Control Panel
RIN	Radio Identity Number

RF	Radio Frequency
RS	Rolling Stock
RS	Recommended Standard
RSSI	Radio Signal Strength Indication
RSTP	Rapid Spanning Tree Protocol
RTC	Real-Time Clock
RTM	Radio Transmission Module
RTP	Real Time-Transport Protocol
RTU	Remote Terminal Unit
SBT	Solis -Blumentritt -Tutuban
SCADA	Supervisory Control and Data Acquisition
SCR	Station Control Room
SDRAM	Synchronous Dynamic Random-Access Memory
SDS	Short Data Service
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SM	Single Mode
SNMP	Simple Network Management Protocol
SPL	Sound Pressure Level
SPD	Surge Protection Device
STI	Speech Transmission Index

STP	Spanning Tree Protocol
TCP	Transmission Control Protocol
TID	Train Identity Number
TSI	Technical Specification for Interoperability
TFT	Thin Film Transistor
TMN	Telecommunication Management Network
TMO	Trunk Mode Operation
TMS	Train Management System
TOCP	Train Operator Control Panel
TRCP	Train Radio Control Panel
TRIU	Train Radio Interfacing Unit
TSS	Traction Substation
TX	Transmission
TX/RX	Transmission/Receiver
UIC	Union International des Chemins de fer (International Union for Railways)
UPS	Uninterruptible Power Supply
USB	Universal Serial Bus
UTC	Universal Time Co-ordinated
UTM	Unified Threat Manager
UTP	Unshielded Twisted Pair
Vpp	Voltage peak to peak

VGA	Video Graphics Array
VLAN	Virtual Local Area Network
VoIP	Voice Over Internet Protocol
VSS	Virtual Switching System
WAN	Wide Area Network
WIMP	Windows, Icons, Menus, Pointer

3.4 Design Standards

The Telecommunications System shall be designed, manufactured, installed, and tested in compliance with the following relevant standards, codes, local regulations, and environmental conditions.

3.4.1 List of Standards

- DOTr Order- Department of Transportation, Philippines; Employer
- Public Telecommunication Policy Act (NTC)
- ANSI: American National Standards Institute
- CISPR: Comité International Spécial des perturbations Radioélectriques
- DIX: Dec, Intel, Xerox
- EIA: Electronic Industries Alliance
- IEC: International Electrical Commission
- IEEE: Institute of Electrical and Electronics Engineers
- IETF: Internet Engineering Task Force
- ISO: International Organization for Standardization
- ITU-T: International Telecommunications Union Telecommunication Standardization Sector
- ITU-R: International Telecommunications Union Radiocommunication Sector
- JIS: Japanese Industrial Standard
- RFC: Request For Comments

Table 3.4.1 Standard and Details

Standard	Series	Details
ANSI/IEEE	802	IEEE Standard for Information Technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements; Power over Ethernet
IEEE	802.3	Ethernet Network Standard
CISPR	22	Information Technology Equipment – Radio disturbance characteristics – Limits and methods of measurement
DIX		The ethernet standard used for TCP / IP, etc.
EIA	568B	Specification of twist pair cable for LAN
	222-H	Structural Standard for Antenna Supporting Structures
ISO	3864	Graphic symbols – Safety colors and safety signs
	11801	Information technology – Generic cabling for customer premises
	9921	Ergonomics – Assessment of speech communication
	14496	Information technology – Coding of Audio-visual objects
ISO/IEC	144156	Information technology – Coding of Audio-visual objects
	27001:2013	Information technology - Security techniques- Information Security Management Systems - Requirements
	60146	General requirements and line commutated converters
	60331	Fire-resistant test
	60332	Test on electric and optical fiber cables under fire conditions
	60364	Low Voltage Electrical Installations
	60529	Degrees of protection provided by an enclosure
	605215	Tests device to verify protection against spraying and splashing water
	60571	Railway applications – Electronic equipment used on rail vehicles

Standard	Series	Details
IEC	60721	Railway applications – Electronic equipment used on rail vehicles
	60754	Test on gases evolved during combustion of materials from cables
	60794	Optical fiber cable
	60849	Sounds systems for emergency purposes
	62040	Uninterruptible power systems (UPS)
	62236	EMC Directive- Railway applications - Electromagnetic compatibility
	62278	Railway Applications Specifications and Demonstration RAMS
	62305	Protection against lightning
NFPA	Article 70, 130	National Fire Protection Association
IEEE	802	Standard about local area network among the IEEE standards
	802.11ac	IEEE Standard for Information technology--Telecommunications and information exchange between systems—Local and metropolitan area networks--Specific requirements--Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications--Amendment 4: Enhancements for Very High Throughput for Operation in Bands below 6 GHz.
ITU-T	G series	Transmission system and media, digital systems and networks
	H.264	Advanced video coding for generic audio-visual services
	I series	Integrated services digital network
	K series	Protection against interference
	Q series	Switching and signaling, and associated measurements and tests
	V series	Data communication over the telephone network
	P series	Telephone transmission quality, telephone installations, local line networks
	X series	Data networks, open system communications, and security

Standard	Series	Details
ITU-R	General	International Principle of Radio Frequency Allocation, Elimination of Radio Interference
JIS	General	Japanese Industrial Standard
RFC	1065	Structure and Identification of Management Information for TCP/IP-based internets
	1157, 3411-3418	Simple Network Management Protocol (SNMP)
	1213	Management Information Base for Network Management of TCP/IP-based internets: MIB-II
	1305/5905	Network Time Protocol (Version 3/ Version 4)
	2328	OSPF Version 2
EIRENE	UIC 950	Functional Requirements Specification v8.0.0, 21 December 2015 or later version
	UIC 951	System Requirements Specification v16.0.0, 21 December 2015 or later version
UNISIG	SUBSET 093	Quality Service Requirements
	SUBSET 126 (Not yet ratified)	ATO-OB/ATO TS FFFIS Application Layer

3.4.2 Environmental Condition

The Communications System shall be able to withstand at a minimum the environmental conditions stipulated below:

1)	Conditions for interior/indoor Equipment	
	a) Temperature Range (open Area):	0 to 40°C
	b) Equipment Room and Control Room:	25 to 30°C
	c) Relative Humidity:	Maximum 90%
2)	Conditions for exterior/outdoor Equipment	

	a) Temperature Range:	0 to 45°C
	b) Relative Humidity:	Maximum 90%
	c) Solar radiation (heat-up and aging/deterioration)	1120 Watt/sqm
3)	Train-borne equipment	
	a) Temperature Range:	0 to 60°C
	b) Relative Humidity:	Maximum 90%
4)	Altitude:	100m or lower
5)	Reference Wind Velocity:	40m/sec
6)	Lightning Area:	Severe Lightning Area
7)	Salt Damage District:	Around 10 km from the coastline

3.5 General Design Requirements

3.5.1 General

The Contractor shall ensure the design of Telecommunication systems will include the following, but not limited to:

- Safety, reliability, and durability shall be secured under given circumstances by adopting proper protection schemes and reasonable equipment and materials.
- Redundancy of the system shall be secured by adopting duplicated and stacked equipment and materials with hot standby applying LA, STP, and VSS protocol/systems.
- A total of initial and running costs shall be minimized by using high-quality equipment and material and applying high-efficiency engineering. Consideration shall be focused on energy saving.
- Considerations to simplify the maintenance and monitoring work by applying new network technology.
- EMC specified in IEC standards or equivalent shall be met to secure satisfactory electromagnetic compatibility in the given circumferential environment.
- RAMS specified in IEC standards or equivalent shall be applied to secure the safety and reliability of the system.
- Temperature control of equipment room, temperature monitoring and ventilation for equipment housing shall be implemented to reduce heat radiation of the equipment and
- devices. (Temperature control of the equipment room is the responsibility of the Civil Contractors. Ventilation and temperature monitoring of equipment housing shall be the responsibility of the Contractor.)

- The Telecommunications shall be designed for continuous operation for over 10 years. The service life of the cables shall be over 20 years.
- Frame grounding for housings of the equipment and shield grounding for the cables shall be with an equipotential grounding system.
- The equipment shall be protected from rust and corrosion caused by the local environment.

3.5.2 Equipment

The Equipment shall be designed and will include the following, but not limited to:

- The time reference to synchronize among the sub-systems shall be acquired from GPS.
- The equipment configuration here shall be installed on the 19 inch-rack in the equipment room.
- Countermeasures against possible overturning shall be applied to the 19 inch-rack.
- The major equipment shall be assembled with components for easy replacement of them for corrective maintenance.
- A Temperature monitoring system for the equipment configured shall be implemented. Equipment.
- Anti-rodent and anti-pest measures should be considered on cable ducts of the equipment room.

3.5.3 Antennas

The Antennas and its system shall be designed, provisioned and will include the following, but not limited to:

- The Antenna type shall be based on the selected location. Diversity type shall be applied as a standard.
- LCX shall be installed with a clamp on the inner wall of the tunnel and the necessary terminator shall be attached at the end of them.
- Measures shall be taken against lightning and other weather conditions.

3.5.4 Other Equipment and Devices

The other Equipment and Devices shall be designed, provisioned and will include the following, but not limited to:

- The communication wirings for passenger services and facilities as the building equipment shall throughout be applied with an IP network.
- Power supply to the terminal devices in the Telecommunications system shall be made from PoE switches (HUB).
- Power supply to the whole telecommunication equipment shall be made via UPS.
- The equipotential grounding shall be applied with the equipotential system.

3.5.5 Software

The Contractor shall supply all the software copies used in this contract, and submit two (2) copies 14 days before the commencement of the actual operation to possess by the Employer; All and any software that had been been produced or modified.

The software copies shall include the following.

- All source code, all execution code, and all database configurations
- The documents related to all the software
- Software development tool for maintenance etc.

3.5.6 Information/System Security (Cyber-Security/ UTM)

The contractor shall take the following measures to secure the security of the system. Security is protecting data from being tampered with or being deleted by unauthorized access from the outside and to protect secrecy. When networks are connected, it is necessary to take measures to prevent malicious unauthorized access.

Specific countermeasures include setting up UTM (Unified Threat Management) etc. A Unified Threat Management (UTM) system will be the approach to information security where a single hardware or software installation provides multiple security functions. UTM simplifies information-security management by providing a single management and reporting point for the security administrator rather than managing multiple products from different vendors. This contrasts with the traditional method of having point solutions for each security function.

The UTM at the minimum should have some converged security features like:

- Network firewall
- Intrusion detection
- Intrusion prevention

Furthermore, Security means that the data handled by the information system is not illegally altered, and the normality of the data is maintained. It is necessary to prevent both falsifications of data with internal malicious intent and illegal data due to error. Specific countermeasures are to set and change passwords, fingerprint authentication, etc.

The Telecommunications installed in the NSRP-South line should take security measures. An input device such as a console, workstation, etc. must be able to set a password and the like.

The Information/Security system shall comply with ISO/IEC 270001: 2013- Requirements for Information technology/ Security techniques for Information Security Management systems.

3.6 System Requirements

3.6.1 General

The detailed System requirements for the Ten (10) Telecommunications Subsystems are detailed in the following Appendices.

- Appendix 1 - Backbone Transmission System (BTS)
- Appendix 2 - Radio System
- Appendix 3 - Voice and Data System

- Appendix 4 - CCTV System
- Appendix 5 - Passenger Information Display System (PIDS)
- Appendix 6 - Public Address System (PA)
- Appendix 7 - Time Server and Master Clock System
- Appendix 8 - Meteorological and Seismic Monitoring System
- Appendix 9 - Power Supply System for Communication Equipment and Devices
- Appendix 10 - Flight Information Display System (FIDS)

3.6.2 Communications System Supervisor (CSS)

The Contractor shall design, install, test, and commission a CSS system for smooth operation, monitoring, control, and logging of important features of the systems. The CSS shall provide relevant data/information for implementing the Condition-based maintenance based on the degradation of normal operating parameters. Also, fault and failure warnings and alarms shall be monitored to provide the OCC staff with information about the capacity of these systems to cope with the traffic being carried.

Besides, fault warnings and alarms shall be monitored to provide the OCC staff with information about the capacity of these systems to cope with the traffic being carried.

Certain equipment is to be monitored at the field locations whereas some systems have a network management facility that can be used to present the necessary aggregate data at a common interface within the OCC equipment room complex.

The Communication Sub-systems shall be monitored and managed through the BTS or dedicated Management System. Nevertheless, relevant alarms and status information shall be sent to the CSS for overall system monitoring.

The Communications System supervisor system at OCC shall have provisions to monitor the communication equipment and the Network Management System as a whole.

The CSS shall be equipped with mass ports and spare ports for future additional requirements.

The CSS system shall incorporate at least the following primary functions:

1) Provide continuous, effective recording of data;
2) Provide continuous, effective monitoring at OCC of all communication equipment's distributed throughout the system;
3) Provide download of logged data on demand (maybe set up as regular automatic polling);
4) Provide facilities to analyze downloaded data on a historical basis and against fixed norms;
5) Alert operations and maintenance staff rapidly to equipment malfunctions, especially those likely to cause disrupted to the operation of the Railway, and provide a facility for acknowledging the alarm;

   a) <u>Event Records</u>

   The CSS System shall record any events caused by faults, malfunctions, warnings, or alarm information generated automatically by the connected communication equipment.

b) Alarms

Audible alarms shall be provided to alert the operations personnel to alarms requiring immediate action or attention. The audible alarms shall be audible against ambient noise levels.

There shall be three categories of audible alarms easily distinguishable by separate tones or sounds for events classified such as Notification, Warning, and Alarm.

It shall be possible to acknowledge alarms individually or in groups from the alarm display page.

A mute facility shall be provided to reduce, but not silence, the level of volume of the initiated alarm for emergency events after the alarm has been acknowledged.

Silencing of urgent and non-urgent alarms shall occur on alarm acknowledgment.

When the status of an alarm returns to normal condition, a return-to-normal message to this effect shall be generated.

All audible alarms shall be accompanied by a corresponding text message, providing details of the alarm.

When an alarm is initially received a corresponding visual-flashing indicator shall appear on the display. Once the alarm has been acknowledged the flashing indicator shall transfer to a permanent illumination.

In the event of multiple events initiating audible alarms, only one alarm shall be broadcast at any time. The highest category of alarm shall always take priority, even if a lower priority alarm is already being broadcast. Once the higher category has been acknowledged and muted, the next lowest category of alarm shall initiate the alarm broadcast.

To avoid unnecessary and nuisance alarms or alarms generated by testing a facility shall be provided to enable alarm blocking/filtering to inhibit particular or global alarms from any display. Inhibited alarms shall activate an appropriate message, detailing the non-alarmed parameters and the remote terminal units affected.

3.6.3 Data Transmission Lines for the other Railway Systems Facilities

Data transmission lines for the other facility of BMS, Power SCADA, Railway Signal, AFC, and CMMS shall be provided with using VLAN and/or independent shared cores on the Backbone System.

The installation demarcation between the Telecommunications system and the other respective railway facility, e.g., Signaling System, Automatic Fare Collection System, etc, shall be set up at the L2 and/or L3 switches in the OCC, CER, or station CERs. For distance ranging equal or more than 60 meters between the CER and Railway facilities which would need to connect to the L3 Switches of the Backbone system, the Telecommunication systems shall provide connection switches necessary to facilitate Backbone Network connections in Railways facilities rooms, location of switches shall be subject to the approval of the Engineer. Down streams after the points shall be the scope of each relevant railway facility.

The quantity and location of the digital and analog monitoring and operation points shall follow the requirement of each discipline. All the signals of the above shall be converted to the IP protocol by each discipline.

Below is the Summary of Scope:

1) Common

- Applied facility: BMS, Power-SCADA, AFC, and Railway Signal
- Line: on Backbone (VLAN) for BMS on separate Cores for Power SCADA, AFC, and Railway Signal
- Installation Division: L2/L3 Switches in CER
- Original Data: Analogue and/or Digital
- Transmission Data: Converted to IP Protocol
- Numbers of Point: provided by each facility

2) AFC System

The scope of works for cable laying and cable containment particularly for AFC systems shall include the following but not limited to:

- The Contractor shall install the power cable and communication cable to the AFC equipment.
- Cables shall be installed in locations that pose no danger to passengers and station staff.
- The communication cable shall be installed so that the influence of noise from the power cable is minimized as much as possible.
- Access point shall be installed in the customer service room, AFC rooms, the waiting room, and on the platform for the ticket counter terminals and the mobile terminals.
- The Contractor shall install L2 and/or L3 switches within the station box if the distance between station CERs and station box exceeds 60 meters.

3.6.4 Cable Systems for Communications

All cables installed on any part of the viaducts, buildings, and stations shall be following the Philippine Electrical Code (PEC 2017 Edition) and Philippine Electronics Code. Where such codes do not comprehensively encompass all requirements, appropriate international standards shall be used.

The cable materials shall be of fire-retardant materials as specified in IEC 60332 or an equivalent standard. Where cables are used in confined spaces the insulation and sheath shall be constructed with Low Smoke Zero Halogen (LS0H, LSZH, LSFH, or LSØH) materials. Testing for halogen-free properties shall be following IEC 60754-1 and 60754-2 or an acceptable equivalent.

All cables and their construction inclusive of any testing certification shall be subject to approval by the Engineer.

All outdoor cables shall be armored and should the cables require screening, the braid shall not be less than 80%.

All cables, wires, cable accessories, termination racks, and other materials shall comply with the Philippines Electrical Code (PEC 2017 Edition) and shall be subject to approval by the Engineer. The Contractor shall supply detailed information and appropriate specifications for all cables, wires, cable accessories, termination racks, and any other materials they propose to use.

All cables shall be resistant to corrosion, vermin, and insect attack. The cables shall be suitable in all respects for continuous operation in the prevailing environmental conditions encountered within the area of use.

Where cables cross the track or other ballasted areas they shall be suitably protected in pipes, conduits, or ducts. The Contractor shall submit their proposed method of cable protection subject to Approval by the Engineer.

If multi-core cables are to be used they shall have an identifiable system of distinguishing individual cores and shall make an allowance of 20% or two (2) cores whichever is greater, for spare purposes. The Contractor shall provide detailed information on the core identification system to be used.

Data transmission cables for connecting to wayside equipment may be either copper or fiber-optic. The Contractor shall submit their selection for Approval by the Engineer. The data transmission system shall be independent of the communications or other transmission systems.

An approved method of identifying manufacture and cable type shall be provided throughout the length of all cables and wires.

The Telecommunications cables used are:

1) Optical Fiber Cable

- The optical fiber cable is mainly used to construct the Backbone system.
- Optical fiber cable conforming to ITU-T G.652B or ITU-T G653A is used as an optical fiber cable.
- The optical fiber cable shall be laid in the trough, duct, etc. so that a ring structure can be formed.
- The optical fiber cable is capable of long-distance transmission between OCC, each station, and Depots, and it is capable of large-capacity communication of up to 10 Gbps.
- The attenuation coefficient of the optical fiber cable shall be 0.5 dB / Km or less at a wavelength of 1310 nm or 1550nm.
- For optical fiber cable, use flame retardant cable and use halogen-free cable.
- In principle, the tension members of the optical fiber cable shall be non-metallic.
- The allowable bending range of the optical fiber cable shall be as follows.
- When laying optical fiber cable: 20 times or more the cable outer diameter
- When fixing the optical fiber cable: 10 times or more the cable outer diameter
- Insertion loss due to fusion splicing shall be 0.2 dB or less.
- The sheath of the optical fiber cable shall use a stainless laminate or a corrugated steel tube to prevent damage from rats.

2) Copper Cable

- UTP/STP cable
- It is a cable made by twisted pair electric wires defined by IEEE 802.3, and it is used for telephone lines and Ethernet, etc.

- The Shielded Twist Pair cable is available in the case that it passes the route where noise measure is necessary to be taken.
- Power cable
- 600V insulation cable of 2 cores
- Grounding conductor
- 600V insulation cable of 1 core
- Heat-resistant, fireproof cable

This cable has a heat-resistant and fireproof performance which is based on NFPA (National Fire Protection Association) standard. This cable is used for speaker cable of the Public Address (PA) system.

- Countermeasure against rats

To protect cables from damage caused by rats, appropriate protection shall be carried out as much as possible. Alternatively, a rat-proof cable shall be used.

3.7 Performance Requirements (General)

3.7.1 RAM Performance

The performance requirements (Reliability, Availability, Maintainability) specified in the ERG and this ERT shall be achieved for the Telecommunications system.

The system shall meet or exceed the requirements of CENELEC Standards EN50126, EN50128, and EN50129 or any other equivalent for RAMS standards and the requirements specified in Section 20 of ERG.

The reliability and maintainability processes and procedures shall be planned, integrated, and developed in conjunction with the operating environment, and the design, development, and production functions to permit the most effective and economic achievements of the systems and equipment design objective.

1) Reliability

The Contractor shall state the reliability figures of all LRU's whose failure would have a significant impact on the system;

The Contractor shall develop a failure mode and analysis inclusive of an assessment in order to determine which Reliability requirements are applicable for all LRU's.

To improve the reliability, optimizing the design of the hardware and software is shall be considered. It is important not to lose the function of the entire system even if a failure occurs. The contractor shall carry out system design based on the concept of fault tolerance as a method of realizing this.

2) Availability

The Contractor shall be responsible for providing a System design, maintenance procedures, and defining the recommended spares to ensure that the Availability requirements of the Telecommunication System shall be achieved.

The availability of the Telecommunications system installation MCRP and NSRP lines shall be 99.95% or more.

A single point failure shall not cause the failure of the overall system.

3) Maintainability

The System shall be designed to maximize availability during traffic hours, to minimize the amount of maintenance required to maintain the System, and to ensure that any maintenance can be performed with the minimum amount of time, the minimum amount of skill, and at a minimum cost.

To effectively carry out maintenance and improve maintainability, design for maintenance policy, and maintenance personnel becomes important.

a) Design for maintenance

The contractor shall design the system to facilitate fault detection function and fault diagnosis and repair.

b) Maintenance Policy

The contractor shall supply materials for maintenance, maintain and standardize manuals for maintenance, and maintain tools for maintenance.

c) Maintenance personnel

The contractor shall provide education and training to improve the skills of maintenance engineers.

The MTTR of the MCRP and NSRP lines shall not exceed 4 hours.

The required MTTR shall be achieved for failures of the whole System or any part of the System, whether service affecting or not.

3.7.2 Configuration of Maintenance

The contractor shall clarify the maintenance of the system and propose to improve the productivity and economy of maintenance. The configuration of maintenance is classified in Corrective Maintenance (CM) and Preventive Maintenance (PM). To implement the Maintenance of the system, Maintenance items for CM and PM need to be clarified. By combining CM and PM in a well-balanced manner, it is important to aim at Maintenance which allows raising productivity and economy. CM means preservation to be done after trouble occurred. Change of failure part, repair, and changeover to spare parts, etc. are implemented. PM means Maintenance to be done systematically to prevent troubles during the use of the system and to keep the system in a state of availability.

3.8 Packing, Shipping, and Delivery

Refer to Employer's Requirements – General Requirement (ERG) for the requirements for Packing, Shipping, and Delivery.

3.9 Testing, Commissioning, and Verification

3.9.1 General

The Contractor shall develop and submit to the Engineer for Approval a detailed Test Plan of the tests and procedure proposed.

The Contractor shall ensure the system is in a state ready for testing and commissioning before the commencement of the tests to be witnessed by the Engineer. The Contractor may conduct trial tests by himself before the Engineer witnesses the tests.

The Contractor shall provide all necessary equipment and test instruments, special tools, emulators, simulators, and test software, to carry out the test at his.

Unless otherwise stipulated herein, the Contractor shall carry out all the tests and commissioning activities following the Employer's Requirements.

The Contractor must bear the cost of all necessary tests. As for the cost of the test which is carried out outside the Philippines, the Contractor must bear the expenses.

All the test plans and procedures with the exact time and date shall be submitted for the approval of the Engineer at least 30 days before any test conduction.

The testing and commissioning shall, as a minimum, include the following items:

1) Factory Acceptance Tests (FAT)

- The Contractor shall carry out the FAT at the premise of designated manufactures.
- The test shall include, but shall not be limited to visual, environmental, electrical, and functional tests on each item of equipment and the associated sub-systems as well as simulation, before delivering them to the site,
- The testing shall be conducted such as to simulate the working conditions as closely as possible.
- Destruction tests shall be carried on components and assemblies to verify the design loading.
- All the tests shall be conducted both on the assembly and on the members/components of each product following the test plan and the applicable standards give a Notice of No Objection by the Engineer.

2) Installation Tests

- The Contractor shall carry out the installation tests for the Telecommunication sub-systems individually in each site on completion of the physical equipment installation including electrical connections.
- Before the installation Tests, visual inspection and operational tests on un-energized equipment shall be carried out to check items including but not limited to:
    a. Workmanship and Cleanliness,
    b. Confirmation of items confirming to rating specified,
    c. Water and dust proofing,
    d. Leveling, Mounting, and Positioning,
    e. Joints and Connections tightness,
    f. Cable-dressing, bending radius, jointing and finish at terminals,
    g. Clearances and dimensions in conformity with the Drawings,
    h. Earthing and Bonding,
    i. Functioning of circuit breakers,
    j. Protection devices.
- The Contractor shall ensure that the equipment has been installed following the Employer's Requirements.

a. The test procedure shall be submitted to the Engineer at least one (1) month before the commencement of each installation test.

b. The Contractor shall measure all cores of the metallic cables and optical fiber cables, including all spare cores.

- All the installation test reports with the information and conclusion on the test result, including serial numbers and the date of manufacturing, shall be submitted to the Engineer for approval.
- Each case, crate, or package shall be waterproof, rot-proof, and insect/rodent-proof, of robust construction and suitable for the intended purpose. The Contractor shall, in determining the packing materials to be used, take cognizance of the climatic conditions likely to occur during the period of transport, shipment, and storage.

3) Partial Acceptance Tests

- Partial Acceptance Test shall be carried out on individual sub-systems at each location, on an area of section – basis to verify the functions, performance, and services after successful completion of the installation Tests.
- The Contractor shall submit a comprehensive Partial Acceptance Tests Plan including a procedure to the Engineer for approval.
- The Partial Acceptance Tests procedure shall include, but shall not be limited to:

a. Objectives of the Partial Acceptance Tests for all Sub-systems,

b. List of specifications and standards reviewed design documentation for reference.

c. Step-by-step test instructions.,

d. Confirmation of items confirming to rating specified,

e. List of the test instrument and special tools,

f. Test record forms,

g. Pass or fail criteria, Joints, and Connections tightness.

- Where performance across interfaces with interfacing contractors or to other interfacing Parties is required to be verified during the Partial Acceptance Tests, the Contractor shall submit a list of such parties and the interface test procedures agreed with the relevant party on Partial Acceptance Tests procedure for the involved Sub-systems.
- The Contractor shall verify that system sub-system performance is based on the Employer's Requirements and the relevant standards are given a Notice of No Objection by the Engineer.
- Wherever applicable, the Contractor shall have local loop backtests on circuits to verify the electrical performance measurements such as error rates and signal levels.
- All equipment setting s and parameters shall be verified, including all local alarms, control, and monitoring functions.
- Coverage tests shall be carried out on service/zone for the CCTV, PAS, and Radio system.
- The Cameras performances such as pan, tilt, and zoom, shall be measured individually, conforming to the specifications given a Notice of No Objection by the Engineer.

- The Contractor shall perform functional checks and signal strength measurements on the radio system for each channel at spots given a Notice of No Objection by the Engineer to verify the radio signal coverage requirements given in this Specification and shall cover, but not limited to, station concourses such as ticket machine area, EV and ESC area, etc., Station platforms and water level indications locations.
- The Partial Acceptance Tests shall be considered completed only when the results have been given a Notice of No Objection by the Engineer.
- Individual Sub-systems shall be operational and ready to be connected to other sub-systems and interfacing systems for testing after the Partial Acceptance Tests have been completed.

4) System Acceptance Tests

- System Acceptance Tests shall be carried out on a sub-system basis after the Partial Acceptance Test has been completed; to achieve the Employer's Taking–Over Certificate of the Works.
- The Contractor shall submit a comprehensive System Acceptance Test Plan including test procedures to the Engineer for Approval, ensuring that the functional and the electrical performances are satisfied.
- The Contractor shall execute load tests both on the normal operation and the emergency status following the designed capacity and the performance to the Employer's Requirements, including the test for checking the function of an alarm system and protection mechanism.
- After the completion of the System Acceptance Tests, the System shall start operation under the functional and electrical performance requirements given a Notice of No Objection by the Engineer.

5) System Integrated Testing and Commissioning

- System Integrated Tests shall be carried out after the completion of the System Acceptance Tests, to prove that the System and the software thereof meet the requirements in terms of the functionality and performance required under the Contract.
- System Integrated Tests shall include but shall not be limited to the following categories,

  a. Integrated Tests with other contractors

  Integrated Tests shall ensure that all the interfaces with the Works of other Contractors shall satisfy the functional and performance requirements.

  b. Total System Integration Tests

  Having completed the Integration Tests with the respective contractors individually, Total System shall be performed to demonstrate that all system module coordinates their functions are satisfied. No clash, crash, or abnormality shall result from having various combinations of possible operations being carried out simultaneously.

- The scope of the Integrated Tests shall include but shall not be limited to;

  a. Test of all functional and performance requirements, including full functional software testing,

  b. Tests of all communications between data transmission equipment,

  c. Tests of visual performance and functions via data transmission equipment,

d. Tests to demonstrate compliance with all the interface requirements,

e. Tests of operational performance under failure conditions

On satisfactory completion of the integrated Testing & Commissioning the tested items will be considered available for Trial Operation.

6) Reliability Demonstration Tests

a. The Contractor shall submit a Reliability Demonstration Test Plan to the Engineer for Approval at least three months before the test.

b. The Contractor shall advise the Engineer in writing the commencement date of Reliability Demonstration Tests.

c. The Contractor shall commence the Reliability Demonstration Tests following the approved Test Plan after the test result of all interface test activities has been given a Notice of No Objection by the Engineer.

d. If the reliability demonstration test fails, the Contractor shall provide all the necessary corrective activities and rectify the fault to the satisfaction of the Engineer.

3.9.2 Test Runs /Trial Operation

The Contractor shall provide special and general attendance during the Test Running and Trial Operations such that persons who conducted the System Integration (On-Site) Testing and Commissioning are available on the Site to solve any problem arising.

3.9.3 Contractors Responsibility for On-site Testing

1) The Contractor shall implement all tests following the Test plan. During the course accuracy as may be required. Upon completion of the installation, and before commissioning, all power cables shall be tested to the acceptance of the Engineer following an agreed Inspection and test plan to demonstrate that is entirely suitable for commercial operation.

2) The Contractor shall be responsible for providing temporary electricity supply, all instruments, gauges, test equipment, tools, accessories, personnel, services, and necessary facilities required for the execution of all tests and inspection. Wherever necessary, the Contractor shall provide two or more sets of testing equipment, tools, and others to expedite testing. All test equipment shall be accompanied with the appropriate calibration certificate by a testing authority of the equipment.

3) Test equipment, tools, and other necessities for subsequent preventive and corrective care to be provided to the engineer as specified herein and shall be available to assist the tests. The use of this test equipment, tools, and others shall be subject to approval by the Engineer.

4) The Contractor shall be responsible for the surveillance and security of the Electric Room and Distribution downstream cables or other electrical equipment in energized before it has been tested and before the relevant Contractors or Sub-contractors' facilities are ready and secured. The Contractor's Responsibility for surveillance and security of the system shall remain in force for each part of the system until such a time that the Engineer issues the appropriate certificate and the Employer take over the System.

3.9.4 Special Tool and Test Equipment

Necessary and sufficient special tools shall be provided for maintenance and repair service in the Communications System.

Diagnostic apparatus shall be provided to check the function and status of the communication equipment.

The diagnostic apparatus shall be provided with the following:

1) Operation manual;
2) Calibration manual;
3) Spare printed circuit board;
4) Spare parts and consumables;
5) Connection cable and connector; and
6) Software (with source code).

The Contractor shall prepare the special tools and testing apparatus list in advance for the Engineer's Approval.

1) The Contractor shall provide a sufficient number of all special tools, enabling the Employer to properly maintain and repair the applied Telecommunication equipment and related system.
2) This shall include diagnostic test equipment to ascertain the functionality of all discrete pieces of specialized equipment including embedded fault monitoring and diagnostic system, portable test equipment, and shop test equipment.
3) The portable test equipment shall consist of a suitable number of pre-programmed laptop computers and standard cable connectors connectable to the equipment to be tested, allowing faults to be quickly and easily diagnosed and allow data download and analysis. Suitable test equipment, hardware, and software interface shall be provided for each sub-system. Test capability should include but not be limited to the measurement of major system parameters.
4) The shop/laboratory test equipment shall consist of at least one set of test benches for each sub-system, whereby the equipment to be tested when removed from the site can be loaded and tested onto the test bench. The tester shall allow functional simulation and fault diagnosis.
5) The Contractor shall propose the type and quantity of test equipment based upon operation analysis. This submission shall be given a Notice of No Objection by the Engineer.
6) The Contractor will be required to maintain the equipment software throughout the guarantee period and hand over the same at the end of the guarantee period. As part of the diagnostic test equipment, the Contractor shall provide the following:
    - Complete operational manual, schematic, maintenance, and calibration instruction for the equipment, including printed circuit boards and microprocessor;
    - Spare parts and consumables;
    - Sets of replacement cable and connector assemblies and a suitable number of interface hardware for each piece of test equipment; and
    - Interface software, including source code.

3.9.5 Requirements for Measurement and Measuring Instruments

The contractor shall provide the measuring instruments necessary for the maintenance of the Telecommunications.

The contractor shall provide the operation manual of the measuring instruments.

Measuring instruments include the following. However, it is not limited to the measuring instrument described here.

(1) Backbone system

- Optical power meter
- Optical Time Domain Reflectometers (OTDR)
- Bit Error Rate (BER) tester

(2) Radio system

- Radio power meter
- Radiofrequency counter
- Spectrum analyzer
- Portable Test Equipment for on-board train equipment.

(3) CCTV system

- Digital multimeter
- Luminance meter
- Monitor for the angle of view adjustment
- LAN cable tester

(4) PA system

- Sound pressure meter
- Noise generator

(5) Power supply system

- Voltmeter
- Ammeter
- Clamp meter

(6) Telecommunication cable

- Ohmmeter (Megger)

(7) Other necessary measuring instruments

The contractor shall provide other necessary measuring instruments as needed.

3.10 Consumables and Spare Parts

Refer to Employer's Requirements – General Requirement (ERG) for the description for consumables and spare parts.

3.11 Interface Requirement

3.11.1 General

The Contractor shall coordinate with interface contractors, sub-contractors, other rail system suppliers, and outside authorities as well to ensure that communication equipment offered shall satisfactorily comply with the Contractual requirements.

The Contractor shall follow the Interface Requirements of the Telecommunications system as specified in the General and Technical Requirements of the Contract. Detailed interface design and system integration within the Package is the responsibility of the Contractor.

This contract is part of an entire project for the North-South Commuter Railway Project. The contractor shall be responsible for interface with Solis-Malolos Project (NSCR) and incorporate measures for a seamless interface and seamless operation.

After completion of the OCC in Mabalacat as part of MCRP, this OCC in Mabalacat shall become the main OCC from which the whole line (from Clark International Airport to Calamba) shall be operated.

3.11.2 System Interfaces

3.11.2.1 Interface Requirements between Telecommunications Sub-systems

Table 3.11.2.1 Interface requirements between Telecommunications Subsystems

Telecommunications Subsystem	Interface requirements	
Backbone system	Radio system	Voice and Data system
	CCTV system	PID system
	PA system	Time saver and Master clock system
	Telecommunication equipment monitoring system	Meteorological and Seismic monitoring system
	Power supply system	Grounding (Earth)
	Building Management System (BMS)	AFC system
	Other if any	
Radio system	Backbone system	Voice system
	Time saver and Master clock system	Telecommunication equipment monitoring system
	Power supply system	Grounding (Earth)

Telecommunications Subsystem	**Interface requirements**	
	Rolling Stock equipment	Other if any
Voice and Data system	Backbone system	Radio system
	Time saver and Master clock system	Telecommunication equipment monitoring system
	Power supply system	Grounding (Earth)
	Other if any	
CCTV system	Backbone system	Time saver and Master clock system
	Telecommunication equipment monitoring system	Power supply system
	Grounding (Earth)	Other if any
PID system	Backbone system	Time saver and Master clock system
	Telecommunication equipment monitoring system	Power supply system
	Grounding (Earth)	Fire alarm system
	Signal System	Other if any
PA system	Backbone system	Time saver and Master clock system
	Telecommunication equipment monitoring system	Power supply system
	Grounding (Earth)	Fire alarm system
	Signal System	Other if any
Time saver and Master clock system	Backbone system	Radio system
	Voice and Data system	CCTV system
	PID system	PA system
	Telecommunication equipment monitoring system	Meteorological and Seismic monitoring system
	Power supply system	Grounding (Earth)

Telecommunications Subsystem	**Interface requirements**	
	Building Management System (BMS)	AFC system
	P-SCADA system	Signal System
	Fire alarm system	Other if any
Meteorological and Seismic monitoring system	Backbone system	Time saver and Master clock system
	Telecommunication equipment monitoring system	Power supply system
	Grounding (Earth)	Other if any
Telecommunication equipment monitoring system	Backbone system	Radio system
	Voice and Data system	CCTV system
	PID system	PA system
	Time saver and Master clock system	Meteorological and Seismic monitoring system
	Power supply system	Grounding (Earth)
	Other if any	
Power supply system	Backbone system	Radio system
	Voice and Data system	CCTV system
	PID system	PA system
	Time saver and Master clock system	Meteorological and Seismic monitoring system
	Telecommunication equipment monitoring system	Grounding (Earth)
	Power system	Other if any
Grounding (Earth)	Backbone system	Radio system
	Voice and Data system	CCTV system
	PID system	PA system

Telecommunications Subsystem	Interface requirements	
	Time saver and Master clock system	Meteorological and Seismic monitoring system
	Telecommunication equipment monitoring system	Power supply system
	Other if any	

3.11.2.2 Interface requirements between Telecommunications and Related system.

Table 3.11.2.2 Interface requirements between Telecommunications and Related system

Item	Interface requirement
Interface with Rolling Stock system	On-Board Radio Equipment
	Train Operator Control Panel (TOCP)
	Train Antenna The roof-mounted antenna on both sides of the trainset.
	Coaxial Cable The cable connecting between the onboard radio system and the antenna.
	Power Supply The power supply of the on-board Radio system shall be supplied with DC 100 V from the Rolling Stock side.
	Train Protection Radio The communication system during an emergency between the driver of trainsets. The communication of the Train Protection Radio shall be displayed at the OCC.
	Data communication The on-board radio equipment has an interface for connecting to the TIS. POI is an input port of the on-board radio equipment. TIS data Other if any
	Train Passenger Emergency Intercom In the case of an emergency, the device will enable communication between the passenger to the train driver. If the call attempts failed to reach the driver, the call will automatically be directed to OCC by the onboard radio system.

Item	Interface requirement
	POI is an input port of the on-board radio equipment.
	Broadcast from OCC to passengers of the train In case of emergency, OCC staff shall be able to broadcast to the passengers through the broadcasting facilities of the train. Broadcasts to trains shall be broadcast to individual trains, grouped trains, and all trains. POI is an input port of the on-board radio equipment.
Interface with the Signaling system	Provision of core fiber of optical fiber cable The transmission path of the Signaling system shall not be accommodated in the MSN system. The transmission line of the Signaling system is configured using the core fiber of an optical fiber cable laid by the Telecommunications side. For this reason, the core fiber of optical fiber cable is provided for the Signaling system. POI is the ODF of the Telecommunication equipment room.
	Clock system Provides time information received from GPS to the Signaling system. POI is an output port of the master clock unit or the Sub-master clock unit.
	Reception of ATS signal Signaling system ATS signal is received to automatically update the information of the PID system and PA system. POI is the output port of the ATS device of the Signaling system.
	Train control signal connection The connection with the Signal system network is the MSC installed in the OCC. POI is an output port of the MSC.
Interface with Power system	Provision of core fiber of optical fiber cable The transmission path of the Power system shall not be accommodated in the MSN system. The transmission line of the Power system is configured using the core fiber of an optical fiber cable laid by the Telecommunications side. For this reason, the core fiber of optical fiber cable is provided for the Power system. POI is the ODF of the Telecommunication equipment room.
	Power reception The power supply of the Telecommunications will be supplied from the power distribution board. POI is a power distribution board.
	Clock system Provides time information received from GPS to the Power system. POI is an output port of the master clock unit or the Sub-master clock unit.
	MSN system

Item	Interface requirement
Interface with AFC system	It provides a communication line of the AFC system to connect from each station to OCC. POI is a port of L3SW / L2SW installed in the Telecommunication equipment room. For distance ranging equal to or more than 60 meters between the CER and AFC rooms, the Telecommunication systems shall provide connection switches necessary to facilitate Backbone Network connections in AFC-related rooms.
	Clock system Provides time information received from GPS to the Power system. POI is an output port of the master clock unit or the Sub-master clock unit.
	CCTV in AFC rooms and cash routes
	Providing data system access points Provide a Wi-Fi access point to the Express train stop station. (For ticket sales of Express train) AFC room, Ticket sales counter, Waiting room, Platform, etc.
Interface with PSD system	Telecommunication equipment monitoring system It provides a communication line of the PSD system to connect from each station to OCC. The communication line provided is to monitor the operating status of the PSD system. POI is a port of the Telecommunication equipment monitoring system installed in the Telecommunication equipment room.
Interface with Architecture system	Telecommunication equipment room of the station Area of the communication equipment room 50 m^2 (Does not include an area of the air conditioning.) Communication UPS room area 50 m^2 (Does not include an area of the air conditioning.) Free access to communication equipment room: 50 cm under the floor Air conditioning: 2 pairs including spare Room temperature: 28°C or less / Humidity: 80% or less (noncondensing) Floor load: Equipment room 800 kg /m^2, UPS room 2000 kg /m^2
	Telecommunication equipment room of OCC Area of the communication equipment room 70 m^2 (Does not include an area of the air conditioning.) Communication UPS room area 50 m^2 (Does not include an area of the air conditioning.) Free access to communication equipment room: 50 cm under the floor Air conditioning: 2 pairs including spare

Item	Interface requirement
	Room temperature: 28°C or less / Humidity: 80% or less (noncondensing) Floor load: Equipment room 800 kg /m², UPS room 2000 kg /m²
	Equipotential grounding The equipotential grounding of station and OCC shall be carried out by the Civil and the Architecture section. The grounding wire shall be carried out to the grounding terminal of the Telecommunication equipment room, by the Architecture section. The ground resistance is measured in cooperation with the Power side and the Signal side.
	Responsible area of CCTV system Responsible area of communication system Paying area and work area in the railway facility area Paid concourse area Platform area Work area such as equipment room Other if any Responsible area of architecture (reference) The details should be confirmed by the architecture. Free area and commercial area in the railway facility area Free concourse area Commercial area Other if any
	Broadcast area of the PA system PA system broadcasting area of Telecommunications Within the railway facility area PA system broadcasting area of architecture (reference) The details should be confirmed by the architecture. Commercial facility area
	Fire alarm system Receive fire occurrence information When a fire occurs, the PID system and the PA system receive fire occurrence information from the fire alarm system. The PID and PA systems inform the passengers that a fire has occurred. POI is an output port of the fire alarm system. Clock system

Item	Interface requirement
	Provides time information received from GPS to the Fire alarm system. POI is an output port of the master clock unit or the Sub-master clock unit.
	Building management system (BMS) Provides a communication line (MSN system line) of the BMS system to connect from each station to OCC. POI is a port of L3SW / L2SW installed in the Telecommunication equipment room.
	CCTV system installed by architecture Provides a communication line (MSN system line) of the CCTV system to connect from each station to OCC. POI is a port of L3SW / L2SW installed in the Telecommunication equipment room.

3.11.2.3 Onboard Communication Interface

This Clause describes the requirements for the Telecommunications System / Radio Contractor and the Rolling Stock Contractors.

Both Contractors shall ensure that all requirements of the Specification on interfaces are comprehensively fulfilled. Below is a brief outline of responsibility between the Contractors. The Contractor shall provide an Interface Management Plan.

Table 3.11.2.3 Radio/Rolling Stock Interface

Item	Item Description	By Contractor
1.	Public Address (PA) System to broadcast speech messages to train passengers from the driver's cab.	Rolling Stock
	Facility to broadcast over the train PA System from the Operations Control Center (OCC) with the associated message content relayed to the train via the Train Radio System	Radio
2.	Passenger emergency intercom to provide audio communication between carriages and the driver's cab to enable passengers to talk to the driver should an emergency occur within the train carriage.	Rolling Stock
	In case the driver does not pick up the passenger emergency intercom, it automatically connects to the OCC, using the onboard radio.	Radio
3.	Driver's intercom system to allow full-duplex audio communication between driver's cabs.	Rolling Stock

Item	Item Description	By Contractor
4.	Train Radio System to allow full-duplex audio communication between the driver and the OCC. Additional interfaces shall be provided within the OCC to relay to the trains PA audio messages.	Radio

3.11.3 Interface between NSCR -EX and NSCR Project:

The Contractor shall coordinate with the NSCR-N1's CP04 Contractor for the effective and efficient interoperable operations of all the Telecommunications System in the NSCR Project.

The Contractor shall follow the set demarcation of the NS01/CP04 System works. However, the contractor shall extend and terminate all Telecommunications Systems that are necessary and will be required to the nearest equipment rooms for both the Northside and Southside of the CP04 contract.

The Contractor shall design and co-ordinate with the CP04 Contractor/Supplier of the NSCR-N1 section for effective integration of all the Telecommunications Systems for NSCR's N1, N2, and SC sections for the IOCC to establish an adequate, interoperable, centralized control of the entire NSCR Line.

For SBT Interface Demarcation of works– Please refer to ERG- Appendix 8.

3.11.4 Interface between NSCR-EX and MMSP Project:

The Contractor shall coordinate with the MMSP's CP106 (E&M) and CP107 (Rolling Stock) Contractors for the effective and efficient handover operations of all required Telecommunications System at Bicutan Station (NSCR-SC) for the MMSP Project.

The Contractor shall follow the set demarcation of the NS01/CP106 System works. However, the contractor shall extend and terminate all Telecommunications Systems necessary and required to the nearest equipment rooms for the CP106 contract.

Below are the NS-01 Interfaces to MMSP's CP106/ CP107 and Civil Contracts. (For Interface Demarcation of works– Please refer to ERG- Appendix 8.)

Table 3.11.4 NS-01 and MMSP Telecommunication Interface

Sub-System	NS-01	Station/ Depot	MMSP Contract	MMSP
TELECOMMUNICATIONS				
MMSP Millimeter-wave		Bicutan	CP106	Shall supply, install and test and commission the equipment.
Backbone System: OFC	Shall provide connectivity to NSCR OCC for Voice and DAtae Systems, CCTV, PA, PIDS AFC.	Bicutan	CP106	Shall supply all equipment needed to connect to the NSCR Backbone System.
Radio Systems: GSM-R	Shall provide the GSM-R Network connectivity for all Voice and Data within the NSCR Line; GSM-R Radios will be provided to Bicutan Station Controller including portable Handheld Radio at Drivers lobby for Operations and Disaster Management	Bicutan	CP106	
Radio Systems: CBTC		Bicutan	CP106	Shall supply and install, test, and commission all CBTC systems.
Voice and Data System	Shall provide the connectivity for all Voice and Data within the NSCR Line; the line to MMSP PABX System.	Bicutan	CP106	Shall supply and install, test, and commission all MMSP PABX systems.
PIDS		Bicutan	CP106	Shall supply and install, test and commission all PIDS in their platforms and concourses.
Public Address (PA) System	Common PA System for FTI and Bicutan to avoid overlapping, MMSP PS System will be integrated with NSCR and will be managed by Station Operator for station announcements. The central announcements will be done by either MMSP OCC or NSCR OCC.	Bicutan and FTI	CP106	
Time Server and Master Clock System	All clocks will be supplied, installed, test and commissioned by NSCR	Bicutan and FTI	CP106	
GSM-R on-board equipment	Shall supply, test, and commission the onboard equipment on MMSP trains	N/A	CP107	Shall install the onboard equipment on MMSP trains.
GSM-R Infrastructure at MMSP Test Track	Shall design, install, test, and commission the GSM-R system/ Infrastructure. Shall identify and supply the testing and diagnostic equipment for the GSM-R Radio Systems	Valenzuela Depot	CP106 - CIVIL	CP106: To provide Backbone Facilities for the GSM-R Infrastructure (Base Station) to be connected to the Switch and OCC/IOCC. CIVIL: To provide space and power for the GSM-R Infrastructure.

TELECOMMUNICATIONS SYSTEM

APPENDIX 1

BACKBONE TRANSMISSION SYSTEM (BTS)

1 INTRODUCTION

1.1 General

This Chapter specifies the technical characteristics of the Backbone Transmission System (BTS) of the Communications System.

1.2 Overview of Backbone Transmission System

The BTS shall provide a common transmission backbone for the Communication Sub-systems: Telephone System, Radio System, Public Address System, Closed Circuit Television System, Passenger Information Display System, Centralized Clock System, and Network Management System. Also, other systems shall be interconnected using the BTS infrastructure as Signaling, SCADA, and Automatic Fare Collection.

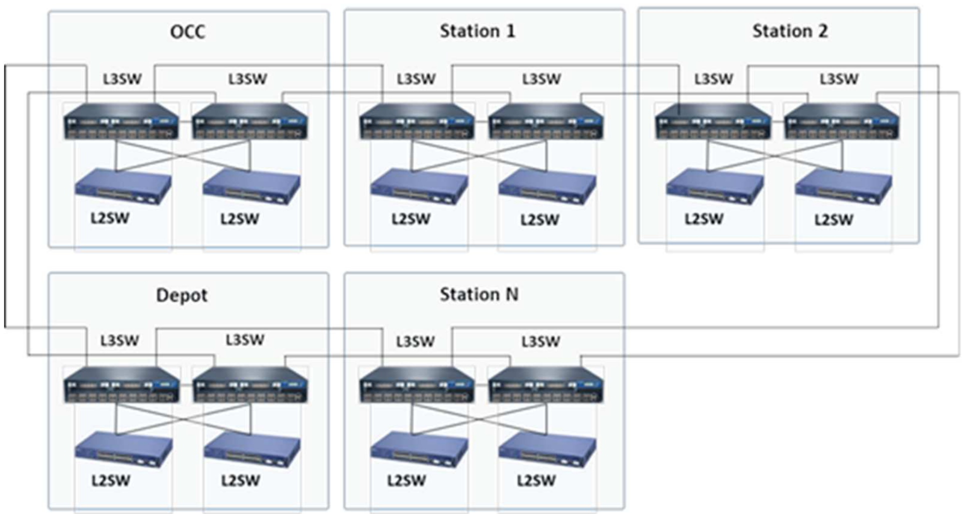


Figure 1.2 The example of the Backbone system configuration

2. SCOPE OF WORKS

2.1 General

The specific requirements on the scope of the works for the BTS shall be as specified below.

2.2 Scope of supply for BTS

The Scope of Supply includes, but is not be limited to, the following:

1) Network Equipment;
2) Flexible Access Multiplex Equipment;
3) Network Management Systems;
4) Single-Mode Optical Fiber Cables;
5) Splice Boxes and Remake Loops;
6) Distribution Frames;
7) Terminating and interconnecting equipment including Termination Protection Devices;
8) Equipment cabinets, racks, and cubicles;

9) All required connectors;
10) All necessary fixtures, fittings, and accessories;
11) Power supply arrangements and cable, earthing including Termination Protection Devices;
12) Communications System Supervisor and storage devices etc., and
13) All other cables of different types, including CAT-5, etc.

2.3 Scope of Services

Before the detailed design phase, the Contractor shall compile and submit a loading report to the Engineer that includes details of the required BTS capabilities, the network throughput associated with the different levels of service, and the worst-case transmission delay times.

The Contractor shall compile and submit performance reports to the Engineer for approval. The Contractor shall be responsible where necessary for reconfiguring the network and providing additional hardware if necessary.

3 PERFORMANCE REQUIREMENTS

3.1 General

The design shall be fault-tolerant with protection against failure provided to achieve the system availability. Protection shall include, but not be limited to path diversity, redundancy, and duplication of reliability-critical equipment, component, and circuits.

3.2 Reliability

The inability to perform any required function, the occurrence of unexpected action, or the degradation of the performance below the specifications shall be considered as a failure. The MTBF shall be the average operating time accumulated by the total population of identical items between failures.

3.3 Availability

The availability of the BTS shall be defined as the availability of the circuit between both endpoints of the Backbone Transmission System where the required bandwidth is available for access.

Any circuit of the BTS shall be considered unavailable when:

- There is a loss of communication between endpoints of the circuit; or
- The quality of the signal transmission within the circuit is below the performance standards stipulated in this Technical Requirements.

The Network Management System shall be considered unavailable if any functions provided by the Network Management System cannot be properly exercised. The availability of the Network Management System shall be better than 99.96%.

3.4 Maintainability Requirements

The Mean Time to Restore (MTTR) of the BTS, its elements, and networking shall be less than four hours (all-inclusive). The service life of the BTS shall not be less than 15 years. The service life of all types of cables shall not be less than 25 years.

3.5 System Safety Requirements

In the event of an optical fiber cable break, the optical transmitter laser output shall shut down to a safe level as defined by IEC-825, ITUT-G 958, or similar references. The shutdown mechanism shall not be software-dependent.

4 FUNCTIONAL REQUIREMENTS OF BACKBONE TRANSMISSION SYSTEM (BTS)

4.1 General

The BTS shall provide Communication support for carrying voice, data, and video signals and guarantee the associated quality of service requested by each sub-system. To cover this broad range of services and interfaces, the BTS shall offer different solutions, most technically appropriate, based on the respective standards and fully conforming to the ITU-T or similar recommendations:

1) Fiber Optic Communication (FOC); and

2) Gigabit Ethernet (GE) backbone (Supporting MPLS-TP).

The BTS shall provide secure end-to-end connectivity for all the sub-systems and also guarantee the specific quality of service requested.

The BTS shall provide a transmission network associated with the respective level of service requested, with sufficient transmission bandwidth to cater to all operational needs and future system expansion. This system will be based on proven, reliable, scalable, and secure technology and adequate standard-based, open architecture.

The BTS shall ensure that in the event of equipment or transmission media failure, no more than one station or site at which a node is located, is affected. Where subsystems are using dedicated Fiber Optic Communications, the subsystem must provide its redundancy solution.

The BTS network shall be designed and implemented in a modular structure to enable it to be further upgraded to a higher capacity system and to be capable of accommodating new technologies.

The BTS network shall incorporate on-line automatic, self-diagnostic maintenance facilities that shall enable fault, configuration, and performance management. All equipment shall be monitored to ensure that a failure, as a minimum down to an electronic circuit level, can be detected and be reported to the internal fault diagnostics system, which shall provide such fault information to the BTS Management System.

4.2 Software Requirements

The operating system software and protocol of the BTS network shall be transparent to all network users. Access to the operating system software for maintenance purposes shall be password protected to allow access by appropriately qualified levels of personnel for maintenance/ database programming. A duplicate copy of all software shall be provided on suitable storage media for backup and further development purposes.

The BTS network shall incorporate a central monitoring system to gather operational data for performance checking, historical trend analysis, and maintenance. This monitoring system shall provide facilities to handle filing, storage, display, and printing of historical records. A duplicate copy of all software shall be provided on suitable storage media for backup and further development purposes.

4.3 Hardware Requirement

The BTS network shall be designed to minimize system breakdowns, or reductions in the level of service, caused by a single point failure. It shall also be designed to facilitate easy extensions and additions.

The BTS network shall be based on a highly modular, diverse redundant architecture to facilitate easy maintenance and upgrading, and to minimize the chances of a breakdown occurring due to common-mode failures or effects.

4.4 Optical Fiber Cable

The scope of supply shall include, but not be limited to, the following:

1. Single-mode optical cables;
2. Splice boxes and remake loops, joint closures;
3. Distribution frames and patch panels;
4. Equipment cabinets, racks, and cubicles;
5. All required connectors and patch cords, pigtails, attenuators; and
6. All installation materials.

The Optic Fiber Cable (OFC) infrastructure shall be formed by two single-mode optical fiber cables, laid along two physically distinct routes. The normal and protected routes shall be routed through different fiber cables with path diversity and meeting only at CER locations.

For the interface of MCRP, NSCR and NSRP-South an additional two (2) x 96 core single-mode fiber optic shall be installed by the Contractor from Malolos to Solis station.

The Contractor shall propose a cable that supports the specific railway constraints and requirements and shall determine the exact total number of fibers needed by all systems required to connect to the backbone and reserve at least 20% of fibers, within each cable, as spares for future use

An optical distribution frame shall be installed in each CER. Optical fiber cables terminated at the optical distribution frame shall be either spliced through or spliced with optical pigtails or terminated at the optical patch panels including the spare fibers. The strand tubes, of the optical cable, shall be connected to allow all kinds of topologies and links needed; point-to-point, direct, or bus.

At least 15 meters of cable slack shall be reserved at all CER for future network modification and expansion. Furthermore, fiber loops shall be provided at intervals agreed by the Engineer. No cable joints shall be allowed along the trackside. The Contractor shall survey the cable route and ensure that cable lengths supplied are such as to avoid possible wastage of cable and additional joints. The laying of fibers shall conform to the manufacturer's recommendation concerning the mechanical constraints, such as the minimum bending radius.

The Contractor shall ensure that the optical budget, of the end-to-end longest connections, is minimum adequately satisfied for the optical specifications of high capacity transmission equipment. The cable attenuation values shall not exceed the values advocated in the standard G 652, ITU-T Non-Dispersion-Shifted Fiber, or an equivalent standard.

The detailed OFC commissioning procedure shall be submitted by the Contractor to the Engineer for approval. This acceptance testing document shall cover all the specific measurements of the optical fiber infrastructure coupled with the maximum "state of the art" expected values. Concerning the list of fiber optic parameters, it shall include, but not be limited, to the following values:

1) Connector losses less than 0.5dB;
2) Splice loss less than 0.1dB; and
3) Reflectance less than -55dB.

4.5 Network Protection

The BTS shall be provided with path protection with self-healing rings or equivalent, multiplex section protection, and sub-network connection protection functions as applicable. No single failure shall affect the availability of the BTS network or the Interfaces. The BTS network shall remain in operation and automatically reconfigure, if necessary, without the need for control by the Network Management System, under the fault conditions. The Normal and Protected routes shall be routed through different Fiber Cables with path diversity.

Automatic path protection switching shall occur upon detection of failure or alarm conditions which will affect the quality of signal transmission. The protection switching shall be completed within 50ms. Manual protection switching shall be initiated by a switch command from the BTS management system.

Failure of any single BTS node shall not affect the operation of the remaining BTS nodes in the network.

All the channel circuits, including spare circuits, shall be terminated at the main distribution frame, digital distribution frame as appropriate for circuit access.

4.6 Giga Ethernet Backbone Protection

The Giga Ethernet backbone shall be based on Rapid Spanning Tree Protocol (RSTP) loops. According to the level of service requested by the sub-systems, the Contractor shall propose the best compromise between each loop, the number of stations, and the RSTP failure recovery time.

4.7 BTS Management System

The system response times of the BTS management system shall be provided by the Contractor for approval by the Engineer.

Each Management Terminal shall be equipped with a minimum 21-inch color monitor to provide graphical representation and display of the network. A log printer shall also be provided. A mass storage device shall be provided with a storage capacity for at least 1-month configuration and alarm data for all the BTS Equipment.

4.8 System Configuration

The BTS Management System shall ensure monitoring and centralized and remote control for all the backbone Networking Equipment.

The BTS Management System and its Workstation shall be installed in the main CER at the OCC. Each BTS Management workstation shall be equipped with a log printer for alarm and event print-out. Two Laptop Service Terminals loaded with Network Management Software and four portable service terminals for maintenance access to the Network elements at various locations shall be provided.

4.9 Operational, Administration, Maintenance & Provisioning (OAM&P) Functions

The BTS Management system and the network elements shall provide operation, administration, maintenance & provisioning (OAM&P) functions following the Telecommunications Management Network (TMN) concept as described in ITU-T Recommendations M-3010 or a similar reference. The BTS Management system shall be able to automatically discover the network equipment and associated links and place them on a topology map.

The BTS Management system shall provide a proactive and efficient monitoring system that helps to detect and avoid potential backbone problems. Protection and alternative routes shall be provided for network management traffic in case of faults in the BTS.

4.10 Alarm and Monitoring

The operational status and performance of all the network elements shall be displayed on a real-time basis by the BTS management system. The status monitoring shall be down to the card level as a minimum.

The network elements shall have alarm logging facilities so that a detailed history of the failure alarms can be retrieved either locally using the portable service terminal or remotely by the BTS management system. The BTS Management System shall be able to correlate all the sub-systems logs and alarms for detailed analysis and debugging in the event of any problem or failure.

Alarms to be collected from network elements shall include, but not be limited to, the following:

1) Any card/ module/ interface failure;
2) Back-up mode activated;
3) Link down, high/low power;
4) High laser bias;
5) Power unit failure;
6) Input failure;
7) Loss of frame alignment;
8) High error rate alarm;
9) Loss of synchronization;
10) Out of frame alignment;
11) Alarm indication;
12) Tributary unit failure;
13) External synchronization failure; and
14) Equipment fan failure.

Failure alarms shall be classified into user-configurable major/minor alarms. All alarms and status changes shall be stored in a local storage of network elements, stored in a mass storage device at the main CER, and outputted to the printer on demand. All alarms and status shall be stamped with time and date. Each alarm log shall include details on the type and nature of the fault, alarm category, fault location, date, and time fault is detected and date and time the fault is cleared.

An audible alarm shall be given at the management work station and shall be reset by maintenance staff on acknowledgment. A local alarm indication for the network element shall be given and shall be reset automatically once the alarm is cleared. A Summary Alarm shall be provided at the rack top to indicate the alarm status of any element within the rack. The Summary Alarm shall be reset automatically once the alarm is cleared.

The BTS management system shall provide a function for the user to enable and disable the output of alarm events to the log printer.

4.11 Performance Monitoring

The BTS management system shall calculate, display, and provide a print-out of the performance statistics for the BTS. In-service performance monitoring for all network elements shall include, but not be limited to the following performance parameters:

1) Laser bias current;
2) Optical power transmitted;
3) Optical power received;
4) Degraded duration in minutes;
5) Severe error seconds;
6) Protection switching counts; and
7) Protection switching duration.

Loss of power shall not cause any corruption or loss of data in the network elements and the management system. The in-service performance data files shall be able to be transferred to disk or any other storage media subject to Approval by the Engineer. The data files shall be in a format to allow analysis using commercially available software.

4.12 Network Configuration and Provisioning

The BTS Management System shall allow the user to configure all existing and new circuits with the following functions:

1) Frame position allocation; and
2) Interface port allocation.

4.13 User Interfaces

BTS management system functions shall be performed through a user-friendly graphical user interface (GUI) in real-time mode.

4.14 Design Requirements

The system design shall integrate the request for a proven, reliable, scalable, secure, standard based on open architecture.

The Contractor shall submit the following information to the Engineer for Approval:

1) Optical link-budget calculations for all the transmission links;
2) The calculations of delay for signal transmission between nodes;
3) The calculations for the backbone network end-to-end jitter and latency;
4) Details on the specifications of each data and voice channel interfaces;
5) Details on the electrical and physical specifications of the local maintenance port which supports remote and local operation, administration, maintenance, and provisioning (OAM&P) functions of the equipment;

6) A list of alarms for which the faults shall be detected;

7) The format in which alarms shall be displayed and remotely accessed for printing and display;

8) The details on the maximum number of tributary signal interfaces that can be supported by the system and the limitations;

9) The details of the management network design, flow of management traffic and protection against node failures or cable failures; and

10) Types and the maximum number of transmission equipment supported by the BTS management system.

The Contractor shall estimate the bandwidth needed to guarantee the level of service requested by all the sub-systems for the Engineer's Approval.

4.15 Technical System Performance

The Contractor shall provide power supply equipment for power conversion if necessary. The equipment shall be EMC compliant and be able to withstand the typical railway environment voltage spikes.

At least 50% spare traffic bandwidth and capacity between nodes shall be provided.

The maximum traffic interruption time on any circuit due to link, node, or any other failure shall be less than 50 ms. for the network. This includes the time duration for protection switching completion following the sequence of events below:

1) From the onset of failure detection to the completion of protection switching;

2) From the clearing of a failure to the completion of protection switching restoration in case of reverted switching; and

3) From the activation of the restoration command to the completion of protection switching restoration in case of non-reverted switching.

The network shall ensure that the maximum traffic interruption time on any circuit due to link, node, or any other failure shall be less than 250 ms.

4.16 Equipment Design

The BTS Equipment design shall be of a standard rack with plug-in units. Hot-swapping capability shall be provided for all cards/units including redundant power supplies. Hot-swapping of the plug-in units shall not affect the equipment operation.

The Contractor shall use only proven equipment with satisfactory results in equivalent networks and environments.

Equipment shall be equipped with protected test points for measurement and performance monitoring without affecting the traffic. Test access facilities shall be provided at different transmission levels.

The Contractor shall ensure that all the requirements of the specifications on interfaces are properly satisfied.

4.17 Cabling and Accessories

The specifications of all cables shall be provided by the Contractor. The requirements on cabling accessories, digital distribution frames, optical distribution frames, main distribution frames shall be as given in Clauses 3.6.11 and 4.4 of this Technical Requirements.

4.18 System Expansion

Additional nodes/switches shall be capable of being inserted into the BTS network without affecting the performance of the network. Any limits on this requirement shall be specified by the Contractor for approval by the Engineer. The BTS shall be compatible with equipment from other manufacturers.

The BTS management system shall be designed and equipped with all necessary hardware, software, and with sufficient capacity for future addition.

The BTS- network shall allow to be expanded to NSCR-N2 and NSCR-SC seamlessly.

TELECOMMUNICATIONS SYSTEM

APPENDIX 2

RADIO SYSTEM

1. OVERVIEW OF THE RADIO SYSTEM

1.1 General Requirements

The Contractor shall design, supply, and commission a GSM-R Radio System for ETCS level 2 Data, ATO Data (to be implemented in the future), non-vital data communication, and voice communication for the train operator, OCC, Depots, Shunting staff, Station and Maintenance staff and shall include the voice cab radios and handheld portable radios.

The onboard GSM-R data-only radios are within the scope of Signaling.

The Contractor shall provide a digital radio communication system, conforming to local and international standards as required to facilitate system-wide voice and data communications to support the Operation and Maintenance of the NSCR system.

The radio communication systems shall:

(a) provide non-essential voice and data communications on Radio System and also;

(b) provide the Signaling data communication for ETCS Level 2 on GSM-R as detailed in Section 2 of the Technical Requirement.

The Contractor shall only proceed with the manufacturing of the Radio System following the configuration that has been approved by the relevant authorities. The Contractor shall submit copies of such approvals to the Engineer for approval before commencing the detailed design, manufacture, and installation of the radio system.

The Contractor shall submit to the Engineer for Approval copies of all approval certificates granted by the relevant authorities, including system licenses before the final design and installation and before the final testing and commissioning as appropriate.

Delivered materials and equipment shall be of proven quality with satisfactory results in equivalent networks and environments.

The Contractor shall deliver all the certifications, relevant to the equipment to be submitted, to the Engineer for approval.

The Contractor shall be responsible where necessary for re-configuring the Radio System and providing additional hardware at no extra cost to the Employer.

The Radio Systems shall consist of a highly modular, diverse redundant architecture, employing "hot standby" techniques as required to facilitate ease of maintenance and be capable of being upgraded to a higher capacity system and be adept in accommodating new technologies.

It shall be designed in such a manner as to minimize the chance of failures due to common-mode failures and to stay fully operational from the user point of view in the event of a single point failure.

The Contractor shall design a Radio system that will comply with the minimum health and safety requirements regarding the Electromagnetic Exposure (EME) to workers and the public as per (a) Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 and (b) the ICNIRP (International Commission on Non-Ionizing Radiation Protection) 2020 Guidelines.

The Radio Systems equipment shall be capable of interfacing with other Communications Systems by voice/data or a combination of both where required.

The Radio Communications systems shall provide voice communication to the PSTN for operations staff per their authorized grade of service.

The Radio System shall support Short Message Service (SMS). Before the design of the Radio networks, the Contractor shall assess the traffic load requirements and level of usage of each system that the radio network is required to support and shall estimate the total loading and submit such details as the frequency plan, traffic calculation, number of radio base stations, inclusive of the related number of masts or towers required, Radio repeaters, predicted coverage map with radio level and traffic capacity, for Approval by the Engineer.

All enclosures for indoor communications equipment shall be to IP 54. Outdoor equipment shall be to IP 65.

All communication cables and wiring (underground, racks, enclosures, interconnections), shall be fire-retardant, low smoke, and free of halogen.

The Radio System shall have central control equipment installed in the main CER and within the station communications room.

Redundant central equipment shall be located in different physical places, at the OCC CER.

The radios shall be fully compliant with both Radio System specifications. The Contractor, if necessary, shall supply repeaters or additional antennas based upon the link budget calculation.

At the project borders, the Radio System shall interface with the other Radio System of the adjacent project. The Radio System shall be fully redundant.

Further, emergency train and/or train operation information (TIS) shall be included in this system. Countermeasures for radio interference and redundancy scheme shall be furnished as essential functions.

Besides, when the train driver finds an abnormality, a protective radio is issued to ensure the safety of the other trains.

The contractor shall supply the onboard radio equipment to the CP NS-02 and CP NS-03 at their manufacturing facilities. The first and second trainsets shall be installed by the CP NS-01 contractor and support by CP NS-02 and CP NS-03. The subsequence trainset shall be installed by CP NS-02 and CP NS-03 contractors. For maintenance vehicles, the contractor shall arrange internally for the supply and installation.

The National Telecommunications Commission (NTC) had assigned the Frequency Band of 876-880 Mhz. to "Co-share" or "Co-use" with Smart Communications which currently uses and operates the frequency band of 870-880 Mhz. The frequency band 876-880 MHz will be used exclusively by DOTr / PNR within the 100-meter corridor of the whole NSCR Line from New Clark City (NCC), Tarlacto Calamba, Laguna.

To ensure non-interference with the NSCR Project, Smart Communications will create a 10 Km. Buffer Zone, measured 5 Kilometers away from each side of the corridor. This Buffer Zone will create a spatial distance to prevent interference to the NSCR's GSM-R coverage and to make sure that Smart cannot use the GSM-R frequency band (Uplink: 876-880 MHz) in all of their base stations within this buffer zone.

Smart can still operate on the remaining 5MHz (downlink: 870-875 MHz). This will create a 1 MHZ Guard Band (875-876 MHz) that is advantageous as an added protection against Adjacent Channel Interference.

If the Base Station outside of the 10 Km Buffer Zone is identified as the one causing "Co-Channel" interference, below are some of the RF interference mitigation techniques for your reference:

1) Turning off or Disabling the Co-Channel Radios- on a per sector basis.

2) Panning of antennas - to a direction that doesn't introduce interference.

3) Down-Tilting of antennas - to the ground, to not affect NSCR's Viaduct coverage.

4) Changing of Antennas with Upper Side-lobe suppression- to limit coverage propagation.

5) Powering down the Transmitter- to a level that will not anymore interfere.

NTC also had approved DOTr /PNR the use of the frequency band of 921-925 MHz which is presently allocated to Studio to Transmitter Links (STL) of Broadcasting Stations and also for the same purpose for the 100-meter corridor of the whole NSCR Line from New Clark City (NCC), Tarlac to Calamba Laguna. Currently, there are no STL operators cross the NSCR alignment. NTC will reassign these Broadcasting STLs another set of frequency bands to be used in cases that there would be existing Broadcasting STLs that will cause interference on the NSCR Line.

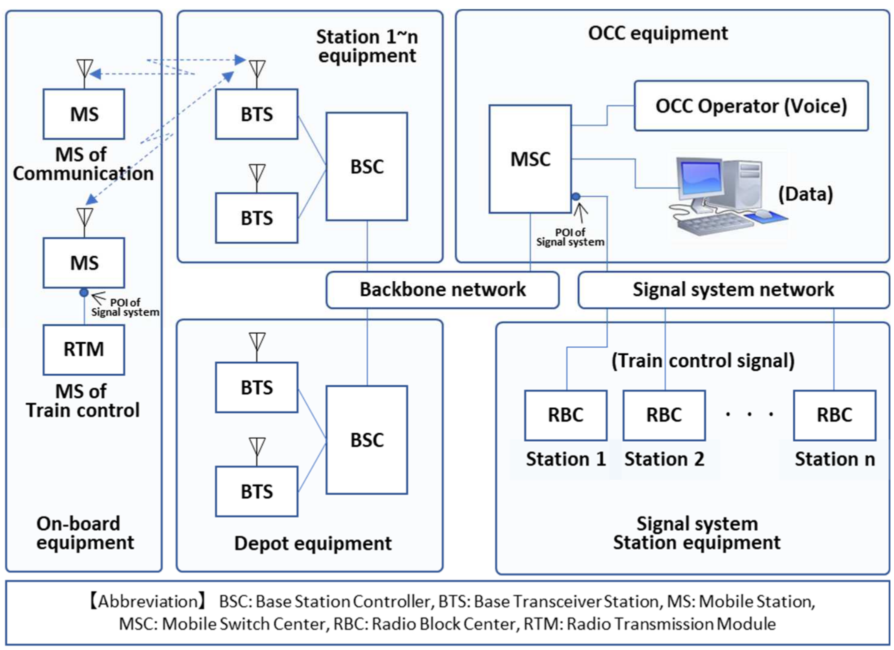


Figure 1.1 The example of the Radio system configuration

1.2 Standards

The Radio Systems shall as a minimum be compliant with the following or equivalent standards:

- IEC 62278 Railway applications: specification and demonstration of RAMS

- TIA-EIA-222 H - Structural Standard for Steel Antenna Towers and Antenna Supporting Structures.

GSM-R Specific standards are:

UNISIG	Subset 093 Quality Service Requirements
UNISIG	Subset 126 (not yet released) ATO-OB / ATO-TS FFFIS Application layer
UIC 950	EIRENE Functional Requirements Specification v8.0.0, 21 December 2015 or later version.
UIC 951	EIRIENE System Requirements Specification v16.0.0, 21 December 2015 or later version.

The provision of the Radio Communications System shall be compliant with local Governmental laws and regulations.

The Contractor shall propose Digital Radio systems that are:

- Proven in service and commonly used in railways;
- Suitable and can meet the operational requirements for this project;
- Complies with the description in this Clause.

The contractor shall include in their submission, the standards that apply to the proposed Radio Systems.

2. SCOPE OF THE WORKS

2.1 General

The System shall be supplied with an Inter System Interface (ISI) for interfacing with other manufacturer's Radio Systems for roaming of trains of adjacent projects.

The Contractor shall supply packet-switched radio systems with an IP backbone. The GSM-R response times shall be compliant with the signaling system requirements for the ultimate number of Base Stations, which can be supported by the Central Radio System equipment.

2.2 Scope of Supply

The Radio System shall include, but not be limited to, the following:

a) Central control equipment including zone controller and central switch;

b) Base stations including the radio site controller, base radios, environmental alarm system, and RF distribution system;

c) Radio access units;

d) Radio control workstations and associated hardware;

e) GSM-R hand-portable radios with accessories shall be similar to a handphone style/shape;

f) Battery chargers for hand-portable radios;

g) Train cab radios complete with a radio transceiver, Human-Machine Interface (HMI) interfacing unit, and power supply equipment, including train-borne antennas;

h) All types of cable, splitters, and accessories to support wide-band signal distribution over designated the designated frequency band for the NSCR application;

i) Antenna and support structure for base stations throughout the system and at the Depots etc.

j) Lightning protection equipment;

k) Distribution frames;

l) Equipment cabinets, racks, and cubicles together with mounting brackets and installation material;

m) Power supplies, cable, connectors, accessories, cabling, and earthing necessary for all equipment for the works;

n) All software required for operation and maintenance of the radio system;

o) Radio network management system;

p) A3/A4 Laser Color printer, connected to the radio management system;

q) Special maintenance tools, measurement tools, and laptops for onsite diagnosis and maintenance; and

r) SIM-card for onboard data radio. The onboard data radios, required for the signaling system, are excluded from the supply of the radio system. Those radios will be included in the scope of the signaling system.

s) Cradle with charger for driver handheld GSM-R unit, to be installed in each cabin of the train.

2.3 Scope of Services

The Contractor shall liaise with all concerned authorities such as the National Telecommunications Commission (NTC) for obtaining the frequency license, equipment approval, and any other authorities to obtain any necessary licenses/clearances for installation and commissioning of the Radio System.

The Contractor shall coordinate with PTE operators and equipment owners in case of interference problems through a Spectrum Coordination Committee.

Further to the general requirements shall include:

1) The Contractor shall coordinate with Civil Works Project Contractors to provide comments or recommendation on the station and Depot buildings, finishes, architectural layouts, installation requirements for antenna supports, availability of duct support facilities for antennas, masts, and other cables;

2) The Contractor shall also coordinate and supervise the installation of the Train-borne Radio equipment with the Rolling Stock manufacturers, to guarantee the interfaces and the end to end solution;

3) The Contractor shall coordinate with the contractors of the adjacent projects and implement all required interfacing equipment to ensure a seamless hand-over without losing any active radio connection;

4) Furthermore, the Contractor will be required to coordinate and interface to any sub-system Contractors;

5) The Contractor shall produce all detailed design documents and drawings. Full details shall be submitted for approval by the Engineer;

6) The Contractor shall produce detailed documents describing the setting of the

radio and system parameters. Full detail shall be submitted for approval by the Engineer; and

7) The Contractor shall produce all design submissions, as-built documents, and drawings under the requirements of the ERG.

2.4 Performance Requirements

Further to the general performance requirements specified of this Technical Requirements, additional performance requirements for the Radio system shall be as specified below.

2.5 Reliability Requirements

The Contractor shall ensure that as a minimum, each of the Radio systems equipment supplied under the Contract complies with the reliability figures herein:

Table 2.5.1 MTBF Figures

Equipment	MTBF (Hours)
Master Site Central control equipment	> 50,000 hours
Base Station Radio	> 80,000 hours
Radio control panel	> 50,000 hours
Mobile radio equipment in train	> 30,000 hours
Hand portable radio	> 25,000 hours
Hand portable radio Chargers	> 25,000 hours
Radio network management system	> 30,000 hours

The handover success rate should be at least 99.5% over train routes under design load conditions.

2.6 Availability Requirements

In determining the availability of the Radio Systems, reliability block diagrams using field failure rates for commercially available equipment shall be produced. Any degraded mode of operation or re-configuration functions provided by the Radio Systems shall not be included in the determination of the system availability.

The conditions which shall be considered as failures shall include, but not be limited to:

1) Failure to initiate an individual call;
2) Failure to initiate group call;
3) Failure to initiate an emergency call;
4) Failure to initiate system call;
5) Failure to perform dynamic re-group set-up;

6) Failure of any one base station;
7) Failure of control equipment;
8) Radio HMI unable to receive a call; and
9) Failure of data communication for ETCS or ATO

Each of the Radio System shall have an overall availability of better than 99.98% based on the Signaling availability requirements.

The Radio Management System shall be considered unavailable if any of the functions provided by the system cannot be properly exercised. The availability of the Radio Management System shall be better than 99.98%.

The Radio System interface to the following systems shall have an overall availability of better than 99.98%:

1) Telephone system;
2) BTS System;
3) Train-borne PA/IPS System;
4) Station PA System;
5) Adjacent Radio System; and
6) Train control and signaling system including adjacent projects.

2.7 Maintainability Requirements

The Mean Time to Restore (MTTR) of the Radio system to full normal operation following a failure shall be less than four hours.

2.8 System Safety Requirements

All equipment must comply with, and be installed in conformance with IEC 60364 or an equivalent standard inclusive of the Philippine Electric Code, Building Codes, etc.

All metallic enclosures shall be provided with an earth terminal. Earthing of all equipment shall be under the overall guidelines for earthing following the Philippine Electrical Code (2017 Edition).

2.9 Application Program Interface

The Radio System supplier shall submit all Application Programming Interface (API) documentation that shows the functions that will be used in the interface design between the radio and non-radio system, as in the case of the train management system.

2.10 Installation Certificate

The Contractor shall propose Radio Systems which are proven and have been adopted in similar environments. For this, the Contractor shall, as part of their proposal, submit an Installation Certificate proving that from the manufacturer of Radio System being proposed has been used in similar conditions on other Rail Systems. The commissioned system should include Remote Base Stations, Central switches, and Dispatchers. The system must have been in satisfactory service for at least two years after commissioning. The certificate shall be issued by a Competent Authority within the Customer's Organization and submitted for approval by the Engineer.

3. SYSTEM REQUIREMENTS

3.1 General

The Radio System shall be a GSM-R Radio System operating in the designated frequency band for NSCR operation.

Radio Systems shall support both voice/data communications and signaling (Train Control).

The Radio System shall provide a common radio communication platform to all radio users.

The BTS shall relay the audio and data signals between the central equipment at OCC and the base stations.

The CER in OCC shall be equipped with all control and monitoring equipment. The central control system shall be fault-tolerant and in a hot-standby configuration.

All the central equipment and MMI Workstations and control panels shall be synchronized within one second by connection to the Master Clock System.

The radio communications shall be continuously recorded in a digital voice recorder provided in the OCC.

The Contractor shall take note that the following arrangements are in place for the Co-use or Co-sharing of Frequency.

1) The creation of the 100-meter corridor along the NSCR Alignment, measured 50 meters on each side of the alignment.

   • This will be the coverage area of NSCR for their GSM-R Network along the alignment.

   • This will be an area that will be tested and will be set as the "No Interference" zone from Smart.

2) The creation of the 50-meter shroud around the perimeter of the NSCR Depots.

3) The creation of a 10 Km. Buffer Zone measured 5 Kms away from the 100-meter corridor.

   • This will be the spatial separation of both networks as interference protection.

   • No Smart Base Station within this zone should use the frequency band of 875-880 MHz

   • Smart to reconfigure their Base Stations to transmit the 5Mhz LTE band of 870-875 MHz only.

4) NSCR GSM-R RF Design:

   • Minimum design coverage of -95 dBm (ETCS Level 2 -Speed of 160 km/hr.)

   The GSM-R EIRENE System Requirements Specification v16.0.0 UIC-951, Section 3.2.2 defines the requirement for the minimum required signal level of the Base Stations: "Coverage probability of 95% on a coverage level of 41.5 uV/m (-95dBm) on lines with ETCS levels 2/3 for speeds lower than or equal to 220 km/h."

   • Carrier to Interference (C/1) ratio of 15 dB which is a conservative value that accounts for any signal fluctuations, environmental or weather conditions, RX desensitization, etc. The Minimum Carrier to Interference (C/1) is 9 dB as per GSM-R /GSM Standards and UIC Reference 0 -8736-2.0.

• Received Signal from Smart with noise at the radio receiver module: -119 dBm

or less, measured inside the train.

Calculation:

Design Signal Coverage: -95 dBm

C/1: 15 dB

Noise Protection Factor: 9 dB

Allowable Received Signal: -119 dBm or less at the Radio Module)

3.2 Radio System Coverage

Both Radio Systems shall provide coverage throughout the entire elevated/at grade operating area. The level of coverage shall be at least 95% of the time over 95% of the designated coverage area.

The GSM-R Radio System shall cover, but not be limited to:

- The full alignment of the viaduct and any other area with CP04 trackwork;
- All station concourses, platforms, escalators, administration areas;
- All station plant room areas, including passenger entrances at ground level;
- All equipment rooms, ancillary buildings, and any other areas where the operation and maintenance staff may gain entry;
- The whole Depots including inside buildings on all floors;
- At grade areas and stations within a radius of 250 meters from station entrances; and
- Sufficient overlap for radio coverage shall be provided at the boundaries of NSCR. The Contractor shall interface with the NSCR-N1 Contractor for a detailed radio coverage plan.

The Contractor shall submit to the Engineer for approval, the coverage calculations, and coverage plots (both uplink and downlinks) to confirm that the required RF coverage stated above can be achieved using the Contractor's proposed antenna locations.

The requirements of verification, testing, and commissioning are given in Clause 3.6 of ERT. Also, the Contractor shall conduct continuous radio frequency signal strength tests following the pre-determined paths given by the Engineer. The Contractor shall submit graphs of the signal strength measurement as part of the Partial Acceptance Test Results of the radio systems to verify contract compliance for both Up-link and Down-link signals.

3.3 Functional Requirements

General

The major functional requirements of the train Radio Systems for the NSCR shall include:

1) Instant communication between the Traffic Controller / Chief Controller and other

designated controllers in OCC and Train Operator for operations;

2) Instant communication between designated controllers and the maintenance/ security staff working along the track and at stations;
3) Instant Emergency communication;
4) Communication between maintenance and operating staff working within the Depot areas, mainline and train cabs; and
5) Data communication for signaling, train status information, text messages, and other control and management functions.

3.4 User Access

The following type of MMI / access unit shall be used on the Radio System:

1) Radio Control Workstation (RCW) - The RCW shall have full dispatcher facilities for Controllers through the use of feature GUI.
2) Radio Access Unit (RAU) - The RAU shall provide all individual and group calls, limited call setup, and receipt through the use of a multi-function feature phone facility connected directly to the radio control. This RAU shall also provide a back-up to the RCW.
3) Radio Control Panel (RCP) - The RCP shall be located at Station Control Rooms and other designated locations and provide full fixed and mobile radio functions including Individual and multi-group calls through the use of a multi-phone facility connected to the Radio System by a fixed radio set.
4) Train Radio Human Machine Interface (TR-HMI) - The TR-HMI shall be integrated into the train cab and shall provide train drivers with all call functions via the radio control head.

3.5 OCC Operation

System-wide NSCR control functions for the Radio System shall normally be performed at the IOCC.

3.5.1 Radio Access at OCC / SCR

The OCC shall have various control positions equipped with radio access/control facilities, as required by the operator. The number of control positions shall be determined in conjunction with an ergonomic study to be performed to maximize efficiency for OCC operations.

3.5.2 System Call Types

The Radio System shall enable the following categories of calls:

1) Individual call

The system shall support individual (point-to-point) voice calls between any two parties. The individual call shall be full-duplex; this shall include a call from any radio to and from the RCW. Dedicated Radios may be half-duplex, the Contractor shall propose which staff shall use half-duplex radios for Approval by the Engineer.

2) Group call

The Radio System shall support group voice calls, enabling communication between several users within a pre-defined area, all being members of the same call group. It shall be possible to modify the composition of the call groups within the network. Any user may be a member of one or more call groups. It shall be possible to modify the local area over which group calls are implemented within the network. The system shall incorporate suitable mechanisms to coordinate calls between users intending to speak during a group call. Only one member of the group involved in a group call can speak at any one time. It shall, however, be possible for a Controller to interrupt the talking member. These calls shall be half-duplex and shall be permitted to all users.

3) Broadcast call

The broadcast call shall be a one-way call from a single user to all users of the same call group within a pre-defined area. Only the OCC shall be permitted to initiate a broadcast call.

4) Data Call:

The System shall support the following:

a) Unprotected data

b) Protected data

c) Pre-formatted/pre-defined text status messages from the train radio, hand-portable radios, or the OCC.

d) The system shall have the facility of transferring data from the train to the OCC.

   The system should be supplied with a Packet Data Gateway (PDG) as per ETSI or equivalent standards/guidelines. External access to the Radio System through the PDG shall be firewall protected.

5) Emergency Call

Train-borne mobile, hand-portables, and the Operation Control Center (OCC) shall be permitted to initiate emergency calls. There shall be two types of emergency calls:

a) Train Emergency call: The train emergency call shall be automatically routed to the designated jurisdiction control Traffic Controller; and

b) Shunting emergency call: The Shunting emergency call shall be sent to all users involved in shunting operations.

6) Backup Mode Operation

In case a base station is not available or the radios are out of reach of a base station, the radios shall support a backup mode of operation such as Direct Mode of Operation (DMO) or Roaming on commercial networks.

The radio shall periodically check the availability of a base station. Once a base station is detected again, the radio shall switch back to the normal mode of operation.

The user shall be informed by visual and audible alarms.

This feature might not apply to all users and therefore shall be configurable by the administrator of the system.

The Contractor shall propose the details of the preferred backup mode of operation.

7) Train PA Call

It shall be possible for the OCC to access the Train-borne PA system and make pre-recorded or live announcements to individual trains, a group of trains, or all trains in a section.

8) System Call Requirements

A minimum of eight (8) priority levels shall be available for assignment to radio users of varying importance. Priority-setting shall be configurable from the central control.

The Radio System shall as minimum support the communication between various parties by the following matrix:

Table 3.5.2.1: System Voice Call Requirements

		OCC	SCR	Train	Hand-portable	PBX extension
Voice Calls	OCC		yes	yes	yes	yes**
	SCR	Yes	yes	yes	yes	yes **
	Train Radio	Yes	yes	yes*	yes	yes*
	Hand-portable	Yes	yes	yes*	yes	yes **
	PBX extension		yes		yes **	

* - Calls authorized by OCC

** - Calls between designated radios and designated PBX extensions

All calls initiated by the traffic controller/crew controller/Chief Controller to the train borne mobile shall be able to use either the Train ID or the Radio ID number.

All calls meant for a hand-portable radio shall use the Radio ID Number.

Calls originating from Traffic Controller/Chief Controller and the train radio shall have overriding priority over all other calls.

3.5.3 System Features

1) User Validation

When a user attempts to gain an entry into the system, its Radio identity number (RIN) shall be verified and validated before permitting access to the Radio System. Users without valid RIN shall be barred from accessing the system.

2) Fast Channel Access

The Contractor shall propose the average channel access time, defined as the elapsed time from the push-to-talk (PTT) operation to the time when the originator receives the transmit prompt subject to the availability of a voice channel.

3) Random Retries

If access is not granted on the first attempt, all the radios shall automatically re-send the call request without user intervention. The Contractor shall submit to the Engineer for Approval the details on the number of retries available and the duration during which this occurs.

4) Multi-party Voice Calls

The system shall support multi-party voice communications between up to six different parties. The call shall be half-duplex and shall be authorized by the RCW.

5) Continuous Channel Updating

The control channel shall continuously transmit assignment information allowing a user to join calls already in progress even if a user misses the initial assignment due to a momentary signal fade or other effects.

6) Multiple Priority Levels

A minimum of eight (8) different priority levels shall be available for assignment to users of varying importance. The Radio System's different priorities shall be assigned to each radio and talk group. When the system gets busy, radios with higher priority shall get a traffic channel allocated before radios with lower priority.

Emergency calls are assigned the highest priority. This shall be ensured even as a ruthless pre-emption.

The system shall provide the recent user priority to enhance call continuity. If a call has cleared in a pause in speech, but another user wishes to speak soon after, the priority level of the group is increased for a timed queue. Therefore, call continuity is preserved.

The system shall allow the RCW to interrupt ongoing radio traffic, should it be necessary.

7) Call Queuing and Call-back

When all voice channels have been assigned and the Radio System is fully loaded, new calls requested shall be queued according to its pre-assigned priorities until a voice channel becomes available. Equal priority users shall be queued on a first-in-first-out basis among themselves. The users shall receive a busy tone indicating that the system is currently busy and the call has been queued.

Channels shall be assigned to users, as they become available, according to their position in the queue. The user shall receive a 'call back tone' informing the user that a channel is now available and the call can now proceed.

8) Out of Range Indication

Audible and visual indications shall be available to inform the user when the radio is out of the RF coverage range of the Radio System. The indication shall be generated automatically when a request for the channel is not acknowledged or when the radio fails to receive control channel information. Audible indication shall be automatically disabled after a few seconds while the visual indication shall remain until the radio moves back into the coverage range.

9) User Registration

A user shall automatically be registered after successfully logging on to the Radio System under the RF coverage zone of a base station. The Radio System shall have a record of the location of all active users such that frequencies are assigned only at the RF coverage zone of the base station where group members are present. The Radio System shall not assign a channel at a base station where group members are not present.

The Radio System shall ensure that a user is only registered within one Base Station RF coverage zone at any one time. The registration shall be continuously updated to reflect the current user identities and locations.

10) User De-Registration

The Radio System shall de-register users to ensure that no channels are assigned at a base station unnecessarily. The Contractor shall submit to the Engineer for Approval of the details of the de-registration.

11) Handover

The Radio System shall support seamless handover across all the RF coverage zones of base stations in the Radio System such that all calls in progress regardless of the call types and call modes shall be maintained without interruption to an ongoing call. The Contractor shall submit details of the handover process.

12) Dynamic Re-Grouping

Radios in different talk-groups shall establish a new talk-group automatically on the receipt and acknowledgment of re-grouping instructions sent over the air by the Radio System. There shall not be any limitation on the number of radios in each talk group and the combination talk group arrangements.

13) System Partition

The transceivers of base stations shall be configurable to process both all radio calls and only train radio calls.

14) System Call

A system call shall be a one-way broadcast call to all the radio users in the Radio System. A system call shall be initiated only from the RCW with a predefined priority level.

A system call shall be initiated in a "polite" or "pre-emption" mode from the RCW logged in with the highest priority only. The "polite" mode shall wait until all the radios are idling before the system call can proceed. The "pre-emption" mode shall interrupt all communications in progress and broadcast to all users in the Radio system immediately.

Visual and audible indications shall be available at the called hand-portable radios to inform the users of an incoming system call. The system call shall be terminated only by the RCW that initiates the call.

15) Data Communication

The Radio System shall as a minimum, support the following data applications:

Text Messages:

a) A maximum of 100 pre-formatted messages shall be stored in the Radio system and each message size shall be up to a maximum of 128 alphanumeric characters;

b) The free-formatted message shall be input through the RCW keyboard and each message shall be up to a maximum of 128 alphanumeric characters; and

c) The Radio System shall support at least 64 status messages and each message size shall be up to a maximum of 40 alphanumeric characters.

16) General data applications

The Radio System shall support data communication between the controller and mobile users to cover timetable information and maintenance and diagnostic applications.

17) Call Party Identification for Telephone Interconnect Calls

The identity of the called or calling party shall be displayed. It shall however be possible to prevent identity to certain users from being displayed in calling or called mode.

18) Closed User Group

Any user who is not within the list of allowed users shall not be able to gain access to any of the functions and services provided by the network.

19) Call forwarding for Telephone Interconnect Calls

The Radio System shall allow incoming voice/message calls to a radio to be forwarded or diverted to another radio within the network. It shall be possible for the user who is attempting to forward a call to converse with the intended recipient before forwarding / diverting the call.

The sub-classes of call forwarding to be supported by the network are as below:

a) Unconditional: Automatically forward the incoming call without any user intervention;

b) Busy: Automatically forward the incoming call without any user intervention if the user is busy in an existing call;

c) No Reply: Automatically forward the incoming call if there is no reply from the intended recipient; and

d) Not Reachable: Automatically forward the incoming call if the intended recipient cannot be contacted via the network.

20) Call Hold for Telephone Interconnect Call

The network shall allow the user to temporarily exit from an existing call by putting the call on hold, however, it shall be possible for the user to rejoin the call on hold at any time.

21) Call Waiting for Telephone Interconnect Call

The Radio System shall notify a radio user, who is engaged on an established call, that another call is waiting to be connected.

22) Call Barring

It shall be possible, using a network management system, to prevent individual radio users from making calls to or receiving calls from certain categories of radio users within the network.

23) Base Station Hang Time

The base station hangs time shall be measured as the time taken for the base station in un-squelch status to squelch status in the absence of PTT signal. The base station hangs time shall be configurable.

24) Preferred Control Channel

All radios shall remain affiliate to a preferred control channel of a designated base station if the signal strength is at an acceptable level in all circumstances including the base station in local trunking mode.

When the preferred control channel signal strength falls below the acceptable level, the radio shall affiliate to another control channel with an acceptable signal level.

3.5.4 Radio Control Workstation (RCW) [Dispatcher] Functionality

3.5.4.1 General

The Contractor shall detail the expansion ability of their RCW Dispatcher network within the switch configuration that has been offered. The radio system shall support a hierarchical dispatcher configuration for the OCC. The higher a particular user is in the hierarchy, the greater their priority within the network.

The RCW shall provide controllers with full functionality with ease of operation and enable reliable communication between users. An unanswered call that has not been acknowledged, shall result in an audible "beep" which shall be made periodically until all calls are acknowledged.

The RCW system shall enable as a minimum the types of the call given below to be initiated by the OCC/Chief Controller/Traffic Controller to the Trains. The Train Controller shall be able to establish these calls without knowing the Radio IDs of the radios involved.

3.5.4.2 RCW Call Features

1) All Trains Calls

Fleet call to all Trains. In a fleet call, the system shall guarantee that the entire fleet is available. Before assigning a channel to a fleet call, the system shall wait for all activity on the users of the communications which comprise the fleet to terminate. As active users end their existing calls, they are in effect put on hold, waiting for the remaining users to become clear. The system will not allow any new calls to be made. When all users are available, the fleet call is granted.

2) Train Group ID Call

The Train Group ID is a Radio ID which will be dynamically allocated by the radio system to a particular group of radios installed on Trains.

The Train Group IDs will also be transparent to all the Train controller operators. During normal operation, there will be no requirement for a Train Controller to utilize any of these IDs in calling a particular Train or group of Trains.

The OCC controller shall input the TID in the RCW or the system shall obtain it from Signaling System. The RCW, through the table in the RCW database, will cross-reference the relevant Train Group ID and establish the relevant call automatically.

3) Base Station ID Call

To determine the geographic area from which a call originates the Radio System control shall log which Base Station site all radio users are registered on. This information shall be updated in real-time. The controller using the RCW shall be able to poll a particular user to determine their location.

4) Train Radio Registration

When a Train begins a new run, the radio system shall receive the new functional Train Identity (TID) via the Radio/ATS interface, which will be entered automatically through the ATS. The Radio System shall validate that an authorized TID has been received and shall allocate a Trunking Group ID to the Train.

The TID assigned by the ATS shall be a combination of train number, direction, and crew number.

The Contractor shall interface the radio system with the ATS system for the initialization of TID in the Radio System.

The RCW shall interface with the ATS System to track the progress of every Train throughout the NSCR. The ATS System shall inform RCW of the occupancy of all tracks and the position of all Signaling points. From this information, the RCW shall determine the path of each Train and 'steps' the description of the Train accordingly and display its location on the railway layout map given on the RCW GUI, with its corresponding TID. This real-time train's location updating from the ATS System shall allow on-screen random selection of the train(s) by the train icon(s) to establish the call without having to select the radio base station.

All calls from the train radios shall include corresponding identification numbering to identify the calling radio unit identification. The TID shall be displayed on the RCW display so that easy identification of the calling Train can be achieved. The radio database shall be utilized to automatically cross-correlate the TID with the relevant Radio ID (RIN) and Crew number.

When the train enters the mainline mode and initializes onto the system, the train location with its respective TID shall be displayed on the RCW GUI on the appropriate side of the station corresponding to the directional ID. As the train moves through the network the train and its TID shall move from Station to station on the GUI line display. If a train registers on the system without a TID, the train shall be shown in a different color with the train ID. The TID shall also identify the direction of travel to the system and the system shall place that Train into one of the two groups of UP or Down.

5) Call Logging

The Radio System shall log all call activities, both incoming and outgoing calls, and all status/messages including free text messages for audit trails indicating action, result, timing.

Access to call logs shall be possible using the controllers RCW and centrally in the OCC Central Equipment Rooms.

The call logs shall be maintained in the Radio System for extended periods of at least 4 weeks and can be archived subsequently. The Radio System shall include a utility for log inspection and search. The call logs shall be able to be exported to Microsoft Excel, Access, or similar without interrupting the normal operation of the Radio System.

Call history with an easy-to-read, on-screen listing of all the previous 32 incoming and outgoing calls including emergency calls shall be provided on a separate pop-up window.

The most recent outgoing calls in the call history list shall be on top of the list. The operator shall be able to scroll down.

The controller shall be able to scroll through the call history. Each call log shall identify the source of the call, the time the call activated, and the time of the call being acknowledged by the called party.

The Contractor shall interface the Telephone System with the multi-channel digital voice recorder system installed in OCC.

6) Train PA Call

A sub-window shall be activated when the Train Public Address is broadcast, (either live or recorded). The display shall allow the chief controller/traffic controller to set up and make PA announcements to an individual train, to a selected group of trains, or all trains in the system.

7) Train Intercom Call

In case a passenger uses the intercom on the train, and the driver does not answer within a programmable number of seconds, the cab radio shall automatically initiate a call to the OCC. The RCW shall be able to receive such an incoming intercom call from the train and talk to the passenger.

8) Train Predefined Status / Message Call

The traffic controller shall be able to enter free text messages or select pre-defined status/message by scrolling through the list of Status Messages and then transmit to an individual train, selected trains, or all trains in the section. The received text message must be displayed on the Train Radio Control Panel regardless of whether the target radio user is involved in a voice call. This shall be accomplished by using simultaneous data and voice facilities. A minimum of 40 Status/Messages shall be able to be stored in the RCW. All messages must be able to be acknowledged to enable the Controller to know the message was received.

9) Train Radio Test

A-Train Radio Test feature shall allow the controller to inquire if a Train radio is operational and within the range of the system before sending an important message.

10) Train Emergency Call

The Controller shall be able to acknowledge an emergency call by pressing a predefined key on the RCW keyboard. An emergency call from a train shall have the highest priority available within the network.

A pop-up window scroll bar shall be displayed with visual and audible alerts showing detail of the Train ID location from which the emergency call originated.

The Controller shall be able to acknowledge the call and then select the calling train to activate two-way communication. If such a call is not answered within a pre-defined number of seconds the call shall be transferred automatically to another designated controller.

11) Priority Alert Call

A pop-up window with visual and audible alert shall show details of the Train ID and location from which a priority call was originated when there is an incoming "High Priority" call. The controller shall be able to acknowledge the call and then select to activate two-way communication.

12) Call Inclusion

The Traffic Controller shall be able to perform 'Call Inclusion' to participate in active calls, allowing the use of pre-emption and a forced call clearing capability.

13) Group Patching

The Controller shall be able to perform Group Patching to handle call authorization for specific types of calls and/or specific users.

The RCW shall be able to pre-store configurations of the Patch groups. These shall be preferably stored in folders represented on the desktop. The controller shall be able to click on one of the patch folders to bring that folder forward.

The Controller shall be able to modify the members of the Patch groups by bringing the folder forward; clicking on the Patch Edit button and adding members to the group. Members may be removed from the group by clicking again on an "unselect" option.

The Controller shall be able to perform Dynamic Regrouping for modification of Individual and Group priorities.

The Controller shall be able to regroup the talk-groups dynamically to allow flexible and versatile group communication. Group call shall be on an "Everyone hears Everyone" basis in line with traditional open channels. Group call communication shall be achieved by pressing a PTT switch following the selection of the group.

14) Calling Party Identification

The RCW shall include Calling Line Identification to display the calling user identification and which Radio Base Station is used.

The RCW shall include Connected Line Identification to display the called user identification for Telephone Interconnect Call.

15) Late Entry Facility

Late Entry Facility shall be provided for users that are busy or unavailable at the time a group call is established. They shall be invited to join in the call at regular intervals for the duration of that call.

16) Hold Function for Telephone Interconnect Call

The RCW shall allow a call Hold function.

17) Call Forwarding for Telephone Interconnect Call

The RCW shall allow Call Forwarding to another Controller if a controller is busy or does not reply with a predefined period.

18) Remote Radio Activation

The Controller shall be able to remotely switch on the microphone and transmitter of the Train radio or Hand-portable and listen to the received audio.

19) Train Radio Status Call

The train driver shall be able to send pre-defined status messages to the OCC Traffic Controller. The System shall support a minimum of 64 Status messages. The status messages shall be proposed by the Contractor.

20) Dynamic Time-out Disable

In emergencies, the system shall be able to cancel the dynamic time-out feature on the radio base station.

21) RCW-ICONS Toolbar

A toolbar is a row of icon buttons at the top of the screen to perform all the RCW call functions shall be provided and shall also include the following buttons. The finalized identification and wording of the buttons shall be given a Notice of No Objection by the Engineer. As a minimum these shall include the following:

a) All Mute;

b) Monitor;

c) Transmit;

d) Telephone Dialer;

e) View; and

f) Time Out.

22) RCW Side menu

A side menu panel shall be provided on the display to allow the type of call to be selected such as free form PA, pre-set PA messages (digital voice stored on the DVA), normal voice, status, priority, or emergency calls.

23) RCW Window templates

The Controller shall be able to set up individual user screen configurations, i.e. different controller window templates. The terminal shall save and recall up to eight different user-defined screen layouts, allowing different controllers to quickly call up preference files based on the log-in role of the controller.

The RCW shall allow different configurations of built-in help functions, designed to assist the controller.

24) RCW Log-on Facilities

The RCW shall incorporate Access Control features and bring up a password-protected Log-on dialogue box to provide access control and security and validation of access permissions when the system is switched on so that the RCW is set to the default condition for all available buttons and actions.

A password-protected exit dialogue box shall be provided and be activated when the exit button is pressed to ensure that the user wants to exit the system.

It should be possible to take over control of another RCW while also retaining its own RCW's control. On taking over control calls should be routed to both the RCWs.

25) RCW Display

The RCW screen display shall be designed to be uncluttered, well-labeled, and logically arranged for ease of use to help the OCC controllers to respond instantly, even during emergencies.

The RCW display shall include the display of a 24-hour format clock in the top right-hand corner of the screen.

3.5.5 Train Radio Operation

The Contractor shall be responsible for the design/application engineering, retrofitting, supervision, testing, and commissioning of the complete Train-borne Radio Communications System.

The Complete Train Radio System shall be installed in both the leading and trailing cabs operating in hot-standby mode to each other but shall be fully independent of each other. The Contractor shall use the train line between the front and rear cabs, for the Train Radio hot standby features. The Train Radio along with TR-HMI, TRIU, etc. shall be provided in the Rolling Stock. Therefore, the physical dimensions, positions, mounting holes, antenna type, cable routes, cable lengths, cable/pin connections to the Rolling Stock PA/TMS systems, protocols, exact data to be exchanged, etc. are to be interface with the Contractor. The Train Radio Interfacing Unit shall monitor the health of the radio transceivers and all other data interfaces to the train-borne Signaling system and shall enable switching to the standby transceivers upon detection of communication failure.

The train radio operates by train ID number talk group communication between two train radios or train radio and hand-portable or train radio and maintenance vehicles; this shall take place only when authorized by the OCC.

Incoming calls to the train radio shall be automatically routed to respective train users/devices such as train drivers, PA systems, Data Systems. Outgoing calls initiated by on-train users/devices shall be automatically established. Calls of varying priorities shall be handled automatically.

Emergency calls including activation, termination, and failure of the emergency call shall be recorded in the event recorder of the trainset. A continuous visual indication from initiation to termination and short audible indication for the duration of up to 20 seconds shall operate on the activation of emergency functions. The audible indication shall appear on the loudspeaker when the handset is on hook.

Automatic confirmation from each radio on receipt of an emergency call from the RCW shall be used to provide a means of determining which train radio receives the emergency calls successfully.

During the broadcast call, the driver shall be prohibited from interfering with the broadcast call. However, in the case of the group call, the driver shall be permitted to talk upon request.

An audible and visual indication from the train radio shall be given to the effect that called party is busy or the network has failed to connect the call.

1) Train to Train call

a) A train radio shall be able to initiate and establish a call to other train radio with a minimum of action like a single keystroke;

b) The calling train radio ID number shall be displayed on the called radio;

c) Once connected, the driver shall be able to communicate with other drivers (s) by using the push to talk button on the handset in full-duplex mode when using the gooseneck microphone;

d) The call shall be connected to the loudspeaker until the driver picks up the handset. Once the driver picks up the Handset the speaker volume should automatically be lowered down;

e) The call shall continue until terminated by the calling driver, an authorized controller, or the network; and

f) If the train moves out of the call group area whilst the call is in progress, an audible and visual indication of the reasons for the loss of the call shall be provided to the driver.

2) Train to other Authorized Users

The train radio shall be capable of initiating and establishing a call to any valid number subject to predefined call restrictions. The call may be initiated by:

a) Selection from a predefined list (up to 999 entries);

b) Direct dialing a subscriber number; and

c) Calling a functional number/Radio ID number.

3) Receive Text Messages

This shall be a normal SMS received by the train radio and displayed on the TR-HMI display window and shall be accompanied with an audible sound;

The message shall be cleared from the display window automatically and stored for retrieval after being displayed for a configurable period or after having been acknowledged by the driver; and

A maximum of five messages shall be stored for retrieval.

4) Registration of Train

a) The registration of the train shall be initiated by the Driver through a dedicated function key on the TR-HMI at the commencement of each journey on the mainline.

b) For successful log-on for a mainline mode of operation, the train control and signaling system (ATS) shall assign a train identification number (TID) through the interface with the radio system. TID shall also be received from onboard ATC by the onboard radio system which shall be transmitted to OCC by the radio.

c) The TID information from the ATS and the TID information received from On-Board ATC shall be validated after which log-on is treated as successful and the TID is shown on the TR-HMI. The Radio System shall maintain a correlation between the Radio Identity (RIN) and the Train Identity (TID). The exact details shall be finalized during the final design stage.

d) Both visual and audible indications shall be available and displayed on the TR-HMI to inform the driver that the log-on request is in progress.

e) Different visual and audible indications shall be available to inform the driver for both successful and unsuccessful log-on.

f) After successful log-on, the Train Identification Number (TID) shall be displayed on the TR-HMI and the OCC Controller shall be able to initiate a call to the train radio by TID from the RCW or RAU.

5) De-Registration

a) The Radio System shall delete the TID upon receiving the deletion of TID from the train control and signaling system. Both visual and audible indications shall be available and displayed on the radio control.

b) The visual indication shall include a warning message together with the TID displayed on the TR-HMI for a configurable period. After this period, both the TID and the warning message shall be automatically removed while the TR-HMI shall display the Radio Identification Number (RIN) of the Train radio.

6) Train Reformation

a) The TID of the Train radio shall be subject to change in the mainline mode of operation when the need arises.

b) Upon receiving the change of TID from the onboard signaling system, the Radio System shall update the TID accordingly.

c) Both visual and audible indications shall be available at the TR-HMI to inform the Driver of the change of TID.

d) The visual indication on the TR-HMI display shall include the following for a configurable period as a minimum:

i) New TID;

ii) Old TID; and

iii) Warning message.

e) After a configurable period, the old TID and the warning message shall be automatically cleared from the display while the RIN of the train radio shall be displayed on the TR-HMI.

7) Register/De-register Train Number

a) There shall be a fixed relationship between the RIN of the radios installed in the Cab and the Train number, which shall remain even if the radio is changed.

b) It shall be possible to register and de-register a train number in one or both of the following ways:

c) Automatically using information from onboard systems, and

d) Automatically via a fixed interface between the train and the radio.

8) Depot Mode

The Train radio in Depot mode shall as a minimum have the following features:

a) Shunter Call

i. The call shall be initiated through a function key on the TR-HMI to the shunter group. The call shall allow direct communication with the shunter on a group call basis without the intervention from the radio MMI Controller.

ii. A maximum of one or two keystrokes shall be allowed to initiate a normal and emergency call correspondingly;

iii. The shunting communication shall be protected from unintentional and unauthorized access; and

iv. It shall be possible for any member of the shunting group including the driver to transmit a shunting emergency call to all shunting groups in the area.

b) It should be possible for the system to record the following:

i. Shunting group composition at a given instant;

ii. The source and a time a shunting emergency call were transmitted;

iii. Recipient of a shunting emergency call; and

iv. Recipient of a shunting call.

9) Shunter Group Membership

A shunting group shall as a minimum consist of the following mobile members.

a) The shunting leader;

b) The shunting driver, who may remain fixed (i.e. in a shunting area) or may change one or more times during a working period; and

c) Up to 5 shunting members.

In addition to the above shunting group members

a) A controller shall be able to be permanently or temporarily associated with the shunting group; and

b) A shunting manager or other authorized person shall be able to temporarily associate with the shunting group.

It shall be possible for the shunting leader to communicate with an external authorized person. This may be initiated by either the shunting leader or the external user. To avoid disturbing a shunting movement the shunting leader shall be informed by a visual and audible indication. The shunting leader can then choose the moment when the external user can join the shunting group.

10) O&M Call

The call shall be set up through the radio MMI in a common Talk Group or using DMO without the intervention of the MMI to allow the train driver to communicate with other personnel using hand-portable radio.

11) Entering the Depots from Main Line

a) The Train Control and Signaling System shall send a signal to the Radio System for deletion of TID when the train is entering the Depot boundary from the mainline;

b) The train radio shall de-register from mainline mode and register to Depot mode automatically;

c) Visual and audible indications shall be displayed on the radio control head to inform the driver that the registration request is in progress;

d) Different visual and audible indications shall be displayed for successful and unsuccessful registration; and

e) Depot identifier and the RIN of the Train radio ID shall be displayed on the TR-HMI after a successful registration.

12) Numbering System

The numbering system for the shunting team, maintenance team, controller, and others shall be based on the functional description as follows.

a) Every shunting team number shall be based on an association of

   i. Service area identifier, and

   ii. Shunting team identifier.

b) Every maintenance team number shall be based on an association of

   i. Service area identifier;

   ii. Type of maintenance team (specialty code); and

   iii. Maintenance team identifier.

c) Every controller number shall be based on an association of

   i. Controller location; and

   ii. Controller identifier.

d) The numbering for other teams shall be treated in the same manner as the maintenance team.

13) Use of alphanumeric numbers

The Train Identity Number (TID), Radio Identity Number (RIN) shall be alphanumeric. The Train ID will comprise up to 10 alphanumeric characters or as requested by the Operator.

3.5.6 Hand-portable User Radio Calls

3.5.6.1 General

The Contractor shall supply different types of hand-held radios, such as:

- General-purpose radio;
- Operational radio; and
- Shunting radio.

Each of these types of radios has specific features. quantities and features of each type of radio shall be proposed by the Contractor, subject to approval by the Engineer. The handheld radios shall support the following call features. These features shall be configurable through radio field programming tools and also through the workstation of the radio management system. Hand-portable radio users shall be able to call other radio users and OCC subject to their level of access.

The Contractor shall configure all the call features nominated by the Engineer. A short audible and visual indication of the functional identity of the calling party/group shall be displayed for each call.

3.5.6.2 Call Types

The hand-portable radio shall support the following voice communication as a minimum:

1) Individual Call
   a) The individual call shall allow two users to talk to each other on a one-to-one basis; and
   b) The conversation of the individual call shall not be heard by other radio users in the talk group.
2) Group Call
   a) Radio users shall normally communicate with each other in a single group. All radio shall be pre-programmed to belong to several groups;
   b) A group call shall be initiated by selecting the desired talk group position on the hand-portable radio and depressing PTT;
   c) The user may speak in a group call when permission in the form of audio indications is granted by the network after the request by using the PTT function; and
   d) An out-of-range indication shall be provided when the user moves out of the group call area whilst the call is in progress.
3) Broadcast Calls
   a) The user shall be informed that they cannot speak as part of the broadcast call.
4) Emergency Call
   a) Emergency call shall be initiated by hand-portable through a dedicated function key and depress PTT as a group call;
   b) When all the channels of the base station are occupied, ruthless pre-emption shall allow the emergency call to take the occupied channel away from the lowest priority talk group at all affiliated base stations to provide instantaneous emergency voice communication;

c) Visual and audible indications shall be available at the called hand-portable radios and/or the OCC to inform the radio users of an incoming emergency call;

d) Emergency calls shall be in the form of group or broadcast call; and

e) The emergency call shall be terminated by the calling party only.

5) Shunt Call

Shunt calls shall be initiated by hand-portable through a dedicated function key and depress PTT as a shunt group call;

3.5.6.3 Hand-portable Operation

1) Enter/Leave Depot Mode

a) Hand-portable radio shall support a Depot mode of operation in a separate Talk Group;

b) Means to enter and leave Depot mode shall be provided; and

c) This functionality shall not be available when a call involving the hand-portable radio is in progress.

2) Register/De-register

The RCW at the OCC shall be capable of registering / de-registering / changing the functional number of the hand-portable radio.

3) Station Radio Communication

a) The station controller in the SCR shall be able to communicate with the adjacent stations and the trains within its station boundary; and

b) The station controller in the SCR shall be able to transmit short text messages to any hand-portable and Train Radio and to receive such messages from other radio users in the network.

3.6 Network Management System

3.6.1 General

The Radio Network Management System shall cover all activities relating to the overall control, supervision, maintenance, and configuration of the entire radio network to ensure the most efficient use of the available resources.

The Radio Management System shall be a centralized control system with Management Workstation, system database, log printer, and mass storage device to be located at the CER at OCC.

A database shall be built for defining the system hardware and software 6configurations. Any change in the database shall be updated automatically on the system disk or mass storage device so that an up-to-date version of the software is available should a system failure or power-down event occur.

3.6.2 Radio Network Configuration Management

The management system shall provide functions to exercise control to collect and provide information to the network elements. Typical functions offered shall include, but not be limited to:

1) Provisioning, element configuration, status, and control;
2) Subscriber management; and
3) Data management.

The radio network provisioning, element configuration, status, and control shall include but will not be limited to the following:

1) Creation, modification, deletion of supervised entities (e.g. site, transceiver, radio channel, etc.);
2) Control channel management strategy;
3) Traffic channel management strategy;
4) Network topology information; and
5) Adjacent cell information at system boundary.

Subscriber management shall include management of individual subscriber and subscribers in groups:

1) Individual subscribers
   a) Train-borne mobile radio;
   b) Controller;
   c) Trackside worker;
   d) General staff;
   e) Data services; and
   f) Administration/management.
2) Subscribers in groups
   a) Mobile may be a member of more than one group. It shall be possible to activate/deactivate the mobile's subscription to these groups;
   b) Activating a group on the mobile shall allow a user to receive a call from that group; and
   c) Deactivating a group on the mobile shall prevent a user to receive a call from that group.
3) The train-borne mobile radio shall as a minimum be a member of the following standard groups
   a) Emergency call;
   b) All train drivers;
   c) Shunting team; and
   d) All mobiles with emergency group call subscriptions shall be prevented from deactivating the emergency group whilst in operation.

Database administration shall include but not be limited to:

- Creation of data for new subscribers, including all privileges, priorities, and subscribed services;
- Disabling of the subscriber;
- Updating of subscriber data in terms of subscriber and operator requirements;
- Deletion of subscriber data due to a subscriber request or operator description; and
- Call usage.

3.6.3 Performance Management

The performance management shall provide data concerning the performance of the Radio System and individual channels to traffic volume to optimize the system configuration, equipment deployment, user grouping, and future sizing of the Radio System.

The performance management shall produce statistical reports on the channel usage and the Radio System performance. The performance management shall have facilities to monitor base station channel traffic on a real-time basis. This will allow for flexible adaptation of traffic configurations to the dynamic traffic requirements. This shall include the following:

1) Traffic measures for data collection and data logging. In particular, the following information shall be available:
    a) Uplink and downlink radio channel activities;
    b) Infrastructure entities activity log;
    c) Individual subscriber activity log; and
    d) Group subscriber activity log.

2) The traffic activity summary report shall have a detailed breakdown of traffic information by a base station, Network node, Gateway/interface, and channel. The following data shall be recorded as a minimum:
    a) RIN;
    b) Talk group ID;
    c) Time, date, and duration;
    d) Type of call;
    e) Base station and channel involved in the call;
    f) Usage time of each channel;
    g) Traffic summary for each channel for 24 hours period at 15 minutes interval; and
    h) Usage time of radio.

The following statistical reports shall be available as a minimum:

a) Hourly;
b) Daily;
c) Weekly;
d) Monthly; and

e) Summary.

Administration of the following performance measurements shall be provided as a minimum:

a) Generation of new measurements;

b) Remote measurements;

c) Activation/deactivation of measurements;

d) Information processing of traffic measurements;

e) Automatic creation of statistics performed by the system administrator;

f) Presentation of statistical data; and

g) Logging of connectivity parameters.

The performance measurement data generation shall cover at least the levels of traffic produced by the users and by control Signaling. This shall include the following:

a) Number of active individual users per base station;

b) Number of registered individual users per location;

c) Number of active user groups per base station;

d) Number of queued call requests by call type and average queued times per base station;

e) Number of emergency calls per individual user and active talk group;

f) Number of single-site calls and average duration;

g) Total number of uplink data messages per user group; and

h) Total number of downlink data messages per user group.

Measurement of service quality shall include the following:

a) Average and worst-case call waiting times for different call types, priority levels, supplementary services invoked per base station;

b) Lost-call rate on random access; and

c) The blocking rate corresponding to failed attempts due to the non-availability of radio or line resources. The system will queue the call request and then subsequently reject the request if the resources do not become available within the time-out period.

Measurements on network aspects shall include the following:

a) Percentage utilization per radio traffic channel;

b) Percentage utilization per major network entity (gateways, interfaces, switches);

c) Random access channel collision rate;

d) Random access channel throughput;

e) Random access channel percentage utilization;

f) Average queue length per priority; and

g) Average queue time per priority.

Measurement of system availability shall include but will not be limited to the following:

a) Provision of radio Tx/Rx availability statistics;

b) Provision of network node availability statistics; and

c) Network link availability.

3.6.4 Security Management

The security management functions shall be, but not limited to the following:

a) Definition of different levels of permitted access to network nodes and network functions by a specific authorized personnel.

b) Supervision of access control.

c) Access control to network management services.

Please refer to ERT-219, Section 3.5.6-Information/System Security (Cyber-Security/ UTM) for a complete Security Management requirements.

3.6.5 Log-On Levels

The radio management system shall offer the levels of log-on as a minimum as per the following:

Table 3.6.5.: Levels of Log-on (for reference only)

Log on Level	Control Functions
6	System administration for all system functions
5	Maintenance administration for system configuration and user data modifications
4	Maintenance supervision for user data modifications and read-only to system configuration
3	Maintenance monitoring for read-only to system configuration and user data
2	Spare
1	Spare

3.6.6 Fault and Alarm Management

1) Fault and Alarm Monitoring

The radio management system shall be provided with the capability of monitoring system alarm status on a real-time basis.

The radio management shall have the ability to store the alarm details in the database for future inquiries and to access the fault alarm history database for retrieval of alarm history data.

In addition to the alarms and status to be shown on the management workstation, the status of the major equipment of the system shall be monitored and displayed with audio and visual indications to the local radio equipment racks.

2) Alarm Handling

The functions for alarm supervision shall include, but not be limited to the following:

a) Supervising individually the functionality of each system up to Base Station level, including monitoring and control of transfer links, power supplies, antennae, and other equipment;

b) Performing fault recognition in real-time; and

c) Investigation and localization of failures up to the PCB level.

The following are the conditions as a minimum shall be provided to the radio management system:

a) Loss of communication links;

b) Loss of master clock synchronization;

c) Failure of power supply unit;

d) Changeover of fault tolerance central equipment;

e) Base station health status;

f) Receiver coupler health status through an RF distribution system fault status;

g) Central equipment health status;

h) Low power and no power alarms for all transmitters;

i) Indication of receiver failures; and

j) Internal diagnostics failure result for radio, control console, interface, or gateway equipment (or Mobile/hand-portable to the user).

All failure alarms shall be time and date stamped.

The failure alarms shall be classified into major or minor alarms by the radio management system and be user-configurable.

Visual and audible indications shall be available for any failure alarm reported to the radio management system. The audible indication shall be enabled and disabled through the radio management system Workstation.

The alarm log shall display the following as a minimum:

a) Description of the alarm;

b) Time and date of the alarm generated;

c) Time and date of the alarm acknowledged; and

d) Time and date of the alarm rectified.

The alarm history database shall be provided with sufficient capacity to store the reported alarms for at least four weeks without carrying out any housekeeping function. The radio management system shall have a summary alarm in the form of a pair of dry contacts or similar devices terminated on the MDF inside the CER. The dry contact or similar device shall be triggered whenever the radio management system has detected an alarm from any equipment at any location. The dry contact or similar device shall be latched until all alarms have been rectified.

3) Alarm Displays

The Contractor shall provide as a minimum, the following general capabilities, and characteristics for the alarm display:

a) The ability to quickly filter the alarm display to view alarms generated from a particular system component or by a geographic location;

b) A color-coding scheme indicating the alarm severity according to the alarm classifications and alarm priority levels;

c) The display of the alarms in chronological order along with their associated timestamps;

d) A scrollable interface, to allow the radio management workstation user to view more alarms that can directly display on one a single screen; and

e) The facility to acknowledge alarms.

4) Fault Printing

The radio management system shall be equipped with a common maintenance printer for the production of hard copies of graphical screen information, system parameter data, maintenance fault history, listing of pre-defined system information, and various performance management reports. The maintenance printer shall be connected to the radio management system workstation.

The log printer connected to the radio management workstation shall print out real-time logging of the maintenance activities as well as fault events.

5) Field Programming

All the radios including a base station, hand portable radio, and Train radio shall have a port for field programming and diagnostic access through a notebook computer. The Contractor shall provide two (2) notebook computers complete with all the necessary software and hardware.

All the radios in the system including, base station, hand portable radio, and Train radio shall be based on a flexible software design to allow programming by a notebook computer.

As a minimum, the following radio parameters shall be configurable into the radio base station and Cab radio:

a) RIN;

b) Talk group;

c) Transmitter output power;

d) Operation frequency;

e) Receiver sensitivity;

f) Frequency deviation;

g) Squelch level; and

h) Uploading and downloading data to a secondary storage device.

The Contractor shall submit a detailed field programming parameter of all the radios for Approval by the Engineer

6) Diagnostic

The fault diagnostic shall perform the following as a minimum:

a) Provide testing to the individual module and card level (FRU);

b) Provide on-line diagnostic help to maintenance personnel through the local maintenance port within each CER and remotely from the CER in OCC only via the centralized radio management system maintenance workstation for the base station only; and

c) Provide self-test facilities and built-in diagnostic routines to enable malfunctions to be automatically displayed and updated.

4 DESIGN / APPLICATION ENGINEERING REQUIREMENTS

4.1 General

The Train Radio System shall conform to all the relevant and current ITU-R, ITU-T, ETSI, and UIC Standards and the National Standards in the country of which the system is being implemented.

Manufacture and assembly of all equipment shall be done incorporating standard current practices adopted by the International Electro-Technical Commission (IEC)/ISO 9000 or an equivalent standard.

The Radio System shall meet the technical system performance and equipment specification as specified herein.

The Radio System shall be supplied with fault-tolerant system architecture to prevent common mode failure to ensure continuous operation with minimal loss of facilities in the event of equipment failure.

The service life of the Radio System shall not be less than 15 years.

The Contractor shall obtain type-approval for all the equipment from the Engineer and assist the latter, on frequency assignment and radio equipment license application.

The system shall be expandable at least up to 1000 terminals without the need for modification, or software upgrade.

The software shall be designed to accommodate the ultimate, fully expanded capacity, without requiring any change to the hardware or firmware of the installed system and without affecting the overall operation or performance of the Radio System.

The system shall be designed to allow ease of use by the users of the system.

The system shall provide facilities to allow ease of maintenance and full reporting of system status derived from the NMS.

The equipment shall be reliable in use and as a minimum meet the failure rate figures defined in Table 1-1 Appendix 2 of this Technical Requirements.

The system shall be inherently resilient and was reasonable not affected by faults on other systems.

The system shall be safe in operation and shall not place users at risk.

The system shall interface with other systems as defined in Table 1-2 Appendix 2 of this Technical Requirements. These interfaces shall be designed into the system to provide reliability and resilience.

The Contractor shall implement the software management and control requirements detailed in the ERG.

Train cab radio shall have a higher priority on all radio channels, that is, the first free channel shall, on-demand, be allocated to the train cab radio.

An emergency call shall, in the event of all channels being busy, be put through immediately by forcibly disconnecting any ongoing call.

Calls from the train cab radio shall be automatically routed to the console of the allocated Traffic Controller and the Chief Controller at the OCC. The Chief Controller shall have the provision of taking over the functions of any of the Traffic Controllers in their absence.

The Signaling between radio base stations and train mobiles, and/or portables shall conform to local and international standards.

4.2 Preliminary Investigation

Prior to the design, the Contractor shall survey the entire NSCR project area and design the GSM-R network to avoid any buildings, obstructions which may potentially affect the transmission of the network, while noting that the Spectrum Committee composed of DOTr-PNR, Contractor and Public Telecommunication Entity, under the supervision of the NTC, will take all responsibility to remove any frequency interference.

The Contractor shall perform several tests and investigations to determine if the allocated frequencies are clear to use for a reliable GSM-R. The Contractor shall also determine any signal disturbance and potential interference, whereby the Contractor shall implement appropriate mitigation measures except for any problems related to the usage of the frequency band should be addressed by the Employer.

The results of the survey, test, and investigation shall be reflected in the design of the system. The results shall be provided to the Engineer for review to include them in the design of the system.

The Contractor shall participate in the Spectrum Coordination Committee in which any interference between GSM-R and the Public Telecommunication Entity is coordinated and discussed.

4.3 Possible Future Problems Related to the Usage of Frequency Band

Any possible future problems related to the usage of frequency bands shall be addressed by the Employer instead of imposing a burden on the Contractor.

The Contractor shall participate in a detailed survey taken under the supervision of NTC to identify any potential interference along the NSCR corridor and fully participate, with other involved parties, to ensure that there will be no interference that will affect the implementation and operation of NSCR's GSM-R System.

4.4 Frequency Planning

The Contractor shall perform radiofrequency planning ensuring efficient use of the available frequency pairs. The frequency plan including detailed calculations shall be submitted to the Engineer for approval.

The system design shall have suitable safeguards to ensure that the operation of a radio set from any other system is either debarred, or its operation does not affect the operation of the Radio System of the NSCR in any way.

The Contractor shall enclose detailed calculations or field tests to establish that there will be no interference from other radio communication links operating in this area in the same band of frequencies.

4.5 Central Switching Equipment Specification

4.5.1 General

The central switch equipment shall be highly reliable, fault-tolerant, and capable of supporting non-stop on-line call processing.

The central switch equipment shall be provided with a hot standby with an automatic changeover in the event of a failure of the working unit.

The critical hardware modules including a central processing device, data bus, and memory device shall be redundant with built-in diagnostics software to ensure continuous operation in single or multiple module failures.

Central switch equipment changeover between main and hot standby shall occur without interruption to the call processing.

The central equipment hardware and software shall be of modular design for ease of future expansion.

The central equipment shall have a duplicated database for the storage of system application software, call processing, radio-location tracking, channel allocations, and diagnostics.

The central equipment audio switch shall be non-blocking to allow any port to be switched to any other port without any predefined limitation.

The links between the central equipment and the audio switching equipment shall be fully duplicated.

The Contractor shall provide the equipment for interfacing the switching controller into the BTS.

There shall be no limitations on the distance of the link between the switch and base station.

4.5.2 Built-in Test Routine

The central equipment shall have built-in test routines for the testing of base stations, user interface control equipment, and central switching equipment of the Radio System. These routines shall be operated in an off-line mode to allow a complete functional test of the module in the problem.

The built-in test routines shall be initiated by the following as a minimum:

1) Local maintenance commands via a notebook computer connected to the local maintenance port;
2) Remote maintenance commands through the radio management system workstation;
3) Self-initiated as a result of the on-line error detection; and
4) Self-initiated as part of the power up-initialization process.

4.5.3 Audio Logging

The Contractor shall provide the interface facilities for audio logging of the Radio System channels. Audio logging shall be achieved using the centralized digital recording system as provided in the OCC.

4.6 Radio Control Workstation (RCW)

4.6.1 General

A self-diagnostic test shall be performed automatically upon every initialization of the RCW readiness state.

The fault and self-diagnostics information shall be processed and displayed on the RCW to indicate the status of the RCW.

The RCWs shall be designed for 24 hours per day, seven days a week continuous operation, with an equipment design life of at least ten years.

All RCWs shall be designed and built to the same specification and shall be fully interchangeable. The Contractor shall ensure that they are operationally and mechanically compatible.

All RCWs shall be possible to allow OCC to assume or relinquish command and control from one OCC controller to another or possibly to only one controller managing the whole fleet of trains and hand portables on the mainline.

RCW shall be able of suppressing data tone signals, interference noise, and squelch bursts to avoid discomfort to users wearing headsets and reduce ambient noise in the control center.

It shall provide directional loudspeakers and restrictions on volume settings to keep the noise levels in the control center at a minimum.

Volume controls shall be readily and constantly accessible.

Sound fields shall be generated on loudspeakers, headset, or both simultaneously.

All OCC controller activities shall be logged for audit trails indicating action, result, timing, and responsibility. The logs shall be maintained in the NMS for extended periods and can be archived subsequently. The NMS shall provide a utility for log inspection and search.

The RCW shall be a self-contained sub-system which shall interface to the central radio control equipment, equipped with a gooseneck mic, select and unselect speakers, headset, PC, console Interface, etc.

To maintain operational independence for maintenance and failure scenarios the RCW shall be a fully self-contained sub-system and its failure shall not impact call-processing elements of the radio communications system.

Failure of the RCW infrastructure shall not impact mobile and hand-portable calls using the Radio System Infrastructure.

Software upgrade or modification of the RCW sub-system and the radio communications system shall be independent and loading on one network should have minimal effect on the performance of the other.

The RCW control equipment shall be in a hot standby configuration.

4.6.2 RCW / ATS Interface Functions

To achieve trains calling via a point and click facility on the RCW using the on-screen Train icons, the RCW shall be required to handle the real-time trains running and location information from the ATS system.

The Contractor shall be responsible for the design of a hardware and software interface with the ATS system.

The Contractor shall provide and install the interfacing cables, connectors, and mounting hardware deemed necessary to interface the Radio System with the ATS System. A communication port shall be available from the ATS System for train running information to the Radio System.

The data shall be capable to be transferred in ASCII format.

All information received from the ATS shall be logged.

4.6.3 RCW Functionality

The RCW functionality shall include, but not be limited to the following:

1) Integrated Radio access through a Graphical User Interface (GUI);
2) Transit Management System;
3) Train ID Number/Train Radio ID correlation and management;
4) Management of interface with Automatic Train Supervision system;
5) Dynamic call set up;
6) Text Transmissions;
7) Status Message selection and initiation;
8) Emergency Call Handling;
9) Call hold, Call queuing, Call waiting and Call Re-routing;
10) Database of all Rolling Stock and Train ID Number Assignment; and
11) Graphical display of trains location superimposed on track/station layout.

4.6.4 RCW Call Initiation

It shall be possible to initiate calls via screen selection using mouse/trackball. Normally the RCW shall be used to initiate calls to train-borne radios. However, it shall be possible to initiate a call to all radios by their RIN/functional identity number.

An additional display window shall show all associated TIDs, with direction IDs and corresponding Train IDs, and all Hand-portables when the Controller activates Radio Base Station on the screen, and it shall be possible to initiate a call to such train radios by TIDs and the hand portable radios by their RIN so displayed on the screen.

The RCW shall enable a silent radio check initialization. The RCW shall receive an acknowledgment from the target radio if it is turned on and within the system's coverage range.

The RCW shall display all Radio Base Stations' current status when requested and display high-level alarms when faults are detected in the radio Communications System by the radio NMS.

In general, when an alarm is raised and an audible and visual alarm shall sound and an alarm indication on the display commences to flash and shall give a description of the fault. Keying-in the "Cancel Alarm" command on the display shall stop the audible alarm and the alarm display shall change to steady. The alarm display shall disappear after the fault is rectified.

Incoming train voice and data calls shall be displayed in an incoming call window on the RCW of the Controller responsible for that track section with an audible ringing tone and indicate by color change of the Radio Base Station through which the calling train is currently working.

Incoming calls from hand-portables shall indicate the Caller ID, the location the person is operating from, and the call type.

Telephone interconnect (PSTN/PBX call) shall be provided and include patching between radio users and telephone landline users. The Controller shall be able to include a third party so that three parties can be included in a conference-type call. The Controller shall be able to leave the call, whereupon the call continues between the other two parties.

4.6.5 RCW Servers

The Contractor shall provide a flexible and structured RCW system that operates on the server network using a Windows operating system. The duplicated RCW Servers shall be located in OCC.

The RCW Servers shall be in a fully redundant configuration with 'hot standby' features whereby recovery of a failed hardware or software component can proceed without interruption of operations. Moreover, there shall be one RCW server that will operate in the "master" state, processing network traffic while a second RCW standby server operates in the passive "standby" state. In the event of failure of the master RCW server the standby RCW server shall automatically assume master status and resumes processing network traffic. The clock timing of the RCW Servers shall synchronize with the NSCR master clock system.

4.6.6 RCW Hardware

The Control Center users shall be able to access the RCW server and the voice dispatch system from a single RCW and the RCWs shall be networked together via a redundant LAN/Ethernet.

Each RCW shall be equipped with the following as a minimum:

1) Keyboard;
2) Mouse or trackball as the pointing device;
3) Headset with microphone and loudspeaker;
4) Loudspeaker;
5) Desktop noise-canceling microphone with integrated PTT switch or gooseneck console mic with a separate PTT; and
6) Data interface socket.

All functionality accessible via the pointing device shall also be available through the keyboard via configurable (hot) keys and /or via keyboard macros.

All workstation displays shall support high-resolution (1280x1024) color graphics and shall be a minimum of a 21-inch color screen.

The RCW shall also include a set of dedicated function keys to enable OCC controllers to execute functions quickly without having to look at the screen.

The RCW server should be based upon a Windows operating system with an Ethernet card and TCP/IP communication protocol.

4.6.7 RCW Graphical User Interface (GUI)

The GUI shall be a WIMP (Windows, Icons, Menus, and a Pointing device) style of interface that allows Controllers to have easy control and expeditious response.

The GUI shall employ a combination of graphic presentations and pull-down menus. The GUI shall provide a consistent style of presentation shall be used across all of the different functions.

The Contractor shall detail the functionality and presentation of the system to meet all the specified requirements for Approval by the Engineer.

The Contractor shall include full samples of all the various screen layouts and GUI configurations for Approval by the Engineer. Multiple windows shall be able to be opened concurrently.

The Contractor shall provide the number of "Radio Control Workstation" as defined in Clause 3.5.1of this Technical Requirements.

The screen display shall as a minimum indicate:

1) A topological map of all the NSCR Stations highlighting the geographical location of the Radio base Stations;
2) An exploded-view showing a graphical representation of the track section which is operated by the Controller;
3) An exploded-view showing a graphical representation of the track section of the Radio Base Station which is selected by the Controller; and
4) The Stations shall be shown as a block on either side of the track so that it is possible to differentiate the direction of travel (North to South, South to North) of the Trains.

4.7 Radio Access Unit (RAU)

4.7.1 General

The Radio Access Unit shall be a multi-button feature phone.

The Radio Access Unit will enable users to make individual calls, emergency calls and to establish Group calls. The RAU shall be equipped with a display window to allow the identification of called parties.

The Radio Access Unit shall connect to the radio system independently from the RCW and provide a backup in the event of failure of the RCW.

The RAU shall be compact in design to enable it to be positioned alongside the RCW.

Traffic Controllers RCW in OCC shall be provided with an RAU, all other controllers shall be provided with only RAUs.

4.7.2 Control Panel

The control panel shall be used for enabling individual calls and group calls and for talk-groups not pre-assigned to the radio control panel.

The control panel shall be equipped with the following as a minimum:

1) Display window for the display of in either 12 or 24-hour format and diagnostic result and 2x14 LCD panel;
2) Transmit button to initiate a call;
3) Indicator for an incoming call;
4) Indicator for an acknowledged call;
5) Called party busy indicator;

6) Volume control;
7) Audio level indicator;
8) Numeric keypad to input RIN and talk-group ID; and
9) Emergency call button.

Each radio control panel shall be used for the call processing of a dedicated talk-group. The talk-group shall be assigned to the radio control panel through software programming.

By depressing the call transmit button, a group call to the talk-group assigned to the radio control panel shall be initiated. The radio control panel shall have a speaker with a volume control switch for audio monitoring. The talk-group selected for communication with the radio control panel shall be routed to the speaker.

Hands-free operation shall also be possible with the RCP.

4.8 Radio Base Station Requirements

4.8.1 General

The Radio Base Station shall consist of a dual carrier designed with inherent redundancy.

4.8.2 Radio Base Station Communications System

As a minimum, the Contractor shall supply, install, test, and commissioning the following elements for each radio base station Communications System:

Remote-controlled radio base stations (including base transceivers, Base controllers, alarm system, RF distribution system, equipment cabinets, combiners and filters, low loss feeder, antenna, and mounting system, etc.)

The Contractor shall install Radio Base Station equipment in either the Communication Equipment Rooms (CER) at the stations or anywhere within the stations based on the cover design as required to provide the specified coverage area throughout the NSCR network.

The Contractor shall submit the details of network design and the locations of radio base station sites and Antennas and any leaky coaxial system necessary to provide the specified coverage area throughout the NSCR network indicating full indoor coverage.

Maintenance facilities (testing of base transceivers, base controllers, etc.) shall be incorporated such that the testing of any radio base station equipment may be performed in the CER by local operation of control switches, without interruption to the whole base transceiver station.

The Contractor shall provide fallback operation for radio base stations to operate in local site operation and maintenance, in the event of failure within the system.

In the event of total failure to the base station controller, the subscriber users shall revert to the direct mode operation.

Radio Frequency Test Loop Equipment that performs loop testing on a per-channel basis shall be provided. The testing shall be able to be performed during normal system operation without interfering with other channels. The tests shall be based on measurements related to BER (Bit Error Rate), BFI (Bad Frame Indication), transmitted output power, and received RSSI (Radio Signal Strength Indication).

The Contractor shall ensure that the maintenance of the radio base station can be performed while the radio base station is operational without affecting other functions.

It shall be possible to undertake maintenance on all redundant cards and components without having to remove or disconnect other cards and components.

4.8.3 Radio Base Station

The Radio Base Station shall be supplied with the following Engineering facilities:

1) Unblocked access to all channels available at the Radio Base Station for local monitoring of incoming and outgoing transmission within the radio base station radio communications system;
2) Local keying of the transmitter through control software;
3) Fully shielded-removable modules with front-mount controls and diagnostic;
4) Readily expandable air interfaces without degradation of the final output power;
5) Software upgrades applied without the need for a site visit; and
6) Radio base stations shall operate in full-duplex mode for all communications.

4.8.4 Radio Base Station Combiner

All transmitter combiners shall be passive. Active splitters if incorporated shall be supervised for failure and reported back to the OCC NMS through the radio base station controller. The Contractor shall propose the type of connectors to be used for interfacing between RF equipment.

All the Combiners supplied shall provide interface ports to allow up to 4 (minimum) frequency channels (transmit and receive) into the LCX and antenna networks.

The Contractor shall ensure that two duplex ports are reserved in the combiner for temporary connection of the transportable units to the antenna network. The duplex ports shall be frequency independent within the frequency band and no tuning shall be required.

4.8.5 Base Station Control Module

The base station shall have fully redundant Base Station Control Modules in a hot-standby mode of operation. The switchover of the base station control module and the power supply shall be transparent to the users and shall automate calling in case of failure of one BSC.

The Base Station Control Module shall be co-located with the base station to perform the following as a minimum:

1) Interface to the BTS to transmit audio and data signal to central equipment; and
2) Initiate local mode.

The front panel of the base station control module shall have indicators for the display of base station status.

4.8.6 Local Mode

The base station shall as a minimum operates in local mode in one of the following methods:

1) Manually from radio management system;
2) Automatically upon the detection of the loss of communication link between central equipment and local equipment; and
3) Automatically upon the detection of fault tolerance central equipment fails.

In local mode, the communication shall be restricted to the radios under the RF coverage zone of the base station only.

Manual switching of the base station to normal operation when operating in local mode shall be possible. Switching shall be achieved either from the base station control module front panel or the radio management system.

4.8.7 Health Status Reporting

The Base station shall as a minimum have an alarm system which shall report the following health status to the radio management system:

1) RF forward power;
2) Power amplifier failure;
3) Power amplifier temperature;
4) Transceiver failure;
5) Local mode;
6) Control channel failure;
7) Control channel transceiver switchover; and
8) Power supply unit failure.

4.8.8 Built-in Test Routine

Built-in test routines shall be able to test the base stations and central equipment of the Radio System. These routines shall operate in an off-line mode to allow a complete functional test of the module in a problem.

As a minimum, built-in test routines shall be initiated by the following:

1) Local maintenance commands via a notebook computer connected to the local maintenance port;
2) Remote maintenance commands via the radio management system workstation;
3) Self-initiated as a result of the on-line error detection; and
4) Self-initiated as part of the power-up-initialization process.

4.9 Train Radio

4.9.1 General

The Train or On-board Radio system consists of Radio Module together with an Interface Control panel, antenna, and display. They shall be provided by the Telecommunications Contractor including coaxial cable between antenna and transceivers. If the power of rolling stock is lost, the configuration data for the onboard Radio system shall be retained.

The Train radio shall be robust, shockproof, and complete with an antenna, radio transceiver unit, and radio control head. The Communications Contractor shall liaise with the Contractor on appropriate EMC, shock, and vibration levels to be adopted in the design/application engineering. The train radio shall be provided in all Electric Multiple Units (EMU's) and locomotives. Each mobile shall be identified by a unique radio identity number.

All equipment and accessories shall comply with the following:

1) IEC 60571 or an equivalent standard;

2) IEC 60529 - IP 54 or an equivalent standard.

Train-borne Radio equipment shall not generate EMI which affects the radio or any other equipment on, or external to the railway. Train-borne Radio equipment shall be designed for protection from external EMI. Notwithstanding this, the Contractor shall be responsible for carrying out any modifications to his equipment to rectify such interference, if the equipment supplied is the originating source, except for any problems related to the usage of the frequency band, which should be addressed by the DOTr.

The train radio installed on the EMU shall interface to the Train-borne PA system. The audio output from the radio receiver shall be muted by 25 dB when a PA announcement is being made on the train. It shall not, however, be possible to reduce the receiver audio output to a level that is inaudible to a person with normal hearing.

The train radio shall interface with the Train Management System (TMS) to transfer data via the radio to a central monitoring point.

The train radio shall have a local port for the connection to a notebook computer with an interface for field programming and diagnostic.

The design shall enable the OCC to communicate with train passengers via the Train Radio System by broadcasting audio announcements within the carriages via the train PA system.

The Contractor shall be responsible for the configuration, set-up, and optimization adjustment of the on-board train radio equipment to ensure full inter-operation with the line side train radio network and facilities within the OCC.

The Contractor shall determine, in conjunction with the radio equipment manufacturer, all of the necessary interfacing requirements to the various sub-systems.

Within each train cab, an integrated hand-portable radio battery charger with cradle shall be provided by and to be installed by the Contractor.

For Rolling Stock, each trainset shall be equipped with 2 sets of train Radio System and the design shall allow automatic switchover to the other radio unit on the train, in the event of a failure of other radio lines.

The Contractor shall provide a complete radio control system including all the interfacing software and hardware for the interface with the train simulator computer.

As a minimum, the Train-borne Radio System to be supplied shall include the following:

1) Train Mobile Transceiver;

2) TR-HMI, speaker and handset with PTT-function;

3) Train-borne Antenna;

4) Equipment cabinets, racks, and cubicles together with mounting brackets, vibration mountings, and installation materials following requirement of Rolling Stock;

5) Power Supply, cables, connectors, accessories, cabling, and earthing necessary for all train-borne radio equipment; and

6) Interfacing hardware and software for the following systems:

a) Train-borne PA System;

b) Passenger Emergency Intercom (PEI);

c) Train Management System (TMS);

d) Signaling Equipment (ATC);

e) Signaling for automatic registration of TID in a mainline mode of operation and;

f) Relay contacts from RS for RS status/alarms.

Auxiliary interfaces for connecting external portable microphones, loudspeakers, and handsets shall be provided.

Cables and wires used for onboard wiring shall be low smoke, fire-retardant, halogen-free type, and confirm to flammability test specified in IEC 60332 Part 3 or an equivalent standard. Cabling, wiring, and termination details shall be submitted to the Engineer for approval.

The Contractor shall interface with the Rolling Stock Contractors for the initial installation of the On-board Radio Systems. The succeeding installations of the Telecommunications equipment in the Rolling Stock will be done by the Rolling Stock Contractors and will be defined by the following Installation schedule:

a) <u>Initial Installation</u>: The Contractor will install all equipment and the Rolling Stock Contractors will actively participate as part of the training. The Rolling Stock Contractors will document all installation procedures and directions.

b) <u>Second Installation</u>: The Rolling Stock Contractors will install all Telecommunications equipment with the Support and Supervision of the Telecommunications Contractor. The Rolling Stock Contractor will review and check if all installation procedures and directions documentations are correct and completely captured.

c) <u>Succeeding Installations</u>: The Rolling Stock Contractors will undertake the installation of the Telecommunications equipment.

4.9.2 Train Human-Machine Interface (TR-HMI)

A) General Requirements

The Contractor shall equip each driver's cab with the necessary Human Machine Interface (HMI) facilities for the operation, control, and monitoring by the driver of the on-board communications systems. The number of handsets required for driver use shall be rationalized and kept to a minimum. In particular, the Contractor shall utilize the TMS monitor to the display. Subject to any reliability constraints, both the Contractors shall take into consideration the integration of all communication operation functions into a single HMI to minimize space requirements.

The Contractors shall ensure that the required number of antennas be minimized and positioned considering the following:

1. The effect of the geometry of the installation location on the radiation/reception performance of the antenna and without exceeding the Rolling Stock gauge;
2. The effect of any protrusions which might affect the radiation/reception performance of the antenna;
3. The effect of any adjacent aerials on the performance of the Radio System;

4. The risk of being struck or otherwise damaged;
5. Electrical safety with proximity to exposed HV lines; and
6. Diversity for improving reception sensitivity.

The systems shall, where appropriate, be interfaced with the TMS for the provision of accurate time and date information.

Suitable automatic test routines shall be available to the driver in the active cab so that the operational integrity of the on-board communications equipment is verified before the train entering passenger service.

All of the cab-mounted equipment shall be fit for purpose and ergonomically designed taking into consideration human factor issues.

Externally mounted equipment shall be dustproof and weatherproof and shall be sufficiently robust to withstand frequent train washing involving continuous exposure to high-pressure water jets, associated chemical cleaning, and mechanical rotary scrubbing brushes.

The design shall incorporate the latest proven technology, which shall be highly reliable and scalable, avoiding common mode failure.

The entire installation for each system shall include a comprehensive diagnostic and fault management facility and shall be interfaced with the TMS to log events/incidents and major fault data. Additionally, the system shall

The Communications systems shall be fully compliant with industry-recognized railway standards, international standards such as ITU-T and ITU-R, and where applicable national standards.

Special attention shall be given to the shielding of all communications equipment and wiring in conjunction with any HV protection required.

B) System Requirements

The TR-HMI shall be integrated into the driver's desk by shall include a display window and function keys.

The TR-HMI shall be compliant with IP54. The display shall have a minimum size of 180 mm (W) x 60 mm (H).

The display shall use icons and menus for easy access and understanding. The display shall be easily legible. The brightness of functional keys, indicator lights, and displays shall be adjustable.

All TR-HMI shall be designed and built to the same specifications and shall be fully interchangeable. All call-related functions shall be possible with the handset ON or OFF the hook.

The display window shall display the following information as a minimum:

1) Incoming call type;
2) Incoming call mode;
3) Calling party identification;
4) Message even when a voice call is in progress;
5) Call proceeding;

6) Call ringing;
7) Call waiting;
8) Radio failure and alarms;
9) Real-time signal strength bar display;
10) TID in mainline mode;
11) Depot identifier and RIN/Train ID in Depot mode;
12) Function menu;
13) The result of radio start-up diagnostic; and
14) The result of the train radio log-on.

These indications shall be specified such that they cannot be confused with any indications related to the safety within the cab.

The following function keys shall, as a minimum, be available on the TR-HMI:

1) Volume control;
2) Acknowledge of an incoming call;
3) Initiate emergency call;
4) Initiate train radio log-on – in Depot or Mainline mode;
5) Initiate OCC call;
6) Initiate Depot shunter call;
7) Initiate group calls in various talk groups;
8) Selection of pre-programmed status messages and transmission;
9) Lamp test;
10) Backlight;
11) 1 to 10 with # and * keys for data entry;
12) 'Enter' key to confirm the input data;
13) Heavy-duty PTT switch; and
14) ON/OFF Control.

The emergency button and ON/OFF Control shall be protected against accidental activation/deactivation.

Switching 'ON' the radio TR-HMI shall cause a self-test of TR-HMI and display the status of the train radio.

Switching 'OFF' the radio TR-HMI intentionally or on power, failure shall be "soft" so that the train radio completes the following house-keeping functions before actually switching off.

1) Controlled termination of a current call;
2) De-register running number;
3) Store required data; and
4) Passenger Emergency Intercom, Train borne public address function and cabin to cabin communication shall continue to be available.

The cab radio shall switch on automatically when the driver's desk is opened, and it shall also be possible to switch on the radio when the desk is not active.

4.9.3 Built-in Test Routine

Built-in test routines shall be capable of testing the train cab radio and the TR-HMI. These routines shall operate in an off-line mode to allow a complete functional test of the module in a problem.

1) The Contractor shall perform automatic self-diagnostic routine test on all Train-borne Radio Communication Equipment and associated equipment upon every initialization; and

2) The fault and self-diagnostics information shall be processed and sent to NMS to indicate the status of the Train-borne Radio Communication equipment to facilitate prompt fault diagnosis and enable NSCR staff to locate faulty modules for first-line replacement. The information shall include, but not be limited to the following:

   a) ATC Link Failure;

   b) TMS Link Failure; and

   c) TR-HMI failure.

3) The Train-borne Mobile Transceiver shall be provided with a radio test port to enable testing of the Train-borne Radio Communication equipment. The port shall be able to interface to a Notebook Computer. As a minimum, one Notebook Computer shall be supplied and shall include the necessary software to present the data in a user-friendly format. The data indicating real-time Train-borne Radio Communications System performance shall be displayed in an informative and comprehensive manner. Information shall be presented graphically where possible. The Contractor shall provide a full description of Train-borne Radio Communications System performance functions to be monitored, as well as those which are not monitored.

4.10 Hand-portable Radio

4.10.1 Accessories

The Contractor shall provide the following Hand-portable radio accessories as a minimum:

1) Clip-on extension microphone with a speaker; and

2) Carrying case with strap.

4.10.2 Built-in Test Routine

Built-in test routines shall test the Hand-portable radio. These routines shall operate in an off-line mode to allow a complete functional test of the module in a problem. As a minimum, built-in test routines shall be initiated by the following:

1) Local maintenance commands via a notebook computer connected to the local maintenance port; and

2) Self-initiated as part of the power up-initialization process.

4.10.3 Battery Charger

The Contractor shall provide a single unit desktop battery charger, capable of operating from AC mains of 230 V +/- 10%, a single phase at 60 Hz +/- 5%, for the recharging of battery packs completed with over-charged and over-discharged protection. The charger shall have suitable protection against wide voltage variations and transients.

The battery charger provided shall have the following facilities as a minimum:

1) Power on indication;
2) Quick charge mode; and
3) Battery pack fully charged indication.

The Contractor shall provide battery chargers to be installed in the cabin of each train, for the train driver to insert and charge the handheld radio.

5. ANTENNA NETWORK

5.1 General

The Contractor shall provide both indoor and outdoor antenna networks for the RF coverage in the system.

Any DAS or LCX network implemented shall be able to support train radio services in the frequency bands for NSCR.

The LCX shall be supported by stand-offs installed at regular intervals as per guidelines issued by ETSI TR 100 053 with the title "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radio site engineering for radio equipment and systems in the mobile service" or an equivalent standard. The use of a common LCX cable for transmission and reception of RF signals or the use of two separate LCX cables for transmission and reception of RF signals shall be justified.

An AC/DC blocking device shall be fitted to the equipment for the protection of equipment and personal safety.

The antenna network for the elevated/at grade section shall primarily be antenna mounted on masts for above ground wide area coverage and a combination of LCX and low-profile antenna at stations, if unavoidable. Special considerations shall be given to interconnecting stations.

The antenna network shall be designed for the propagation of wideband radio signals in the frequency ranges specified band for NSCR operations.

The antenna network shall be designed so that the signal level received at the farthest point from the transmitting and receiving ends of the radiating component of the network is not less than the minimum required RF signal level into the respective receivers.

The system should be designed so that for the Down-Link signal, the signal strength received at the farthest point of the required coverage area from the corresponding base station for that area, is more than the minimum required strength. The Signal strength is required by a hand-portable after considering losses for indoor penetration loss, penetration loss, feeder margin, etc.

The Contractor shall submit all the calculations of signal loss in the antenna network for the Engineer to approve the adequacy of the Design/Application Engineering.

Consideration shall be given to the fact that Public Land Mobile Network (PLMN) Operators use the same frequencies outside of the range of NSCR, the spill-over outside the ROW of NSCR shall be minimized without jeopardizing the availability and coverage of NSCR itself.

5.2 Outdoor Antenna

The outdoor antenna shall be robust construction utilizing corrosion-resistant aluminum alloy and shall be protected from lightning strikes. The feeder cable connection shall be weatherproof and fully sealed.

The outdoor antenna shall as a minimum fulfill the following requirements:

1)	Operating frequency	the frequency band for NSCR operation (Tx/Rx)
2)	Bandwidth	as required for optimum operation to cover the operational frequency band.

At above-ground sites, the Contractor shall propose the type of antenna to be adopted for transmitting and receiving. Diversity receiving aerials shall be provided (if necessary).

5.3 Train-borne Antenna

The antenna shall be mounted suitably on each EMU Cab to meet the required performance specifications without causing any electromagnetic interference to other equipment onboard the Train.

The Contractor shall submit the drawings showing the recommended placement of the antenna on the EMU cab with the trackside LCX and high-point antenna. The Contractor shall submit the path calculations for the received signal for areas of coverage for Approval by the Engineer.

The low-profile antenna on each of the EMU Cab shall not infringe the kinematic envelope. The antenna and mounting brackets shall be extremely rugged low-profile design and shall withstand the effects of car washing plants, mechanical vibration, dust accumulation, and other physical hazards typical of a railway environment.

Where applicable, the antenna feed shall consist of pre-terminated, double screened, flexible, 50 Ohm, RF feeder cable. The feeder routing shall be designed to avoid the effects of EMI.

5.4 Antenna Towers at Radio Base Stations

The towers shall be designed and constructed for working and installation in the geographical and environmental conditions prevailing in the NSCR project area. All towers shall comply with the requirements of Standard EIA/TIA-222-H or an equivalent standard.

The towers shall be self-supporting steel structures. All steel used shall be hot-dip galvanized in full compliance with the relevant ISO or ASTM specifications or IS 4759 or an equivalent standard. The galvanized tower members shall further be treated suitably to protect from rusting. Any damage to the galvanizing during the erection shall be repaired or replaced by the Contractor before acceptance by the Engineer.

The towers shall be designed to withstand a minimum wind load of 250 km/h or the maximum wind speed of the concerned zone as currently defined by the PAGASA Meteorological Department while supporting the maximum number of antennae required of the same type/size, located at full height.

For design purposes, the combined projected area of these antennae shall be maximized against the wind direction. The tower loading must consider the cyclonic wind loads, seismic conditions, antenna loads, all tower accessories, and at least 100% safety margin against structural failure for the actual anticipated configuration.

The Contractor shall design/build the base/foundations / earthing / fencing of the tower. It is expected that the foundations can be constructed from standard concrete and reinforced steel. However, the Contractor shall do soil testing to ensure the adequacy of the soil bearing pressure to support the weight of the tower as well as the antennae/support structures and to resist the overturning moments generated in the survival wind speed, which shall be the highest recorded wind gust speed for the Project area. During construction of the Tower Foundation, the Contractor shall be responsible for the safety of the site and any nearby structures.

The linear and torsional sway of the tower under the worst loading conditions shall be restricted to a value such that no degradation of system performance is experienced. A rest platform with guard railing and seat every 20 m. and a 400 mm wide climbing ladder with 20 mm diameter rungs at intervals of 300 mm to the top of the tower shall be provided.

All towers shall be equipped with a suitable cable rack to house the feeder cable to antenna, and cable clamps of suitable design shall be provided and installed.

For earthing of the tower, holes of suitable diameter shall be provided near the base of the tower, which shall be used by the Contractor. At least two earth at an adequate distance apart but interconnected shall be provided. The earth resistance should be less than one ohm under all weather conditions.

The tower shall have lightning conductors of appropriate design and size, which shall be earthed through dedicated copper conductors of suitable cross-section coming down from the top of the tower to the base of the tower to be grounded.

The towers shall be equipped with Aviation Warning Lights in conformity with the relevant requirements of the Philippine Civil Aviation Authority. A means of preventing unauthorized access onto the ladder shall be provided.

TELECOMMUNICATIONS SYSTEM

APPENDIX 3

VOICE AND DATA SYSTEMS

1. INTRODUCTION

1.1 General

This Chapter specifies the technical characteristics of the Voice and Data System of the Telecommunications System.

1.2 Overview of the Voice and Data System

The Voice and Data system shall be provided for IP telephones, common LAN, and handy Telephone systems inside OCC, stations, Depots, and the other railway facilities including a Wi-Fi system for staff. Exclusive lines between/among OCC and train crews, station staffs, and shunting staffs together with a digital voice recorder shall be furnished as essential functions.

The system shall be configured with a router, server, IP-PBX, and L2/L3 network switches over the protocol of SIP, RTP, QoS, and the other necessary ones.

Incoming lines from Land Line (Telephone) and ISP (Internet) shall be received and integrated at the OCC and distributed to each station via the above backbone system.

2. SCOPE OF WORKS

2.1 General

The specific requirements on the scope of the works for the Voice and Data System shall be as specified below.

2.2 Scope of supply for the Voice and Data System.

<u>A) Voice System:</u>

The Telephone System shall be based on an IP-PBX platform and technologies using VoIP/SIP and 10/100 Base-T PoE ports consisting of a Central IP exchange/soft-switch and Remote Site equipment forming the railway telephone network operating via IP Network.

The Telephone System shall be capable of supporting all types of telephone sets including analog, digital, IP, and operator terminal, and shall include as a minimum, but not be limited to, the following items:

- A redundant Central IP-PBX providing system control, with gateway and soft-switch functions together with connectivity for a minimum of 500 users with a minimum traffic rate of 6 HCS, to fulfill the project requirements plus a spare capacity of 25%, whichever is the larger, shall be provided. Remote IP-PBX's shall be installed where necessary.
- Support general-purpose voice communication between all sites throughout the entire project and also to the PSTN.
- The IP-PBX Telephone System shall be 100% non-blocking for all internal calls between telephone extensions.
- Calls to and from the Controller Workstation positions and the PSTN shall be 100% non-blocking.
- The Contractor shall propose grouping and access rights to separate mission-critical connections, managers, customer service, and office staff for Approval by the Engineer.
- Local VoIP enabled converged communications IP/Ethernet switch and associated Data Transmission System connectivity to parent IP-PBX / gateway / soft switch for individual remote IP telephones;

- IP/SIP compatible telephones;
- The recording system of mission-critical telephones and radio voice calls (refer to Appendix 2, Sub-Clause 3.5.4.2 item 5), including search and playback functions, shall be provided as an integral part of the IP-PBX System, preferably combined with the voice recorder of the radio system;
- Support and implementation for conventional/legacy non-packet switched voice trunk and interfaces required to communicate and integrate with the external PSTN network including mobile telephone network.

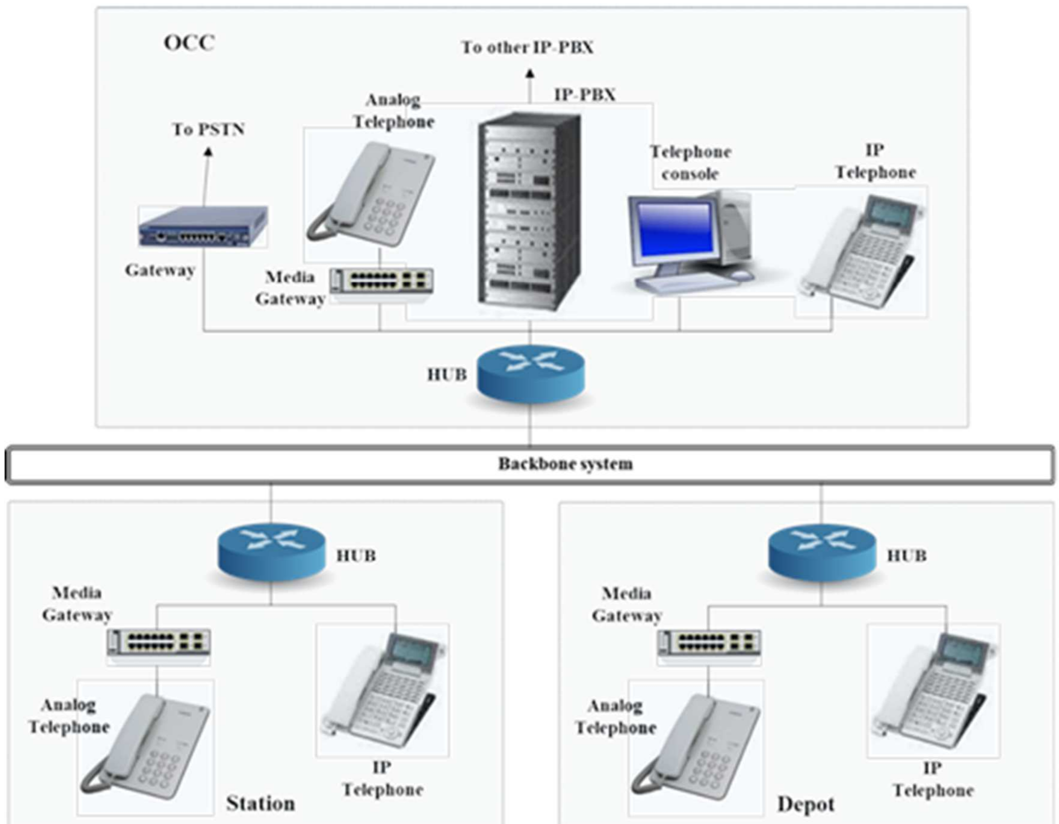


Figure 2.2 The example of Voice system configuration

1) Direct Line Telephones (DLT)

a) Direct line telephones shall be provided for:

- Mission-critical operators such as managing director, traffic controllers, rolling stock and Depot controller, infrastructure/facilities controller, commercial controller, station master;
- Emergency services, such as police, fire brigade, and hospital; and
- Emergency telephones inside elevators. (cabling and compartment by the Contractor)

b) The DLT service shall have a higher Grade of Service (GoS) than the PBX service when calling between telephone switches.

c) The IP-PBX Telephone System shall provide dedicated direct line VoIP communication between designated users for high priority/emergency communication.

d) When incoming direct line calls are queuing, the designated telephone terminal shall be able to put the currently connected caller on hold, attend to another call and afterward re-establish conversation with the original caller. The IP-PBX Telephone System shall as a minimum be capable of holding up to ten calls simultaneously.

e) It shall be possible to call a direct line telephone extension using no more than two actions on the operator Controller Workstation.

2) Office Telephone

a) All telephones shall be of IP/SIP compatible phones.

b) Several types of office telephones shall be used, depending on the intensity of use and ranking of staff or location installed.

c) Furthermore, the Contractor shall enable conference calls between multiple telephone sets within the system as well as with external participants.

d) At least two (2) meeting rooms in the OCC, shall be equipped with video conference facilities.

3) Intercom System

a) Master device

- In case of a call from Slave devices, it is displayed which Slave devices are calling.
- If a station staff receives an incoming call from another Slave device while talking with Slave devices, an incoming call indication shall be given to the Master device.
- Both handset and handsfree sets are available for calling.
- Calling from Slave devices can be done with a simple operation such as a one-touch button.
- The alarm generated in the Intercommunication system can be displayed on the Master device.

b) Slave device

- Slave devices are the microphone and speaker built-in type and make a handsfree call possible.
- The Slave devices shall be installed at an appropriate height based on ergonomics so that it can be used by many passengers.
- Slave devices shall be waterproof, strong, and corrosion-resistant.

<u>B) Data Systems</u>

- The interface of the PoE HUB shall be 10/1000Base-T and 100Base-TX.
- In access from the terminal, it is connected to the data network by Wi-Fi.
- UTM has functions such as IDS / IPS, anti-virus, anti-spam, Web filtering in addition to the function of the firewall.
- IP-sec gateway function is required for the Express Ticket Selling system.

- The server consists of a mail server, Web server, file server, etc. and they are installed in the equipment room of OCC.
- Connection with the Internet network shall be done in the equipment room of the OCC. For connection with the Internet network, Point of Interface (POI) is set up in the OCC. Also, the contractor shall be responsible for connection with the Internet network.
- It is assumed that the Data system conforms to IEEE802.11a/b/g/n/ac, authentication WPA 2-PSK, encryption AES.

The Data system shall be installed in the following location.

▪ Area where station staff performs business

▪ Areas where OCC staff work

▪ AFC system area

Express train stop station (For the station name, refer to the AFC system documentation)

▪ AFC room

▪ Ticket sales counters

▪ Waiting room

▪ Platforms

▪ Other if any

▪ Depot Building Areas

▪ Security room

▪ Light repair shop

▪ Unscheduled repair shop

▪ Wheel re-profiling shop

▪ Other if any

C) Office Administration LAN

- The Office Administration System shall consist of a Local Area Network (LAN) system throughout all areas of the Project as necessary to support the requirements of any systems forming part of the Project.
- Each location as a minimum shall have high availability, non-blocking, core switch to connect to each host and provide the aggregation LAN link.
- All stations and Depots including the outdoor area of the Depots shall be equipped with Wi-Fi access for staff based on IEEE 802.11ac or better. The Wi-Fi shall be suitable for administrative tasks, VOIP calls, MMS, BIM, and access for other equipment that is required for maintenance purposes.
- Where required, distributed access switches connected via Gigabit Ethernet optic fiber links shall be provided to expand the connectivity over the entire project.
- The Office Administration system shall support a minimum of 100 Mbps and Gigabit Ethernet.

- All LAN services shall be provided with high availability path-protected links having a reroute time of <50 ms.
- A File server, Mail server, and WEB server with groupware, anti-virus, anti-spam, and WEB filtering shall be installed by the Contractor in the Communication Equipment Room of the OCC.

Where an Ethernet LAN distribution network is required for any of the individual communications systems the following functions shall be integrated into the overall Ethernet system as follows:

- The network shall be expanded as required to incorporate this additional requirement. This shall include due consideration for all capacity requirements and increase in ports and access switch locations; and
- Special attention shall be paid to the redundancy of the system especially in terms of distribution and access switches such that the failure of any single switch will not leave an area without coverage of the system's operational requirement.
- Secure gateways shall be provided for connection to the internet at Central Control. These two gateways shall be routed to separate Internet Service Providers (ISPs) and configured as multi-hosting to ensure the high availability of internet connectivity.
- Each designated LAN outlet shall be designed to support a 100 Base-T Ethernet (including TX version) and 1000 Base-T Ethernet connectivity.
- All Ethernet LANs shall conform to IEEE 802.3.
- The network devices shall support the DHCP dynamic assignment of IP address for connection by portable computers.
- The network shall support networking protocols operating at level 3 (network layer) and level 2 (data link layer) of the OSI reference model. Also, both networks shall be able to switch between dissimilar LANs under multiprotocol environments such as TCP/IP, IPX/SPX.
- It shall be possible to add further terminal computers to this office administration with no requirement for reconfiguration of the system.

TELECOMMUNICATIONS SYSTEM

APPENDIX 4

CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM

1. INTRODUCTION

1.1 General

This Chapter specifies the technical characteristics of the Closed-Circuit Television (CCTV) System of the Telecommunications System.

1.2 Overview of the Closed-Circuit Television (CCTV) System

The system provides monitoring and surveillance inside and outside the railway building and related facilities. Camera images can be viewed in each station from the Station Master Control room and the OCC. Depending on their location, cameras can be of fixed or Pan/tilt/zoom type, indoor type, or outdoor type.

The Video recorder shall have a sufficient capacity of at least, one (1) month with high-quality images.

On each platform, a monitor will be installed, for the train driver to view the boarding and alighting of passengers.

On-board Rolling Stock CCTV systems are not included in this system.

2. SCOPE OF WORKS

2.1 General

The specific requirements on the scope of the works for the Closed-Circuit Television (CCTV) System shall be as specified below.

2.2 Scope of supply for the Closed-Circuit Television (CCTV) System.

2.2.1 System configuration

The CCTV system shall comprise all items of control equipment, software, equipment power supplies, control units, interfaces, equipment cabinets and enclosures, video recorders, monitors, cameras, all cabling to and between respective items, and all cabling to the interface terminations with other systems, accessories, and fittings. These items shall be provided by the Contractor.

The Contractor shall design the station CCTV surveillance system to provide 100% coverage of the following specific areas at all stations. However, the stairs and escalators outside of the station shall provide CCTV coverage to the largest extent possible by installing fixed cameras were necessary for security purposes.

The location of the CCTV monitors and control panel shall be as follows:

- A CCTV control HMI system shall be provided in the SCR and OCC;
- HMI for the SCR shall consist of a work station with a minimum of one (1) number of LCD monitors of a minimum of 22" and a keyboard with joystick controllers and mouse-keyboard controller
- A CCTV monitor with a minimal size of 40 inches shall be installed on the wall of the SCR. The Contractor shall demonstrate the appropriate size of the screen by simulation and calculation.
- HMI for the appropriate controller in the OCC shall consist of work stations with a minimum of two LCD monitors of a minimum of 22" and a keyboard with joystick controllers and mouse-keyboard controllers. A minimum of 2 workstations shall be provided for general monitoring. One additional workstation shall be provided at the Power SCADA desk.

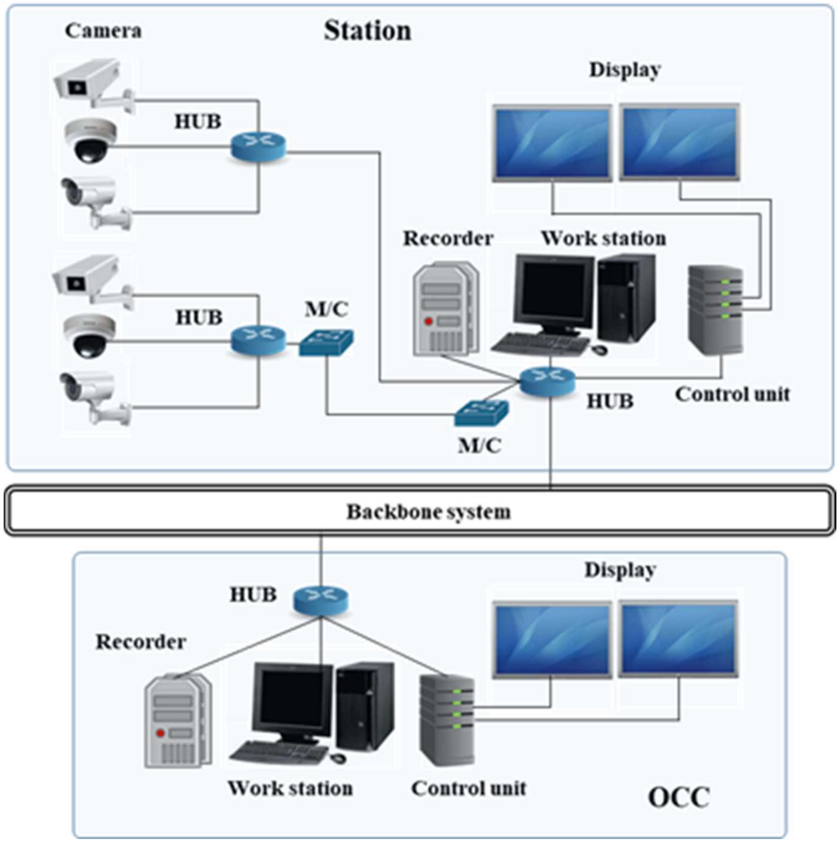


Figure 2.2.1 CCTV system configuration for Mainline

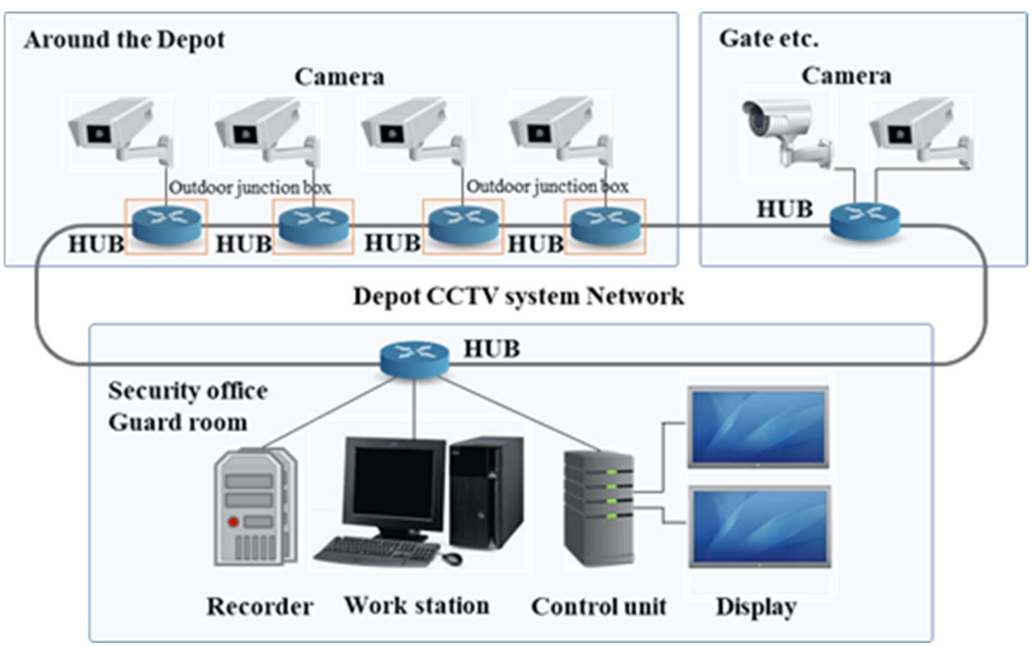


Figure 2.2.2 CCTV system configuration for Depots

2.2.2 System Requirements:

1) CCTV Cameras

- All CCTV cameras shall be of the color CCD type with the low light capability to produce clear and detailed picture quality under high lighting contrast conditions.
- All the CCTV system equipment shall fully conform to the environmental conditions described in the ERG.
- For operational reasons, each CCTV camera shall have a unique identifier.
- The camera data sheets shall be submitted with the Technical Description in the design documents.
- The cameras used for the coverage have to be fixed focus cameras and shall cover the designated area with “glare-free” and “not distorted” video streams. PTZ cameras are to be deployed to investigate areas of interest that have been identified by the video coverage of the fixed lens cameras.

  The minimum technical specification shall include:

  - Camera Type 1

    Fixed cameras in standard outdoor housings equipped with fixed focal length lenses and fixed orientation.
  - Camera Type 2

    Fixed cameras in vandal-resistant and dome housings equipped with fixed focal length lenses and fixed orientation.
  - Camera Type 3

    Fixed cameras in dome indoor housings equipped with fixed focal length lenses and fixed orientation.
  - Camera Type 4

    Pan/Tilt/Zoom (PTZ) cameras in standard outdoor housings with variable focal length lenses with adjustable orientation in both the vertical and horizontal directions.
  - Camera Type 5

    Pan/Tilt/Zoom (PTZ) cameras in dome indoor housings with variable focal length lenses with adjustable orientation in both the vertical and horizontal directions.

2) Camera General Requirements

- The image compression shall be H.264 with one high resolution and one low-resolution video stream.
- The cameras shall be powered by PoE (IEEE 802.3af) using CAT 5 Ethernet cable, which shall use LS0H type cables for indoor cameras.
- Video resolution 2048x1536, H.264, MPEG-4, or better video compression.
- Video stream of minimal 25 frames per second.
- Overall delay maximum 120 ms.
- Color video with light as low as 1.0 lux, B/W pictures with light as low as 0.3 lux.
- Shall have auto iris control, gain control, white balance, and backlight compensation.

- Compact vandal and dust-resistant design that is fit to cope with the environmental conditions of the project.
- Shall have suitable surge protection at the camera side and switch side.

3) Environmental

Where appropriate to the location and its associated environment, camera housings shall be equipped with a screen washer, screen defogger, reservoir of screen washing fluid, sun shield, and visor.

Outdoor headwall monitors at the platform stopping point shall be provided for the driver to ensure it is safe to close the train doors. The monitors shall be suitably protected against direct sunlight and inclement weather to provide a clear picture to the driver.

4) Housing Arrangement for Cameras

The housing arrangement shall be designed for both outdoor and indoor use and shall meet requirements for camera enclosures as indicated below.

It shall protect both the camera and lens combination. The housing arrangement shall as a minimum have the following technical specifications and features:

- It shall be tampered proof and vandal resistant; and
- The enclosure shall be rated IP66, NEMA-4, or better.

The Housing shall either be integrated with the camera by the manufacturer or it shall be of the same make as the camera.

5) Mounting for Cameras

The Contractor shall provide suitable mounting designs, which shall be suitable for indoor and outdoor units designed for fixed cameras or camera housing installations.

As a minimum, the mounting shall have the following features:

- Feed-through design for cable management;
- 360o rotation, 180o tilt;
- Versatile design;
- Adjustable mount heads; and
- Corrosion-resistant finish.

To ensure compatibility, the mounting along with housing/camera combination shall be inspected during the FAT.

6) High Speed PTZ Camera (Day/Night)

The camera shall have Pan, Tilt, and Zoom features suitable for indoor and outdoor surveillance.

The camera shall have a 26 X optical zoom and 12X digital zoom.

The camera shall operate using PoE (IEEE 802.3af).

PTZ cameras shall have sufficient pan, tilt, and zoom range to cover the area. The Contractor shall confirm this by simulation and subsequent demonstration.

7) CCTV Monitors

The monitors shall have adequate background protection/screen to avoid direct sun or glare from sunlight and provide adequate visibility for a clear view of the displays.

The approval of the Engineer is final regarding the clarity and satisfactory background screen to be provided and the mountings provided should allow for vertical shifting of the monitors.

a) The operator CCTV monitors/workstation shall provide as a minimum requirement:

- Screen size (image size) of 22" or larger;
- Screen resolution at least 1920 x 1080;
- Pixel response time of 5 ms gray to gray;
- USB ports;
- Luminance of 450 Cd/sqm or higher;
- 24/7 operation; and
- Each CCTV workstation shall be equipped with a CCTV-control panel.

b) Platform headwall monitors at the platform stopping point shall:

- Be installed at the proper location and angle for good visibility from the driver's cabin of the train;
- Shall not obstruct movement or visibility of passengers or staff;
- Have adequate background protection/screen to avoid direct sun or glare from sunlight and provide adequate visibility for a clear view of the displays;
- Luminance level: minimum 1000 Cd/sqm;
- Suitable for the outdoor industrial environment; and
- 24/7 operation.

c) The video wall in the OCC building security room shall be no less than an 8 x 22" size monitor.

d) The Video wall in the OCC shall be provided by the Signaling section. The CCTV system shall interface with the video wall.

8) CCTV Coverage

a) Coverage plan

The Contractor shall propose a CCTV coverage plan for the stations and the Depots that will indicate the intended CCTV coverage for the areas. The coverage plan shall show graphically the coverage area of each camera with different colors for detection, recognition, and identification.

b) Detection

In 95% of all covered areas, the recorded video stream shall provide sufficient resolution for an appropriate application to recognize a left object and detect a person.

c) Recognition

In 15% of all covered areas, the recorded video stream provides sufficient resolution for an appropriate application to recognize an unknown person.

d) Identification

In 5% of all covered areas, the recorded video stream provides sufficient resolution for an appropriate application to identify an unknown person.

9) General Coverage

The CCTV system shall cover 95% of all public areas and 60% of all non-public areas in stations, Depots, and associated buildings.

Specific areas to be covered shall include:

- Train doors and platform edge (to be displayed at the headwall monitor in the OCC and SCR);
- Escape routes and cash transfer routes;
- Escalator landings;
- Emergency exits;
- Passenger help points and fire-fighting equipment;
- Elevators;
- Ticket vending machines;
- Ticket sales;
- Cash handling room;
- AFC gates;
- Substations and sectioning post stations;
- Entrance/exit of the OCC buildings and the Depots;
- Roads and stabling area in the Depots;
- Access routes (within contract limits) to the station;
- All battery posts
- All-access and egress points along the railway alignment including access ramps and emergency staircases.
- Ancillary buildings
- TSS entrances and outdoor equipment; and
- Any other location which requires CCTV monitoring subject to the Engineer's Approval.

The CCTV cameras viewing the platform edge shall give an unobstructed view of train doors and passengers in that vicinity. The Contractor shall propose the optimum number of cameras to achieve the requirements as indicated, subject to the Engineer's Approval.

10) Design coordination

The design of the CCTV system shall be coordinated with the architectural layouts to ensure that blind spots are minimized and to ensure that cameras do not obscure the view of signage or vice versa. For cash handling and cash storage rooms, the Contractor shall ensure that the CCTV viewing angle captures at least 2 vantage points and without blind spots.

11) Video quality

The produced videos shall be of evidential grade quality (for police investigations and prosecution cases) and free from:

- Discoloring of any direction and show the original color of the object;
- Barrel-cushion distortion and show the real geography;
- Contrast and brightness impact through external lighting; and
- Pixilation (moving objects shall not cause).

12) Video Processing

a) Video export

The System shall not apply any compression to the picture when it is exported from the system and the exported picture shall not undergo any format conversion that affects the content or picture quality. Also, a video authentication method shall be available to export selected video sequences with the guarantee of integrity that the given video has not been tampered with and is coming from the alleged source or origin. Recordings should be exported to a standalone storage/player or directly to CD, data DVD, or Hard disk.

b) Video Screen

In the Station Control Room (SCR), the control, selection, and viewing of CCTV pictures by the operational staff shall be via the CCTV workstation's display or via an additional LED-backlit LCD (wall-mounted or desktop) to allow monitoring of other station single images or images combined in split form.

c) Video Interfaces

The video system shall interface to other systems to provide additional functionality:

- Interface to SCADA to monitor for defective system and devices;
- Interface to the access control system to monitor selected doors or areas; and
- Interface to the fire alarm system to automatically show the fire alarm zone.

d) Video Stream Marker

The recorded video streams shall be presented on the GUI with activity markers to indicate recording sections that have been triggered by alarms or events. The operator shall be able to search the recorded video based on alarms, events, and other defined triggers of the video analytics settings.

e) Video Stream

At all CCTV screens and workstations, the operator shall be able to select any camera on the system and watch the live video stream. In case of an event or alarm, the operator shall be able to select seamlessly the historic video streams of that camera that led to the event or alarm.

f) Video Compression

Video compression and transmission as well as other norms shall be according to international standards. All images of cameras installed at a station shall be recorded permanently. The availability and storage capacity of the camera images shall be for 30 days of real-time recording unless otherwise agreed with the Engineer.

13) Depots

The Depots CCTV System shall be integrated into the overall system to allow controllers to monitor and record events in the Depots. CCTV inside the OCC Building shall be provided by the Contractor.

14) Archive

The Contractor shall provide a means of archiving all recorded CCTV videos at both the stations' video recorder and OCC video recorder onto removable media for remote storage.

15) Requirements for CCTV Video Analytics System

The video content analysis feature shall assist the daily security operators' work by providing relevant and reliable alarms.

a. Unattended Object, Irregular Pattern Detection

The station cameras shall be able to detect an unattended bag or irregular pattern in the CCTV coverage area. The video analytics system shall be versatile and able to cover different scenarios as detection of left baggage, passenger falling from an escalator, or attempting to pass through gates illegally.

b. Intrusion Detection

It should be possible to detect and alert when a person enters a protected zone or station area outside of hours. The video analytics system shall be capable of detecting loitering activities and shall have face recognition functionality.

c. Rule-Based Detection

The rule-based configuration detection engine enables applying multiple rules per camera, linking events from multiple cameras and sensors to produce an intelligent, reliable, and comprehensive surveillance picture.

16) Video Recording and Retrieving

The Network Video Recording System (NVRS) shall provide cost-effective local recording, storage, and retrieval facilities at the stations.

Moreover, regarding the local recording system, the main CER shall also have a redundant NVRS for recording any video signals monitored in the OCC.

All recordings shall have the associated camera's unique identifier, time, and date information stamped and superimposed onto the video image. Facilities to recover any recordings using time and/or location requests shall be implemented.

The video recorder shall be capable of operation for 24 hours per day, 365 days per year.

The Contractor shall provide sufficient storage medium to archive a minimum of 7 days of stored recordings for all the cameras in high resolution and a minimum of 30 days of storage in low resolution. The operator shall be able to retrieve, monitor, and playback images from this system without affecting any of the recording functions.

The NVRS shall use Redundant Server Based Network Video Recorders with NAS/RAID storage boxes and DVD burners.

The Contractor shall provide a user-friendly facility for inserting / modifying / detecting at least 10 characters at each input signal to the station switching matrix.

17) Fault and Alarm Management

All alarm statuses of the CCTV system equipment including cameras, video recorders, switches, etc. as necessary shall be monitored by CMSS in the main CER and shall automatically generate an audio/visual alarm on the CMSS/CSS Workstation on the occurrence of an event.

18) Network Video Recorder Server

The NVR Server shall as a minimum fulfill the following specifications:

- Redundant power supply;
- Sufficient processor capacity, suitable to allow future software updates and upgrades;
- Sufficient memory capacity;
- Dual network connection with load balancing and failover support;
- CD-drive and USB connection; and
- Self-monitoring for hard disk status, voltage, fans, and temperature.

19) Network Attached Storage/ RAID HDD Storage:

Separate NAS/RAID HDD shall be provided with each supplied NVR.

The RAID HDD Storage shall as a minimum fulfill the following specifications:

- Redundant power supply;
- Sufficient processor capacity suitable to allow future software updates and upgrades;
- Self-monitoring for hard disk status, voltage, fans, and temperature;
- Sufficient memory capacity;
- Dual network connection with load balancing and fail-over support;
- CD-drive and USB connection;
- Support simultaneous playback and recording in full-duplex operation;
- Hot-swappable hard disks;
- Allow for a different type of RAID configurations; and
- Sufficient hard disk bays to allow for future extension of the line.

20) CCTV Management System Software (CMSS)

CMSS shall be an enterprise-class client/server-based IP video security solution that provides seamless management of digital video, and data across an IP network. The video management and operating system shall be designed to work with CCTV products as part of a total video security management system to provide full virtual matrix switching and control capability. It shall offer a complete video surveillance solution that will be scalable from a few to hundreds of cameras that can be added on a unit by unit basis.

The software shall be licensed and shall operate on an open architecture and shall require no proprietary software. The Server software shall be installed in a server PC in the main CER with a backup server.

a) The video management system shall consist of four software modules or as per the vendor design:

- The central server - for device management, Client management, software configuration upload and download to Client stations, firmware and software upgrades;
- Network video recorder- for the recording of all cameras at the station;

- Client Software - for video monitoring on PC; and
- Video from other sites may be viewed from single or numerous workstations simultaneously at any time.

b) The Central Server Software shall provide the following:

- Configuration of monitoring stations;
- Programming of alarm triggered automatic events for clearly defined surveillance tasks;
- System set up with limited operation options for clearly defined surveillance tasks; and
- Programming of automatic recording events on an NVRS.

The Software shall display MPEG-4, or better non-proprietary standard, video streams in real-time simultaneously at frame rates ranging from 1 fps to 25 fps and resolution ranging from ¼ CIF to 16 CIF.

The server shall authenticate the users and give access to the software Client application based on predefined user access rights.

The System shall allow the recording, live monitoring, and playback of archived video simultaneously.

The CMSS shall be designed to use IT infrastructure and require no special cabling. It shall be capable of using the Backbone Transmission System. The CMSS shall be able to auto-discover any CCTV equipment. The CMSS shall provide the ability to batch-update firmware in encoders and decoders. The CMSS shall be able to simultaneously configure multiple encoders or decoders, even of different types. When devices of different types are being configured, only the parameters available in all devices are available for configuration.

The CMSS shall export video data optionally in its native recording format to a DVD drive, a network drive, or a USB drive. The exported data in the native recording format shall include all associated analysis data. Viewer software shall be included with the export. Once installed, the viewer software allows the playback of the streams on any compatible Windows PC.

The CMSS software shall allow, as a minimum: the live display of cameras, live display of camera sequences, control of PTZ cameras, playback of archived video, retrieval of archived video, instant replay of live video, use of site maps, use of procedures, the configuration of system settings, configuration, and programming of PTZ Cameras, features such as camera addressing, backlight control function, auto tours, detailed presets, view camera in a video tile, view map or procedure in a video file and support digital zoom on PTZ cameras live video streams.

The software shall be capable of video recording on any of the following options: inbuilt hard disks on the server, direct-attached storage boxes attached to servers, network-attached storage, and storage area network.

The software shall provide a reporting utility for tracking but is not limited to the following options. (video and images shall be stored with reports for documenting events):

a) Alarms;

b) Incidents;
c) Operator logs; and
d) Service requests.

The software shall provide a file export tool for export of a single frame of the video in JPEG/BMP or other superior file formats and export of motion video files in media player format for transport and playback on computers utilizing a Windows environment.

The software shall allow for the installation of anti-virus and network security software.

The software's database server shall offer the capability to be installed on multiple servers to enable distributed architecture on the LAN.

21) Operator Client Interface

The operator software shall allow the user to display the following:

- Creation of connections to the standard monitors, quad split displays, video wall, and other multi-screen displays (1, 2, 4, 9, 16 cameras simultaneously) especially on the desk of the operators in the SCR and the OCC.
- On the video wall (by Signaling) it shall be possible to view anyone camera either in a multi-screen display as above and on a complete 70" tile along with the other tiles in any combination from any station or cameras in any sequence as desired;
- Display of the alarm and status information from video endpoints;
- Easy selection of predefined video, and telemetry settings;
- Connection to multiple monitors, multicasting to automatically clone data if multiple viewers are to see the same camera over the LAN without overloading a single encoder; and
- Real-time control of camera PTZ facilities via the on-screen control from OCC and on-screen control and joystick at the stations, as per priority defined.

As a minimum the Operational Controls of the NVRS are:

1) The System shall be provided with a Systems Administrator (at the highest level of the priority) and should be able to add, edit and delete users with rights who shall be able to override those commands of the OCC operator, SCR operator, or Police Booth operator; and
2) It shall be possible to view the ability/rights of each user or the cameras which can be viewed and controlled as per the permission assigned by the administrator at the OCC server. The levels of priority shall be in the following decreasing order – Administrator at OCC, Manager at OCC, Technician at OCC, and Operator or Controller in SCR /security personnel at the station.

Operator software shall be a PC-based software tool designed as an alternative to the keyboard workstations. The application shall allow the operators to make video connections at the touch of a button using a simple user interface.

The Administrator through the relevant software attached to the server shall be able to perform the following:

- Control of Event Handling System (EHS);
- Network fault diagnosis and notification;

- Performance monitoring and call records, informing managers of the behavior of the video network;
- 24/7 operator data backup, providing a means by which system managers can back up the centralized backup database at set intervals while the system is still active; and
- Recorded images from a single camera may also be played back on multiple video windows.

The CMSS shall support a search of recorded video for motion in user-specified areas of a camera image. This intelligent post-recording motion search shall work for cameras connected via encoders.

22) System Expansion

All CCTV equipment provided shall be modularly expandable to an expansion capacity of 20% by the addition of cards and/or modules, and an expansion capacity of 50 % by addition of racks or cabinets without the need to replace the installed hardware and software of the system.

23) Station Yard Monitoring

- <u>Service:</u> Video monitoring and recording.
- <u>Camera:</u> PTZ and/or fixed type,

  Location; OCC, Depots, Sub-stations (platform, concourse),

  Image format; MPEG-4 (CIF available),

  Image compression; H.264,

  Numbers of pixel; 1,280 × 1,024 (5:4) or 1,280 × 960 (4:3),

  IP code; IP66,

  Lens; varifocal (for fixed type),

  Onboard CCTV; provided by rolling stock.
- <u>Monitor:</u> Desktop type LCD 19-inch, wall Type LCD 40 inch,

  Screen division: 1, 1/4, 1/9, 1/16, 1/25, 1/36,

  Installation site; OCC and each station.
- <u>Recorder:</u> Digital type (DVR-HDD),

  Preservation period; 30days-24hours.
- <u>Controller:</u> PTZ shall be controlled from the monitor,

  Operation shall be simplified using GUI,

  Monitoring shall be continuous using NVMS.
- <u>Door Monitor Unit:</u> Monitoring around the door for driver' confirmation,

  Screen Division: 1/4; Camera exclusive use.
- <u>Network:</u> IP protocol with 10/100/1000base-T,

  Cable: UTP CAT5e or FOP via common backbone system,

  Data Compression: minimum numbers of pixel and frame rate,

  H.264 and moving body detention device.

TELECOMMUNICATIONS SYSTEM

APPENDIX 5

PASSENGER INFORMATION DISPLAY SYSTEM (PIDS)

1. INTRODUCTION

1.1 General

This Chapter specifies the technical characteristics of the Passenger Information Display System (PIDS) of the Telecommunications System.

1.2 Overview of the Passenger Information Display System (PIDS)

The system shall provide guide display information on train operation, delay information, emergency evacuation, etc. to secure safety and passenger's convenience.

Displayed messages in the system shall be capable of being updated from the OCC. The display boards shall adopt either LED and be connected to the IP network.

2. SCOPE OF WORKS

2.1 General

The specific requirements on the scope of the works for the Passenger Information Display System (PIDS) shall be as specified below.

2.2 Scope of supply for the Passenger Information Display System (PIDS)

A. System configuration

PID system consists of operation consoles, displays, control servers, etc. However, the system configuration is not limited to this.

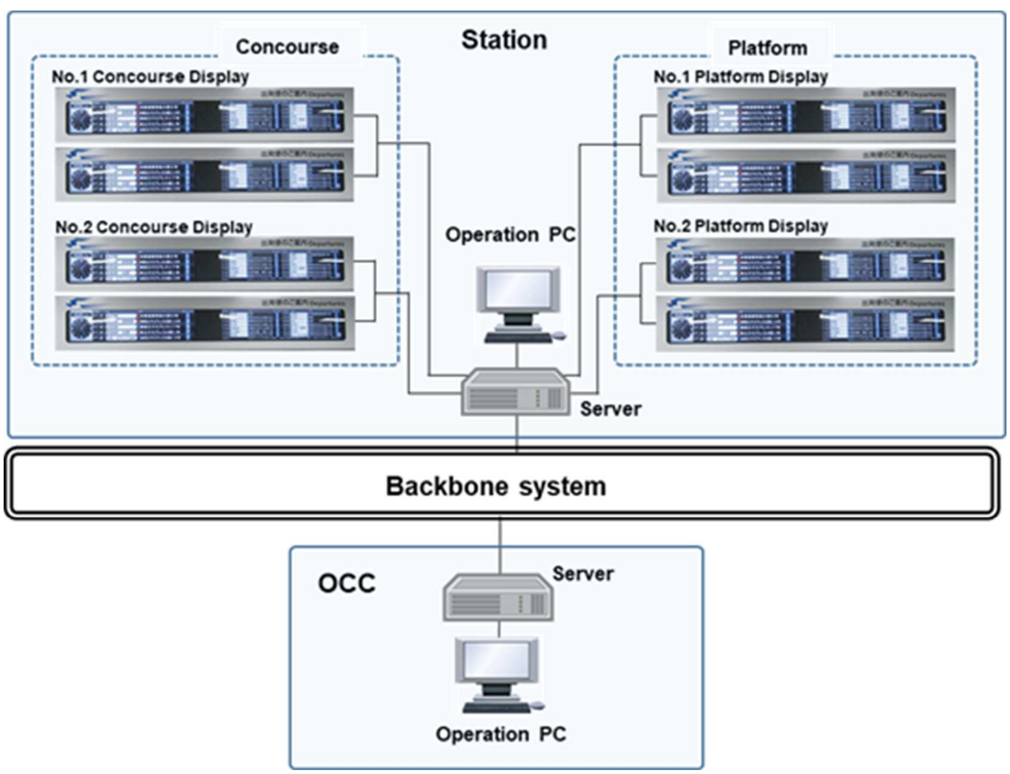


Figure 2.2 An example of PID system configuration

B. System functions

Displays are installed on the platform and in the concourse and shall inform the passengers of trains arrival and departure or any other special/emergency messages.

Information shall be presented in English and Filipino.

The PIDS shall include, but not be limited to the following:

1) PIDS control equipment;
2) Concourse and platform PIDS Ultra Bright LED display boards;
3) (Location; platform, concourse, and ticket barrier in the station)
4) Number of Pixels: 1920 x 1080 (Single/Double Face)
5) LED monitors complete with mounting fixtures/ accessories for platforms and concourse PIDS displays.
6) Display Input: PRC (train operation), TSMCS (time), FACP (emergency evacuation)
7) Workstation (operation disk in OCC and station)
8) Network: IP protocol with 10/100/1000 base-T
9) Cable; UTP CAT5e via common backbone
10) Power supply; separated
11) HMI Workstation integrated with the PA HMI;
12) PIDS management system;
13) All software required for the operation of the PIDS including software, both application, and operating systems;
14) Data communication equipment;
15) Distribution frames;
16) Equipment cabinets, racks, and cubicles;
17) Equipment housing, mounting brackets, and installation materials;
18) All equipment power supplies, cables, connectors, accessories, cabling, and earthing necessary for the Works;

Information presented on the PIDS screens shall be based on information from the ATS from signaling and shall be continuously updated according to the actual trains schedule.

The system shall be modular and easy to expand for future stations.

The PIDS on the platform shall:

- Be double-sided and installed on a single pole on the platform or hanging from the roof (to be agreed with the Civil Contractors);
- Indicate the platform number;
- Give the information on the first train to arrive (in minutes);
- Give the information on the second train to arrive (in minutes);
- Indicate the destination;
- For future expansion, be able to indicate the type of train (commuter, express train, etc.); and

- Be able to indicate emergency messages, passenger guide, delay information, advertisement, etc. inputted from the OCC operation console.

The information shall be legible during day and night time.

A minimum of 2 PID's per platform shall be supplied. The Contractor shall determine the optimum viewing distance and minimum interference to passengers' positions.

The layout and information on the screen shall be programmable from the PIDS management system.

The PIDS shall also be able to indicate additional train operation-related messages, such as "the last train", "passing train", "train delayed", etc. and also presented messages, such as "evacuation".

The PID in the concourse shall:

- Be single-sided. The rear side shall have a fixed text "EXIT";
- Be located above the AFC-gates, hanging from the ceiling; and
- Give a list of trains departing from the station including platform and time of departure.
- Be able to indicate emergency messages, passenger guide, delay information, advertisement, etc. inputted from the OCC operation console, the information shall be legible during day and night time.

The Contractor shall submit their design for Approval by the Engineer.

TELECOMMUNICATIONS SYSTEM

APPENDIX 6

PUBLIC ADDRESS (PA) SYSTEM

1. INTRODUCTION

1.1 General

This Chapter specifies the technical characteristics of the Public Address (PA) System of the Telecommunications System.

1.2 Overview of the Public Address (PA) System

The system shall provide audio announcements on train operation, train approaching, railway accidents, and the like to ensure safety and passenger's convenience.

Besides voice input from the microphone in the OCC and each station, automatic announcements shall be made from the DVAS. Automatic announcements shall also be triggered by the Signaling ATS-system. The speaker wiring shall be for a high impedance system. The sound level shall automatically adjust according to the ambient noise level in the announcement area.

2. SCOPE OF WORKS

2.1 General

The specific requirements on the scope of the works for the Public Address (PA) System shall be as specified below.

2.2 Scope of supply for the Public Address (PA) System

The Contractor shall supply the Public-Address System at all stations and within the Depots and any other location as considered necessary. The Contractor shall propose the locations of the PA speakers based on an audio simulation, to guarantee a good quality sound in all areas.

The Contractor shall install the speaker in each lift. Cabling from the lift car to terminals in the lift machine room is provided by the Contractors.

Automatic announcements shall be in English and Filipino.

The Public Address (PA) system shall be capable of interfacing with the Passenger Information Display System (PIDS) to provide announcements that are consistent with the Passenger Information Display System in an emergency or abnormal situation.

The PA system shall comply with the requirements of ISO 9921:2003 or an equivalent standard.

The PA system shall be capable of general message broadcasting and also of broadcasting emergency messages.

The hardware and software of the PA system shall be of modular design to allow easy expansion of the system. Expansion of input and output ports for the amplifier switching equipment shall be achieved by the simple addition of plug-in cards or modules.

All equipment shall be of modern design, fully electronic, modularly constructed, and with proven field performance.

The amplifier switching equipment shall use solid-state switches. No relays or reed switches shall be used in this equipment.

Amplifiers and automatic noise control and sensing devices to achieve optimum sound pressure levels shall be provided.

Noise sensing shall be installed to detect the ambient noise where the background noise varies considerably.

All audio recordings shall comply with ISO 3901: International Standard Recording Code or an equivalent standard.

The PA system shall be capable of automatically delivering at least 100 individual prerecorded vocal messages to public areas, offices, equipment rooms, and pre-defined broadcasting zones.

Manual announcement initiated by an operator shall be possible at all times and shall override automatic announcements.

The PA system shall be able to receive, amplify and distribute background music, pre-recorded messages, or live announcements that originate from the local control room, dependent on architectural layout, control points shall be provided on platforms.

The PA system shall be segregated into various zones to accommodate the intended operation. As a minimum, zones shall be provided for public areas of the access levels (including the entrances and the emergency stairs), concourses, and each platform.

The design and installation of the PA system shall not preclude the addition of further zones for extension of the access area coverage into retail areas, where such retail areas exist.

Under hazardous conditions such as a fire, the PA system shall be an important means to assist in evacuation and crowd control.

All evacuation routes, including all normally out of bounds to the public, areas, staircases, and corridors shall be covered by the PA system.

The PA coverage shall also be provided for all non-public areas where personnel may be located during their normal duties, including the station control room, ticket office(s), cash office, and staff rooms.

Zone selection shall be dependent upon the origin of the PA transmission:

- From the PA console located in the station control room, announcements shall be capable of being made to one or any combination of zones; and
- From a Controller Workstation located in the OCC, announcements shall be capable of being made to any combination of zones in any number of locations.

All local control room PA control consoles and panels shall incorporate a microphone, zone selection as appropriate to the application, and a non-latching "press to talk switch".

Zone selection shall revert to "no zone selected" after a programmable delay after the PTT button has been pressed (or re-pressed) and released.

The PA control consoles shall allow the manual selection of stored pre-recorded messages to be broadcast to a selected zone or zones.

The PA system shall also permit pre-recorded messages to be triggered automatically according to a user-configured schedule or time interval.

The number of pre-recorded PA messages shall be sufficient for operational purposes with 50% additional spare capacity for future expansion.

The PA control consoles located in the station control rooms shall also incorporate industry-standard input sockets and controls to enable music to be fed into the PA system from proprietary audio equipment. This input shall be capable of being permanently selected to allow continuous broadcasting.

Activation of a pre-recorded, automatic, or live message shall automatically suppress the continuous music broadcast.

Except for the local pre-recorded broadcasts, the local PA "press to talk" controls shall be given priority over broadcasts originating from the OCC.

Within a station control room, an initial activated "press to talk" switch shall be given priority control of the particular zone of which the PA system is addressing. Upon release or reset of the zone selection control, the PA system shall revert to its previous mode of operation (either inoperative or continuously broadcasting).

The Backbone Transmission System (BTS) shall be used as the long-distance transmission medium for audio signals originating from the OCC.

The PA system shall interface with the digital radio network and telephone system to enable live announcements by dialing a prefixed number.

The distribution of the audio signals shall be configured to ensure no single point of failure shall result in the inability to broadcast intelligible PA announcements to any area of any zone.

As well as being used for general announcements, the PA system shall be used for the transmission of emergency messages to evacuate passengers in the event of a fire or other emergency scenarios.

The design of the PA system shall consider the integrity requirements associated with such functionality and be compliant with IEC 60849 requirements for audio evacuation systems.

PA speaker cables shall be sufficiently rated for the load and distance required of each speaker chain.

Dual cable runs shall be used to feed the PA zone arrangement to ensure PA coverage is maintained under equipment failure or individual cable damage.

Speakers within each broadcasting zone shall be connected to two amplifiers.

The PA system shall, through automatic sensing and control equipment, ensure that the broadcast sound level provided as necessary throughout the dedicated area is 10dB greater than the ambient noise level up to a maximum of 90dBA within the average variance ±3dB.

The average output rating of each amplifier shall be at least 1.5 times larger than the actual demand output wattage.

The PA system shall adopt a sound pressure level compatible with the architectural design and the associated acoustics with recessed type speakers for false ceiling areas and wall or surface mounted type speakers for other areas.

The PA system shall enable automatic sound pressure level adjustment of the range on either side of the designed level to accommodate the actual ambient conditions.

The PA system (from the input to the microphone to the output of the speakers) shall have a 90% intelligibility rating when tested under IEC 60268-16 or an equivalent standard and an STI-PA (tested with portable instruments).

The sound pressure level throughout the buildings shall also be compliant with the requirements in the current local fire code for emergency broadcasting in the event of a confirmed fire alarm and ensure that the intelligibility of the broadcasts shall achieve as a minimum the specified STI value.

Computer-based simulations shall be carried out to demonstrate that the proposed PA system design shall satisfy the specified STI standards.

All PA announcements from the OCC other than pre-recorded announcements shall be recorded by the central digital voice recording system.

A. System configurations

PA system consists of amplifiers, speakers, microphones, noise cancellers, etc. However, the system configuration is not limited to this.

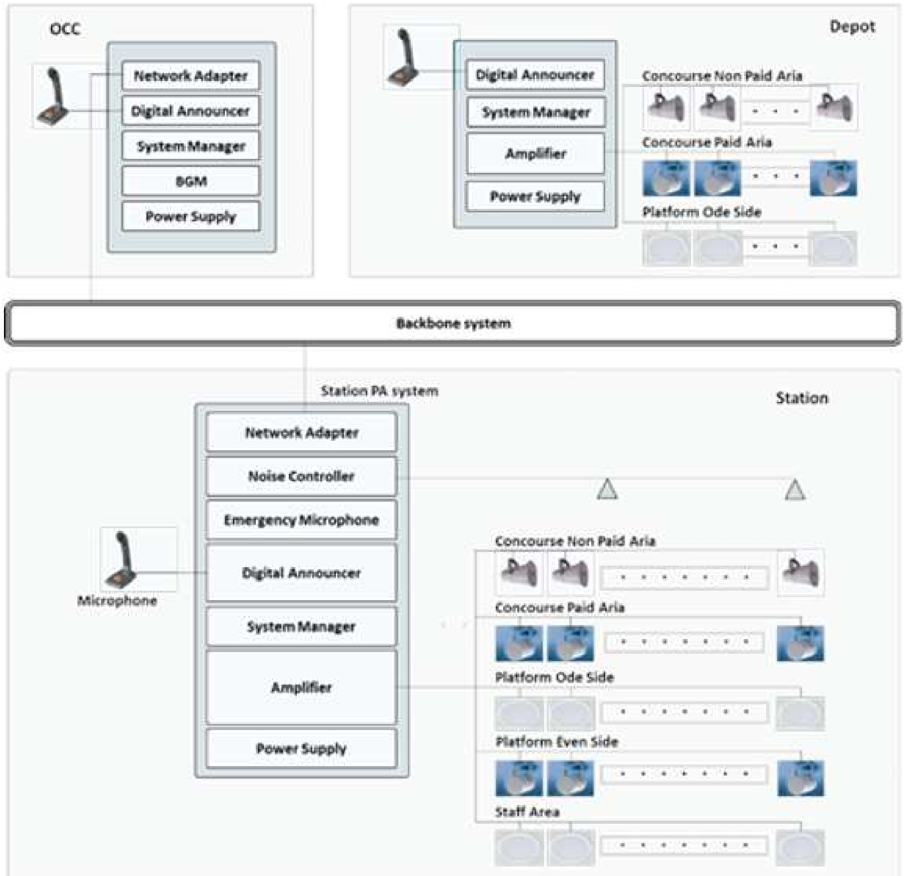


Figure 2.2 The example of PA system configuration

Loudspeakers and Microphones:

Each zone shall be equipped with a sufficient number of speakers located throughout the zone to provide a uniform audio level.

Loudspeakers shall not be driven at more than 80% of their maximum allowable input rating.

Speakers located in external zones shall be compliant with IP65.

Speakers located in internal zones shall be compliant with IP54. The frequency response shall be over the range of 100 Hz-15 kHz.

- Cable: UTP CAT5e via common backbone
- Speaker wiring: Fire-resistant low smoke zero halogen cable in compliance with IEC 60331. Wires shall have sufficient current-carrying capacity.
- Broadcast Area: Platform, concourse, staircase, and ticket barrier in each station
- Broadcast Input: Microphone and DVAS (OCC), microphone including remote and

wireless ones (each station)

- Priority:
  - No.1 Built-in amplifier Microphone,
  - No.2 Remote Microphone,
  - No.3 Wireless Microphone,
  - No.4 Automatic Broadcasting,
  - No.5 Spare Input

Regardless of the above, if emergency any broadcasting facilities shall be equipped, they shall be with the highest priority. In the case where lower priority announce shall be disturbed by higher priority announce, it shall be continued just after completion of the higher priority one. However, announcements for train operation (Departure and Arrival) shall be excluded.

- Speaker: Loudspeaker (10W or more), rustproof, waterproof, fireproof

  Speakers in the office area shall be with the attenuator.

- Amplifier: The capacity shall, at least, the total wattage of all the speakers connected.

  Location: OCC and each Station

  SPL: Above 20dB from an ambient noise level

- Network: IP protocol with 10/100/1000base-T

  Cable: UTP CAT5e via common backbone

  Speaker wiring: PVC 1.2mm (high impedance system)

  Remote microphone code: Exclusive code specified by the manufacturer

B) System functions

1) Network configurations at stations

The speaker system shall be redundant by using two amplifiers in one broadcasting area.

The broadcast area of the platform shall be independent for each platform.

The devices of the PA system installed at OCC and each station are connected via the IP network of the Backbone system.

PA system shall be able to detect disconnection, short circuit, a leakage current of speaker line by maintenance function.

Even if all external power supply is stopped, the PA system shall be able to continue broadcasting with the built-in battery installed in the PA system.

The speaker cable of the PA system shall be a heat and fire resistance cable.

If a fault occurs in the PA system, alarms should be displayed for each unit to identify the fault location.

It shall have a recording and reproduction function for confirming the broadcast contents of the PA system.

2) Functions at stations

The PA system receives train operation information from the ATS of the train Signal System and automatically broadcasts the information to the platform and the concourse.

The PA system detects the noise with the noise sensor and adjusts the output level by the automatic level adjustment function. By adjusting the output level, the PA system can broadcast with a comfortable volume in all areas.

The PA system shall be able to broadcast chime sound before the automatic and manual announcement.

In case of emergency, evacuation guidance announcements can be made for all broadcasting areas with the highest priority by pressing the emergency button.

The automatic announcement function can be turned ON / OFF by a switch.

The PA system has a standby amplifier, and it is a redundant configuration that automatically switches to the standby amplifier in case of failure.

The PA system's microphone is a wireless microphone and push-button type (push-to-talk).

When using the microphone, a level meter or monitor speaker for checking the sound level shall be provided.

The PA system shall be able to automatically announce fire occurrence to all broadcasting areas in linkage with Fire alarm equipment.

The PA system shall be able to do the automatic announcement, manual announcement, and emergency announcement.

- Automatic announcement

  In interlocking with the ATS of the train Signal System, the PA system shall perform automatic announcements to passengers on the platform when the train approaches.

- Manual announcement

  Staff at the station shall be able to perform manual announcements with the PA system.

  The manual announcement shall be able to select the broadcast area. It is assumed that the broadcast area can select one area, group area, all broadcasting areas by button selection of the microphone.

  OCC staff shall be able to select one station, group station, all stations by button selection of the microphone.

  To selected stations, OCC staff shall be able to broadcast external sound sources (ex. CD, radio, etc.).

- Emergency announcement

  In interlocking with the Fire alarm system, evacuation announcements shall be automatically made to all broadcasting areas when a fire occurs.

  By pressing the emergency button, evacuation guidance broadcasting shall be possible for all broadcasting areas with the highest priority.

- Broadcast language

  The Broadcast contents shall be able to select English and Tagalog.

- Priorities of broadcasting shall be as follows:

Emergency announcement

Manual announcement from the station

Manual announcement from OCC

Automatic announcement

- Broadcast areas are as follows. The broadcast area should be selectable.

Concourse within ticket gate

Concourse outside the ticket gate

Platform for the north

Platform for the south

Staff area etc.

3) PA system at OCC and Depots

PA system installed in OCC and Depots are used for normal communication and emergency communication.

PA system of OCC building and Depot buildings should be broadcasted selectively for each area.

In case of fire, the PA system of OCC and Depots shall be able to announce automatically for evacuation guidance to all broadcasting areas, in interlock with the Fire alarm system.

The PA system of OCC and Depots shall be able to do evacuate guidance announcements to all areas with the highest priority by pressing the emergency button.

The broadcasting area of the Depots is as follows.

- Security room
- Light repair shop
- Unscheduled repair shop
- Wheel re-profiling shop
- Other if any

TELECOMMUNICATIONS SYSTEM

APPENDIX 7

TIME SERVER AND MASTER CLOCK SYSTEM

1. INTRODUCTION

1.1 General

This Chapter specifies the technical characteristics of the Time Server and Master Clock System of the Telecommunications System.

1.2 Overview of the Time Server and Master Clock System

The system shall provide an accurate time for all the relevant sub-systems via NTP services for passenger convenience and correct synchronization between systems.

Slave clocks shall be installed in staff areas and public areas.

The time information shall be obtained from GPS and delivered through an IP network by intelligent protocols. The time information shall be displayed on the slave clocks via the Master clock and sub-master clocks. The slave clocks shall be powered via sub-master clocks. Other equipment except slave clocks shall be powered via the L2 switch (PoE) on the upper streamside.

2. SCOPE OF WORKS

2.1 General

The specific requirements on the scope of the works for the Time Server and Master Clock System shall be as specified below.

2.2 Scope of supply for the Time Server and Master Clock System

A. System configurations

The Time server and Master clock system is composed of a Master clock unit, a sub Master clock unit, clock controller, Slave clock, and the like. However, the system configuration is not limited to this. The Master clock unit shall be installed in the equipment room in the OCC building, the sub-Master clock unit and the clock controller shall be installed in the equipment room in each station and OCC building. Below are the general specifications:

- Reference Time: UTC (coordinated universal time)
  - Acquired the time using GPS antenna with calibration unit.
- Master Clock: Time Server built-in, NTP protocol with time monitor
  - Distribute time signal to the sub-systems and sub-master clock
  - Power interruption back-up; 3 hours, with slave clock-stop function.
- Sub-Master Clock: Mounted in every station to drive respective slave clocks.
- Slave Clock: Mounted in each station, OCC, SCR various workshops, and each substation.
- OCC and SCR to be equipped with digital single-faced clocks, indicating HH:MM: SS.
- Public areas, canteen, workshop: analog or digital type (single face and double face).
  - Mounting: Wall hanging and/or suspended type.
  - Reference Size: Visibility of 60 m or as required for room size, subject to the Engineer's Approval.
- Network: IP protocol with 10/100/1000base-T Cable; UTP CAT5e via common backbone.

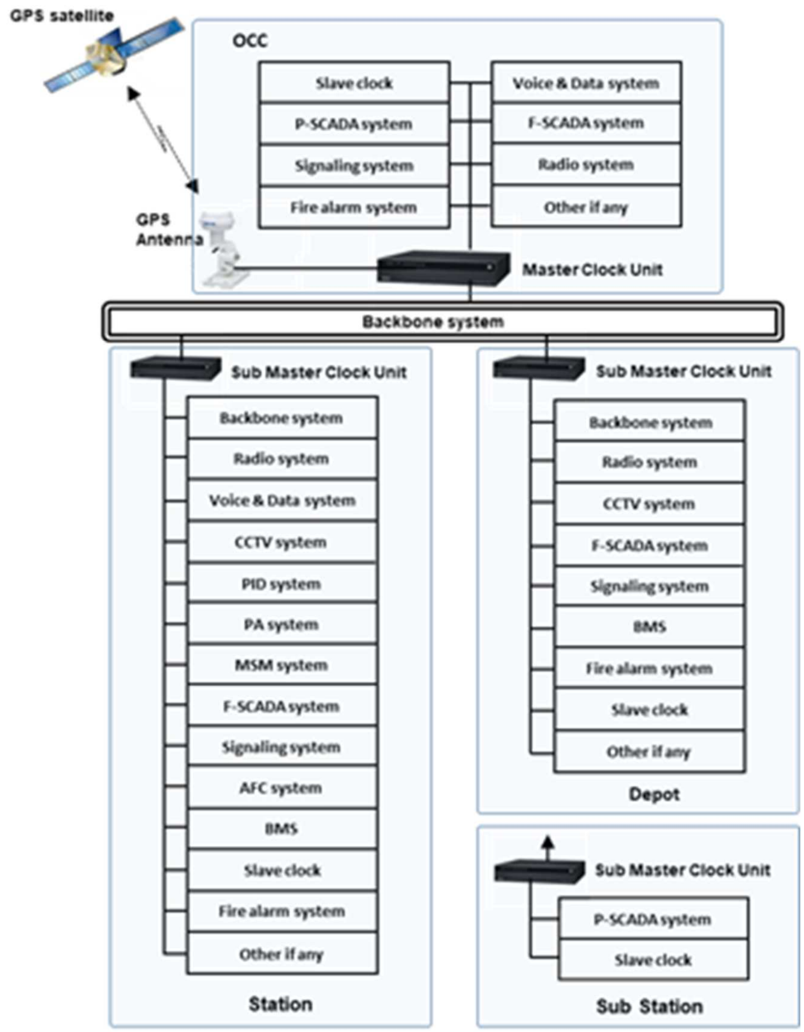


Figure 2.2 The example of Time server and Master clock system configuration

B. System functions

1) System

The Time server and Master clock system shall support the provision of time to Ethernet TCP / IP networks.

The Time server and Master clock system shall have a Time server function to supply time to other systems by NTP/SNTP/Time Protocol.

The Time server and Master clock system detects the absence or abnormality of GPS time information and outputs an alarm.

2) GPS antenna

The GPS antenna receives the reference time from the GPS satellite and conveys the information to the Master clock unit.

When a surge voltage such as lightning is applied, the surge protector protects the Time server and Master clock system by flowing the surge current from the antenna to the ground.

The antenna shall be waterproof and weather-resistant against direct sunlight, wind, rain, etc.

The antenna shall be installed in an appropriate position that can be confirmed with the eyes. Also, the support of the antenna has a strong structure and the safety rate of wind pressure load is double.

3) Master clock unit

The Master clock unit shall have a GPS receiver function, to acquire accurate time from the GPS.

The Master clock unit converts the signal received from the GPS into SNTP. The Master clock unit distributes time to the systems and the Slave clock of OCC.

The Master clock unit has crystal (quartz) inside and can hold the exact time by itself.

The Master clock unit distributes time to all sub- Master clock units via the Backbone system.

Network time synchronization over the data network shall be using SNTP, with an accuracy of ± 0.1 s/day to the reference.

4) Sub-Master clock unit

The sub-master clock unit synchronizes with the Master clock unit and distributes the time to the Slave clock.

The sub-Master clock unit has crystal (quartz) inside, and it is possible to hold accurate time by itself.

Network time synchronization over the data network shall be using SNTP, with an accuracy of ± 0.1 s/day to the reference.

5) Clock controller

The Clock controller is necessary when the Slave clock does not have the function of receiving the time directly from the network.

The Clock controller is installed at the OCC and at the stations to make it easy to add and replace the Slave clock.

The Clock controller receives the time from the sub-Master clock unit and multicasts the time to the Slave clock.

Since the clock controller controls the Slave clock, it is not necessary to allocate IP addresses to individual Slave clock at the time of addition or replacement of the Slave clock.

The power of the clock controller shall be powered by PoE conforming to IEEE802.3af.

6) Slave clock

The Slave clock receives the time transmitted from the Master clock unit or the sub- Master clock unit and displays the time in analog or digital form.

The Slave clock is connected to the Master clock unit or the sub- Master clock unit via LAN.

The Slave clock shall have an automatic adjustment function. When the signal is restored after the signal has been interrupted due to a failure of the Master clock unit or the sub Master clock unit or disconnection of the cable, the accurate time must be displayed automatically and immediately.

The Slave clock has a crystal (quartz) inside and the time should be held independently by itself, even if the signal from the Master clock unit or sub- Master clock unit is lost.

There are two types of analog Slave clocks and a digital Slave clock. The time display on the Passenger Information Display (PID) is also possible.

The Slave clock is powered from PoE conforming to IEEE 802.3af.

The installation place of the Slave clock is as follows. However, this example does not prevent proposals from the contractor.

- In the office at stations
- Besides the display board of the PID system
- In the office at OCC
- In the office at Depots
- Shops in Depots will have a Light repair shop, Unscheduled repair shop, Wheel re-profiling shop
- Other if any

TELECOMMUNICATIONS SYSTEM

APPENDIX 8

METEOROLOGICAL AND SEISMIC MONITORING SYSTEM

1. INTRODUCTION

1.1 General

This Chapter specifies the technical characteristics of the Meteorological and Seismic Monitoring System of the Telecommunications System.

1.2 Overview of the Meteorological and Seismic Monitoring System

The Meteorological and Seismic Monitoring System shall be provided for the prevention of possible damage suffered from designated natural disasters to the railway facilities and the safety of passengers. The natural disaster shall be predicted by information from the sensor of Anemometer, Rain Gauge, Seismograph, and Water Level.

2. SCOPE OF WORKS

2.1 General

The specific requirements on the scope of the works for the Meteorological and Seismic Monitoring System shall be as specified below.

2.2 Scope of supply for the Meteorological and Seismic Monitoring System

A. System configurations

Meteorological and Seismic Monitoring system consists of sensors (anemometer, rain gauge, seismograph) and measuring equipment, etc. Below is the general specification.

- Wiring: UTP Cat5E (from the sensor to the common backbone).
- Measurement: Continuous data acquisition. Check the data reach alarm setpoints (dry contact).
- Power Supply: 1p2w 230V(100W)

B. System functions

1) Wind speed measuring equipment (Anemometer)

The wind speed measuring equipment shall be able to measure instantaneous wind speed, average wind speed, maximum instantaneous wind speed.

When the wind speed value exceeds the threshold value or when a failure occurs in the equipment, an alarm signal shall be output.

The wind speed measuring equipment is capable of storing measured data and transferring measurement data to external terminals such as PC.

The display of the alarm can arbitrarily be set.

The wind speed measuring equipment shall take countermeasures against surge penetration from the outside and shall have a structure resistant to static electricity and external noise.

- Function:

  Measurement accuracy: Maximum wind speed 70m/s, Resolution ability 1m/s

- Installation location:

  Malolos station, Buendia station, Santa Rosa station, Depots

- Monitoring Department:

  Measurement value shall be displayed in real-time on a monitor of the Facility control section of OCC.

2) Rainfall measuring equipment (Rain gauge)

The rainfall measuring equipment shall be able to measure 1-hour rainfall, daily rainfall, continuous rainfall, etc.

When the rain value exceeds the threshold value or when a failure occurs in the equipment, an alarm signal shall be output.

The rainfall measuring equipment is capable of storing measured data and transferring measurement data to external terminals such as PC.

The display of the alarm can arbitrarily be set.

The rainfall measuring equipment shall take countermeasures against surge penetration from the outside and shall have a structure resistant to static electricity and external noise.

- Function

  Measurement accuracy: When rainfall per hour is 40 mm or less: Within ± 1 mm

  When rainfall per hour exceeds 40 mm: Within ± 3%

- Installation location

  Nichols station, Bicutan station, Depots

- Monitoring department

  Measurement value shall be displayed in real-time on a monitor of the Facility control section of OCC.

3) Earthquake measuring equipment (Seismograph)

The earthquake measuring equipment shall be able to calculate the seismic intensity from the acceleration and period of the shake and to display the seismic intensity on the earthquake measuring equipment.

When an earthquake occurs, an alarm shall be generated and made known.

The display of the alarm can arbitrarily be set.

The earthquake measuring equipment shall take countermeasures against surge penetration from the outside and shall have a structure resistant to static electricity and external noise.

- Function

  Measurement accuracy: Acceleration measurement range: 3 directions 3000 gal

  Frequency measurement range: 0.3 to 10 Hz

- Installation location

  San Fernando station, Bicutan station, Sucat station, Alabang station, Depots

- Monitoring department

  Display the acceleration value from the display recording device on the monitor of the Facility control section of the OCC.

TELECOMMUNICATIONS SYSTEM

APPENDIX 9

POWER SUPPLY FOR TELECOMMUNICATIONS SYSTEM (UPS)

1. INTRODUCTION

1.1 General

This Chapter specifies the technical characteristics of the Power Supply for Telecommunications System.

1.2 Overview of the Power Supply for Telecommunications System

The Power Supply to the Telecommunications System shall be provided via the exclusive UPS. The wirings from the UPS to the equipment and devices in OCC, stations, and along the viaduct shall be included in this scope of work. Related grounding works to the common grounding plates provided by the power supply system shall also be included in this scope work.

The work shall include an Uninterruptible Power Supply (UPS) system and distribution for the communication equipment and/or devices.

Power wiring from the UPS to the communication equipment and terminal devices in the OCC, Depots, sub-stations, and stations shall be included in the scope of the communication works.

Related grounding works to the common grounding system shall be included.

2. SCOPE OF WORKS

2.1 General

The specific requirements on the scope of the works for the Power Supply for Telecommunications System shall be as specified below.

The power supply to the communication equipment and devices in this system shall be provided based on the following.

1) UPS
   - Input; 3 Phase-3 Wire 400 VAC or 3 Phase-4 Wire 400 VAC (60Hz);
   - Output; 1 Phase-2 Wire 230 VAC or 3 phase-4 Wire 400 VAC (60Hz); and
   - Power Supply: via an inverter (in normal mode), via bypass circuit (in emergency mode).
2) Power interruption backup: 3 hour (station), 3 hour (OCC).
3) The exact rating of the UPS shall be calculated by the Contractor.
4) Wiring and cabling: XLPE/PVC installed on cable tray or in conduit and compliance with PEC 2017 edition.
5) Allowable voltage drops: within 2% from the UPS distribution board.
6) Allowable short circuit current: 15 kA (OCC and station).
7) Grounding PVC Wire (with the size not melted by grounding fault current). Connection: from bonding points at the communications system to copper grounding bar in the EPS and/or electrical room provided by building electrical works.
8) Exception: Regardless of the above, the following power supply shall be provided by the Power Supply System

   Power supply to the CCTV cameras mounted on the lighting poles in the Depot areas shall be provided by the Power distribution system.

Power supply to the AP and CTF on the antenna poles and the meteorological and seismic sensors along the viaduct shall also be provided by the power system.

9) The UPS Power Supply for AFC equipment and devices in the OCC building shall be fed from the communication UPS.

Power supply to the CCTV cameras mounted on the lighting poles in the Depot areas shall be provided by the Power distribution system.

The power supply to the antenna along the trackway between stations shall be provided by the Power distribution system.

10) UPS specification:

The input of the UPS shall be protected from overvoltages and surges of current. Additionally, it shall be protected from the effects of lightning. The UPS shall also function as a filter to remove transients and other electrical noise, which may affect the operation of electronic equipment.

A bypass switch shall also be provided to enable maintenance to be undertaken and to circumvent the UPS unit should a malfunction occur.

Batteries shall be maintenance-free.

The design and performance of the UPS shall be following the latest edition of IEC 60146 and IEC 62040 or an acceptable equivalent standard.

The UPS shall be equipped with fans and filters for air-cooling. The Contractor shall indicate whether any forced-air cooling or constant temperature control is required.

The UPS shall be provided with output current limiters, which afford short–circuit protection. The overload capacity of the inverter shall be 150% for one (1) minute and 125% for the next ten (10) minutes.

In addition to the above, the UPS shall be capable of monitoring and detecting potential malfunctions; these include:

a) Overload;

b) Overvoltage and current;

c) Under voltage; and

d) Temperature.

Should the battery temperature exceed the specified maximum during charging, the inverter shall terminate the charging to prevent the thermal runaway of the batteries.

The Contractor shall propose a suitable charging time for the batteries after being fully discharged.

An alarm shall be generated for each of the above-mentioned features should they occur.

The operational status of the UPS shall be capable of being exhibited using a Liquid Crystal Display (LCD) or a similar device. The differing features of the UPS shall be selectable using a keypad; these would include but not be limited to the following:

a) Input voltage;

b) Input current;

c) Power factor;

d) Frequency;

e) Battery voltage;

f) Battery and rectifier current;

g) Output voltage and current;

h) Inverter kW; and

i) Temperature.

The UPS shall be capable of providing information to the OCC. An alarm shall be generated for failure or malfunction of the items indicated above.

The UPS mechanical construction shall allow for maintenance from the front.

The output from the UPS shall be fed into a distribution cabinet where power will be disseminated accordingly to supply equipment needing power. The distribution cabinet shall be supplied with circuit breakers, which shall be suitably rated for the equipment they supply and will be following the Philippine Electrical Code (PEC 2017 Edition). The Contractor shall supply all equipment and accessories per equipment requirements.

The UPS and other power supply equipment shall be designed with a spare capacity of 25% of the nominal load.

Transformers used within the power supply system shall be suitably rated and shall be of the low-loss type.

The complete power supply system shall interface with the electrical supply system.

All power supplies, which are not connected to established earth, shall be equipped with earth fault detection capability. Indications of the earth's status shall be sent to the OCC as an equipment alarm.

All power supply transformers shall have sufficient tapping available to enable power supply voltage adjustments to be made per load requirements.

All equipment and cables shall be capable of withstanding overvoltages and other power supply surges, which may be caused by lightning, switching effects, etc. The Contractor shall submit for Engineer's Approval the design of the lightning protection scheme proposed.

Front panels of power supply cubicles shall include, as a minimum, indications, and instruments to display the status of the power system.

Unless otherwise specified the above UPS Specification shall be applicable for all UPS supplied under the Contractor, having a rating of more than 5 KVA.

The UPS System must have a proven track record of satisfactory performance of the same model and rating.

2.2 Scope of supply for the Power Supply for Telecommunications System

A. System configurations

The UPS consists of rectifiers, inverters, batteries, a distribution board for Telecommunications, and so on. However, the configuration is not limited to this. The UPS shall be installed in the equipment room of the OCC and stations.

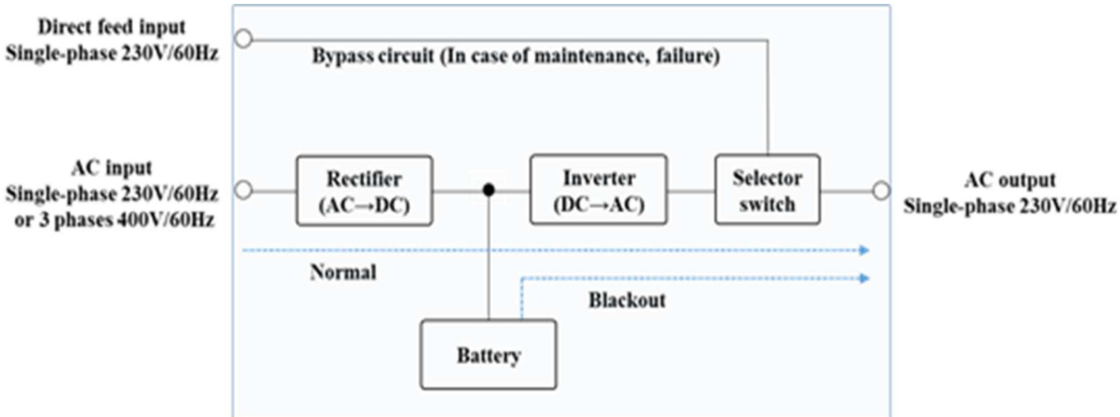


Figure 2.2 The example of Power supply system configuration

B. System functions

The UPS receives power of single-phase 230V/60Hz or 3 phase 400V/60Hz and supplies uninterruptible power to Telecommunications.

1) Rectifier unit

The rectifier unit is a device that receives single-phase 230V/60Hz or 3 phase 400V/60Hz power and rectifies it to direct current. The output is supplied to inverters and batteries.

2) Inverter unit

The inverter unit receives DC power from the rectifier and outputs single-phase 230V/60Hz. The output is connected to the distribution board for Telecommunications.

3) Battery unit

The battery receives DC power from the rectifier and stores it. When a power outage or rectifier fails etc. the battery supplies DC power to the inverter.

The storage battery shall have the capacity to supply power as follows.

- The Power supply facilities of the station shall have a capacity capable of supplying power for three hours to the load of the connected communication equipment and other equipment.
- Power supply equipment of the OCC shall have a capacity capable of supplying power for one hour to the load of the connected communication equipment and other equipment. This is based on the assumption that the power source of the emergency generator is received from the power system within one hour.

4) Distribution board

- The distribution board relays the output of the inverter unit and supplies single-phase 230V/60Hz power to Telecommunications.
- The distribution board has terminals corresponding to the number of power lines of the equipment to be connected, and circuit breakers suitable for each power load are installed.

5) Power supply

The capacity of the Power supply system shall have a margin of 30% or more for the total load capacity (including the capacity expected in the future) of the Telecommunication equipment and other equipment to be connected.

The Power supply system shall have a function to supply stable power during normal power reception, power failure, etc.

The UPS shall be on-line type. It receives a Power system of single-phase 230V/60Hz or 3 phase 400V/60Hz, rectifies it to DC power once, outputs single-phase 230V/60Hz with inverter again, and supplies power to Telecommunication equipment via distribution board.

At the time of a power outage, the DC power stored in the battery is supplied to the inverter, converted to single-phase 230V/60Hz, and supplied to the distribution board for Telecommunications.

When a power failure is restored, the communication system shall be automatically restored to full operating condition without any human intervention.

By manual switch operation, the UPS can be bypassed, and the maintenance can be done. When the maintenance is completed, the normal operation state can be returned by manually operating the switch. Manual switch operation must be performed without interruption.

In the event of a fault, it automatically switches to a commercial Power supply, and the Power supply of single-phase 230V/60Hz is guaranteed. Bypass switching is done without interruption.

UPS is selected as a module type and has a redundant configuration in which spare units are mounted. Even if anyone unit fails, it will be automatically switched to standby, and stable power can be continuously supplied.

The Power is to supply the following Telecom as follows.

- Backbone system
- Radio system
- Voice and Data system
- CCTV system
- Passenger Information Display (PID) system
- Public Address (PA) system
- Time server and Master clock system
- Meteorological and Seismic Monitoring system
- Telecommunication Equipment Monitoring (TEM /CSS) system
- Flight Information Display System (FIDS)

TELECOMMUNICATIONS SYSTEM

APPENDIX 10

FLIGHT INFORMATION DISPLAY SYSTEM (FIDS)

1. INTRODUCTION

1.1 General

This Chapter specifies the technical characteristics of the Flight Information Display System (FIDS) for Telecommunications System.

1.2 Overview of the Flight Information Display System (FIDS)

A Flight Information Display System shall be provided in all stations displaying the flight arrival and departure information of Clark International Airport (CIA).

2. SCOPE OF WORKS

2.1 General

The specific requirements on the scope of the works for the Flight Information Display System (FIDS)shall be as specified below.

2.2 Scope of supply for the Flight Information Display System (FIDS)

The FIDS shall display the arriving and departing flights from Clark International Airport (CIA) and shall be suitable to accommodate future system expansion.

This system shall be interoperable and have a similar configuration and presentation as the FIDS being provided for the NSCR stations.

Flight information shall be derived directly from the CIA's FIDS with the same image and format similar to the CIA's FIDS in their airport terminals.

The FIDS server for the whole NSCR line shall be located in (CIA) Station.

All costs associated with the third party works at CIA to facilitate the connection of the CIA FIDS shall be borne by the Contractor.

A) Technical Requirements:

The FIDS shall be independent and separated from the Passenger Information Display System (PIDS).

The flight information shall be distributed using the backbone network as shown in Figure 3.4.2- FIDS Architecture.

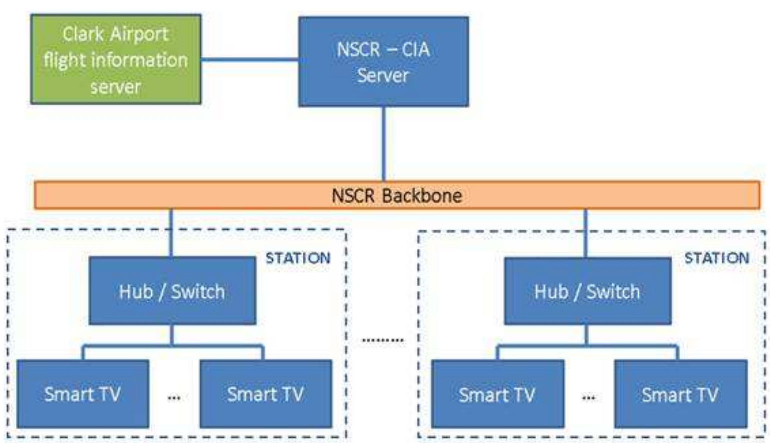


Figure 2.2- FIDS Architecture.

B) Contractors Requirements:

The contractor shall propose two (2) locations for the FIDS, one (1) in the paid, and one (1) in the unpaid area of each station. The displays or screens be installed in pairs, one (1) display for departing flights, the other (1) screen shall display arriving flights. The exact locations in each station should be coordinated with the Architectural and Stations Team to determine the exact positions with regards to passenger flow.

The proposed locations of the displays shall be submitted to the Engineer for approval and shall take into consideration the positions of station entrances, and the location of ticket machines. The positioning shall be coordinated with the station designers and contractors.

The Contractor shall demonstrate the proposed display meets all requirements and suitability for the proposed locations and applications.

C) System Requirements/ Specifications:

The requirements for the displays are:

- The estimated size of each display is 55 inches as a minimum.
- Business/Commercial Grade: made for Digital Signage.
- Image quality shall be minimal 1920x1080 pixels; HD Display
- For 24/7 operations: Minimum 19/7 operations.
- Minimum Brightness 700 nit (cd/m2) -Auto-Brightness option preferred.
- Wide viewing angle; H/V 178/178
- Non-glare display; made for semi-indoor applications.
- Displays shall be dustproof; Minimum IP 54.

The information to be displayed on the screens and will be dependent on the image feed from the CIA but shall include and not be limited to the following:

- Destination or Origin,
- Operator /Flight number,
- Partner/ Flight number
- Scheduled time of departure/arrival,
- ETA/ETD
- Flight Status
- Gate

As a minimum, the flight information should display up to six (6) hours of departure/arrival information.

All cabling for power, network, and other connections shall be provided by the contractor.

End of Section

4 POWER SUPPLY SYSTEM

I. The Malolos-Clark Railway Project (MCRP)

4.1 Scope of Works

4.1.1 General

This Specification covers the requirements for the design, manufacturing, factory test, packing, delivery at the Site, installation, training and setting, testing, commissioning, and interfacing works for completing the Power Supply system for the Malolos-Clark Railway Project (Malolos-Clark) The work shall include the following: 1) Main Line with thirteen (13) Traction Substations (TSS), four (4) Battery Posts (BP), one (1) Sectioning Post (SP) and at North Depot, one (1) Depot Traction station (Depot SS), one (1) Depot Sectioning Post (Depot SP) are planned to construct, and the locations and site conditions are described as follows:

Table 4.1-1 Location of TSS, SP, BP at Mainline and Depot Area

Substation TSS No	Location (m)	Nearest Station	Electric Company
No.10	37km410	Malolos	MERALCO
No.11	42km370	Calumpit	MERALCO
BP-1	44km350	Apalit	MERALCO PELCO III
No.12	45km920	Apalit	PELCO III
No.13	49km300	Apalit	PELCO III
No.14	54km690	San Fernando	PELCO III
BP-2	55km810	San Fernando	PELCO III SFELAPCO
No.15	57km680	San Fernando	SFELAPCO
No.16	61km990	San Fernando	SFELAPCO
No.17	66km660	Angeles	SFELAPCO
No.18	71km000	Angeles	SFELAPCO
BP-3	72km520	Angeles	SFELAPCO/AEC
No.19	73km100	Angeles	AEC
No.20	75km962	Angeles	AEC
BP-4	77km800	Clark	AEC/CEDC
No.21	79km440	Clark	CEDC

Substation TSS No	Location (m)	Nearest Station	Electric Company
SP	83km436	CIA	CEDC
No.22	84km450	CIA	CEDC
SS Depot	+1km600	CIA	CEDC

1) 69kV switchgears, transformers, rectifier equipment and 6.6kV substation cubicles shall be outdoor type. All the equipment of BP, SP, DC switchgears and control panels are indoor type. All the equipment installed in indoor shall be of permeation preventive structure of the water of the drops from ceiling, walls and others.

2) Electric Companies MERALCO, PELCO III, SFELAPCO, AEC and CEDC (hereunder electric companies) power connection work where described in this ERT, the work shall include all arrangements and costs associated with new electric companies' power supply to each traction Substation (SS) to be installed under the contract.

   The work as described below shall be carried out by the Contractor.

   i. Construction of power receiving equipment including receiving Cable from 69kV VCT of electric companies within premises of each SS.
   ii. Procurement and installation of power cable from electric companies VCT box in each SS.
   iii. Payment of Guarantee Cost and Connection Cost, which is required by electric companies upon entering into a contract to receive an electrical supply.
   iv. Any negotiations with electric companies regarding above shall be carried out by the Contractor.
   v. All details of materials and construction work by the Contractor shall follow to electric companies' standards.

3) The complete cable network and cable support system up to connection in substations shall be carried out by others. However, the cable size and types shall be decided by the Contractor. The Contractor shall coordinate with Interfacing Contractors and other Interfacing Parties with regard to the cable type, size, and includes but shall not be limited to the following:

   i. 6.6kV cable network to connect 6.6kV substation cubicles.
   ii. VCT shall be provided by electric companies in accordance with the Philippine Electrical Code.
   iii. DC Feeder cable network to connect OCS.
   iv. Cabling for interlinked tripping between TSS.
   v. Cabling of Optical Fiber cable for Power SCADA system.
   vi. Cabling of Optical Fiber cable for TSS, SP and BP telephone system.

4) The Contractor shall coordinate with Interfacing Contractors and other Interfacing Parties for each TSS, SP, BP and other equipment.

5) TSS, SP and BP space preparation, levelling including necessary banking, building construction including utilities such as fire detection and/or ventilation, indoor and outdoor

lighting, earthing equipment and etc. will be designed and constructed by other contractors, and the Contractor needs to coordinate with them.

6) The power supply equipment when in operation in normal and degraded mode shall not exceed the heat dissipation figures used in the sizing of the fans and air-conditioning used in the various rooms that house power supply equipment.
7) Power SCADA System for each TSS, SP, BP and Electric Room includes CCTV supervising system for each TSS, SP and BP entrance and outdoor equipment;
8) Power SCADA System for each TSS, SP, BP and Electric Room includes the door key status (open/close) monitor for TSS, SP, BP doors.
9) Protective provisions relating to electrical safety and earthing which includes but shall not be limited to earthing equipment, cables, non-current carrying metallic components and etc.
10) Resolution of interface issues with Interfacing Parties;
11) Special tools;
12) Spare parts and consumable;
13) Furniture, shock treatment charts, rubber mats, first aid boxes and danger notice plates;
14) Documentation, and
15) Services;

    The Services to be performed by the Contractor shall include the following:

    i. Design, supply, system quality management, installation, testing including integrated testing and commissioning of the complete electrical power supply system;
    ii. Presentations, reviews and audit support as described in the General Requirements;
    iii. Interface management with interfacing Contractors
    iv. Design, identification of locations for:
    v. Concrete foundations for any equipment;
    vi. Floor cinder concrete;
    vii. Ground bus bar, terminals and ground rods for TSS, SP, BP and buried pipes, cable pit and hand holes for cable wiring.
    viii. System operations;
    ix. Decommissioning, removal and/or disposal of temporary works; and
    x. Defects liability of the Permanent Works after commissioning as stipulated in the Contract.

16) Where cable containment is not provided by others then cable containment shall be supplied by the Contractor which shall have 25% spare capacity for expansion works. All cable containment material, fixing methods, and routing shall be given a Notice of No Objection by the Engineer.

4.1.2 System Requirements

1) 69kV Power receiving from electric companies.

    i. All the TSSs receive the power directly from electric companies by two incoming lines.

ii. The Contractor shall coordinate the requirements and layouts for accommodations and facilities of the receiving equipment in TSSs.

iii. In electric companies' power substations, electric companies will provide their own protection relays for protection of the 69kV outgoing feeders of electric companies networks. For the 69kV feeders at each substation, the Contractor shall coordinate with electric companies on the requirements for protection and shall provide and install suitable protection relays and facilities for the protection of 69kV incoming feeders in substations.

iv. electric companies shall provide independent voltage transformers (VT) and current transformers (CT) in an exclusive use package in each substation for metering electrical energy on each incoming feeder. To meet with the electric companies' requirements of energy metering, the Contractor shall coordinate with electric companies the details of the metering devices at the design stage of installation. The energy meter (MOF) will be provided by the electric companies. The Contractor shall provide the space for these devices for housing the VCT. The Contractor shall coordinate with electric companies on the necessary installed spaces and locations and miscellaneous.

v. 69kV feeder cables from the electric companies' substation to TSS of the Project will be provided and installed by electric companies. The Contractor shall coordinate with electric companies and other Interfacing Parties on the interface between the TSS and electric companies' substation. All the necessary works, equipment, materials, and fees for connection of the 69kV incoming feeders shall be borne by the Contractor. The Contractor shall liaise with electric companies regarding the provision of all connection details of the 69kV incoming cables.

vi. The Contractor shall coordinate with electric companies and other Interfacing Parties regarding the routing and containment of the incoming 69kV feeders.

vii. The Contractor shall coordinate with Interfacing Contractors and other Interfacing Parties with regard to the equipment weight imposed on the foundations by the substation power supply system equipment. The Contractor shall assure that the actual loading of permanent installation and delivery does not exceed the agreed loadings.

viii. The Contractor shall provide the electric power if required, using in the substation electric power equipment etc.

ix. Power factor shall be maintained between 0.9 and 0.95.

2) TSS (Traction Substation) shall include 69kV circuit breakers, Rectifier transformers, Rectifiers, DC 1,500V Switchgears, Re-generating devices, protective relays, cables and other, but not limited to, for train traction power, and 6.6kV substation cubicle with Distribution transformer for AC 6.6kV power supply.

3) Cables in the TSSs, SP and BPs

i. The Contractor shall provide all cables for 69kV AC, 6.6kV AC, 1500V DC and Low voltage using in each TSS, SP and BP.

ii. TSSs, SP and BPs

Interfacing Contractors shall provide rooms, including the required structure openings, equipped with building services, for the DC traction substations. The Contractor shall coordinate with Interfacing Contractors and other Interfacing

Parties regarding the delivery, installation and structure openings of each TSS, SP and BP equipment. The LV power to traction substation including lighting and battery chargers shall be provided by operation transformer in the traction substations.

iii. The Contractor shall provide 1500V DC feeder cables from DC switchgears to connecting terminals of OCS structure at the TSSs, SP and BPs.

4) Earthing, Bonding, Lightning Protection

The Contractor shall provide safe and secure grounding to protect people and equipment from reverse flashover in the ground fault and electric shock.

i. The earth mats and earth terminal boards for each TSS, SP, BP and other structures shall be provided by other contractors. The Contractor shall be responsible for all the connection to the terminal boards located inside each TSS, SP and BP. In the event that extension cables from terminal boards to all equipment and all outdoor facilities which are needed earthing, the Contractor shall provide such extension cables.

ii. The Contractor shall provide the earthing connection from mats to all outdoor facilities of TSSs, SP and BPs directly.

iii. The Contractor shall verify and confirm the earthing quality which complies with the required regulations and standards provided by other contractors.

iv. The Contractor shall coordinate its requirements for earthing (including earth mats), bonding and lightning protection with Interfacing Contractors.

v. Step voltage and touch voltage shall be verified that the calculated values are allowable tolerance range when the grounding fault voltage is generated at TSS, the calculation method of step voltage and touch voltage shall be complied with IEEE80-2000.

vi. The contractor shall apply epoxy floor finishes in all room and areas where power supply equipment shall be installed. Should the contractor fix the likes of pulling hooks to the floor to aid in equipment delivery the floor shall be made good and repairs made to the epoxy floor finish.

vii. Ground resistance value shall be less than 1Ω.

4.1.3 System Overview

1) System Studies

Power related studies the Contractor shall carry out and submit results to the Engineer for Approval shall not be limited to:

i. The Contractor shall undertake his own studies, calculations, analysis and confirm the required number, sizing and location of TSS taking into account of timetable simulation data, section data, rolling stock data, traction system data and etc.;

ii. BP (Battery Post) traction power simulation studies;

iii. Re-generating power absorbing device study, specification and effect;

iv. Track layout of MCRP in this project for DC traction power study is shown on the Drawing MCRP-DWG-PSS-1001

v. 6.6kV AC load flow study;

vi. Short circuit current, voltage dropping study and flicker study;

vii. AC and DC Harmonics study;

viii. Protection relay setting and system protection coordination study;

ix. Cable study, main circuit, LV and control cables voltage drop, capacity and etc.;

x. Power supply design study, including the whole system;

xi. Grounding and lightning protection study;

xii. Stray current corrosion control study will be performed by OCS contractor and coordination with the party shall be done by the Contractor.

xiii. EMC and EMI study about traction power supply system for true truck

xiv. Electrolytic corrosion mitigation measure study;

xv. The Contractor shall perform all necessary Power System Study simulations in corporate with ETCS Model Simulation for DC traction power supply system with consideration of 3 minutes headway.

These results shall be including for power supply demand calculation.

2) Power Supply System General Requirements

i. Power supply to MCRP shall be from the electric companies 69kV to TSSs and distributed to the DC traction system and AC 6.6kV power distribution.

ii. DC traction equipment shall supply 1500V DC to the OCS system.

iii. BP traction equipment shall supply 1500V DC to the OCS system.

iv. The Contractor shall develop its own strategy for earthing, bonding, lightning protection and corrosion control in accordance with applicable Standards IEC, IEEE, Philippine Electrical Code or equivalent equal.

v. All E&M systems equipment shall be bonded to the system earth bus bar in accordance with applicable Standards IEC, IEEE, Philippine Electrical Code or equivalent equal.

vi. All indoor and outdoor power supply equipment shall meet IP requirements, standards and regulations or equivalent equal appropriate for the location and conditions.

vii. Lightning arrestor shall be provided at Power receiving point of all the TSS, SP and BP.

3) System Integrity

i. The 6.6kV AC power distribution system shall be designed to ensure continuity of supply and the specified MCRP system performance under single outage conditions. The AC power distribution system shall be provided with a protection system to ensure that in the event of a faulty element is isolated; no other equipment is disconnected by the operation of such a protection device.

ii. The power supply system design shall ensure that cables and equipment shall be separated and protected to ensure that:

a) A single failure of an element of the power supply system shall:

- affect the operation or not result in failure of any other power supply system element;
- result in the total loss of power distribution to any part of the MCRP Line.

b) The opportunity for an incident external to the power supply system which affects the operation, or results in failure of an element within the power supply system, or results in a total loss of power distribution to any part of the MCRP Line shall be minimized.

c) The DC traction system shall be designed to ensure that it shall not affect the time tabled operation of trains.

d) The DC traction system shall include protective tripping to ensure that any faults are disconnected quickly.

e) It shall not be possible for faults to be masked by regenerative power from Trains.

f) A Zone Protection Scheme shall be applied for 6.6kV distribution system. The distribution circuit shall be protected by over current protection relays. 69kV receiving bus bars in each substation shall be protected by bus zone protection relays.

4) 69kV power receiving.

i. Two independent incoming lines in all substations from electric companies.

a) All the substations and Depot receive two independent incoming lines from electric companies.

b) Estimated capacity of these substations shall be the total capacity required to supply the entire line.

c) For distribution system 6.6kV AC will be made by 69kV/6.6kV transformer.

d) The load transfer between two electric companies' feeders shall be transferred without any disruption to revenue service.

ii. The 69kV/6.6kV transformers and 69kV switchgear of the substation shall be designed and provided to support the strictest requirement.

iii. The Contractor's design shall be in accordance with electric companies' regulation, through analysis and simulation, of the validity of the power supply system configuration to satisfy the harmonics and other requirements of the design, and the Contractor shall enhance the configuration if it is found to be inadequate.

5) 69kV System

i. The permissible operating voltage of 69kV shall be in the zone between minimum -10% of operation voltage and maximum +10% of operation voltage in accordance with electric companies standard.

ii. The 69kV system shall be designed to ensure that voltage regulation under normal feeding is maintained within 5% of normal voltage at any point on the 69kV system and shall ensure that it is maintained within 7% under any single outage condition.

iii. All 69kV switchgears shall be designed and provided to support the ultimate capacity operation of the MCRP System, as well as the 6.6kV distribution system.

6) DC Traction System

i. The DC traction substations shall provide power to the Overhead Contact line System with DC traction supply at a nominal 1500V DC and return shall be via the running rails.

ii. The instantaneous voltage at any train along the route shall not fall below 1100V DC during normal operations with all substations in rated service and shall not fall below 1000V DC with any abnormal operating condition under any single outage condition.

iii. Two (2) rectifier banks shall be installed at every traction substation on main line and shall have estimated capacity sufficient for the simultaneous operation.

iv. One rectifier unit shall be used for ordinary use and the other is used for standby.

v. Three (3) rectifier banks shall be installed at Depot substation and shall have estimated capacity sufficient for the simultaneous operation.

vi. One (1) or two (2) rectifiers units shall be used for ordinary use and the other is used for standby.

vii. One DC feeder circuit breaker for each traction substation shall be provided for DC feeder redundancy system. This standby circuit breaker shall be able to operate by changing over of disconnecting switches instead of failed circuit breaker.

viii. Linked breaking system utilizes optical fiber cables shall be prepared for DC traction feeder circuit protection between main line TSSs.

7) BP (Battery Post)

i. The BP system shall store surplus regenerative energy in battery and discharge it to another accelerating train.

ii. The surplus regeneration energy shall be efficiently charged to/from the battery to prevent regenerative braking failure.

iii. The high charge-discharge characteristic of the BP system shall reduce energy waste and promote power demand peak-cut.

iv. The BP system shall improve traction power quality through line voltage stabilization.

v. The BP system shall be utilized to safely bring passengers to the nearest station during adjacent TSS power failure. The BP's shall be sized to allow for multiple trains within the electrical sections to move out of the affected section.

vi. The BP system shall have flexible control of charge-discharge cycles in accordance to the battery's State-of- Charge.

vii. The BP system shall provide power to the Overhead Contact line System with DC traction supply at a nominal 1500V DC and return shall be via the running rails.

viii. The instantaneous voltage at any train along the route shall not fall below 1100V DC during normal operations with all substations in rated service and shall not fall below 1000V DC with any abnormal operating condition under any single outage condition.

ix. The exact number, the location and the required capacity of the battery post shall be determined during the traction power simulation study. The simulation shall determine the optimum quantity and position of the battery posts to maximize the overall energy efficiency of the system. The quantity of battery posts as stated in Clause 4.1.1 is for reference purposed only.

x. Most suitable power storage system in terms of high energy density, high power density and economic efficiency shall be selected from using the comparison table in detail design.

8) Supervisory Control and Data Acquisition (SCADA)

i. The power supply system and the distribution system shall normally be controlled remotely from the SCADA system and monitored at the SCADA system in the OCC.

ii. Telephone sets shall be installed at each TSS, BP and SP and provided by the Communication Contractor. The Contractor shall coordinate with the Communication Contractor about the type of telephone set, location, numbers of line and so forth.

9) 6.6kV distribution system for power supply system

i. Looped 6.6kV parallel power distribution system (ordinary use side and standby use side) shall be designed and provided. One system shall be connected to a north bound substation and another is connected a south bound substation.

ii. The reciprocal support circuit shall be connected between the above two substations of each system. In case ordinary use distribution line from a substation stops, electric power can supply through other side line.

iii. One circuit for each direction in looped system distribution line is prepared for Electric rooms.

iv. Distribution transformer 69kV/6.6kV are prepared in the substations and listed in Chapter 5, and in depot exclusive use two Distribution transformers are designed.

10) TSS equipment

i. 69kV Switch gears:

69kV outdoor type, metal enclosed gas insulated or air insulated switchgear (eco-friendly type)

ii. Rectifier equipment

69kV/1180V gas insulated self-cooling or oil insulated transformer self-cooling Rectifier transformer (eco-friendly type);

Rectifier, 1500V 6000kW, 12 pulses pure water heat pipe cooling type,

AC Bus duct between Rectifier Transformer and Rectifier DC 1500V outdoor type metal enclosed air insulated switchgear with high-speed circuit breaker and disconnecting switches

iii. Distribution Transformer

The 69kV/6.6kV distribution transformers shall be gas insulated or oil insulated self-cooling.

iv. DC 1500V Indoor type air insulated switchgear with disconnecting switches.

DC 1500V Switch gears

DC 1500V Indoor type air insulated switchgear for Rectifier positive protection.

DC 1500V Indoor type air insulated switchgear for Rectifier Negative separation.

DC 1500V Indoor type air insulated switchgear for DC feeder protection

v. Guidance on quantifying greenhouse gas emission reductions from the baseline for electrical and electronic products and systems shall be considered in accordance with IEC TR 62726.

11) Harmonics

i. The power supply design shall comply with the maximum of total permissible voltage distortion of electric companies' requirements for limitation of higher harmonics at the 69 kV termination points to the electric companies' grid.

ii. Harmonic distortion of output current shall be not more than 5% in total, not more than 3% each (at rated output).

4.2 Definitions and Abbreviations

4.2.1 Definitions

In This Specification, the following defined terms shall have the meanings ascribed to them below:

Standard Terminology	In general definitions applied to traction power and protective relay function conform to the British Standards (BS), American National Standards Institute (ANSI), International Electromechanical Commission (IEC) standards or European Norm Standards (EN).
Earthing	Same as 'Grounding'. The connection for equipment enclosures and non-current carrying metal parts to the earth to provide safety to personnel, public and equipment.
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.
Medium Voltage	As applied for this Contract, the medium voltage is over 600V AC.
Low Voltage	As applied for this Contract, low voltage refers to voltage not exceeding 600V AC.
Breaking Capacity	This is the capability to interrupt a maximum rated short circuit or fault current at a rated maximum voltage. Thus, it is usually expressed in volt-amperes, kilovolt amperes, or megavolt amperes.
Headway	The time interval between following trains.
PLC (Programmable Logic Controller)	PLC is a programmable controller, which utilizes ladder diagram programming and advanced instructions for use in Automation environment.

RTU (Remote Terminal Unit)	Interface unit between control panels installed in each SS, BP, SP and SCADA.
Traction Substation	Traction Substation receives 69kV AC and converts 69kV AC to 1500V DC for feeding traction power and to 6.6kV AC to MCRP power distribution system
Medium voltage Electrical Room	Medium voltage Electrical Room receives 6.6kV power and transforms 6.6kV to 400-230V AC in the Depot for supplying power to depot.
Railway Electric Room (RER)	Railway Electric Room receives 6.6kV power and transforms 6.6kV to 400-230V AC at each Station for supplying power to each station.
Switchgear	Means Isolator Switches, Circuit Breakers, Interrupters, Cutouts and other apparatus used for the operation, regulation and control of electrical circuits.
Withstand Capability	Rated capability of equipment to survive without damage by the mechanical forces of a short circuit or the thermal effects of a short circuit downstream from the equipment. Also, a rated capability of equipment which will withstand without damage for specified power frequency over-voltage and/or for surge or impulse voltage.

4.2.2 Abbreviations

AEC	Angeles Electric corporation
AWG	American Wire Gauge
BIT	Built in Test Diagnostics
BP	Battery Post
CEDC	Clark Electric Distribution Corporation
FAT	Factory Acceptance Test
GNAN	Gas-Insulated Self-Cooled
GNAF	Gas-Insulated Self-Cooled Forced-Air Cooled
GDAF	Gas-Insulated Forced-Gas Forced-Air Cooled
GIS	Gas insulated switchgear
HSCB	High Speed Circuit Breaker
HSVCB	High Speed Vacuum Circuit Breaker
HT	High Tension (in this Project means 6.6kV)

LBS	Load Break Switch
LSOH	Low Smoke Zero Halogen
MCCB	Molded Case Circuit Breaker
MERALCO	Manila Power company
MOF	Metering Out Fit
MRT	Mass Rapid Transit
MW	Messenger Wire
NDTs	Non Destructive Tests
ONAF	Oil-Immersed Forced-Air Cooled
ONAN	Oil-Immersed Self-Cooled
PELCO	Pampanga Electric Cooperative, Inc.
PLC	Programmable Logic Controller
Rms	Root Mean Square
SCR	Station Control Room
SE	System Earth
SF6	Sulfur Hexafluoride
SFELAPCO	San Fernando Electric Light and Power Co., Inc.
SP	Sectioning Post
STRASYA	Standard Urban Railway System for Asia
TP	Triple Pole
VDU	Visual Display Unit
VVVF	Variable Voltage Variable Frequency

4.3 Design Criteria and Standards

Design criteria of the power supply system of this Project are as follows.

4.3.1 Design Life

(1) Application of state-of-the-art Technology;

(2) Design proven in service;

(3) Design life is 30 years;

(4) Minimum life cycle cost;

(5) Low maintenance cost;

(6) Use of interchangeable and modular components;

(7) Extensive and prominent labelling of parts, cables and wires;

(8) Use of unique serial numbers for traceability of components;

(9) High reliability;

(10) Low energy loss;

(11) System safety;

(12) Sufficient and necessary redundancy in system;

(13) Environment friendly to avoid contamination by oil leakage in case of incident;

(14) Adherence to operational performance requirements; and

(15) Maximum utilization of indigenous materials and skills, subject to quality conformity.

4.3.2 Proven Design

1) The Contractor shall develop the design based on this Specification and on proven and reliable engineering practices. The design details shall be submitted with technical data and calculations to the Engineer for his review.

2) The system, including all sub-systems and equipment, shall be of proven design.

3) Sub-systems and equipment proposed by the Contractor shall have been in use and have Railway System over a period of at least five years.

4) Where similar equipment or sub-systems of a different rating are already proven in service, then the design shall be based on such equipment. In case these stipulations are not fulfilled, the Contractor shall furnish sufficient information to prove the basic soundness and reliability of the offered sub-system and compliance with the design criteria.

4.3.3 Adequate margin

Adequate margin shall be built into the design particularly to take care of the higher ambient temperatures, dusty conditions, and high seasonal humidity, etc. prevailing in Manila.

4.3.4 EMC (Electromagnetic Compatibility)

1) The Contractor shall guarantee that the traction power supply equipment is taken the measures preventing an electromagnetic interference (EMI) from any equipment supplied by the Interfacing parties and the Interfacing Contractor in the depot.

2) The Contractor shall submit an EMC Control Plan to the Engineer for Approval.

3) The Plan shall include the measures to reduce conducted, induced and radiated emissions to acceptable levels as specified by IEC 62236: Railway Applications-Electromagnetic Compatibility.

4) The Plan shall specify the measures to increase the immunity of the traction power supply equipment for the main track.

5) The Plan shall specify the basic protective measures proposed for all electrical and electronic subsystems and components, and the specific protective measures to be adopted for selected subsystems and components.

6) The Plan shall analyze EMI/EMC impacts on the design of the traction power supply equipment, the train, and wayside equipment as well as the general environment.

7) Particular attention should also be paid to additional requirements in earthing, bonding, shielding, filtering and cable arrangements.

8) The Contractor shall conduct full EMI tests on each one set of equipment and type tests as well as full EMC tests on complete traction power supply equipment in accordance with IEC 62236.

9) Non-safety related systems interface

10) The Contractor shall take appropriate measures to ensure that EMC is achieved between the traction power supply equipment and track-side equipment.

11) Environmental EMC

12) The electrical equipment composed traction power supply system in the depot shall not produce interference with radio, television, tape recorder/players, heart pace-makers, radar, computer systems, magnetic media, portable and cellular telephones, etc., in the TSS, BP, SP.

    This includes action by static electricity, magnetic field and electric field.

4.3.5 Applicable Standards

Technical regulatory standards on Japanese railways (TRTRS): 2012

The interpretation of the technical regulatory standards on Japanese railways: 2005

IEC 60034 (Clause 5.6.2)	Rotating electrical machines
IEC 60038	IEC standard voltages
IEC 60044-1	Instrument transformers – Part 1: Current transformers
IEC 60044-2	Instrument transformers – Part 1: Inductive voltage transformers
IEC 60071	Insulation Co-ordinations
IEC 60076	Power transformers
IEC 60076-10	Power transformers – Part 10: Determination of sound level

IEC 60076-11	Power transformers – Part 11: Dry-type transformers
IEC 60076-15	Power transformers – Part 15: Gas filled transformers
IEC 60099	Surge arresters
IEC 60129	Alternating current disconnectors (isolators) and earthing switches
IEC 60146	Semiconductor converters
IEC 60287	Electric cables – Calculation of current rating
IEC 60296	Fluids electro technical applications – Unused mineral insulating oils for transformers and switchgear
IEC 60502	Cables
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 60622	Sealed nickel-cadmium prismatic rechargeable single cells
IEC 60850	Railway applications – Supply voltage of traction systems
IEC 60870	Tele-control equipment and systems
IEC 60947	HV, MV, LV switchgear
IEC 61000	Electromagnetic compatibility (EMC)
IEC 61936-1	Power installations exceeding 1kV a.c. Part 1 common rules
IEC 61992	Railway Applications - Fixed installation - DC switchgear
IEC 62236	Railway applications – Electromagnetic compatibility
IEC 62271, IEC 62271-203	High-voltage switchgear and control-gear
IEC 62278 (Clause 3.2.2)	Railway Applications-Specifications and demonstration of reliability, availability, maintainability and safety (RAMS)
IEC TR 62726	Guidance on quantifying greenhouse gas emmission reductions
IEEE 519 (Clause 5.3.5, 5.4.5)	IEEE recommended practices and Requirements for Harmonic Control in Electrical Power Systems

BS 6651 (Clause 5.7.4)	Code of practice for protection of structures against lightning
EN 50122-1	Railway applications Fixed installations Electrical safety, Earthing and the return circuit.
Philippine Electrical Code	
Philippine Distribution Code	
Philippine Grid Code	
National Structural Code of The Philippines	
National Building Code of The Philippines	

Proposals for the adoption of alternative standards shall be submitted to the Engineer for review.

4.4 Technical Requirements

4.4.1 Switchgear

(1) Standards

All 69kV and high voltage switchgear shall be designed and manufactured in accordance with the requirements of applicable Philippine Standards equivalent to IEC 62271, High-Voltage Switch gear and Control gear or equivalent as appropriate.

(2) 69kV Switchgear

1) 69kV switchgear for TSS shall include the following:

   69kV incoming circuit breaker units for ordinary feeders and/or for standby feeders, and

   69kV circuit breaker units for protecting rectifier transformer.

2) Each of 69kV switchgear with circuit breaker shall be designed with adequate current ratings and short circuit braking duty according to its intended function.

3) The 69kV switchgear shall be compact module type in design, metal enclosed and suitable for outdoor installation, the 69kV switchgear shall comprise any of the following.

   a. Air insulated vacuum circuit breakers withdrawable type.

   b. Gas insulated vacuum circuit breakers withdrawable type.

4) The 69kV switchgear shall be designed for the following minimum ratings and not exceed 2.5 p.u. overvoltage for any switching or breaking duty:

   a. Rated voltage: 69kV

   b. Number of phases: 3

   c. Rated frequency: 60Hz

d. Rated short circuit breaking and making capacity: to meet the 69kV/6.6kV system fault level not less than 50kA

e. Rated current: 630A

f. Auxiliary power supply voltage for operating device: 105V DC

g. Auxiliary power supply voltage for auxiliary circuit: 400/230V AC

5) The 69kV switchgear shall include the following equipment:

a. Circuit breaker which can withdraw or fix mounted circuit breakers;

b. Earthing switches;

c. Current transformers of suitable ratings and temperature class for protection and measuring; and

d. Voltage transformers of suitable ratings and temperature class for protection and measuring.

e. Lightning arrestor shall be installed with adequate specification in accordance with the Philippine Electrical Code.

6) Protection and measuring facilities shall include the following:

a. 69kV bus zone protection relays shall be provided;

b. Voltmeter and under-voltage protection for bus sections shall be provided; and

c. Ammeter, kilowatt meter, over-current and earth fault protection for rectifier circuits.

7) Guidance on quantifying greenhouse gas emission reductions from the baseline for electrical and electronic products and systems shall be considered in accordance with IEC TR 62726.

(3) DC Switchgear

1) DC switchgear comprising DC high speed circuit breakers shall be provided for switching off the rectifier DC incoming feeds and outgoing feeds to overhead contact line system. The DC switchgear shall be equipped with necessary functions for SCADA control and indication.

2) The DC switchgear shall be constructed in accordance with IEC 61992 railway applications, fixed infrastructure - DC switchgear.

3) The DC switch gears consists of following types

a. HSCB, protection for Rectifier Positive circuit minimum includes;

- DC HSCB
- DC current transformer for reverse current protection
- DC voltage transformer
- Relay for above function.
- Fault indicator
- Mimic bus

b. DS, protection for Rectifier Negative circuit minimum includes;
- DC Negative Disconnecting Switch (manual)
- DC current transformer for measurement
- Relay for grounding protection (64PB)
- Fault indicator
- Mimic bus

c. HSCB, protection for outgoing feeder circuit minimum includes;
- DC HSCB
- DC current transformer for over current protection
- DC current transformer for measurement
- DC lightning arrester for open section
- DC Disconnecting Switch (Motor operation)
- DC Disconnecting Switch for stand by HSCB (Motor operation)
- Relay for above function.
- Fault indicator
- Mimic bus

d. Stand by HSCB for outgoing feeder minimum includes;
- DC HSCB
- DC current transformer for over current protection
- DC current transformer for measurement
- Conversion switch for stand by function
- Fault indicator
- Mimic bus

e. DC switch gear for the regenerative Positive circuit minimum includes
- DC HSCB
- Relay for above function.
- Fault indicator
- Mimic bus

f. DC switchgear for the regenerative Negative circuit minimum includes;
- DC Negative Disconnecting Switch (manual)
- Fault indicator
- Mimic bus

4) The DC switchgear shall be provided with minimum ratings in accordance with the following parameters:

   a. Rated voltage 1500V DC;

   b. Rated current 4000A and 5000A

   c. Rated breaking current 100kA for HSCB.

5) The DC switchgear shall be of metal-clad multi-cubicle type, with withdrawal circuit breakers for positive pole switching and isolating.

6) All DC switchgears shall be isolated from the ground and the switchgears shall be rigidly fixed to the floor with anchor bolts.

7) Negative connections shall be a collector bar incorporating earth returns and monitoring.

8) Rectifier circuits shall incorporate reverse current tripping.

9) OCS contact feeder protection shall detect short circuit (by direct acting trip devices in DC circuit breakers) and limited faults (by multifunction relay with DC fault selective device) but shall not cause tripping due to load current in other operating modes.

10) In the event of OCS contact feeder protection failure, all the circuit breakers for feeding the same track and the same section shall trip automatically with Tele-command breaking devices.

11) In the event of OCS contact feeder protection failure, all the circuit breakers for feeding the same track, the adjacent section of failure section, all the circuit breakers for feeding another track shall be opened automatically.

12) OCC Operator is able to open the necessary circuit breaker manually in case the command was send from stations, trains and others.

13) In case the command was sent from the train at one side of the station, the OCC Operator should open the necessary circuit breaker manually.

(4) Current transformers

Design and supply of current transformers for AC and DC shall meet the following requirement or equivalent.

1) Design and installation shall be in accordance with relevant standards and regulations.

2) Class and rating shall be suitable for metering, monitoring and protection requirements.

(5) Voltage transformers

Design and supply of voltage transformers for AC and DC shall meet the following requirement or equivalent.

1) Design and installation shall be in accordance with relevant standards and regulations.

2) Class and rating shall be suitable for metering, monitoring and protection requirements.

4.4.2 Rectifiers and Rectifier Transformers

(1) General

1) Each rectifier transformer and rectifier set combination shall incorporate full load overall efficiency of not less than 98% and power factor of not less than 95% lagging.

2) Each rectifier transformer and rectifier set combination shall provide linear inherent DC voltage regulation of not less than 6% of the full load voltage, from light transition load (approximately 1%) to 100% full load and shall be as linear as technically feasible up to the 300% full load current. The inherent voltage regulation at 300% full load shall ensure that the voltage at the rectifier load terminals shall not be less than 1150V DC.

3) The output DC voltage for each rectifier transformer and rectifier set combination, at light transition load, shall not exceed 1590V DC.

4) The DC traction supply system shall be designed to provide a voltage that is self-limiting to 1650V DC at no load.

5) Each rectifier transformer and rectifier set combination shall be designed in accordance with Engineer's requirements and to satisfy the requirements of this Performance Specification and following:

   a. 100% Continuous

   b. 130% to 150% overload – 120 minutes

   c. 300% overload – 1 minute.

(2) Rectifier Transformers

1) 69kV/1.18kV Rectifier transformers shall comply with relevant standards and regulations. Rectifier transformers shall be rated to supply the full DC traction system load within the continuous rating, with any one rectifier transformer out of service.

2) The overload ratings of rectifier transformers shall be utilized to accommodate any abnormal loading in the event of train bunching or due to any abnormal DC traction feeding arrangements.

3) Rectifier transformers shall be designed in accordance with relevant standards and regulations and shall incorporate an earthed metal screen between high voltage and low voltage windings, if necessary.

4) Off-load tapping links shall be provided on the high voltage winding to provide rated output at +5.0% to -5.0% of nominal supply voltage, in increments of 2.5%.

5) Two secondary windings shall be provided, one connected in star and the other one connected in delta, to provide double six phases supply to the rectifier.

6) Rectifier transformers shall be fitted with a temperature alarm device, and temperature tripping and pressure alarm and gas pressure tripping to be monitored by the SCADA.

7) The insulation shall conform as a minimum to temperature 'Class B' as defined with relevant standards and regulations.

8) Rectifier transformers shall be of oil insulated or gas insulated self-cooling type with an enclosed bus ducting or cable connection to the rectifier cubicle.

(3) Rectifier Sets

1) Rectifier sets shall provide nominal 1500V DC traction supply to the Overhead Contact line System.

2) Rectifier sets shall accommodate the load cycle requirements as defined with relevant standards and regulations for "Extra Heavy Traction Duty Class D" as a minimum, and to ensure that other duty satisfies the power supply system load requirements.

3) Rectifier sets shall be protected against any physical contact and shall be suitably enclosed.

4) Rectifier sets shall be fitted with a temperature alarm device and temperature tripping device, to be monitored by the SCADA system.

5) Rectifier sets shall be designed to deliver a 12-pulse DC output.

6) Rectifier sets shall be natural cooling type or heat-pipe cooling type or an equivalent cooling type.

7) When adopting a natural cooling system and connecting diode in parallel, diode fuses shall be provided to disconnect any faulty diode.

8) Faulty diode detection shall be provided and shall be monitored by the SCADA system.

9) Rectifier sets shall be rated for voltage of nominal 1500V DC at continuous load (full load).

(4) Surge Suppression

1) The DC traction supply voltage shall be permitted to rise to a maximum of 2100V DC during the regenerative breaking of the trains. In addition, the DC traction system shall sustain transient voltage surges of up to 10kV for up to 1 millisecond between the positive and negative poles.

2) Suitable surge and transient absorption circuits and surge diverters shall be provided to protect the rectifier sets from the effects of lightning strikes on the overhead contact and running rail.

(5) Harmonics

Harmonic distortion at the points of common coupling shall be limited to ensure the power quality.

(6) Isolating and Earthing Facilities

Isolating and earthing facilities shall be provided in order to enable maintenance to be carried out safely on the rectifier transformers and the rectifier sets.

4.4.3 Transformers

(1) Standards

69kV/6.6kV power transformers and 6.6kV/0.4kV operation transformers shall comply with relevant standards and regulations.

(2) 69kV/6.6kV Distribution transformers

1) The 69kV/6.6kV distribution transformers shall be non-flammable oil immersed type, molded or gas insulated off-load tap-changing, out-door type, Class B and eco-friendly type or equivalent with the following minimum ratings and requirements.

2) The Contractor shall determine actual rated power based on Chapter 5 Power Distribution System.

a. Nominal voltage

High voltage winding: 69kV

Low voltage winding: 6.6kV

b. Number of phases: 3

c. Rated frequency: 60Hz

d. Type of cooling: Moulded, natural or forced air

e. Off load tap changing equipment:

Tap changing of ± 5% with 2.5% each. The transformer shall provide full capacity at all tapping positions.

f. The base of the transformer shall be designed to spread the weight of the transformer over as large an area as possible within its space envelope.

3) The rated insulation level shall comply with the following minimum requirement:

a. Lightning impulse withstand voltage:

Both high and low voltage winding shall comply with relevant standards and regulations.

b. Power frequency withstand voltage for 1 minute:

Both high and low voltage winding shall comply with relevant standards and regulations.

c. Neutral grounding method: Directly earthing for high voltage winding and low voltage winding according to neutral earthing mode of the distribution system

d. Noise level:

Permissible noise level shall comply with the Philippine environmental standard.

e. Air-filled cable box for high and low voltage termination shall be provided.

f. Fault detection: gas pressure and gas temperature

(3) 6.6kV/400-230V operation transformers

The 6.6/0.4kV operation transformers for supplying power to control equipment shall be mold or oil-immersed type, off-load tap-changing, indoor type and eco-friendly type with the following minimum ratings and requirements:

1) One 6.6/0.4kV transformer shall be installed in the traction substations.

2) The rated power shall be determined by the Contractor as part of its design of works.

3) The 6.6/0.4kV operation transformers shall comply with the following minimum ratings and requirements:

a. Rated voltage

- High voltage winding: 6.6kV

- Low voltage winding: 400/230V

b. Number of phases: 3 (3phase-3wire method)

c. Rated frequency: 60Hz

d. Type of cooling: moulded, natural or forced air-cooling.

e. Off load tap changing equipment: Tap changing of ± 5% with 5.0% each step to comply with Philippine Grid Code of the Philippines.

f. Connection designation: Dyn11

4) The rated insulation level shall comply with the following minimum ratings and requirement.

   a. Lightning impulse withstand voltage:

      Both high and low voltage winding shall comply with relevant standards and regulations.

   b. Power frequency withstand voltage for 1 minute:

      Both high and low voltage winding shall comply with relevant standards and regulations.

4.4.4 Control Source for Substations

(1) Battery Units

1) For the receiving substation, and traction substations, the Contractor shall provide DC 110V battery system for safety tripping, service current functions and power to the SCADA remote terminal units.
2) The battery system shall be rated to supply the standing loads for a minimum of 3 hours in the event of a charger supply failure, and at the end of that period shall be capable of operating each item of equipment for two cycles, i.e., one cycle is open and close.
3) During such duty output voltage shall be within the tolerances defined for operation in the relevant equipment specifications.
4) The 110V batteries shall be of the NiCad type, maintenance free type and shall not emit hazardous gases.

(2) Battery Chargers

1) Battery chargers shall be provided with self-regulation and shall be capable of restoring a minimum of 80% of battery capacity within 4 hours of full discharge.
2) Sufficient indications shall be provided on the battery charger to provide status information of the battery charger system, as a minimum this shall include battery voltage, trickle charge and booster charge currents, battery charge functioning and battery charge failure. In addition, status information shall be provided to the SCADA system.
3) Battery chargers shall incorporate measuring instruments such as ammeters and voltmeters as a minimum.
4) In receiving substations and traction substations, AC auxiliary power for the battery charger shall be fed from the secondary circuit of operation transformer.

4.4.5 BP (Battery Post)

(1) The BP system consists of following;

1) Control Panel

   - Charge and discharge control
   - System monitoring

- Schedule and Sequence control
- Data logging
- Remote maintenance

2) Filter Panel/Chopper
3) DC switch panel
4) Capacitor panel
5) Resistor panel

(2) Rating and Specifications

1) Rated Current: ≥1200A.
2) Nominal input voltage: 1500V DC
3) Rated input voltage: 1650V DC.
4) Maximum voltage: 1800V
5) Housing for BP shall be outdoor type.

4.4.6 Power SCADA (SCADA for Power Supply System)

(1) General

1) The Contractor shall design, supply, install test and commission a microprocessor based Supervisory Control and Data Acquisition (SCADA) system for smooth operation, monitoring, control and logging of important features of the traction power system on the MCRP Line.
2) The equipment shall be controlled and monitored comprising with each TSS, BP, SP but not limited to.
3) At the OCC Central workstations are to be provided giving an effective means of display and control.
   a. At the OCC three (3) displays showing various equipment states is to be provided.
   b. The central computer server shall maintain an historical database of all messages transmitted over the Power SCADA links and the Contractor shall provide a means of accessing that database.
4) Necessary RTU shall be installed to provide the most economic configuration based upon cost balances between RTU modularity and cabling costs, consistent with the performance requirements of this Specification.
5) Communications between the equipment in the traction substations, electric room shall be over a duplicated communications network dedicated to Power SCADA, which shall be provided.
6) In the event of a communications failure between a station and the central database the station traction power SCADA equipment shall continue to function as an autonomous system, maintaining a local database and all Power SCADA facilities.
7) The Power SCADA system shall incorporate, but shall not be limited to, the following primary facilities:
   a. Provide continuous, effective monitoring at OCC;
   b. Alert operations and maintenance staff rapidly to equipment malfunctions,

especially those likely to cause disruption to operation of the railway;

c. Provide clear, comprehensive displays and printed logs of equipment status to each operator workstation;

d. Provide comprehensive displays and printed logs based upon historical data, with the option of overlaying data from earlier periods;

e. Time-tag all events detected by the Power SCADA system, to 20 milliseconds resolution for selected high-speed inputs, and to present this information in logs as a true system-wide sequence of events;

f. Provide comprehensive periodic records of energy demand and consumption;

g. Provide automatic and manual control of receiving, traction and auxiliary power equipment;

h. Generate routine maintenance schedules automatically, based upon elapsed time and equipment operation times;

i. Provide centralized data storage and software back-up system.

j. Provide displays for supervising of each CCTV installed in each TSS and SP for the sight over view.

k. Power SCADA System for TSSs, SP, BPs and Electric Rooms includes the door key status (open/close) monitor for each TSS, SP, BP doors.

8) To improve the automation of the substations shall be as followings:

a. Avoiding proprietary protocols and being able to integrate equipment of different manufactures to realize interoperability.

b. Using technologies that can reduce the cost in wiring and engineering time.

c. Seeking for improvements in the commissioning and maintenance tasks

(2) Applicable Design Standards

The power SCADA system shall be compliant with the standard shown below:

1) ISO, International Organization for Standardization;

2) IEC, International Electro-technical Commission;

3) IEEE 802.3 series, Standard for Ethernet based LAN system;

(3) Qualifications of Equipment Manufacturer and Providers

All materials and equipment to be provided for the Power SCADA shall be of proven design and shall be provided by a manufacturer who has successfully accomplished similar supervisory control and data acquisition system projects for a period of at least 10 years.

(4) Design reliability

1) System Availability

The system shall be designed to achieve at least the following levels of system availability:

a. The complete Power SCADA system shall be designed to meet 99.99% or higher hardware availability.

b. The availability figures for Traction Power functionality and the Traction power decision support facilities shall be higher than 99.97%.

c. The availability figures for other Power SCADA subsystems viz. Software Development and Training Simulator shall be higher than 99.7%.

d. Any equipment manufactured by the Contractor shall have its failure rate determined strictly in accordance with its appropriate operating environment.

e. Any degraded mode of operation or re-configuration functions provided by the Delivered System shall not be included in the determination of the Delivered System availability.

2) Redundant design

a. Redundancy shall be incorporated in the design to cater for failures that will have impacts on safety and normal operation of the MCRP operation. However, redundancy shall be incorporated where failure cannot be tolerated even for short periods..

b. The system shall therefore be designed around small autonomous items of equipment but shall be commensurate with an economical overall solution.

c. Failure of any equipment node on the network shall not affect the local operation nor prevent communication between any other connected equipment nodes.

3) Noise

All Power SCADA system equipment shall operate in accordance with the design criteria in the very high "electrical noise" environment normally associated with MRT systems due to electrical fields created by traction supplies and strong magnetic fields. Equipment shall be immune to the effects of conducted and radiated electrical interference.

4) Time to Repair

The Power SCADA system shall have an MTTR less than 30 minutes. This time shall not include the time taken for a technician to arrive at the initial reported failure site.

5) Lightning Protection

a. The contractor shall ensure that all equipment is fully protected against the effects of mains surges and direct and indirect lightning strikes. Protection shall be applied to incoming mains power supplies and to input and output signal lines to externally located sensors, transducers, actuating equipment, etc. or to any other equipment likely to be affected.

b. All surge suppression equipment shall be self-contained and self-resetting.

c. The suppression equipment shall be so selected that the let-through voltage specification does not exceed the absolute maximum voltage specified for the particular equipment being protected.

d. Signal lines from external sensors at risk from the effects of lightning shall have surge suppressers fitted at both ends of each line and shall be installed and connected in accordance with the manufacturer's recommendations.

(5) Main Operating Facilities

The Power SCADA system shall include, but shall not be limited to the following facilities:

1) Continuous, effective monitoring and/or control of selected equipment over the entire MCRP Line;

2) Expeditious alerting of operations and maintenance personnel, by mean of corresponding audible and visual alarms, of any identified equipment malfunction, especially those likely to cause disruption to the operation of the MCRP Line;
3) Clear, comprehensive displays and printed records of selected equipment status at each workstation;
4) Comprehensive displays and printed records based upon historical data, with the option of overlaying data from earlier periods;
5) Records of energy demand and consumption and other data at electric companies incoming feeders, each station, traction and depot service substation for checking bills, for the electric companies' trend analysis and cost budgeting purposes;
6) Time-tagging of all events detected by the Power SCADA system, to a high-speed resolution for selected high-speed inputs, and presentation of this information in records as a true sequence of events;
7) Monitoring of selected equipment running times and provision of comprehensive records of the overall operating costs and energy efficiency;
8) Facilities for manual control of selected equipment; the Contractor shall provide detail of such facilities for review and approval by the Engineer;
9) Facilities for recommending re-configuration of the operation of selected equipment in the event of a failure or alarm occurring, to enable rapid action by the controller;
10) Automatic generation of maintenance requests which are based upon selected equipment running times;
11) Centralized data storage and software back-up facilities for the complete Power SCADA system.

(6) Control and Monitoring Items of Power Supply System

1) The Power SCADA system shall control and monitor the 69kV AC, 6.6kV AC, 1.5kV DC and LV power supplies, which shall include indications of the status of all electrically operated switching devices on the 69kV AC, 6.6kV AC and 1500V DC systems, together with alarm and protective devices.
2) The same requirement shall also apply to the main breakers and tie breakers of the main LV switchboards in each electric room.
3) Power SCADA monitoring facilities for power supplies shall include, but shall not limited to:
   a. Voltage of all 69kV, 6.6kV, 400V AC and 1500V DC busbars;
   b. Current of all 69kV, 6.6kV, 400V AC and 1500V DC busbars;
   c. Status of circuit breakers and disconnecting switches;
   d. Rectifier current;
   e. All DC feeder currents
   f. Status of all protection equipment;
   g. Operation of alarm and protection devices.
   h. Status of emergency generator
   i. Status of DC battery and charger

(7) Event Record

1) The Power SCADA system shall record any events caused by faults, malfunctions, warnings or alarm information generated automatically by the selected equipment.

2) A central recording system shall be provided to record the following events, including but shall not limited to:

   a. Change of state of remote terminal unit input parameters;

   b. Events designated as alarms;

   c. Change in the Power SCADA workstation configuration;

   d. Change in the Power SCADA system configuration by operations personnel;

   e. Faults;

   f. Control actions;

   g. Text entered by operations personnel;

   h. System generated massages, e.g. equipment malfunction;

   i. Change to the configuration of the Power SCADA central database.

3) Events shall be given an order of priority to allow events to be classified, sorted and filtered. Subject to the requirements of the approved operations plan, events shall be classified as:

   a. Emergency – This type of fault shall require instant attention in order to minimize interruption of the normal operation of the MCRP Line or risk of injury to personnel or passengers and shall be classified as an alarm;

   b. Urgent – This type of fault shall require reasonably prompt, but not instant attention in order to minimize interruption of the normal operation of the MCRP Line and shall be classified as an alarm;

   c. Non-urgent – This type of fault shall be dealt with in a more convenient manner while more urgent events are dealt with first. This type of event shall not directly result in any degradation of the normal operation of the MCRP Line and shall be classified as an alarm only.

4) The event records shall be available as a text table, with each event classified by its priority level and shall be tagged with details of the date and time at which the event occurred. Additionally, the operations personnel identification code shall be recorded for each event that is initiated by the operations personnel. Each event shall be displayed and highlighted until acknowledged by the operations personnel. All events shall continue to be displayed until the event has been acknowledged and cancelled in the automatic event log and provided the fault has been satisfactorily rectified in the equipment which generated the event.

(8) Alarms

1) Audible alarms shall be provided to alert the operations personnel to a problem requiring immediate action or attention. The audible alarms shall be clearly audible against ambient noise level.

2) There shall be three categories of audible alarms easily distinguishable by separate tones or sounds for events classified as emergency, urgent and non-urgent as defined in Clause 4.5.7.3).

(9) Response Times

1) The display of each Safety Critical system shall require rapid updates of the

workstation displays of the status and event data, together with a rapid response by the Power SCADA system to control inputs. The status of any circuit breaker trip, protecting any Safety Critical equipment, shall also be identified on the workstations and recorded in the event record, within 2 seconds of its occurrence.

2) Updating of displays shall ensure that no displayed data shall be more than 30 seconds. No event shall take longer to be registered on a display than 5 seconds for urgent alarms and 3 seconds for emergency alarms. The display of non-urgent events shall take no more than 10 seconds after the occurrence.

3) "Housekeeping" commands such as changes of the display format or color scheme philosophy shall be executed by the Power SCADA system within 5 seconds of the completion of the input procedure.

4) The normal operation of all the remote terminal units shall be verified by the Power SCADA system at intervals not exceeding 30 seconds. In the event of any failure or malfunction of a remote terminal unit, a corresponding massage shall be displayed on the appropriate workstations as a Power SCADA system alarm.

5) The Safety Critical systems for this Power SCADA shall include, but shall not be limited to the following:

   a. Traction power and high voltage distribution;

   b. Fire detection in substations

(10) Interface Requirement

1) The Power SCADA system shall have the following interfaces to collect the monitoring information and to control the operating. The Contractor shall select the optimal interface from the interface described below.

   a. Digital input:

      12V, 24V, 50V, 110V DC, 220V AC (at least 2kV isolation)

   b. Analogue input:

      0-10V, 0-10mA, 4-20mA DC

   c. Pulse input:

      12V, 24V DC up to 10 pulses/sec. (at least 2kV isolation)

   d. Digital output:

      Non-voltage free contact, 12V, 24V, 110V DC, 220V AC

   e. Analogue output:

      0-10V, 4-20mA DC

   f. Serial link:

      RS232C, RS442

   g. Ethernet:

      100 Base series or more

2) Optical fiber network shall be provided for not only Power SCADA but also other sub packages (Telecommunications and Signal System etc.). Interface between Power SCADA and optical fiber network shall be Optical Distribution frame (ODF) including Telecommunications. The optical fiber cables between ODF and Power SCADA shall be provided.

3) The Contractor shall liaise with and coordinate his Works with Interfacing Parties to ensure the Works fully comply with the design criteria and with the program constraints of this and Interfacing Contracts.

(11) Backup Operating Facilities

1) Backup Operating Facilities shall be equipped only for open/close operation of all circuit breakers and only for monitoring of all circuit breakers' statuses, when main operating facilities in OCC are failed.

2) Backup Operating Facilities shall be used as training facilities for power supply and distribution system operation with sequence simulator by off-line system.

(12) Power Supplies

1) The Power SCADA equipment shall be designed to accommodate an electrical supply derived from either a nominal 400V AC 3-phase 60Hz,

2) The power supply for Power SCADA shall be supplied through UPS. UPS shall be capable of providing the specified performance continuously for a minimum period of four hours.

3) Power supply to RTUs shall be supplied from 110V battery system of control source for substations.

(13) Substation Automation

1) The automation of substations shall be compliant with IEC61850.

2) Shall avoid proprietary protocols and being able to integrate equipment of different manufacturers shall be required.

3) The technologies which can reduce the cost in wiring and engineering time shall adopted.

4) Shall be compliant with IEC61850 which defines a fast and reliable point to multi point message exchange procedure that shall be used to replace copper wiring in the data exchange between the cabinets in a substation.

4.4.7 Photo Voltaic Power Generation Systems

(1) General

The Contractor shall design, supply, install and commission a Photovoltaic Power Generation System as specified herein,

1) The Contractor shall be responsible for implementing a Photovoltaic Power Generation System which achieves as a minimum the specified levels of performance.

2) The scope of works for the Photovoltaic Power Generation System shall be as follows:

i) Crystalline Silicon PV Modules

ii) Workstation (including software)

iii) Color A3 printer

iv) Thermometer

v) Pyranometer

vi) PV module mounting system including all structural supports, hangers, fixtures, fixings and accessories.

vii) Power Conditioners

viii) All necessary interconnection wiring, interface units, hardware and software to provide a complete and fully operational system.

ix) All necessary earthing system for solar power generation system.

x) Cables/wires, conduit, wire ways, trunking and all accessories

xi) Metering systems

xii) Web-based remote monitoring system

xiii) All weather type display monitor installed in the station concourse for public awareness.

xiv) Other materials and parts which are not specifically mentioned herein but are necessary for the proper assembly, installation, and safe operation of the equipment shall be furnished including special tools and all required spare parts and consumables during the warranty period.

3) Construction/Complete Installation

4) Testing and Commissioning

5) Performance Warranty

6) Data Logging System

i) Performance monitoring of Solar PV System

ii) Periodic electrical testing (power quality assessment, thermo-graphic inspection, solar panel power output measurements, etc.)

iii) Provide monthly energy generation and revenue data.

iv) Cleaning of Solar Panels, semi-annual schedule

7) The following works are not included in the Scope of this Division:

i) Furniture including desks and chairs in the PV Control Room

8) Photovoltaic Power Generation System shall be interfaced with Power SCADA

(2) System Design and Performance Requirments

1) General

i. The PV modules shall be installed with aluminum fittings for mounting installation on the rooftop of stations (Calumpit, Apalit, San Fernando, Angeles), Depot Workshop, Light Repair shop and OCC building.

ii. The Display Monitor for publicity shall be indoor type wall-mounted structure and shall be installed in the concourse, however the installation location shall be determined during the detail stage in cooperate with civil works.

iii. The proposed installation location shall be coordinated with the station design.

iv. The Power Conditioners and Remote Monitoring System shall be installed in the PV System Control System located at the station building ground floor.

v. The exact number, the location and the method of installation of solar panels shall be determined during the detail design stage in cooperate with civil works.

vi. Proposed approximate peak solar power output shall be as following:

- Calumpit station : 100kWp
- Apalit station : 100kWp
- San Fernando station : 100kWp
- Angeles station : 100kWp
- Workshop in Depot : 1000kWp
- Light Repair Shop in Depot : 310kWp
- OCC building in Depot : 100kWp

(3) Particular Requirements

1) PV Module

i. Cell Type: Crystalline Silicon

ii. Compliance: IEC 61215/61730

iii. Nominal Max. Power (Pmax): not less than 300W (under Standard Test Conditions of 1 kW/m^2 at 25 deg C, Aie Mass 1.5)

iv. Operating temperature : - 40 deg C ~ +85 deg C

v. Conversion efficiency : not less than 18%

vi. Front Cover Material : Tempered glass (not less than 3mm thick)

vii. Frame Material: Anodized aluminium

viii. Power output warranty: not less than 25 years, linear

ix. Warranty on Materials and Workmanship: not less than 12 years

2) Power Conditioner

i. Compliance: IEC61727

ii. Panel Type: Outdoor IP65 (per IEC 60529), closure type, wall mount or free-standing

iii. Operating Temperature: －25℃ ~ +60 ℃

iv. Rated Input Voltage: not less than DC 360V

v. Rated Output Voltage: not less than AC 400V

vi. Output frequency: 60 Hz

vii. Output Waveform: Pure Sine Wave

viii. Phase: 3-phase

ix. Range of Operating Input Voltage: according to manufacturer's specification

x. Power Factor: 0.90 minimum

xi. Total Harmonic Distortion of Output Current: not more than 5% in total, not more than 3% each (at rated output)

xii. Power Conversion Efficiency: not less than 97%

xiii. PV Power Control: Maximum power point tracking (MPPT)

xiv. Protection Function: Over voltage relay, under voltage relay, over frequency relay, under frequency relay, over voltage ground relay, Island operation detecting function.

3) PV Combiner

i. Panel Type : IP 65 for outdoor, IP 21 for indoor, floor-mounted

ii. Maximum voltage : 1000V DC

iii. SPD protection: Type2 pluggable

4) Circuit Breaker

i. Compliance: Per IEC 60947 Part I-III; IS 60947 Part I-III; EN 50521

ii. Main Breaker ampacity rating for AC Combiner

5) Cables

i. DC Power Cables:
- Sizing by Contractor, to comply with the Philippine Electrical Code (PEC) and other applicable regulatory requirements
- Per EN 50618
- Rating: 1500 V
- Temperature Range: -40 deg C ~ +120 ℃

ii. AC Power Cables
- Sizing by Contractor, to comply with the Philippine Electrical Code (PEC) and other applicable regulatory requirements
- Per IEC 60227
- Rating @ 90 deg C: 600 Volts

6) Display Monitor for publicity

i. Ingress Protection: IP20 (indoor)
ii. Display Type: LED 4K 50 inch with hanging bracket
iii. Digit Height: not less than 100mm, reading distance up to 40m
iv. Representable values shall be following but not limited to:
- Today's total AC output power (kWh)
- Total AC output energy since installation (kWh)
- Current generated energy (kW)
- CO_2 reduction value since installation (kg-CO2)
- Solar radiation intensity (kW/ m^2)
- Ambient Temperature (deg ℃)
- Real pictures of various components of PV system installed
- Other various images for the passengers for public awareness.

7) Thermometer

i. The thermometer shall be used for measuring temperature of panel installation place for monitoring
ii. Sensor Type: Pt100
iii. Measuring Range (deg ℃): －30~60
iv. Case Material: white thermal resistant, UV-proof plastic

8) Pyranometer
i. The pyranometer shall be used for measuring solar radiation for monitoring
ii. Compliance Standard: ISO9060 Secondary Standard
iii. Sensitivity: Approx. 7mV/kW・m2
iv. Measurement Range: 0~2000w/m2
v. IP: 67
vi. Response Time (95%):5sec

(4) Testing and Commissioning

1) General

i. Comply with the requirements of the Philippine Electrical Code (PEC).

ii. The Contractor shall carry out complete operating and performance tests of the System and all equipment therein to demonstrate that the specified levels of performance shall be achieved.

2) Quality control of components in relation to the standards which define them

i. The Contractor shall supply certificates of conformity issued by the manufacturer of the component, certifying that the product supplied complies with international safety and quality standards.

ii. The components shall be properly marked to ensure that they can be identified and used on the worksite with no possibility of confusion.

3) Complete Operating and Performance Tests on the Equipment

i. After complete installation of the system, the operating and performance tests shall take place in the operational environment of the project.

ii. The content of the tests shall be as set out in detail below:

- Systematic operation tests of all system components.
- Integration tests, with simulation of all other Systems and sub-systems to confirm integrity of all interfaces.
- Comprehensive tests to ensure interfaced equipment are properly working, correct data exchange and readings. Calibration of tests shall be performed to verify accurate readings.
- All other tests required by the Engineer to prove compliance with the Specification.

iii. A complete log of the settings and readings of all interface equipment, controls, gauges and instruments shall be maintained throughout the testing period.

iv. The Contractor shall provide such instruments or equipment necessary and perform measurements for Performance Tests.

v. All inspection and test result shall be submitted to the Engineer.

4.4.8 Cables

(1) General

1) All cables shall be sized to carry the continuous current required by the specification and shall be based on the Contractor's calculations. The cables shall be able to withstand the short circuit currents inherent in the Contractor's design.

2) The ratings applied to any cable shall be determined by the most onerous installation condition in any cable route.

3) All cables and cable support facilities to be installed in the substations shall be low smoke non-halogen compound (LSZH) type and fire retardant.

(2) High and Medium Voltage Cables

The ratings of cables used on the 69kV and 6.6 kV power supply system shall be determined by the calculation in accordance with IEC60287 or equivalent equal for a maximum operating conductor temperature of 90^0 C.

(3) Cables for 69kV system

1) Cables shall comply with relevant standards and regulations.
2) Cables for 69kV distribution shall have cross-linked polyethylene (XLPE) insulation or equivalent, single cores and stranded copper or aluminum conductor in trefoil formation sized to suit the power supply system design and to satisfy short circuit current requirements.
3) The Contractor shall coordinate with the electric companies with regard to cable routing and conduits for cables for 69kv feeders between the electric companies' substations and the substations.

(4) Cables for 6.6kV between equipment

1) Cables shall comply with relevant standards and regulations.
2) Cables for 6.6kV between equipment shall be provided with three cores and stranded copper conductor in trefoil formation sized to suit the power supply design and to satisfy short circuit current requirements.
3) In the traction substations, Fire Resistant cables which comply with IEC60331, 60332-1, or equivalent shall be applied to cables for 6.6kV between equipment.
4) The cables shall be of low smoke non-halogen compound (LSZH) type and fire retardant.

(5) Cables for Low Voltage distribution

Cables shall have cross-linked polyethylene (XLPE) insulation or equivalent, single cores and stranded copper conductor in quatrefoil formation sized to suit the power supply system design and to satisfy short circuit current requirements.

(6) Optical Fiber cable for interlinked tripping device

1) Optical Fiber cable shall be installed for interconnection between the interlinked tripping devices located in between each traction substations.
2) Optical Fiber cable shall have sufficient capacity and capability for telecommunication work among each TSS, BP, SP but not limited to.
3) Optical Fiber cable for interlinked tripping device shall be installed into the wayside cable troughs by telecommunication work.

(7) Cable Route and Cable Racks

1) In all substations, all the cables shall be installed in the cable pit, cable trough, cable rack and equivalent.
2) Supporters shall be installed in the cable pit, cable trough, cable rack and equivalent to keep adequate distance.
3) The Contractor shall design the appropriate cable route between equipment and

provide racks for cabling in the substations. The Contractor shall coordinate with Interfacing Contractors with regard to the openings for cable entrance on the building walls and floors.

4) All openings for cable entrance on the building walls and floors shall be stopped with non-inflammable materials by the Contractor after all cables have been installed, to prevent fire extension.

(8) Drawings and List for Review

1) The Contractor shall provide the following lists, as a minimum, to the Engineer for Approval:

The cable list shall include but shall not be limited to the following information for each individual cable:

a. Cable identification number
b. Type of cable
c. Rated voltage
d. Number of cores
e. Cable size
f. Overall diameter
g. Cable termination at each end
h. Connection point at each end with equipment identification and terminal numbers
i. Cable routing

2) The Contractor's drawing submittals shall include but shall not be limited to the following:

a. Cross section drawings for cabling including following information:
   - Mounting position of cables, brackets and troughs;
   - Cable route and cabling method between mainline and substation/electrical supply rooms.
b. Diagrammatic plans for cable route in tunnels, viaducts and Depot and so forth.

All drawings shall include legend for all symbols used in the drawing.

4.5 Installation Requirement

4.5.1 General Requirements

The Contractor shall comply with all Enactments in executing the Works, at least including all statutory provisions on occupational health and safety.

The Contractor shall co-ordinate with the Interfacing Parties of this Contract and Other Contractors in the execution of the works.

The Contractor shall also co-operate with all Relevant Authorities in the execution of the Works.

The installation of all equipment shall be undertaken at all times by suitably trained and competent employees of the Contractor, to the satisfaction of the Engineer.

Only appropriate tools, plant, equipment and vehicles shall be used.

Installation of all equipment shall be in accordance with the coordinated installation plan (CID) described in the ERG.

Installation of all equipment shall conform to the best industry practices.

Precautions shall be undertaken to ensure the safety of personnel and equipment for all installation works.

The Contractor shall, prior to starting any installation work, identify any possible hazards, and implement measures of eliminating and/or controlling such potential hazards, in line with safe working practices.

Further details on the Site safety management are described in the ERG.

The Contractor shall coordinate with the relating Contracts regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the civil infrastructure.

The Contractor shall coordinate its requirements for grounding and bonding system with Interfacing Contractors (CP N-01--CP N-05), such as wiring routes and locations of ground rods installation.

The Contractor shall ensure that all areas of work are sufficiently illuminated for the Works to be undertaken and that a safe system of work is employed for all activities.

The Contractor shall operate a robust system for the control of persons entering or working upon the Site. The system shall include as a minimum:

(a) Register of all employees;

(b) Personal identification, with photograph;

(c) Levels of competency;

(d) Date of expiry;

(e) Date of issue;

(f) Signature; and

(g) Register of all visitors.

The Contractor shall co-operate, at all times, with the Engineer and Other Contractors to ensure that the Site is protected from unauthorized admission, either willfully or otherwise. The Contractor shall make due provision for the safe access and egress to the Site of Works for its staff and subcontractors. This access shall be maintained such that it is free of all hazards and is in a safe condition throughout the duration of the Works.

4.5.2 Specific Requirements

The installation work pertaining to this Contract shall at least include the following:

(1) Finalization of the Construction and Installation Program;

(2) Survey on the Site and review the technical requirements shown in this Specification and the Employer's Drawings;

(3) Production of the calculation sheets and installation drawings for the Site installation;

(4) Installation in accordance with the finalized installation drawings;

(5) Co-ordination with Other Contractors;

(6) Submission of the installation reports and records;

(7) Production of as built drawings, documents, calculation sheets, and records.

4.5.3 Construction and Installation Plan

The Contractor shall undertake installation work in stages as shown in the detailed installation program. Installation, testing and commissioning of later stages shall not impact revenue operation of earlier stages.

As a minimum, the detailed Construction and Installation Plan shall at least include all the activities described in Chapter 3.1 of this PS, installation details and methods of all activities equipment and tools to be used for installation, safety issues, supervision, temporary land occupation needed and the vehicles to be used for installation.

4.5.4 Temporary Works

The design of the Temporary Works shall be submitted to the Engineer for review.

All Temporary Works shall be removed on completion of the Section, or as directed by the Engineer. All Temporary Works shall be clearly distinguishable from the Permanent Works.

4.5.5 Quality Management

(1) The Contractor shall adopt an appropriate quality management system throughout the entire the Site installation period to ensure that the System performance requirements as specified in Chapter 3 of this PS are achieved.

(2) The Contractor shall provide sufficient number of suitably experienced supervisors and skilled workers to ensure that the progress and quality of the work, both on the Site and in the Contractor's workshops, are maintained to the satisfaction of the Engineer.

(3) Supervisors shall have a minimum of five years' previous experience in a supervisory capacity on similar projects and all the skilled workers including linesmen electricians' fitters and craftsmen, shall have a minimum of two years' previous experience in installation of similar systems.

(4) The Contractor's supervision system shall be responsible not only for the supervision of the Concerned system installation but also for the supervision of the installation of the primary fixing system (civil inserts), the ground mats and systems, etc. that are to be installed by the Contractors. The supervisors shall work on a full-time basis during the entire installation process.

(5) The Contractor shall maintain a set of drawings at each project Site which accurately reflect the current status of field changes. The Contractor shall Approval from the Engineer for any such changes. The Contractor shall prepare final drawings showing the as built configuration. These drawings shall be developed in a logical format to facilitate routine system maintenance and troubleshooting. All drawings and details shall be endorsed by the Contractor.

(6) The Engineer reserves the right to undertake, at any time, checks on the proficiency of the Contractors staff, licensing and all associated documentation. Should any of the Contractors staff be found incompetent or unlicensed he shall be removed from the site until their competency has been established.

4.5.6 Installation of Cables

Laying of Cables

(1) Cable risers shall be protected with cable trays/ steel conduit pipes.

(2) Bending radius of low voltage cables shall be not less than 8 times for single core type and 6 times for multi core type the outside diameter of the cable respectively.

(3) Cable trays shall be fixed to the wall or the ceilings, fixing intervals shall be less than 1.5 m.

(4) Cables laying with cable trays on the vertical direction shall be bound tightly at the 1.5 m intervals.

(5) No tension is permitted for splicing of the cables.

(6) Openings for cables drawn into cubicles shall be protected properly so that no pest or moisture can enter.

(7) Occupancy of cables in the trough shall be not more than 60 %

(8) The Contractor shall coordinate with Interfacing Contractors (CP N-01--CP N-05) regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the civil infrastructure.

4.6 Interfacing Requirements

4.6.1 General

The Contractor shall liaise and coordinate with Interfacing Parties to ensure the effective and compatible coordination of all aspects of design, installation, testing and commissioning of work.

4.6.2 Contractor's Responsibility

(1) The Contractor shall ensure that all the interface items as listed in Clause 6.3 of this specification shall be included in the interface management plan.

(2) Other items not mentioned in the interface items but are relevant to the design, installation, testing and commissioning of permanent works, shall also be included in the interface management plan.

4.6.3 Interface Control Sheet

The Contractor shall review the design and coordinate with relevant Contractors and electric utility companies as detailed below:

No	Interface Description	Design Requirement	Design Size& location	Supply	Fix	Remarks
	<ELECTRIC COMPANIES>					
1	Incomming 69kV line	CP NS-01	Electric Companies	Electric Companies	Electric Companies	

No	Interface Description	Design Requirement	Design Size& location	Supply	Fix	Remarks
2	Metering device interface	Electric Companies	CP NS-01	CP NS-01	CP NS-01	
3	Specification of receiving equipment	CP NS-01	CP NS-01	CP NS-01	CP NS-01	
	<Telecommunications Equipment>					
1	SCADA I/F	CP NS-01	CP NS-01	CP NS-01	CP NS-01	
2	CATV I/F	CP NS-01	CP NS-01 (TLC)	CP NS-01	CP NS-01	
3	Telephone I/F	CP NS-01	CP NS-01	CP NS-01 (TLC)	CP NS-01 (TLC)	
	<OCS >					
1	Leading out of feeder line and return circuit	CP NS-01 (OCS)	CP NS-01	CP NS-01 (OCS)	CP NS-01	
	<Distrubution >					
1	Leading out of distribution line	CP NS-01 (PDS)	CP NS-01	CP NS-01 (PDS)	CP NS-01	
	<Distrubution station equipment>					
1	Distribution transformer capacity	CP NS-01	CP NS-01 (PDS)	CP NS-01 (PDS)	CP NS-01	
	<Rolling Stock, Train operation,OCS >					

No	Interface Description	Design Requirement	Design Size& location	Supply	Fix	Remarks
1	Rectifier Capacity	CP NS-01	CP NS-01 (OCS) CP NS-02 CP NS-03	CP NS-01 (OCS) CP NS-02 CP NS-03	CP NS-01	
	<Rolling Stock, Train operation,OCS >					
1	Voltage Drop in Traction system	CP NS-01	CP NS-01 (OCS) CP NS-02 CP NS-03	CP NS-01 (OCS) CP NS-02 CP NS-03	CP NS-01	

4.7 Testing, Commissioning and Verification

4.7.1 General

The Contractor shall develop a full Test Plan which shall be submitted for approval by the Engineer. The tests mentioned herein are indicative and shall be the minimum requirement. The Contractor shall clearly categorize the types of tests required in this Part with the followings in the Test Plan:

Pre-commissioning tests, Commissioning tests, and Trial Run / Trial operation.

(1) Test Certificates

All principal test records and test certificates duly endorsed by the Contractor's professional engineer are to be submitted for the approval by the Engineer. These test records and certificates shall be supplied for all tests, whether or not the Engineer has witnessed them. The information given on such test certificates shall be sufficient to identify the materials or equipment to which the certificate refers.

(2) Cost and Tests

1) The Contractor shall bear all the cost of necessary tests.

2) As for the cost of test which is carried out outside Philippines, the Contractor shall bear the expenses relating witnessing and the verification by the Employer and the Engineers.

3) Test Plan and Procedures

All the test plans and procedures with the exact time and date shall be submitted for the Engineer for Approval at least 30 days prior to and test conduction.

Not tests can be undertaken unless the relevant plans have been given a Notice of No Objection by the Engineer.

4.7.2 Factory Acceptance Tests (FAT)

FAT shall comprise Type Tests, Sample Tests, Routine Tests, Life, Endurance and Destruction Tests, and any additional tests requested by the Engineer.

The testing shall be conducted such as to simulate the working conditions as closely as possible.

Upon the request of the Engineer, destruction tests shall be carried on components and assemblies to verify the design loading.

All the tests shall be conducted both on the assembly and on the members/components of each product in accordance with design specifications and applicable Standards.

4.7.3 Contractors Responsibilities for On-site Testing

(1) The Contractor shall implement all tests in accordance with the Test Plan. During the course accuracy as may be required. On completion of erection and prior to commissioning, all power cables shall be tested to the acceptance of the Engineer in accordance with an agreed Inspection and Test Plan to demonstrate that it is entirely suitable for commercial operation.

(2) The Contractor shall be responsible for providing temporary electricity supply, all instruments, gauges, test equipment, tools, accessories, personnel, services and necessary facilities required for the execution of all tests and inspection. Wherever necessary, the Contractor shall provide two or more sets of testing equipment, tools, and others to expedite testing. All test equipment shall be accompanied with the appropriate calibration certificate by a testing authority of the equipment.

(3) Test equipment, tools, and others necessary for subsequent preventive and corrective maintenance are to be provided to the Engineer as specified herein and shall be available to assist the tests. The use of these test equipment, tools and others shall be subject to approval by the Engineer.

(4) The Contractor shall be responsible for surveillance and security of the E/R and Distribution downstream cables or other electrical equipment is energized before it has been tested and before the relevant Contractors or Sub-contractors' facilities are ready and secured. The Contractor's responsibility for surveillance and security of the system shall remain in force for each part of the system until such a time that the Engineer issues the appropriate certificate, and the Employer takes over the System.

4.7.4 Installation Tests

Installation Tests An inspection and visual verification of ratings and connections with equipment shall be carried out prior to installation tests.

Un-energized equipment shall be inspected for its visual and tested for operation after installation of equipment. Inspections and tests shall include the following:

- Cleanliness,
- Workmanship,
- Confirmation of items conforming to ratings specified,
- Water and dust proofing,
- Leveling, mounting and positioning,

- Joints and connections tightness,
- Cables – dressing, bending radii, jointing and finish at terminals,
- Clearances and dimensions in conformity with drawings,
- Grounding and bonding.
- Functioning of circuit breakers, load break switches, isolating switches and their interlocks.
- Protection devices, and
- Phase sequence verification.
- Ground resistance shall be measured individually, and for the subsystem and system.
- Insulation Resistance
- The insulation resistance of all 6.6kV circuits shall be tested with an insulation tester of 2.5kV rating. All LV circuits comprising ac and AC and DC auxiliary circuits shall be tested with a 500 V insulation tester.
- Tests on Current Transformers shall include the following:

  Insulation resistance.

  Winding resistance.

  Polarity of Connections up to equipment terminals, and

  Ratio and magnetization curve verification.
- Tests on Voltage Transformers shall include the following:

  Voltage ratio.

  Insulation resistance, and

  Polarity of connections up to the equipment terminals
- Secondary and primary injection tests shall include the following:

  Tests shall be carried out at a minimum of three settings if multiple settings are available.

  Test results of operation boundaries and operating times shall be recorded.
- Batteries and Chargers

  Discharge tests and charging tests shall be carried out to verify the capacity of the batteries and all functions available on the charger. Continuous measurements of battery voltages shall be made together with periodic readings of the electrolyte specific gravities and temperatures. No addition of electrolyte is permitted during discharge tests.

  The operation of the boost charge facility and the effect of the voltage dropping diodes shall also be demonstrated.
- Control, Indication and Alarm Functions shall include the following:

  Insulation resistance and continuity of all cores of cables shall be identified and tested, and the correct functioning of all control, indication and alarm devices shall be verified.
- Switchgear

All switchgear, including circuit breakers, load break switches and grounding switches, shall be operated to prove that the operating gear, tripping devices, protective gear and mechanical interlocking are satisfactory.

- Metering Instruments and Transducers

  All current and voltage transformers, metering instruments and transducers shall be calibrated by voltage and current injection to prove their accuracy classes.

4.7.5 Receiving Acceptance Tests

The following tests shall form part of on-site and System Acceptance Tests as part testing of the equipment and system:

(1) Functional Tests and Interlock Tests shall include the followings:

All control and protection functions and electrical/mechanical interlocks shall be tested.

(2) Primary Injection Tests shall include the followings

The Contractor shall carry out primary injection tests on each protective system, to prove the auxiliary circuit connections, the relay fault setting values, the correct metering indications and the stability limits.

(3) AC/DC Pressure Tests shall include the following

The insulation resistance of all circuits shall be measured before and after the dc pressure test using a 5kV insulation tester. The minimum phase-to-phase and phase-to-ground insulation resistance shall be 100 mega ohms.

Pressure tests shall be carried out on completed cable lengths of high voltage cables in accordance with IEC 60502 or equivalent equal.

(4) Energization

- The Contractor shall prepare operation safety rules and procedures for the approval by the Engineer before Energization.
- The Contractor shall check all to ensure safe Energization.
- All power equipment shall be subject to inspection by inspectors from the Electrical Inspectorate of the Employer before Energization. The Contractor shall ensure all the Employer's Requirements.
- The Contractor shall be responsible for the operation of traction and auxiliary power equipment. Upon request by the Engineer, the contractor shall be responsible for the disconnection and the subsequent reconnections of the power equipment.

4.7.6 Integrated Testing and Commissioning

(1) Integrated Testing and Commissioning refers to those tests undertaken in order to demonstrate that the various components of the systems operate satisfactorily between one another, and meet all specified requirements for design, operability, safety, and integration with other Works and systems. These tests shall be entirely within the requirements of one or more of the project contracts or they shall involve a multiplicity of contract procedure. The final Integrated Testing and Commissioning shall be conducted after the SCADA system and OCC have become operational.

(2) Systems that can be tested without depending on the running of trains, such as SCADA

system, the emergency trip system shall have their integration tests scheduled to commence as early as possible. It is preferable that any interface problems associated with these "no train" system tests be identified and resolved prior to the test running.

(3) The following is an indicative listing of those Integrated Testing and Commissioning functions that necessarily to be integrated with others to demonstrate that the equipment and controls of the Power Distribution System meet the Contract Specifications and demonstrate a safe-to-operate condition. This listing is not exhaustive and shall be updated by the appropriate contractor, to demonstrate functionality, completeness and safety of the installed works and shall be submitted to the Engineer for his approval.

- E/R, Distribution board space and Generator failure mode test.
- Remote control and monitoring test through SCADA system at OCC
- Emergency trip system tests.
- Power system functional tests.
- EMI/EMC tests.
- Touch/step potential tests.

The Contractor shall provide attendance to the Engineer during integrated test in relation to the insulation of train station platforms provided by the other contractors.

- On-load Tests and Directional Tests

Once sufficient load current is established, voltages and currents into protection and metering equipment shall be verified to ensure correct operation of protection relays and accuracy of meter readings at local and remote locations.

4.7.7 Test Run and Trial Operation

The Contractor shall provide special and general attendance during the Test Run and Trial Operation period such that the persons who conduct the On-Site Testing and Commissioning are available on the Site to solve any problem arising from the Test Run and Trial Operation.

4.7.8 Test Verification

(1) The Contractor shall carry out the pre-commissioning and commissioning tests to verify that the performance of the System meets the Employer's Requirements before the substantial completion of the Works.

(2) One of the Performance Tests which shall be conducted by the Contractor in conjunction with relevant Contractors, Sub-contractors and other Parties is the measurement of EMI levels at locations that have received a Statement of approval by the Engineer. Such measurements shall be conducted prior to Energization of the Traction Power System, and then during Service Trials and commercial operation of the train services to ensure that the EMI levels meet the Employer's Requirements and are in accordance with the Contractor's designs which shall be given a Notice of No Objection by the Engineer.

(3) Should the performance of the System deviate from the Contractor's designs give a Notice of No Objection by the Engineer, the Contractor shall rectify the deviation in the shortest possible time.

(4) The Contractor shall submit a certified report of the results of these Tests to the Engineer within 14 days from the date when the Engineer confirmed that the Contractor has passed each of the Tests.

4.8 Measuring and Special Tools

4.8.1 Special tools

General Requirements for measuring and special tools are described in the General Requirements.

4.9 Training Requirements

4.9.1 General

The Contractor shall supply the appropriate training for the operation and maintenance staff of the Employer according to the General Requirements. The Contractor shall submit the training plan to the Engineer.

4.9.2 Scope of Training

The Contractor shall provide the theoretical and practical training for software and hardware used for the Power Distribution system to the Employer's staff and instructors.

4.9.3 General Requirements

The training shall be provided at the places where can achieve the great effect to the trainee. The training locations shall be at places with factory, domestic, overseas and at other required places. The optimum locations shall be proposed for the training.

4.9.4 Training Plan

The Contractor shall prepare and submit the training plan to the Engineer for the review. The training plans shall include the purpose, contents, method, location, time and period.

4.9.5 Training Courses

(1) The Contractor shall prepare a detailed training course related to the operation of the power supply and distribution system.

(2) The training for the power supply and distribution systems shall cover normal and emergency modes of operation.

(3) The training for emergency situation shall include the following:

- Investigation method of failure point, effective and efficient handling of hardware and software at the emergency situation for train operation and the Distribution system (main line);
- Recovering method from the emergency situation caused by system error or other cases;
- Judgment procedure of transition to backup system and recovery;
- Data recording, data recovering and data store;
- Preparation for unexpected situation; and
- Training of all the matters on the train operation.

(4) The Contractor shall supply the training of system design and configuration to the staff of the Employer. This training shall include the following:

- The outline of the systems,
- The system configuration and data configuration, and
- The principle of train operation.

(5) The Contractor shall supply the following trainings to the system maintenance staff of the Employer:

- The principle of train operation,
- Prevention and repair of maintenance methods and duties,
- Repair by unit change,
- Direction for test devise and investigation method, and
- The software maintenance including data configuration, data preparation, data modification and debug of system software.

(6) The Contractor shall supply the Training Facility at Training Center as mentioned at CP NS-01 Chapter 9. Training Facility at Training Center.

4.9.6 Maintenance Courses

The maintenance courses shall be developed to acquire all necessary knowledge and skills for preventive maintenance and corrective maintenance for each system.

(1) The maintenance courses shall be developed to acquire all necessary knowledge and skills for adjustment and configuration of system parameter for new installing system and parts.

Intended training maintenance staff shall include at least the following:

- Distribution system maintenance staff,
- Trainer and instructor of the Employer,
- Manager, and
- Any other defined person by the Employer.

(2) The contents for the maintenance training shall include the following:

- Train operation principle;
- Works and method of preventive maintenance and corrective maintenance;
- Failure correction of unit exchange level;
- Operation method for test equipment;
- Failure investigation and maintenance support;
- Reading of operating manual, maintenance manual, circuit diagram and wiring diagram;
- Software maintenance for data modification, data generation, database configuration and system software configuration; and

- Backup and load for data and software.

(3) Training plan submitted from the Contractor shall include the following:

- Schedule of training course,
- Purpose of training,
- Curriculum of training,
- Composition of training course,
- Necessary or providing training facilities,
- Training material and manual,
- Qualification of instructor, and
- Evaluation method for the training.

4.9.7 Training Materials

(1) The Contractor shall provide all necessary devises for training, special tools, training materials, training devises and training supplemental materials.

(2) Training supplemental materials and training devices shall be durable construction and become the Employer's property.

(3) The Contractor shall provide the computer-based training system.

(4) The Contractor shall prepare and submit training manual 60 days before start of the training to the Engineer for review.

(5) Modification and change of training manual throughout the contract period shall be responsible of the Contractor.

Training manual shall become the Employer's property.

4.9.8 Qualification and Certification

(1) The Contractor shall record the attendance of trainee. The contractor shall submit details of evaluation criteria and compression authorization before start of the training course to the Engineer for review.

(2) The Contractor shall prepare an evaluation report regarding the degree of understanding and proficiency of each curriculum, and knowledge level for each trainee. The Contractor shall also submit this evaluation report to the Engineer.

4.10 Maintenance Requirements

The Contractor shall prepare and submit operation and maintenance plan to the Engineer for review. The maintenance plan shall be included the following:

- Working description of first line maintenance, second line maintenance, third line maintenance;
- The cycle of each maintenance works;
- Annual periodic maintenance plan;
- Equipment and subsystem related the tasks;
- Operation methods of the tasks;
- Devices and test equipment for implementation the tasks;

- Flowcharts or illustrations for failure investigation;
- Recovery method;
- Prevention method; and
- Estimation period and staff volume.
- Software support Manuals

II. The North South Railway Project-South line (Commuter) (NSRP-South)

4.1 Scope of Works

4.1.1 General

This Specification covers the requirements for the design, manufacturing, factory test, packing, delivery at the Site, installation, training and setting, testing, commissioning, and interfacing works for completing the Power Supply system under the North South Railway Project - South Line (Commuter)

1) Total eighteen (19) Traction Substations (TSS) on Main Line and one (1) Sectioning Post (SP) are planned to construct and the locations and site condition are described as follows.

Table 4.1-1 Location of TSS and SP at Mainline and Depot Area

Substation TSS No	Location (m)	Nearest Station	Electric Company
TSS1	-	Solis	MERALCO
No. S1	4km600	Espana	MERALCO
No. S2	9km541	Paco	MERALCO
No. S3	13km116	Edsa	MERALCO
No. S4	16km280	Nichols	MERALCO
No. S5	20km614	Bicutan	MERALCO
No. S6	23km220	Sucat	MERALCO
No. S7	25km730	Sucat	MERALCO
No. S8	28km040	Alabang	MERALCO
No. S9	31km209	Muntinlupa	MERALCO
No. S10	34km229	San Pedro	MERALCO
No. S11	36km892	Pacita	MERALCO
No. S12	40km162	Binan	MERALCO
No. S13	43km105	Santa Rosa	MERALCO
No. S14	45km675	Cabuyao	MERALCO
No. S15	49km093	Cabuyao	MERALCO
No. S16	51km603	Banlic	MERALCO

Substation TSS No	Location (m)	Nearest Station	Electric Company
No. S17	54km919	Banlic	MERALCO
Depot SP	In the Depot	Banlic	MERALCO
No. S18	56km104	Calamba	MERALCO

With the exception of TSS1 which has a supply of 34.5kV all other substations shall be supplied with 115kV.

The scope covers all switchgear, 115kV and 34,5kV transformers, rectifier equipment and 6.6kV substation cubicles shall be outdoor type. All the equipment of DC switchgears and control panels are indoor type. All the equipment installed in indoor shall be of permeation preventive structure of the water of the drops from a ceiling, walls and others.

2) Meralco power connection work where described in this ERT, the work shall include all arrangements and costs associated with Meralco power supply to each TSS to be installed under the contract. The work as described below shall be carried out by the Contractor.

- Construction of power receiving equipment including receiving Cable from 115 kV or 34.5kV VCT of Meralco, within premises of each TSS.

- Procurement and installation of power cable from Meralco VCT box in each TSS.

- Payment of Guarantee Cost and Connection Cost, which is required by Meralco upon entering into a contract to receive an electrical supply.

- Any negotiations with Meralco regarding above shall be carried out by the Contractor.

-All details of materials and construction work by the Contractor shall follow to Meralco standards.

3) The complete cable network and cable support system up to connection in TSS shall be carried out by others. However, the cable size and types shall be decided by the Contractor. The Contractor shall coordinate with Interfacing Contractors and other Interfacing Parties with regard to the cable type, size, and includes but shall not be limited to the following:

-115 kV or 34.5kV cable to substation to cable terminal box (VCT box) including excavation, reclamation and all facilities;

- 6.6kV cable network to connect 6.6kV substation cubicles.

- VCT shall be provided by Meralco in accordance with the Philippine Electrical Code.

- DC Feeder cable network to connect OCS.

- Cabling for interlinked tripping between the TSS;

- Cabling of Optical Fiber cable for Power SCADA system.

- Cabling of Optical Fiber cable for TSS and SP telephone system.

4) Metro Manila Subway Project (hereunder the Project/ MMSP) and NSRP-South will be connected at Bicutan station for through train operation.

The Contractor shall consider the through operation, plan and provide required equipment's.

5) The Contractor shall coordinate with Interfacing Contractors and other Interfacing Parties for each TSS and SP equipment.

6) TSS space preparation, levelling including necessary banking, building construction

including utilities such as fire detection and/or ventilation, indoor and outdoor lighting, drainage, earthing equipment and etc. will be designed and constructed by other Contractors and the Contractor needs to coordinate with them.

7) The power supply equipment when in operation in normal and degraded mode shall not exceed the heat dissipation figures used in the sizing of the fans and air-conditioning used in the various rooms that house power supply equipment.

8) Power SCADA System for each TSS and SP Electric Rooms includes CCTV supervising system for each TSS and SP entrances and outdoor equipment;

9) Power SCADA System for each TSSs, SPs and Electric Rooms includes the door key status (open/close) monitor for TSS and SP doors shall be designed and constructed by other Contractors and the Contractor needs to coordinate with them.

10) Protective provisions relating to electrical safety and earthing which includes but shall not be limited to earthing equipment, cables and non-current carrying metallic components, and etc.

11) Resolution of interface issues with Interfacing Parties;

12) Special tools;

13) Spare parts and consumable;

14) Furniture, shock treatment charts, rubber mats, first aid boxes and danger notice plates;

15) Documentation; and

16) Services

    The Services to be performed by the Contractor shall include the following:

    1) Design, supply, system quality management, installation, testing including integrated testing and commissioning of the complete electrical power supply system;

    2) Presentations, reviews and audit support as described in the ERG

    3) Interface management with interfacing Contractors

    4) Design, identification of locations for:

       Concrete foundations for any equipment;

       Floor cinder concrete;

       Ground bus bar, terminals and ground rods for TSS and SP, buried pipes, cable pits and hand holes for cable wiring.

    5) Decommissioning, removal and/or disposal of temporary works; and

    6) Defects liability of the Permanent Works after commissioning as stipulated in the Contract.

17) All drawings are conceptual design drawings and details shown on the drawings are for information only. The accuracy of preliminary details shown on the drawings can't be guaranteed. The Contractor will prepare detailed design drawings to achieve requirements of the ERT.

18) Where cable containment is not provided by others then cable containment shall be supplied by the Contractor which shall have 25% spare capacity for expansion works. All cable containment material, fixing methods, and routing shall be given a Notice of No Objection by the Engineer.

4.1.2 System Requirements

(1) 115 kV or 34.5 kV Power receiving from MERALCO.

1) All the TSS receive the power directly from MERALCO by two incoming lines. The Contractor shall coordinate the requirements and layouts for accommodations and facilities of the receiving equipment in TSS.

2) In MERALCO power TSS, MERALCO will provide their own protection relays for protection of the outgoing feeders of MERALCO networks. For the feeders at each substation, the Contractor shall coordinate with MERALCO on the requirements for protection and shall provide and install suitable protection relays and facilities for the protection of the incoming feeders in TSS.

3) MERALCO shall provide independent voltage transformers (VT) and current transformers (CT) in an exclusive use package in each TSS for metering electrical energy on each incoming feeder. To meet with the MERALCO's requirements of energy metering, the Contractor shall coordinate with MERALCO the details of the metering devices at the design stage of installation. The energy meter (MOF) will be provided by the MERALCO. The Contractor shall provide the space for these devices for housing the VCT. The Contractor shall coordinate with MERALCO on the necessary installed spaces and locations and miscellaneous.

4) Feeder cables from the MERALCO TSS to TSS of the Project will be provided and installed by MERALCO. The Contractor shall coordinate with MERALCO and other Interfacing Parties on the interface between the TSS and MERALCO's substation. All the necessary works, equipment, materials, and fees for connection of the incoming feeders shall be borne by the Contractor. The Contractor shall liaise with MERALCO regarding the provision of all connection details of the incoming cables.

5) The Contractor shall coordinate with MERALCO and other Interfacing Parties regarding the routing and containment of the incoming feeders.

6) The Contractor shall coordinate with Interfacing Contractors and other Interfacing Parties with regard to the equipment weight imposed on the foundations by the TSS power supply system equipment. The Contractor shall assure that the actual loading of permanent installation and delivery does not exceed the agreed loadings.

7) The Contractor shall provide the electric power if required, using in TSS electric power equipment etc.

8) Power factor shall be maintained between 0.9 and 0.95.

(2) TSS (Traction Substation) shall include 115kV or 34.5kV circuit breakers, Rectifier transformers, Rectifiers, DC 1,500V Switchgears, Re-generating devices, protective relays, cables and other, but not limited to, for train traction power, and 6.6kV substation cubicle with Distribution transformer for AC 6.6kV power supply.

(3) Cables in the TSS and SP

The Contractor shall provide all cables for 115kV and 34.5kV AC, 6.6kV AC, 1500V DC and Low voltage using in the each TSS and SP.

1) TSS and SP

Interfacing Contractors shall provide rooms, including the required structure openings, equipped with building services, for the DC at TSS. The Contractor shall coordinate with Interfacing Contractors and other Interfacing Parties regarding the delivery, installation and structure openings of each TSS equipment. The LV power to the TSS including lighting and battery chargers shall be provided by operation transformer in TSS and SP.

2) The Contractor shall provide 1500V DC feeder cables from DC switchgears to connecting terminals of OCS structure at each TSS and SP.

(4) Earthing, Bonding, Lightning Protection

The Contractor shall provide safe and secure grounding to protect people and equipment's from reverse flashover in the ground fault.

1) The earth mats and earth terminal boards for each TSS, SP and other structures shall be provided by other contractors. The Contractor shall be responsible for all the connection to the terminal boards located inside each TSS and SP. In the event that extension cables from terminal boards to all equipment's and all outdoor facilities which are needed earthing, the Contractor shall provide such extension cables.

2) The Contractor shall coordinate its requirements for earthing (including earth mats), bonding and lightning protection with Interfacing Contractors.

3) The Contractor shall verify and confirm the earthing quality which complies with the required regulations and standards provided by other contractors.

4) Step voltage and touch voltage shall be verified that the calculated values are allowable tolerance range when the grounding fault voltage is generated at TSS, the calculation method of step voltage and touch voltage shall be complied with IEEE80-2000.

5) The contractor shall apply epoxy floor finishes in all room and areas where power supply equipment shall be installed. Should the contractor fix the likes of pulling hooks to the floor to aid in equipment delivery the floor shall be made good and repairs made to the epoxy floor finish.

6) Ground resistance value shall be less than 1Ω.

4.1.3 System Overview

(1) System Studies

Power related studies the Contractor shall carry out and submit to the Engineer for Approval shall include but not be limited to:

1) DC traction power simulation studies and data analyses, such as timetable data, section data, rolling stock data, traction system data and etc.

2) Re-generating power absorbing device study, specification and effect;

3) 6.6kV AC load flow study;

4) Short circuit current, voltage dropping study and flicker study;

5) Harmonics study;

6) Protection relay setting and system protection coordination study;

7) Cable study, main circuit, LV and control cables voltage drop, capacity and etc.;

8) Power supply design study, including the whole system;

9) Grounding and lightning protection study;

10) EMC and EMI study about traction power supply system.

11) Electrolytic corrosion mitigation measure study.

12) The Contractor shall perform all necessary Power System Study simulations in corporate with ETCS Model Simulation for DC traction power supply system with consideration of 3 minutes headway.

    These results shall be including for power supply demand calculation.

(2) Power Supply System General Requirements

1) Power supply to MCRP shall be from the ELECTRIC COMPANIES 115kV or 34.5kV as stated to TSSs and distributed to the DC traction system and AC 6.6kV power distribution.

2) DC traction equipment shall supply 1500V DC to the OCS system.

3) The Contractor shall develop its own strategy for earthing, bonding, lightning protection and corrosion control in accordance with applicable Standards IEC, IEEE, Philippine electrical code, or equivalent equal.

4) All E&M systems equipment shall be bonded to the system earth bus bar in accordance with applicable Standards IEC, IEEE, Philippine electrical code, or equivalent equal.

5) All indoor and outdoor power supply equipment shall meet IP requirements, standards and regulations or equivalent equal appropriate for the location and conditions.

(3) System Integrity

1) The 6.6kV AC power distribution system shall be designed to ensure continuity of supply and the specified NSRP-South system performance under single outage conditions. The AC power distribution system shall be provided with a protection system to ensure that in the event of a faulty element is isolated; no other equipment is disconnected by the operation of such a protection device.

2) The power supply system design shall ensure that cables and equipment shall be separated and protected to ensure that:

    - A single failure of an element of the power supply system shall:

        a. affect the operation or result in failure of any other power supply system element;

        b. result in the total loss of power distribution to any part of the NSRP-South Line.

        The opportunity for an incident external to the power supply system which affects the operation, or results in failure of an element within the power supply system, or results in a total loss of power distribution to any part of the NSRP-South Line shall be minimized.

3) The DC traction system shall be designed to ensure that it shall not affect the time tabled operation of trains.

4) The DC traction system shall include protective tripping to ensure that any faults are disconnected quickly.

5) It shall not be possible for faults to be masked by regenerative power from Trains.

6) A Zone Protection Scheme shall be applied for 6.6kV distribution system. The distribution circuit shall be protected by over current protection relays. 115kV or

34.5kV receiving bus bars in each TSS shall be protected by bus zone protection relays.

7) Lightning arrestor shall be provided at Power receiving point of all the TSS and SP.

(4) 115 kV or 34.5 kV power receiving

1) Two independent incoming lines in all TSS from MERALCO.

-All the TSS receive two independent incoming lines from MERALCO.

-Estimated capacity of these TSS shall be the total capacity required to supply the entire line.

-The load transfer between two MERALCO's feeders shall be transferred without any disruption to revenue service.

2) The 115kV/6.6kV or 34.5kV/6.6kV transformers, 115kV/1.18kV or 34.5kV/1.18kV Rectifier transformer and 115kV or 34.5kV switchgear of the substation shall be designed and provided to support the strictest requirement.

3) The Contractor's design shall be in accordance with MERALCO regulation, through analysis and simulation, of the validity of the power supply system configuration to satisfy the harmonics and other requirements of the design, and the Contractor shall enhance the configuration if it is found to be inadequate.

(5) 115kV / 34.5 kV System

1) The permissible operating voltage of 115kV or 34.5kV shall be in the zone between minimum -10% of operation voltage and maximum +10% of operation voltage in accordance with MERALCO standard.

2) The 115kV and 34.5kV system shall be designed to ensure that voltage regulation under normal feeding is maintained within 5% of normal voltage at any point on the 115kV system, and shall ensure that it is maintained within 7% under any single outage condition.

3) All 115kV and 34.5kV switchgear shall be designed and provided to support the ultimate capacity operation of the NSRP-South System, as well as the 6.6kV distribution system.

(6) DC Traction System

1) The DC at TSS shall provide power to the Overhead Contact line System with DC traction supply at 1500V DC and return shall be via the running rails.

2) The instantaneous voltage at any train along the route shall not fall below 1100V DC during normal operations with all TSS in rated service and shall not fall below 1000V DC with any abnormal operating condition under any single outage condition.

3) The Contractor shall consider voltage drop and rectifier capacity each TSS.

4) Two (2) rectifier banks shall be installed at every TSS on main line and shall have estimated capacity sufficient for the simultaneous operation. One rectifier unit shall be used for ordinary use and the other is used for standby.

5) Three (3) rectifier banks shall be installed at the substation including power supply to Depot and shall have estimated capacity sufficient for the simultaneous operation. One (1) or two (2) rectifiers units shall be used for ordinary use and the other is used for

standby.

6) One DC feeder circuit breaker for each TSS shall be provided for DC feeder redundancy system. This standby circuit breaker shall be able to operate by changing over of disconnecting switches instead of failed circuit breaker.

7) Linked breaking system utilizes optical fiber cables shall be prepared for DC traction feeder circuit protection between mainline TSS.

(7) Supervisory Control and Data Acquisition (SCADA)

The power supply system and the distribution system shall normally be controlled remotely from the SCADA system and monitored at the SCADA system in the OCC.

Telephone sets shall be installed at each TSSs and SP provided by the Communication Contractor. The Contractor shall coordinate with the Communication Contractor about the type of telephone set, location, numbers of line and so forth.

(8) 6.6kV distribution system for power supply system

1) Looped 6.6kV parallel power distribution system (ordinary use side and standby use side) shall be designed and provided. One system shall be connected to a north bound substation and another is connected a south bound substation.

2) The reciprocal support circuit shall be connected between the above two TSS of each system. In case ordinary use distribution line from a TSS stops, electric power can supply through other side line.

3) One circuit for each direction in looped system distribution line is prepared for Electric rooms.

4) Distribution transformer 115kV/6.6kV or 34.5kV/6.6kV are prepared in the substations and listed in Chapter 5, and in depot exclusive use two Distribution transformers are designed.

(9) TSS equipment

1) 115kV and 34.5kV Switchgear

115kV and 34,5kV Outdoor type, metal enclosed gas insulated or air insulated switchgear;

2) Rectifier equipment

115kV/1180V and 34.5kV/1180V Gas insulated or oil insulated self-cooling type Rectify transformer;

1500V 6000kW, 12 pulses pure water heat pipe cooling type,

AC Bus duct between Rectifier Transformer and Rectifier DC 1500V outdoor type metal enclosed air insulated switchgear with high-speed circuit breaker and disconnecting switches, and

3) Distribution Transformer

The 115kV/6.6kV and 34.5kV/6.6kV distribution transformers gas insulated or oil insulated self-cooling, out-door type and eco-friendly type.

4) DC 1500V Indoor type air insulated switchgear.

DC 1500V Switch gears Indoor type air insulated switchgear with disconnecting switches.

DC 1500V Indoor type air insulated switchgear for Rectifier positive protection.

DC 1500Vdisconnecting switches for Rectifier Negative separation.

DC 1500V Indoor type air insulated switchgear for Re-Generating Resistor.

5) Re-generating power absorbing equipment

The power absorbing equipment shall be consisting of the following;

a) Resistor compartment

b) Regenerative chopper (IGBT based) and smoothing capacitor compartment

c) DC reactor, high speed DC circuit breaker and disconnection switch compartment.

6) Guidance on quantifying greenhouse gas emission reductions from the baseline for electrical and electronic products and systems shall be considered in accordance with IEC TR 62726.

(10) Harmonics

1) The power supply design shall comply with the maximum of total permissible voltage distortion of MERALCO requirements for limitation of higher harmonics at the 115 kV and 34,5 kV termination points to the MERALCO's grid.

2) Harmonic distortion of output current shall be not more than 5% in total, not more than 3% each (at rated output).

(11) Opening of Blumentritt Station

At the opening of Blumentritt Station the power for NSRP-South shall be supplied from the NSCR No.1 TSS. The Contractor shall coordinate with the NSCR Contractor regarding the TSS location and all associated connections to systems provided by the Contractor.

4.2 Definitions and Abbreviations

4.2.1 Definitions

In This Specification, the following defined terms shall have the meanings ascribed to them below:

Standard Terminology	In general definitions applied to traction power and protective relay function conform to the British Standards (BS), American National Standards Institute (ANSI), International Electromechanical Commission (IEC) standards or European Norm Standards (EN).
Earthing	Same as 'Grounding'. The connection for equipment enclosures and non-current carrying metal parts to the earth to provide safety to personnel, public and equipment.
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.

Medium Voltage	As applied for this Contract, the Medium voltage is over 600V AC.
Low Voltage	As applied for this Contract, low voltage refers to voltage not exceeding 600V AC.
Breaking Capacity	This is the capability to interrupt a maximum rated short circuit or fault current at a rated maximum voltage. Thus, it is usually expressed in volt-amperes, kilovolt amperes, or megavolt amperes.
Headway	The time interval between following trains.
PLC (Programmable Logic Controller)	PLC is a programmable controller, which utilizes ladder diagram programming and advanced instructions for use in Automation environment.
RTU (Remote Terminal Unit)	Interface unit between control panels installed in each SS, SP and SCADA.
Traction Substations	TSS receives either 115 kV or 34,5 kV AC depending on location and converts to 1500V DC for feeding traction power and to 6.6kV AC to NSRP-South power distribution system.
High voltage Electrical Room (HER)	High voltage Electrical Room receives 6.6kV power and transforms 6.6kV to 400-230V AC in the Depot for supplying power to depot.
Railway Electric Room (RER)	Railway Electric Room receives 6.6kV power and transforms 6.6kV to 400-230V AC at each Station for supplying power to each station.
Switchgear	Means Isolator Switches, Circuit Breakers, Interrupters, Cutouts and other apparatus used for the operation, regulation and control of electrical circuits.
Withstand Capability	Rated capability of equipment to survive without damage by the mechanical forces of a short circuit or the thermal effects of a short circuit downstream from the equipment. Also, a rated capability of equipment which will withstand without damage for specified power frequency over-voltage and/or for surge or impulse voltage.

4.2.2 Abbreviations

AWG	American Wire Gauge

BIT	Built in Test Diagnostics
FAT	Factory Acceptance Test
GNAN	Gas-Insulated Self-Cooled
GNAF	Gas-Insulated Self-Cooled Forced-Air Cooled
GDAF	Gas-Insulated Forced-Gas Forced-Air Cooled
GIS	Gas insulated switchgear
HSCB	High Speed Circuit Breaker
HSVCB	High Speed Vacuum Circuit Breaker
HT	High Tension (in this Project means 6.6kV)
LBS	Load Break Switch
LSOH	Low Smoke Zero Halogen
MCCB	Molded Case Circuit Breaker
MERALCO	Manila Power company
MMSP	Metro Manila Subway Project
MOF	Metering Out Fit
MRT	Mass Rapid Transit
MW	Messenger Wire
NDTs	Non Destructive Tests
ONAF	Oil-Immersed Forced-Air Cooled
ONAN	Oil-Immersed Self-Cooled
PLC	Programmable Logic Controller
Rms	Root Mean Square
SCR	Station Control Room
SE	System Earth
SF6	Sulfur Hexafluoride
SP	Sectioning Post
STRASYA	Standard urban Railway System for Asia

TP	Triple Pole
VDU	Visual Display Unit
VVVF	Variable Voltage Variable Frequency

4.3 Design Criteria and Standards

4.3.1 Design Criteria

Design criteria of the power supply system of this Project are as follows.

4.3.2 Design Life

(1) Application of state-of-the-art Technology;

(2) Design proven in service;

(3) Design life is 30 years;

(4) Minimum life cycle cost;

(5) Low maintenance cost;

(6) Use of interchangeable and modular components;

(7) Extensive and prominent labelling of parts, cables and wires;

(8) Use of unique serial numbers for traceability of components;

(9) High reliability;

(10) Low energy loss;

(11) System safety;

(12) Sufficient and necessary redundancy in system;

(13) Environment friendly to avoid contamination by oil leakage in case of incident;

(14) Adherence to operational performance requirements; and

(15) Maximum utilization of indigenous materials and skills, subject to quality conformity.

4.3.3 Proven Design

(1) The Contractor shall develop the design based on this Specification and on proven and reliable engineering practices. The design details shall be submitted with technical data and calculations to the Engineer for his review.

(2) The system, including all sub-systems and equipment, shall be of proven design.

(3) Sub-systems and equipment proposed by the Contractor shall have been in use and have Railway System over a period of at least five years.

(4) Where similar equipment or sub-systems of a different rating are already proven in service, then the design shall be based on such equipment. In case these stipulations are not fulfilled, the Contractor shall furnish sufficient information to prove the basic soundness and reliability of the offered sub-system and compliance with the

design criteria.

4.3.4 Adequate Margin

Adequate margin shall be built into the design particularly to take care of the higher ambient temperatures, dusty conditions, and high seasonal humidity, etc. prevailing in Manila.

4.3.5 EMC (Electromagnetic Compatibility)

(1) The Contractor shall guarantee that the traction power supply equipment is taken the measures preventing an electromagnetic interference (EMI) from any equipment supplied by the Interfacing parties and the Interfacing Contractor in the depot.

(2) The Contractor shall submit an EMC Control Plan to the Engineer for Approval.

(3) The Plan shall include the measures to reduce conducted, induced and radiated emissions to acceptable levels as specified by IEC 62236: Railway Applications-Electro-Magnetic Compatibility.

(4) The Plan shall specify the measures to increase the immunity of the traction power supply equipment for the main truck.

(5) The Plan shall specify the basic protective measures proposed for all electrical and electronic subsystems and components, and the specific protective measures to be adopted for selected subsystems and components.

(6) The Plan shall analyze EMI/EMC impacts on the design of the traction power supply equipment, the train, and wayside equipment as well as the general environment.

(7) Particular attention should also be paid to additional requirements in earthing, bonding, shielding, filtering and cable arrangements.

(8) The Contractor shall conduct full EMI tests on each one set of equipment and type tests as well as full EMC tests on complete traction power supply equipment in accordance with IEC 62236.

(9) Non-safety related systems interface

(10) The Contractor shall take appropriate measures to ensure that EMC is achieved between the traction power supply equipment and track-side equipment.

(11) Environmental EMC

(12) The electrical equipment composed traction power supply system in the depot shall not produce interference with radio, television, tape recorder/players, heart pace-makers, radar, computer systems, magnetic media, portable and cellular telephones, etc., in the TSS, SP.

(13) This includes action by static electricity, magnetic field and electric field.

4.3.6 Applicable standard

Technical regulatory standards on Japanese railways (TRTRS): 2012

The interpretation of the technical regulatory standards on Japanese railways: 2005

IEC 60034 (Clause 5.6.2)	Rotating electrical machines
IEC 60038	IEC standard voltages
IEC 60044-1	Instrument transformers – Part 1: Current transformers
IEC 60044-2	Instrument transformers – Part 1: Inductive voltage transformers
IEC 60071	Insulation Co-ordinations
IEC 60076	Power transformers
IEC 60076-10	Power transformers – Part 10: Determination of sound level
IEC 60076-11	Power transformers – Part 11: Dry-type transformers
IEC 60076-15	Power transformers – Part 15: Gas filled transformers
IEC 60099	Surge arresters
IEC 60129	Alternating current disconnectors (isolators) and earthing switches
IEC 60146	Semiconductor converters
IEC 60287	Electric cables – Calculation of current rating
IEC 60296	Fluids electro technical applications – Unused mineral insulating oils for transformers and switchgear
IEC 60502	Cables
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 60622	Sealed nickel-cadmium prismatic rechargeable single cells
IEC 60850	Railway applications – Supply voltage of traction systems
IEC 60870	Tele-control equipment and systems
IEC 60947	HV, MV, LV switchgear
IEC 61000	Electromagnetic compatibility (EMC)
IEC 61936-1	Power installations exceeding 1kV a.c. Part 1 common rules

IEC 61992	Railway Applications - Fixed installation - DC switchgear
IEC 62236	Railway applications – Electromagnetic compatibility
IEC 62271, IEC 62271-203	High-voltage switchgear and control-gear
IEC 62278 (Clause 3.2.2)	Railway Applications-Specifications and demonstration of reliability, availability, maintainability and safety (RAMS)
IEC TR 62726	Guidance on quantifying greenhouse gas emission reductions
IEEE 519 (Clause 5.3.5, 5.4.5)	IEEE recommended practices and Requirements for Harmonic Control in Electrical Power Systems
BS 6651 (Clause 5.7.4)	Code of practice for protection of structures against lightning
EN 50122-1	Railway applications Fixed installations Electrical safety, Earthing and the return circuit.

Philippine Electrical Code

Philippine Distribution Code

Philippine Grid Code

National Structural Code of The Philippines

National Building Code of The Philippines

Proposals for the adoption of alternative standards shall be submitted to the Engineer for review.

4.4 Technical Requirements

4.4.1 Switchgear

(1) Standards

All high voltage switchgear shall be designed and manufactured in accordance with the requirements of applicable Philippine Standards equivalent to IEC 62271, High-Voltage Switch gear and Control gear or equivalent as appropriate.

(2) 115kV and 34.5kV Switchgear

1) 115kV and 34,5kV switchgear for TSS shall include the 115kV and 34,5kV incoming circuit breaker units for ordinary feeders and/or for standby feeders.
2) Each of 115kV and 34,5kV switchgear with circuit breaker shall be designed with adequate current ratings and short circuit braking duty according to its intended

function.

3) The 115kV and 34,5kV switchgear shall metal enclosed and suitable for outdoor installation. The 115kV and 34,5kV switchgear shall comprise any of the following:

   a. Air insulated vacuum circuit breakers withdrawable type.

   b. Gas insulated vacuum circuit breakers which can withdraw type

4) The switchgear shall be designed for the following minimum ratings and not exceed 2.5 p.u. overvoltage for any switching or breaking duty:

   a. Rated voltage: 115kV and 34,5kV depending on location

   b. Number of phases: 3

   c. Rated frequency: 60Hz

   d. Rated short circuit breaking and making capacity: to meet the 34.5kV and 115kV system fault level not less than 40kA

   e. Rated current: 1,250A

   f. Auxiliary power supply voltage for operating device: 105V DC

   g. Auxiliary power supply voltage for auxiliary circuit: 400/230V AC

5) The 115kV and 34.5kV switchgear shall include the following equipment:

   a. Circuit breaker which can withdraw or fix mounted circuit breakers;

   b. Earthing switches

   c. Current transformers of suitable ratings and temperature class for protection and measuring; and

   d. Voltage transformers of suitable ratings and temperature class for protection and measuring.

   e. Lightning arrestor shall be installed with adequate specification in accordance with the Philippine Electrical Code.

6) Protection and measuring facilities shall include the following:

   a. 115kV and 34.5kV bus zone protection relays shall be provided;

   b. Voltmeter and under-voltage protection for bus sections shall be provided; and

   c. Ammeter, kilowatt meter, over-current and earth fault protection for rectifier circuits

7) Guidance on quantifying greenhouse gas emission reductions from the baseline for electrical and electronic products and systems shall be considered in accordance with IEC TR 62726.

(3) DC Switchgear

1) DC switchgear comprising DC high speed circuit breakers shall be provided for switching off the rectifier DC incoming feeds and outgoing feeds to overhead contact line system. The DC switchgear shall be equipped with necessary functions for SCADA control and indication.

2) The DC switchgear shall be constructed in accordance with IEC 61992 railway

applications, fixed infrastructure - DC switchgear.

3) The DC switch gears consists of following types

a. HSCB, protection for Rectifier Positive circuit minimum includes;
   - DC HSCB
   - DC current transformer for reverse current protection
   - DC voltage transformer
   - Relay for above function.
   - Fault indicator
   - Mimic bus

b. DS, protection for Rectifier Negative circuit minimum includes;
   - DC Negative Disconnecting Switch (manual)
   - DC current transformer for measurement
   - Relay for grounding protection (64PB)
   - Fault indicator
   - Mimic bus

c. HSCB, protection for outgoing feeder circuit minimum includes;
   - DC HSCB
   - DC current transformer for over current protection
   - DC current transformer for measurement
   - DC lightning arrester for open section
   - DC Disconnecting Switch (Motor operation)
   - DC Disconnecting Switch for stand by HSCB (Motor operation)
   - Relay for above function.
   - Fault indicator
   - Mimic bus

d. Stand by HSCB for outgoing feeder minimum includes;
   - DC HSCB
   - DC current transformer for over current protection
   - DC current transformer for measurement
   - Conversion switch for stand by function
   - Fault indicator
   - Mimic bus

e. DC switch gear for the regenerative Positive circuit minimum includes
   - DC HSCB
   - Relay for above function.
   - Fault indicator

- Mimic bus

f. DC switchgear for the regenerative Negative circuit minimum includes;
   - DC Negative Disconnecting Switch (manual)
   - Fault indicator
   - Mimic bus

4) The DC switchgear shall be provided with minimum ratings in accordance with the following parameters:
   a. Rated voltage 1500V DC;
   b. Rated current 4000A and 5000A
   c. Rated breaking current 100kA for HSCB.
5) The DC switchgear shall be of metal-clad multi-cubicle type, with withdrawal circuit breakers for positive pole switching and isolating.
6) All DC switchgears shall be isolated from the ground and the switchgears shall be rigidly fixed to the floor with anchor bolts.
7) Negative connections shall be a collector bar incorporating earth returns and monitoring.
8) Rectifier circuits shall incorporate reverse current tripping.
9) OCS contact feeder protection shall detect short circuit (by direct acting trip devices in DC circuit breakers) and limited faults (by multifunction relay with DC fault selective device) but shall not cause tripping due to load current in other operating modes.
10) In the event of OCS contact feeder protection failure, all the circuit breakers for feeding the same track and the same section shall trip automatically with Tele-command breaking devices.
11) In the event of OCS contact feeder protection failure, all the circuit breakers for feeding the same track, the adjacent section of failure section, all the circuit breakers for feeding another track shall be opened automatically.
12) OCC Operator is able to open the necessary circuit breaker manually in case the command was send from stations, trains and others.

(4) Current transformers

Design and supply of current transformers for AC and DC shall meet the following requirement or equivalent.

1) Design and installation shall be in accordance with relevant standards and regulations.
2) Class and rating shall be suitable for metering, monitoring and protection requirements.

(5) Voltage transformers

Design and supply of voltage transformers for AC and DC shall meet the following requirement or equivalent.

1) Design and installation shall be in accordance with relevant standards and regulations.
2) Class and rating shall be suitable for metering, monitoring and protection requirements.

4.4.2 Rectifiers and Rectifier Transformers

(1) General

1) Each rectifier transformer and rectifier set combination shall incorporate full load overall efficiency of not less than 98% and power factor of not less than 95% lagging.

2) Each rectifier transformer and rectifier set combination shall provide linear inherent DC voltage regulation of not less than 6% of the full load voltage, from light transition load (approximately 1%) to 100% full load and shall be as linear as technically feasible up to the 300% full load current. The inherent voltage regulation at 300% full load shall ensure that the voltage at the rectifier load terminals shall not be less than 1150V DC.

3) The output DC voltage for each rectifier transformer and rectifier set combination, at light transition load, shall not exceed 1590V DC.

4) The DC traction supply system shall be designed to provide a voltage that is self-limiting to 1650V DC at no load.

5) Each rectifier transformer and rectifier set combination shall be designed in accordance with Engineer's requirements and to satisfy the requirements of this Performance Specification and following:

   a. 100% Continuous

   b. 130% to 150% overload – 120 minutes

   c. 300% overload – 1 minute.

6) The Contractor shall consider how to carry in and install at each substation and plan rectifier transformer that can be divided if necessary.

(2) Rectifier Transformers

1) 115kV/1.18kV and 34.5/1.18kV Rectifier transformers shall comply with relevant standards and regulations. Rectifier transformers shall be rated to supply the full DC traction system load within the continuous rating, with any one rectifier transformer out of service.

2) The overload ratings of rectifier transformers shall be utilized to accommodate any abnormal loading in the event of train bunching or due to any abnormal DC traction feeding arrangements.

3) Rectifier transformers shall be designed in accordance with relevant standards and regulations and shall incorporate an earthed metal screen between high voltage and low voltage windings, if necessary.

4) Off-load tapping links shall be provided on the high voltage winding to provide rated output at +5.0% to -5.0% of nominal supply voltage, in increments of 2.5%.

5) Two secondary windings shall be provided, one connected in star and the other one connected in delta, to provide double six phases supply to the rectifier.

6) Rectifier transformers shall be fitted with a temperature alarm device, and temperature tripping and pressure alarm and gas pressure tripping to be monitored by the SCADA.

7) Rectifier transformers shall be of gas insulated or oil insulated self-cooling type to have anti-flame-able characteristics and to prevent ingress of moisture.

8) The insulation shall conform as a minimum to temperature 'Class B' as defined with

relevant standards and regulations.

(3) Rectifier Sets

1) Rectifier sets shall provide nominal 1500V DC traction supply to the Overhead Contact line System.
2) Rectifier sets shall accommodate the load cycle requirements as defined with relevant standards and regulations for "Extra Heavy Traction Duty Class D" as a minimum, and to ensure that other duty satisfies the power supply system load requirements.
3) Rectifier sets shall be protected against any physical contact and shall be suitably enclosed.
4) Rectifier sets shall be fitted with a temperature alarm device and temperature tripping device, to be monitored by the SCADA system.
5) Rectifier sets shall be designed to deliver a 12-pulse DC output.
6) Rectifier sets shall be natural cooling type or heat-pipe cooling type or an equivalent cooling type.
7) When adopting a natural cooling system and connecting diode in parallel, diode fuses shall be provided to disconnect any faulty diode.
8) Faulty diode detection shall be provided and shall be monitored by the SCADA system.
9) Rectifier sets shall be rated for voltage of nominal 1500V DC at continuous load (full load).

(4) Surge Suppression

1) The DC traction supply voltage shall be permitted to rise to a maximum of 2100V DC during the regenerative breaking of the trains. In addition, the DC traction system shall sustain transient voltage surges of up to 10kV for up to 1 millisecond between the positive and negative poles.
2) Suitable surge and transient absorption circuits and surge diverters shall be provided to protect the rectifier sets from the effects of lightning strikes on the overhead contact and running rail.

(5) Harmonics

Harmonic distortion at the points of common coupling shall be limited to ensure the power quality.

(6) Isolating and Earthing Facilities

Isolating and earthing facilities shall be provided in order to enable maintenance to be carried out safely on the rectifier transformers and the rectifier sets.

4.4.3 Transformers

(1) Standards

115kV/6.6kV and 34.5kV/6.6kV Distribution transformers and 6.6/0.4kV operation transformers shall comply with relevant standards and regulations.

(2) Distribution transformers

1) The distribution transformers shall be non-flammable oil immersed type, molded or gas insulated off-load tap-changing, out-door type, Class B and eco-friendly type or equivalent with the following minimum ratings and requirements.

2) The Contractor shall determine actual rated power based on Chapter 5 Power Distribution System.

a. Nominal voltage

High voltage winding: 115kV and 34,5kV

Low voltage winding: 6.6kV

b. Number of phases: 3

c. Rated frequency: 60Hz

d. Type of cooling: ONAN/ONAF or GIAN/GFAN

e. Off load tap changing equipment:

Tap changing of ±10% with 2.5% each. The transformer shall provide full capacity at all tapping positions.

f. The base of the transformer shall be designed to spread the weight of the transformer over as large an area as possible within its space envelope.

3) The rated insulation level shall comply with the following minimum requirement:

a. Lightning impulse withstand voltage:

Both high and low voltage winding shall comply with relevant standards and regulations.

b. Power frequency withstand voltage for 1 minute:

Both high and low voltage winding shall comply with relevant standards and regulations.

c. Neutral grounding method: Directly earthing for high voltage winding and low voltage winding according to neutral earthing mode of the distribution system

d. Air-filled cable box for high and low voltage termination shall be provided.

e. Fault detection: gas pressure and gas temperature.

(3) 6.6kV/400-230V operation transformers

The 6.6kV/0.4kV operation transformers for supplying power to control equipment shall be mold or oil-immersed type, off-load tap-changing, indoor type and eco-friendly type with the following minimum ratings and requirements:

1) One 6.6kV/0.4kV transformer shall be installed in the TSS.

2) The rated power shall be determined by the Contractor as part of its design of works.

3) The 6.6kV/0.4kV operation transformers shall comply with the following minimum ratings and requirements:

   a. Rated voltage

      - High voltage winding: 6.6kV

      - Low voltage winding: 400/230V

   b. Number of phases: 3 (3phase-3wire method)

   c. Rated frequency: 60Hz

   d. Type of cooling: moulded, natural or forced air-cooling.

   e. Off load tap changing equipment: Tap changing of ±10% with 5.0% each step to comply with Philippine Grid Code of the Philippines

   f. Connection designation: Dyn11

4) The rated insulation level shall comply with the following minimum ratings and requirement:

   a. Lightning impulse withstand voltage:

      Both high and low voltage winding shall comply with relevant standards and regulations.

   b. Power frequency withstand voltage for 1 minute:

      Both high and low voltage winding shall comply with relevant standards and regulations.

4.4.4 Control Source for Traction Substations

(1) Battery Units

1) For the receiving TSS, the Contractor shall provide DC 110V battery system for safety tripping, service current functions and power to the SCADA remote terminal units.

2) The battery system shall be rated to supply the standing loads for a minimum of 3 hours in the event of a charger supply failure, and at the end of that period shall be capable of operating each item of equipment for two cycles, i.e., one cycle is open and close.

3) During such duty output voltage shall be within the tolerances defined for operation in the relevant equipment specifications.

4) The 110V batteries shall be of the NiCad type, maintenance free type and shall not emit hazardous gases.

(2) Battery Chargers

1) Battery chargers shall be provided with self-regulation and shall be capable of restoring a minimum of 80% of battery capacity within 4 hours of full discharge.

2) Sufficient indications shall be provided on the battery charger to provide status information of the battery charger system, as a minimum this shall include battery voltage, trickle charge and booster charge currents, battery charge functioning and battery charge failure. In addition, status information shall be provided to the SCADA system.

3) Battery chargers shall incorporate measuring instruments such as ammeters and voltmeters as a minimum.

4) In receiving TSS, AC auxiliary power for the battery charger shall be fed from the secondary circuit of operation transformer.

4.4.5 Power SCADA (SCADA for Power Supply System)

(1) General

1) The Contractor shall design, supply, install test and commission a microprocessor based Supervisory Control and Data Acquisition (SCADA) system for smooth operation, monitoring, control and logging of important features of the traction power system on the NSRP-South Line.

2) The equipment shall be controlled and monitored comprising with each TSS, SP, RER, SER, REH and HER but not limited to.

3) At the OCC Central workstations are to be provided giving an effective means of display and control.

4) Necessary RTU shall be installed to provide the most economic configuration based upon cost balances between RTU modularity and cabling costs, consistent with the performance requirements of this Specification.

5) Communications between the equipment in the TSS, electric room shall be over a duplicated communications network dedicated to Power SCADA, which shall be provided.

6) In the event of a communications failure between a station and the central database the station traction power SCADA equipment shall continue to function as an autonomous system, maintaining a local database and all Power SCADA facilities.

7) The Power SCADA system shall incorporate, but shall not be limited to, the following primary facilities:

a. Provide continuous, effective monitoring at OCC;

b. Alert operations and maintenance staff rapidly to equipment malfunctions, especially those likely to cause disruption to operation of the railway;

c. Provide clear, comprehensive displays and printed logs of equipment status to each operator workstation;

d. Provide comprehensive displays and printed logs based upon historical data, with the option of overlaying data from earlier periods;

e. Time-tag all events detected by the Power SCADA system, to 20 milliseconds resolution for selected high-speed inputs, and to present this information in logs as a true system-wide sequence of events;

f. Provide comprehensive periodic records of energy demand and consumption;

g. Provide automatic and manual control of receiving, traction and auxiliary power equipment;

h. Generate routine maintenance schedules automatically, based upon elapsed time and equipment operation times;

i. Provide centralized data storage and software back-up system.

j. Provide displays for supervising of each CCTV installed in each TSS and SP for the sight overview.

k. Power SCADA System for TSSs, SP and Electric Rooms includes the door key status (open/close) monitor for each TSS and SP doors shall be designed and constructed by other contractor.

8) To improve the automation of the substations shall be as followings:

a. Avoiding proprietary protocols and being able to integrate equipment of different manufactures to realize interoperability.

b. Using technologies that can reduce the cost in wiring and engineering time.

c. Seeking for improvements in the commissioning and maintenance tasks.

(2) Applicable Design Standards

The power SCADA system shall be compliant with the standard shown below:

1) ISO, International Organization for Standardization;

2) IEC, International Electro-Technical Commission;

3) IEEE 802.3 series, Standard for Ethernet based LAN system.

(3) Qualifications of Equipment Manufacturer and Providers

All materials and equipment to be provided for the Power SCADA shall be of proven design and shall be provided by a manufacturer who has successfully accomplished similar supervisory control and data acquisition system projects for a period of at least 10 years.

(4) Design reliability

1) System Availability

The system shall be designed to achieve at least the following levels of system availability:

a. The complete Power SCADA system shall be designed to meet 99.99% or higher hardware availability.

b. The availability figures for Traction Power functionality and the Traction power decision support facilities shall be higher than 99.97%.

c. The availability figures for other Power SCADA subsystems viz. Software Development and Training Simulator shall be higher than 99.7%.

d. Any equipment manufactured by the Contractor shall have its failure rate determined strictly in accordance with its appropriate operating environment.

e. Any degraded mode of operation or re-configuration functions provided by the Delivered System shall not be included in the determination of the Delivered System availability.

2) Redundant design

a. Redundancy shall be incorporated in the design to cater for failures that will have impacts on safety and normal operation of the MCRP operation. However, redundancy shall be incorporated where failure cannot be tolerated even for short periods.

b. The system shall therefore be designed around small autonomous items of equipment but shall be commensurate with an economical overall solution.

c. Failure of any equipment node on the network shall not affect the local operation nor prevent communication between any other connected equipment nodes.

3) Noise

All Power SCADA system equipment shall operate in accordance with the design criteria in the very high "electrical noise" environment normally associated with MRT systems due to electrical fields created by traction supplies and strong magnetic fields. Equipment shall be immune to the effects of conducted and radiated electrical interference.

4) Time to Repair

The Power SCADA system shall have an MTTR less than 30 minutes. This time shall not include the time taken for a technician to arrive at the initial reported failure site.

5) Lightning Protection

a. The Contractor shall ensure that all equipment is fully protected against the effects of mains surges and direct and indirect lightning strikes. Protection shall be applied to incoming mains power supplies and to input and output signal lines to externally located sensors, transducers, actuating equipment, etc. or to any other equipment likely to be affected.

b. All surge suppression equipment shall be self-contained and self-resetting.

c. The suppression equipment shall be so selected that the let-through voltage specification does not exceed the absolute maximum voltage specified for the particular equipment being protected.

d. Signal lines from external sensors at risk from the effects of lightning shall have surge suppressers fitted at both ends of each line and shall be installed and connected in accordance with the manufacturer's recommendations.

(5) Main Operating Facilities

The Power SCADA system shall include, but shall not be limited to the following facilities:

1) Continuous, effective monitoring and/or control of selected equipment over the entire NSRP-South Line;

2) Expeditious alerting of operations and maintenance personnel, by mean of corresponding audible and visual alarms, of any identified equipment malfunction, especially those likely to cause disruption to the operation of the NSRP-South Line;

3) Clear, comprehensive displays and printed records of selected equipment status at each workstation;

4) Comprehensive displays and printed records based upon historical data, with the option of overlaying data from earlier periods;
5) Records of energy demand and consumption and other data at MERALCO incoming feeders, service substation for checking bills, for the MERALCO trend analysis and cost budgeting purposes;
6) Time-tagging of all events detected by the Power SCADA system, to a high-speed resolution for selected high-speed inputs, and presentation of this information in records as a true sequence of events;
7) Monitoring of selected equipment running times and provision of comprehensive records of the overall operating costs and energy efficiency;
8) Facilities for manual control of selected equipment; the Contractor shall provide detail of such facilities for review and approval by the Engineer;
9) Facilities for recommending re-configuration of the operation of selected equipment in the event of a failure or alarm occurring, to enable rapid action by the controller;
10) Automatic generation of maintenance requests which are based upon selected equipment running times;
11) Centralized data storage and software back-up facilities for the complete Power SCADA system.

(6) Control and Monitoring Items of Power Supply System

1) The Power SCADA system shall control and monitor the 115kVAC, 34.5kVAC, 6.6kVAC, 1.5kV DC and LV power supplies, which shall include indications of the status of all electrically operated switching devices on the 115kVAC, 6.6kV AC and 1500V DC systems, together with alarm and protective devices.
2) The same requirement shall also apply to the main breakers and tie breakers of the main LV switchboards in each electric room.
3) Power SCADA monitoring facilities for power supplies shall include, but shall not limited to:
   a. Voltage of all 115kVAC, 34.5kV, 6.6kV, 400V AC and 1500V DC busbars;
   b. Current of all 115kVAC, 34.5kV, 6.6kV, 400V AC and 1500V DC busbars;
   c. Status of circuit breakers and disconnecting switches;
   d. Rectifier current;
   e. All DC feeder currents
   f. Status of all protection equipment;
   g. Operation of alarm and protection devices.
   h. Status of emergency generator
   i. Status of DC battery and charger

(7) Event Record

1) The Power SCADA system shall record any events caused by faults, malfunctions,

warnings or alarm information generated automatically by the selected equipment.

2) A central recording system shall be provided to record the following events, including but shall not limited to:

a. Change of state of remote terminal unit input parameters;

b. Events designated as alarms;

c. Change in the Power SCADA workstation configuration;

d. Change in the Power SCADA system configuration by operations personnel;

e. Faults;

f. Control actions;

g. Text entered by operations personnel;

h. System generated massages, e.g. equipment malfunction;

i. Change to the configuration of the Power SCADA central database.

3) Events shall be given an order of priority to allow events to be classified, sorted and filtered. Subject to the requirements of the approved operations plan events shall be classified as:

a. Emergency – This type of fault shall require instant attention in order to minimize interruption of the normal operation of the NSRP-South Line or risk of injury to personnel or passengers and shall be classified as an alarm;

b. Urgent – This type of fault shall require reasonably prompt, but not instant attention in order to minimize interruption of the normal operation of the NSRP-South Line and shall be classified as an alarm;

c. Non-urgent – This type of fault shall be dealt with in a more convenient manner while more urgent events are dealt with first. This type of event shall not directly result in any degradation of the normal operation of the NSRP-South Line and shall be classified as an alarm only.

4) The event records shall be available as a text table, with each event classified by its priority level and shall be tagged with details of the date and time at which the event occurred. Additionally, the operations personnel identification code shall be recorded for each event that is initiated by the operations personnel. Each event shall be displayed and highlighted until acknowledged by the operations personnel. All events shall continue to be displayed until the event has been acknowledged and cancelled in the automatic event log and provided the fault has been satisfactorily rectified in the equipment which generated the event.

(8) Alarms

1) Audible alarms shall be provided to alert the operations personnel to a problem requiring immediate action or attention. The audible alarms shall be clearly audible against ambient noise level.

2) There shall be three categories of audible alarms easily distinguishable by separate tones or sounds for events classified as emergency, urgent and non-urgent as defined in Clause 4.5.7.3).

(9) Response Times

1) The display of each Safety Critical system shall require rapid updates of the workstation displays of the status and event data, together with a rapid response by the Power SCADA system to control inputs. The status of any circuit breaker trip, protecting any Safety Critical equipment, shall also be identified on the workstations and recorded in the event record, within 2 seconds of its occurrence.

2) Updating of displays shall ensure that no displayed data shall be more than 30 seconds. No event shall take longer to be registered on a display than 5 seconds for urgent alarms and 3 seconds for emergency alarms. The display of non-urgent events shall take no more than 10 seconds after the occurrence.

3) "Housekeeping" commands such as changes of the display format or color scheme philosophy shall be executed by the Power SCADA system within 5 seconds of the completion of the input procedure.

4) The normal operation of all the remote terminal units shall be verified by the Power SCADA system at intervals not exceeding 30 seconds. In the event of any failure or malfunction of a remote terminal unit, a corresponding massage shall be displayed on the appropriate workstations as a Power SCADA system alarm.

5) The Safety Critical systems for this Power SCADA shall include, but shall not be limited to the following:

a. Traction power and high voltage distribution;

b. Fire detection in TSS

(10) Interface Requirement

1) The Power SCADA system shall have the following interfaces to collect the monitoring information and to control the operating. The Contractor shall select the optimal interface from the interface described below.

a. Digital input:

12V, 24V, 50V, 110V DC, 220V AC (at least 2kV isolation)

b. Analogue input:

0-10V, 0-10mA, 4-20mA DC

c. Pulse input:

12V, 24V DC up to 10 pulses/sec. (at least 2kV isolation)

d. Digital output:

Non-voltage free contact, 12V, 24V, 110V DC, 220V AC

e. Analogue output:

0-10V, 4-20mA DC

f. Serial link:

RS232C, RS442

g. Ethernet:

100Base series or more

2) Optical fiber network shall be provided for not only Power SCADA but also other sub packages (Telecommunications and Signal System etc.). Interface between Power SCADA and optical fiber network shall be Optical Distribution frame (ODF) including Telecommunications. The optical fiber cables between ODF and Power SCADA shall be provided.

3) The Contractor shall liaise with and coordinate his Works with Interfacing Parties to ensure the Works fully comply with the design criteria and with the program constraints of this and Interfacing Contracts.

(11) Backup Operating Facilities

1) Backup Operating Facilities shall be equipped only for open/close operation of all circuit breakers and only for monitoring of all circuit breakers' statuses, when main operating facilities in OCC are failed.

2) Backup Operating Facilities shall be used as training facilities for power supply and distribution system operation with sequence simulator by off-line system.

(12) Power Supplies

1) The Power SCADA equipment shall be designed to accommodate an electrical supply derived from either a nominal 400V AC 3-phase 60Hz,

2) The power supply for Power SCADA shall be supplied through UPS. UPS shall be capable of providing the specified performance continuously for a minimum period of four hours.

3) Power supply to RTUs shall be supplied from 110V battery system of control source for TSS.

(13) Substation Automation

1) The automation of substations shall be compliant with IEC61850.

2) Shall avoid proprietary protocols and being able to integrate equipment of different manufacturers shall be required.

3) The technologies which can reduce the cost in wiring and engineering time shall adopted.

4) Shall be compliant with IEC61850 which defines a fast and reliable point to multi point message exchange procedure that shall be used to replace copper wiring in the data exchange between the cabinets in a substation.

4.4.6 Photo Voltaic Power Generation Systems

(1) General

The Contractor shall design, supply, install and commission a Photovoltaic Power

Generation System as specified herein,

1) The Contractor shall be responsible for implementing a Photovoltaic Power Generation System which achieves as a minimum the specified levels of performance.

2) The scope of works for the Photovoltaic Power Generation System shall be as follows:

i) Crystalline Silicon PV Modules

ii) Workstation (including software)

iii) Color A3 printer

iv) Thermometer

v) Pyranometer

vi) PV module mounting system including all structural supports, hangers, fixtures, fixings and accessories.

vii) Power Conditioners

viii) All necessary interconnection wiring, interface units, hardware and software to provide a complete and fully operational system.

ix) All necessary earthing system for solar power generation system.

x) Cables/wires, conduit, wire ways, trunking and all accessories

xi) Metering systems

xii) Web-based remote monitoring system

xiii) All weather type display monitor installed in the station concourse for public awareness.

xiv) Other materials and parts which are not specifically mentioned herein but are necessary for the proper assembly, installation, and safe operation of the equipment shall be furnished including special tools and all required spare parts and consumables during the warranty period.

3) Construction/Complete Installation

4) Testing and Commissioning

5) Performance Warranty

6) Data Logging System

i) Performance monitoring of Solar PV System

ii) Periodic electrical testing (power quality assessment, thermo-graphic inspection, solar panel power output measurements, etc.)

iii) Provide monthly energy generation and revenue data.

iv) Cleaning of Solar Panels, semi-annual schedule

7) The following works are not included in the Scope of this Division:
   ii) Furniture including desks and chairs in the PV Control Room

8) Photovoltaic Power Generation System shall be interfaced with Power SCADA

(2) System Design and Performance Requirments

1) General

i. The PV modules shall be installed with aluminum fittings for mounting installation on the rooftop of stations (Paco, Nichols, FTI, EDSA), Light Repair shop and OCC building.

ii. The Display Monitor for publicity shall be indoor type wall-mounted structure and shall be installed in the concourse, however the installation location shall be determined during the detail stage in cooperate with civil works.

iii. The proposed installation location shall be coordinated with the station design.

iv. The Power Conditioners and Remote Monitoring System shall be installed in the PV System Control System located at the station building ground floor.

v. The exact number, the location and the method of installation of solar panels shall be determined during the detail design stage in cooperate with civil works.

vi. Proposed approximate peak solar power output shall be as following:

- Paco station : 100kWp
- Nichols station : 100kWp
- FTI station : 39kWp
- EDSA : 100kWp
- Light Repair Shop in Depot : 310kWp
- OCC building in Depot : 100kWp

(3) Particular Requirements

1) PV Module

i. Cell Type: Crystalline Silicon

ii. Compliance: IEC 61215/61730

iii. Nominal Max. Power (Pmax): not less than 300W (under Standard Test Conditions of 1 kW/m^2 at 25 deg C, Aie Mass 1.5)

iv. Operating temperature : - 40 deg C ~ +85 deg C

v. Conversion efficiency : not less than 18%

vi. Front Cover Material : Tempered glass (not less than 3mm thick)

vii. Frame Material: Anodized aluminium

viii. Power output warranty: not less than 25 years, linear

ix. Warranty on Materials and Workmanship: not less than 12 years

2) Power Conditioner

i. Compliance: IEC61727

ii. Panel Type: Outdoor IP65 (per IEC 60529), closure type, wall mount or free-standing

iii. Operating Temperature: －25℃ ~ +60 ℃

iv. Rated Input Voltage: not less than DC 360V

v. Rated Output Voltage: not less than AC 400V

vi. Output frequency: 60 Hz

vii. Output Waveform: Pure Sine Wave

viii. Phase: 3-phase

ix. Range of Operating Input Voltage: according to manufacturer's specification

x. Power Factor: 0.90 minimum

xi. Total Harmonic Distortion of Output Current: not more than 5% in total, not more than 3% each (at rated output)

xii. Power Conversion Efficiency: not less than 97%

xiii. PV Power Control: Maximum power point tracking (MPPT)

xiv. Protection Function: Over voltage relay, under voltage relay, over frequency relay, under frequency relay, over voltage ground relay, Island operation detecting function.

3) PV Combiner

i. Panel Type : IP 65 for outdoor, IP 21 for indoor, floor-mounted

ii. Maximum voltage : 1000V DC

iii. SPD protection: Type2 pluggable

4) Circuit Breaker

i. Compliance: Per IEC 60947 Part I-III; IS 60947 Part I-III; EN 50521

ii. Main Breaker ampacity rating for AC Combiner

5) Cables

i. DC Power Cables:
- Sizing by Contractor, to comply with the Philippine Electrical Code (PEC) and other applicable regulatory requirements
- Per EN 50618

- Rating: 1500 V
- Temperature Range: -40 deg C ~ +120 ℃

ii. AC Power Cables
- Sizing by Contractor, to comply with the Philippine Electrical Code (PEC) and other applicable regulatory requirements
- Per IEC 60227
- Rating @ 90 deg C: 600 Volts

6) Display Monitor for publicity

i. Ingress Protection: IP20 (indoor)
ii. Display Type: LED 4K 50 inch with hanging bracket
iii. Digit Height: not less than 100mm, reading distance up to 40m
iv. Representable values shall be following but not limited to:
   - Today's total AC output power (kWh)
   - Total AC output energy since installation (kWh)
   - Current generated energy (kW)
   - CO_2 reduction value since installation (kg-CO2)
   - Solar radiation intensity (kW/ m^2)
   - Ambient Temperature (deg ℃)
   - Real pictures of various components of PV system installed
   - Other various images for the passengers for public awareness.

7) Thermometer

i. The thermometer shall be used for measuring temperature of panel installation place for monitoring.
ii. Sensor Type: Pt100
iii. Measuring Range (deg ℃): －30~60
iv. Case Material: white thermal resistant, UV-proof plastic

8) Pyranometer
i. The pyranometer shall be used for measuring solar radiation for monitoring.
ii. Compliance Standard: ISO9060 Secondary Standard
iii. Sensivity: Approx. 7mV/kW・m2
iv. Measurement Range: 0~2000w/m2
v. IP: 67
vi. Response Time (95%):5sec

(4) Testing and Commissioning

1) General

i. Comply with the requirements of the Philippine Electrical Code (PEC).

ii. The Contractor shall carry out complete operating and performance tests of the System and all equipment therein to demonstrate that the specified levels of performance shall be achieved.

2) Quality control of components in relation to the standards which define them

i. The Contractor shall supply certificates of conformity issued by the manufacturer of the component, certifying that the product supplied complies with international safety and quality standards.

ii. The components shall be properly marked to ensure that they can be identified and used on the worksite with no possibility of confusion.

3) Complete Operating and Performance Tests on the Equipment

i. After complete installation of the system, the operating and performance tests shall take place in the operational environment of the project.

ii. The content of the tests shall be as set out in detail below:

- Systematic operation tests of all system components.
- Integration tests, with simulation of all other Systems and sub-systems to confirm integrity of all interfaces.
- Comprehensive tests to ensure interfaced equipment are properly working, correct data exchange and readings. Calibration of tests shall be performed to verify accurate readings.
- All other tests required by the Engineer to prove compliance with the Specification.

iii. A complete log of the settings and readings of all interface equipment, controls, gauges and instruments shall be maintained throughout the testing period.

iv. The Contractor shall provide such instruments or equipment necessary and perform measurements for Performance Tests.

v. All inspection and test result shall be submitted to the Engineer.

4.4.7 Cables

(1) General

1) All cables shall be sized to carry the continuous current required by the specification and shall be based on the Contractor's calculations. The cables shall be able to

withstand the short circuit currents inherent in the Contractor's design.

2) The ratings applied to any cable shall be determined by the most onerous installation condition in any cable route.

3) All cables and cable support facilities to be installed in the TSS shall be low smoke non-halogen compound (LSZH) type and fire retardant.

(2) High and Medium Voltage Cables

The ratings of cables used on the 115kV,34.5kV and 6.6 kV power supply system shall be determined by the calculation in accordance with IEC60287 or equivalent equal for a maximum operating conductor temperature of 90^0 C.

(3) Cables for 115kV and 34.5kV system

1) Cables shall comply with relevant standards and regulations.

2) Cables for 115kV and 34,5kV distribution shall have cross-linked polyethylene (XLPE) insulation or equivalent, single cores and stranded copper or aluminum conductor in trefoil formation sized to suit the power supply system design and to satisfy short circuit current requirements.

3) The Contractor shall coordinate with the MERALCO with regard to cable routing and conduits for cables for 115kV and 34.5kV feeders between the MERALCO's TSS and the TSS of project.

(4) Cables for 6.6kV between equipment

1) Cables shall comply with IEC 60502 or equivalent equal.

2) Cables for 6.6kV between equipment shall be provided with three cores and stranded copper conductor in trefoil formation sized to suit the power supply design and to satisfy short circuit current requirements.

3) In the TSS, Fire Resistant cables which comply with IEC60331, 60332-1 or equivalent shall be applied to cables for 6.6kV between equipment.

4) The cables shall be of low smoke non-halogen compound (LSZH) type and fire retardant.

(5) Cables for Low Voltage distribution

Cables shall have cross-linked polyethylene (XLPE) insulation or equivalent, single cores and stranded copper conductor in quatrefoil formation sized to suit the power supply system design and to satisfy short circuit current requirements.

(6) Optical Fiber cable for interlinked tripping device

1) Optical Fiber cable shall be installed for interconnection between the interlinked tripping devices located in between each TSS.

2) Optical Fiber cable shall have sufficient capacity and capability for telecommunication

work among each TSS, SP but not limited to.

3) Optical Fiber cable for interlinked tripping device shall be installed into the wayside cable troughs by telecommunication work.

(7) Cable Route and Cable Racks

1) In all substations, all the cables shall be installed in the cable pit, cable trough, cable rack and equivalent.

2) Supporters shall be installed in the cable pit, cable trough, cable rack and equivalent to keep adequate distance.

3) The Contractor shall design the appropriate cable route between equipment and provide racks for cabling in the TSS. The Contractor shall coordinate with Interfacing Contractors with regard to the openings for cable entrance on the building walls and floors.

4) All openings for cable entrance on the building walls and floors shall be stopped with non-inflammable materials by the Contractor after all cables have been installed, to prevent fire extension.

(8) Drawings and List for Review

1) The Contractor shall provide the following lists, as a minimum, to the Engineer for review:

The cable list shall include but shall not be limited to the following information for each individual cable:

a. Cable identification number
b. Type of cable
c. Rated voltage
d. Number of cores
e. Cable size
f. Overall diameter
g. Cable termination at each end
h. Connection point at each end with equipment identification and terminal numbers
i. Cable routing

2) The Contractor's drawing submittals shall include but shall not be limited to the following:

a. Cross section drawings for cabling including following information:

-Mounting position of cables, brackets and troughs;

- Cable route and cabling method between mainline and substation/electrical supply rooms.

b. Diagrammatic plans for cable route in tunnels, viaducts and Depot and so forth.

All drawings shall include legend for all symbols used in the drawing.

4.5 Installation Requirements

4.5.1 General Requirements

The Contractor shall comply with all Enactments in executing the Works, at least including all statutory provisions on occupational health and safety.

The Contractor shall co-ordinate with the Interfacing Parties of this Contract and Other Contractors in the execution of the works.

The Contractor shall also co-operate with all Relevant Authorities in the execution of the Works.

The installation of all equipment shall be undertaken at all times by suitably trained and competent employees of the Contractor, to the satisfaction of the Engineer.

Only appropriate tools, plant, equipment and vehicles shall be used.

Installation of all equipment shall be in accordance with the coordinated installation plan (CID) described in the ERG.

Installation of all equipment shall conform to the best industry practices.

Precautions shall be undertaken to ensure the safety of personnel and equipment for all installation works.

The Contractor shall, prior to starting any installation work, identify any possible hazards, and implement measures of eliminating and/or controlling such potential hazards, in line with safe working practices.

Further details on the Site safety management are described in the ERG.

The Contractor shall coordinate with the relating Contracts regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the civil infrastructure.

The Contractor shall coordinate its requirements for grounding and bonding system with Interfacing Contractors (CP05 and CP S-01 to CP S-07), such as wiring routes and locations of ground rods installation.

The Contractor shall ensure that all areas of work are sufficiently illuminated for the Works to be undertaken and that a safe system of work is employed for all activities.

The Contractor shall operate a robust system for the control of persons entering or working upon the Site. The system shall include as a minimum:

(a) Register of all employees;

(b) Personal identification, with photograph;

(c) Levels of competency;

(d) Date of expiry;

(e) Date of issue;

(f) Signature; and

(g) Register of all visitors.

The Contractor shall co-operate, at all times, with the Engineer and Other Contractors to ensure that the Site is protected from unauthorized admission, either willfully or otherwise.

The Contractor shall make due provision for the safe access and egress to the Site of Works for its staff and Sub-Contractors. This access shall be maintained such that it is free of all hazards and is in a safe condition throughout the duration of the Works.

4.5.2 Specific Requirements

The installation work pertaining to this Contract shall at least include the following:

1. Finalization of the Construction and Installation Program;
2. Survey on the Site and review the technical requirements shown in this Specification and the Employer's Drawings;
3. Production of the calculation sheets and installation drawings for the Site installation;
4. Installation in accordance with the finalized installation drawings;
5. Co-ordination with Other Contractors;
6. Submission of the installation reports and records;
7. Production of as built drawings, documents, calculation sheets, and records.

4.5.3 Construction and Installation Plan

The Contractor shall undertake installation work in stages as shown in the detailed installation program. Installation, testing and commissioning of later stages shall not impact revenue operation of earlier stages.

As a minimum, the detailed Construction and Installation Plan shall at least include all the activities described in Chapter 3.1 of this PS, installation details and methods of all activities equipment and tools to be used for installation, safety issues, supervision, temporary land occupation needed and the vehicles to be used for installation.

4.5.4 Temporary Works

The design of the Temporary Works shall be submitted to the Engineer for review.

All Temporary Works shall be removed on completion of the Section, or as directed by the Engineer. All Temporary Works shall be clearly distinguishable from the Permanent Works.

4.5.5 Quality Management

(1) The Contractor shall adopt an appropriate quality management system throughout the entire the Site installation period to ensure that the System performance requirements as specified in Chapter 3 of this PS are achieved.

(2) The Contractor shall provide sufficient number of suitably experienced supervisors and skilled workers to ensure that the progress and quality of the work, both on the Site and in the Contractor's workshops, are maintained to the satisfaction of the Engineer.

(3) Supervisors shall have a minimum of five years' previous experience in a supervisory capacity on similar projects and all the skilled workers including linesmen electrician's fitters and craftsmen, shall have a minimum of two years' previous experience in installation of similar systems.

(4) The Contractor's supervision system shall be responsible not only for the supervision of the Concerned system installation but also for the supervision of the installation of the

primary fixing system (civil inserts), the ground mats and systems, etc. that are to be installed by the Contractors. The supervisors shall work on a full-time basis during the entire installation process.

(5) The Contractor shall maintain a set of drawings at each project Site which accurately reflect the current status of field changes. The Contractor shall Approval from the Engineer for any such changes. The Contractor shall prepare final drawings showing the as built configuration. These drawings shall be developed in a logical format to facilitate routine system maintenance and troubleshooting. All drawings and details shall be endorsed by the Contractor.

(6) The Engineer reserves the right to undertake, at any time, checks on the proficiency of the Contractors staff, licensing and all associated documentation. Should any of the Contractors staff be found incompetent or unlicensed he shall be removed from the site until their competency has been established.

4.5.6 Installation of Cables

Laying of Cables

1. Cable risers shall be protected with cable trays/ steel conduit pipes.
2. Bending radius of low voltage cables shall be not less than 8 times for single core type and 6 times for multi core type the outside diameter of the cable respectively.
3. Cable trays shall be fixed to the wall or the ceilings, fixing intervals shall be less than 1.5 m.
4. Cables laying with cable trays on the vertical direction shall be bound tightly at the 1.5 m intervals.
5. No tension is permitted for splicing of the cables.
6. Openings for cables drawn into cubicles shall be protected properly so that no pest or moisture can enter.
7. Occupancy of cables in the trough shall be not more than 60 %
8. The Contractor shall coordinate with Interfacing Contractors (CP05 and CP S-01 to CP S-07) regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the civil infrastructure.

4.6 Interfacing Requirements

4.6.1 General

The Contractor shall liaise and coordinate with Interfacing Parties to ensure the effective and compatible coordination of all aspects of design, installation, testing and commissioning of work.

4.6.2 Contractor's Responsibility

(1) The Contractor shall ensure that all the interface items as listed in Clause 4.6.3 of this specification shall be included in the interface management plan.

(2) Other items not mentioned in the interface items but are relevant to the design, installation, testing and commissioning of permanent works, shall also be included in the interface management plan.

4.6.3 Interface Control Sheet

The Contractor shall review the design and coordinate with relevant Contractors and the electric utility company as detailed below:

No	Interface Description	Design Requirement	Design Size & location	Supply	Fix	Remarks
	<MERALCO>					
1	Incomming 115kV line	CP NS-01	MERALCO	MERALCO	MERALCO	
2	Metering device interface	MERALCO	CP NS-01	CP NS-01	CP NS-01	
3	Specification of receiving equipment	CP NS-01	CP NS-01	CP NS-01	CP NS-01	
	< Telecommunications equipment>					
1	SCADA I/F	CP NS-01	CP NS-01 (TLC)	CP NS-01 (TLC)	CP NS-01 (TLC)	
2	CATV I/F	CP NS-01	CP NS-01 (TLC)	CP NS-01 (TLC)	CP NS-01 (TLC)	
3	Telephone I/F	CP NS-01	CP NS-01 (TLC)	CP NS-01 (TLC)	CP NS-01 (TLC)	
	<OCS >					
1	Leading out of feeder line and return circuit	CP NS-01 (OCS)	CP NS-01 (PSS,OCS)	CP NS-01 (OCS)	CP NS-01 (OCS)	
	<Distrubution >					
1	Leading out of distribution line	CP NS-01 (PDS)	CP NS-01 (PSS,PDS)	CP NS-01 (PDS)	CP NS-01 (PDS)	

No	Interface Description	Design Requirement	Design Size & location	Supply	Fix	Remarks
	<Distrubution station equipment>					
1	Distribution transformer capacity	CP NS-01	CP NS-01 (PDS)	CP NS-01 (PDS)	CP NS-01	
	<Rolling Stock, Train operation,OCS >					
1	Rectifier Capacity	CP NS-01	CP NS-01 (OCS) CP NS-02 CP NS-03	CP NS-01 (OCS) CP NS-02 CP NS-03	CP NS-01	
	<Rolling Stock, Train operation,OCS >					
1	Voltage Drop in Traction system	CP NS-01	CP NS-01 (OCS) CP NS-02 CP NS-03	CP NS-01 (OCS) CP NS-02 CP NS-03	CP NS-01	

4.7 Testing, Commissioning and Verification

4.7.1 General

The Contractor shall develop a full Test Plan which shall be submitted for approval by the Engineer. The tests mentioned herein are indicative and shall be the minimum requirement. The Contractor shall clearly categorize the types of tests required in this Part with the followings in the Test Plan:

a) Pre-commissioning tests,

b) Commissioning tests, and

c) Trial operation.

(1) Test Certificates

All principal test records and test certificates duly endorsed by the Contractor's professional engineer are to be submitted for the approval by the Engineer. These test records and certificates shall be supplied for all tests, whether or not the Engineer has witnessed them. The information given on such test certificates shall be sufficient to identify the materials or equipment to which the certificate refers.

(2) Cost of Tests

1) The Contractor must bear the cost of all necessary tests.

2) As for the cost of the test which is carried out outside Philippines, the Contractor must bear the expenses relating the witnessing and the verification by the Employer and the Engineer.

3) Test Plan and Procedures

All the test plans and procedures with the exact time and date shall be submitted for the approval of the Engineer at least 30 days prior to any test's conduction.

Not tests can be undertaken unless the relevant plans have been given a Notice of No Objection by the Engineer.

4.7.2 Factory Acceptance Tests (FAT)

FAT shall comprise Type Tests, Sample Tests, Routine Tests, Life, Endurance and Destruction Tests, and any additional tests requested by the Engineer.

- The testing shall be conducted such as to simulate the working conditions as closely as possible.
- Upon the request of the Engineer, destruction tests shall be carried on components and assemblies to verify the design loading.
- All the tests shall be conducted both on the assembly and on the members/components of each product in accordance with design specifications and applicable Standards.

4.7.3 Contractors Responsibilities for On-site Testing

The Contractor shall implement all tests in accordance with the Test Plan. During the course accuracy as may be required. On completion of erection and prior to commissioning, all power cables shall be tested to the acceptance of the Engineer in accordance with an agreed Inspection and test plan to demonstrate that it is entirely suitable for commercial operation.

The Contractor shall be responsible for providing temporary electricity supply, all instruments, gauges, test equipment, tools, accessories, personnel, services and necessary facilities required for the execution of all tests and inspection. Wherever necessary, the Contractor shall provide two or more sets of testing equipment, tools, and others to expedite testing. All test equipment shall be accompanied with the appropriate calibration certificate by a testing authority of the equipment.

Test equipment, tools, and others necessary for subsequent preventive and corrective maintenance are to be provided to the Engineer as specified herein and shall be available to assist the tests. The use of these test equipment, tools and others shall be subject to approval by the Engineer.

The Contractor shall be responsible for surveillance and security of the E/R and Distribution downstream cables or other electrical equipment is energized before it has been tested and before the relevant Contractors or Sub-Contractors facilities are ready and secured. The Contractor's responsibility for surveillance and security of the system shall remain in force for each part of the system until such a time that the Engineer issues the appropriate certificate and the Employer takes over the System.

4.7.4 Installation Tests

(1) Installation Tests

- An inspection and visual verification of ratings and connections with equipment shall be carried out prior to installation tests.
- Un-energized equipment shall be inspected for its visual and tested for operation after installation of equipment. Inspections and tests shall include the following:
- Cleanliness,
- Workmanship,
- Confirmation of items conforming to ratings specified,
- Water and dust proofing,
- Leveling, mounting and positioning,
- Joints and connections tightness,
- Cables – dressing, bending radii, jointing and finish at terminals,
- Clearances and dimensions in conformity with drawings,
- Grounding and bonding.
- Functioning of circuit breakers, load break switches, isolating switches and their interlocks.
- Protection devices, and
- Phase sequence verification.
- Ground resistance shall be measured individually, and for the subsystem and system.
- Insulation Resistance

The insulation resistance of all 6.6kV circuits shall be tested with an insulation tester of 2.5kV rating. All LV circuits comprising ac and AC and DC auxiliary circuits shall be tested with a 500 V insulation tester.

- Tests on Current Transformers shall include the following:
  - Insulation resistance.
  - Winding resistance.
  - Polarity of Connections up to equipment terminals, and
  - Ratio and magnetization curve verification.

- Tests on Voltage Transformers shall include the following:
  - Voltage ratio.
  - Insulation resistance, and
  - Polarity of connections up to the equipment terminals
- Secondary and primary injection tests shall include the following:
  - Tests shall be carried out at a minimum of three settings if multiple settings are available. Test results of operation boundaries and operating times shall be recorded.
  - Batteries and Chargers
  - Discharge tests and charging tests shall be carried out to verify the capacity of the batteries and all functions available on the charger. Continuous measurements of battery voltages shall be made together with periodic readings of the electrolyte specific gravities and temperatures. No addition of electrolyte is permitted during discharge tests.
  - The operation of the boost charge facility and the effect of the voltage dropping diodes shall also be demonstrated.
- Control, Indication and Alarm Functions shall include the following:
  - Insulation resistance and continuity of all cores of cables shall be identified and tested, and the correct functioning of all control, indication and alarm devices shall be verified.
  - Switchgear
  - All switchgear, including circuit breakers, load break switches and grounding switches, shall be operated to prove that the operating gear, tripping devices, protective gear and mechanical interlocking are satisfactory.
  - Metering Instruments and Transducers
  - All current and voltage transformers, metering instruments and transducers shall be calibrated by voltage and current injection to prove their accuracy classes.

4.7.5 Receiving Acceptance Tests

The following tests shall form part of on-site and System Acceptance Tests as part testing of the equipment and system:

(1) Functional Tests and Interlock Tests shall include the followings:

All control and protection functions and electrical/mechanical interlocks shall be tested.

(2) Primary Injection Tests shall include the followings:

The Contractor shall carry out primary injection tests on each protective system, to prove the auxiliary circuit connections, the relay fault setting values, the correct metering indications and the stability limits.

(3) AC/DC Pressure Tests shall include the following:

The insulation resistance of all circuits shall be measured before and after the dc pressure test using a 5kV insulation tester. The minimum phase-to-phase and phase-to-ground insulation resistance shall be 100 mega ohms.

Pressure tests shall be carried out on completed cable lengths of high voltage cables in accordance with IEC 60502 or equivalent equal.

(4) Energization

- The Contractor shall prepare operation safety rules and procedures for the approval by the Engineer before Energization.
- The Contractor shall check all to ensure safe Energization.
- All power equipment shall be subject to inspection by inspectors from the Electrical
- Inspectorate of the Employer before Energization.
- The Contractor shall be responsible for the operation of traction and auxiliary power equipment. Upon request by the Engineer, the Contractor shall be responsible for the disconnection and the subsequent reconnections of the power equipment.

4.7.6 Integrated Testing and Commissioning

(1) Integrated Testing and Commissioning refers to those tests undertaken in order to demonstrate that the various components of the systems operate satisfactorily between one another, and meet all specified requirements for design, operability, safety, and integration with other Works and systems. These tests shall be entirely within the requirements of one or more of the project contracts or they shall involve a multiplicity of contract procedure. The final Integrated Testing and Commissioning shall be conducted after the SCADA system and OCC have become operational.

(2) Systems that can be tested without depending on the running of trains, such as SCADA system, the emergency trip system shall have their integration tests scheduled to commence as early as possible. It is preferable that any interface problems associated with these "no train" system tests be identified and resolved prior to the test running.

(3) The following is an indicative listing of those Integrated Testing and Commissioning functions that necessarily to be integrated with others to demonstrate that the equipment and controls of the Power Distribution System meet the Contract Specifications and demonstrate a safe-to-operate condition. This listing is not exhaustive and shall be updated by the appropriate Contractor, to demonstrate functionality, completeness and safety of the installed works and shall be submitted to the Engineer for his approval.

- E/R, Distribution board space and Generator failure mode test.
- Remote control and monitoring test through SCADA system at OCC
- Emergency trip system tests.
- Power system functional tests.
- EMI/EMC tests.
- Touch/step potential tests.

The Contractor shall provide attendance to the Engineer during integrated test in relation to the insulation of train station platforms provided by the other Contractors.

- On-load Tests and Directional Tests

Once sufficient load current is established, voltages and currents into protection and metering equipment shall be verified to ensure correct operation of protection relays and accuracy of meter readings at local and remote locations.

4.7.7 Test Run / Trial Operation

The Contractor shall provide special and general attendance during the Test Run or Trial Operation period such that the persons who conduct the On-Site Testing and Commissioning are available on the Site to solve any problem arising from the Test Run or Trial Operation.

4.7.8 Test Verification

(1) The Contractor shall carry out the pre-commissioning and commissioning tests to verify that the performance of the System meets the Employer's Requirements before the substantial completion of the Works.

(2) One of the Performance Tests which shall be conducted by the Contractor in conjunction with relevant Contractors, Sub-Contractors and other Parties is the measurement of EMI levels at locations that have received a Statement of approval by the Engineer. Such measurements shall be conducted prior to Energization of the Traction Power System, and then during Service Trials and commercial operation of the train services to ensure that the EMI levels meet the Employer's Requirements and are in accordance with the Contractor's designs that have been given a Notice of No Objection by the Engineer.

(3) Should the performance of the System deviate from the Contractor's designs given Notice of No Objection by the Engineer, the Contractor shall rectify the deviation in the shortest possible time.

(4) The Contractor shall submit a certified report of the results of these Tests to the Engineer within 14 days from the date when the Engineer confirmed that the Contractor has passed each of the Tests.

4.8 Measuring and Special Tools

4.8.1 General Requirements of Measuring and Special Tools

General Requirements for measuring and special tools are described in the General Requirements.

4.9 Training Requirements

4.9.1 General

The Contractor shall supply the appropriate training for the operation and maintenance staff of the Employer according to the General Requirements. The Contractor shall submit the training plan to the Engineer.

4.9.2 Scope of Training

The Contractor shall provide the theoretical and practical training for software and hardware used for the Power Distribution system to the Employer's staff and instructors.

4.9.3 General Requirements

The training shall be provided at the places where can achieve the great effect to the trainee. The training locations shall be at places with factory, domestic, overseas and at other required places. The optimum locations shall be proposed for the training.

4.9.4 Training Plan

The Contractor shall prepare and submit the training plan to the Engineer for the review. The training plans shall include the purpose, contents, method, location, time and period.

4.9.5 Training Courses

(1) The Contractor shall prepare a detailed training course related to the operation of the power supply and distribution system.

(2) The training for the power supply and distribution systems shall cover normal and emergency modes of operation.

(3) The training for emergency situation shall include the following:

- Investigation method of failure point, effective and efficient handling of hardware and software at the emergency situation for train operation and the Distribution system (main line);
- Recovering method from the emergency situation caused by system error or other cases;
- Judgment procedure of transition to backup system and recovery;
- Data recording, data recovering and data store;
- Preparation for unexpected situation; and
- Training of all the matters on the train operation.

(4) The Contractor shall supply the training of system design and configuration to the staff of the Employer. This training shall include the following:

- The outline of the systems,
- The system configuration and data configuration, and
- The principle of train operation.

(5) The Contractor shall supply the following trainings to the system maintenance staff of the Employer:

- The principle of train operation,
- Prevention and repair of maintenance methods and duties,
- Repair by unit change,
- Direction for test devise and investigation method, and
- The software maintenance including data configuration, data preparation, data modification and debug of system software.

4.9.6 Maintenance Courses

a) The maintenance courses shall be developed to acquire all necessary knowledge and skills for preventive maintenance and corrective maintenance for each system.

The maintenance courses shall be developed to acquire all necessary knowledge and skills for adjustment and configuration of system parameter for new installing system and parts.

Intended training maintenance staff shall include at least the following:

- Distribution system maintenance staff,
- Trainer and instructor of the Employer,
- Manager, and
- Any other defined person by the Employer.

b) The contents for the maintenance training shall include the following:

- Train operation principle;
- Works and method of preventive maintenance and corrective maintenance;
- Failure correction of unit exchange level;
- Operation method for test equipment;
- Failure investigation and maintenance support;
- Reading of operating manual, maintenance manual, circuit diagram and wiring diagram;
- Software maintenance for data modification, data generation, database configuration and system software configuration; and
- Backup and load for data and software.

c) Training plan submitted from the Contractor shall include the following:

- Schedule of training course,
- Purpose of training,
- Curriculum of training,
- Composition of training course,
- Necessary or providing training facilities,
- Training material and manual,
- Qualification of instructor, and
- Evaluation method for the training.

4.9.7 Training Materials

(1) The Contractor shall provide all necessary devises for training, special tools, training materials, training devises and training supplemental materials.

(2) Training supplemental materials and training devices shall be durable construction and become the Employer's property.

(3) The Contractor shall provide the computer-based training system.

(4) The Contractor shall prepare and submit training manual 60 days before start of the training to the Engineer for review.

(5) Modification and change of training manual throughout the contract period shall be responsible of the Contractor.

Training manual shall become the Employer's property.

4.9.8 Qualification and Certification

(1) The Contractor shall record the attendance of trainee. The Contractor shall submit details of evaluation criteria and compression authorization before start of the training course to the Engineer for review.

(2) The Contractor shall prepare an evaluation report regarding the degree of understanding and proficiency of each curriculum, and knowledge level for each trainee. The Contractor shall also submit this evaluation report to the Engineer.

4.10 Maintenance Requirements

The Contractor shall prepare and submit operation and maintenance plan to the Engineer for review. The maintenance plan shall be included the following:

- Working description of first line maintenance, second line maintenance, third line maintenance;
- The cycle of each maintenance works;
- Annual periodic maintenance plan;
- Equipment and subsystem related the tasks;
- Operation methods of the tasks;
- Devices and test equipment for implementation the tasks;
- Flowcharts or illustrations for failure investigation;
- Recovery method;
- Prevention method; and
- Estimation period and staff volume.
- Software support manuals

End of Section

5 POWER DISTRIBUTION SYSTEM

I. The Malolos-Clark Railway Project (MCRP)

5.1 Scope of Works

5.1.1 General

These requirements cover for the design, manufacturing, factory test, packing, delivery, installation, training, testing, commissioning, and interfacing works for completing the power distribution system on the MCRP.

The power distribution system are facilities for supplying electricity to railway facilities that require power, such as the stations, the depot, signaling system and telecommunications facilities, etc.

The power used by the stations, the depot, signaling system and telecommunications, etc. shall be supplied from the substation at high voltage (6.6 kV) and distributed via cables to each facility.

For the MCRP, it is necessary to supply distribution power to the line from the five power companies (MERALCO, PELCO III, SFELAPCO, AEC and CEDC) according to the Philippine franchise law. The Contractor shall apply to the power companies for all temporary and permanent supplies to be utilized on this project.

The purpose of this design is to construct a reliable power distribution system.

(1) The work shall include the following:

Main line

1) 6.6kV distribution cable network in the main line to stations.

2) Low voltage cabling to ancillary buildings and battery posts, etc.;

3) Low voltage cabling for maintenance outlet and signaling equipment on the on the main line;

4) Low voltage cabling for outdoor lighting;

5) Outdoor lighting (including control panels) on the viaduct;

Stations and Depot

1) 6.6kV distribution cable network in the Mabalacat Depot;

2) Railway Electrical Rooms (hereinafter referred to as RER) and High Voltage Receiving Room (hereinafter referred to as HRR) in the stations and High voltage Electrical Room (hereinafter referred to as HER) in the Mabalacat Depot;

3) Distribution boards in the Mabalacat Depot;

4) Emergency Generators at CIA and in the OCC building and Training Center in Mabalacat Depot.;

5) DC battery chargers and the battery cubicles for HRR in the station and HER in the

OCC building and Training Center;

6) Low voltage cabling for outdoor lighting, outdoor mechanical equipment and buildings which require electric power in the Mabalacat Depot;
7) Outdoor lighting (including control panels and concrete foundations) in the Mabalacat Depot;
8) Coordination with the interfacing Contractors (CP N-01 to CP N-05, CP04), regarding civil, structure, building service and architecture works including modifications required for installation of the requirement and restoring to final finishing;
9) Measuring and special Tools
10) Spare parts and consumables;
11) Documentation; and
12) Services

(2) The Services to be performed by the Contractor shall include the following:

1) Design, supply, system quality management, installation, testing including integrated testing and commissioning of the complete electrical distribution system;
2) Presentations, reviews and audit support as described in the General Requirements;
3) Interface management;
4) Decommissioning, removal and/or disposal of temporary works; and
5) Defects liability of the Permanent Works after commissioning as stipulated in the Contract.

All Employer's Drawings are conceptual design drawings and details shown on the drawings are for information only. The accuracy of preliminary details shown on the drawings cannot be guaranteed. The Contractor shall prepare detailed design drawings to achieve requirements of the ERT.

Where cable containment is not provided by others then cable containment shall be supplied by the Contractor which shall have 25% spare capacity for expansion works. All cable containment material, fixing methods, and routing shall be given Notice of No Objection by the Engineer

5.1.2 Scope of Supply

The Contractor shall supply all equipment necessary in order to accomplish the function required.

(1) Scope of works for 6.6kV Distribution systems

1) The Contractor shall provide all cables for 6.6kV power distribution systems.
2) The Contractor shall consider the effect of the induction voltage of the external transmission line (MERALCO, PELCO III, SFELAPCO, AEC and CEDC) on the distribution line of this Project and shall coordinate with the relevant Contractors

regarding the provision of study and measures.

3) In the embankment sections the contractor shall install cable containment for the 6.6kV cables and other cables.

4) In the Mabalacat Depot, 6.6kV cables shall be installed in buried ducts, concrete troughs, and manholes. The Contractor shall coordinate with the relevant Contractors regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the Civil infrastructure.

5) Riser cables from the substations and other buildings on the pillars in elevated sections shall be protected by galvanized steel pipes and/or covered cable trays.

6) In the station area, 6.6kV cables shall be installed on cable trays on the wall and/or on the ceiling.

(2) Scope of works for HRR and RER in the stations.

The Contractor shall provide all the equipment which enables work to be performed in accordance with the requirements of the contract. This includes the following:

1) 6.6kV Switchgear.

2) 6.6kV transformers.

3) Low voltage cables between transformers and switchgear.

4) Main switchgear.

5) Battery chargers, DC battery cubicles, earthing terminals, 6.6kV cables, low voltage cables and connection works.

6) Main earthing system with earthing rods and protecting conduits for stations shall be provided and installed by the Civil Contractor.

7) Earthing cables between main earthing system and earthing terminals.

(3) Scope of works for HER in the Mabalacat Depot

The Contractor shall provide all the equipment which enables work to be performed in accordance with the requirements of the contract. This includes the following

1) 6.6kV switchgear.

2) 6.6kV transformers.

3) Low voltage cables between transformers and switchgear.

4) Main LV Switchgear.

5) Battery chargers, DC battery cubicles, earthing terminals, 6.6kV cables, low voltage cables and connection works.

6) Main earthing system with earthing rods, and protecting conduits shall be provided and installed by the Civil Contractor.

7) Earthing cables between main earthing system and earthing terminal in HER.

(4) Scope of works for Emergency Generator Room (hereinafter referred to as EGR)

1) The Contractor shall provide all the equipment which enables work to be performed in accordance with the requirements of the contract.
2) Low voltage generator works.
3) Control equipment, low voltage cables, control cables and attachments work.

(5) Scope of works for DB in the Mabalacat Depot

1) The Contractor shall provide all the equipment which enables work to be performed in accordance with the terms of this Contract.
2) 6.6kV switchgear.
3) 6.6kV transformer.
4) Main LV Switchgear.
5) Low voltage cables between transformers and low voltage switchboards.
6) Main earthing system with earthing rods, earthing wires and protecting conduits shall be provided and installed by the Civil Contractor.
7) Earthing cables between main earthing system and earthing terminals in the DB.

(6) Scope of works for low voltage distribution in the main line

1) Low voltage cables in the main line shall be installed in cable containment provided by the contractor.
2) Low voltage cables work for outdoor lighting equipment, matching device box for track circuit (Signaling System equipment) and outlet for maintenance.
3) The Contractor shall provide outdoor lighting (including control panels) for emergency stairs etc.,
4) Protection devices for cable installation.

(7) Scope of works for low voltage distribution in the Mabalacat Depot

1) Low voltage cables in the Mabalacat Depot shall be installed in buried ducts, concrete troughs, and manholes respectively.
2) Low voltage cables work for outdoor lighting equipment, outdoor mechanical equipment and all buildings which require electric power
3) The Contractor shall provide outdoor lighting (including control panels) for emergency stairs etc.,
4) Outdoor lighting fixtures shall be mounted on poles.

(8) Scope of works for outdoor lighting in the Mabalacat Depot

1) The Contractor shall provide outdoor lighting (including control panels) in the Mabalacat Depot yard for maintenance works.
2) Outdoor lighting fixtures in the Mabalacat Depot yard shall be mounted on the poles and beams of the OCS.
3) Outdoor lighting on the road in the Mabalacat Depot shall be mounted on poles.

(9) Scope of works for outlets for maintenance

1) The Contractor shall provide outlets for maintenance on the main line, the locations and quantity of which shall be proposed by the contractor and approved by the Engineer.
2) Outlets for maintenance shall be mounted on the wall in the main line.

(10) Scope of works for earthing system

1) The main earthing system shall be provided by Civil Contractors.
2) The Contractor shall provide the earthing terminals in the RER and HER.
3) Contractor shall provide earthing cables between the main earthing system and earthing terminals.

(11) Out of Scope of works

1) Building works for RER, HRR and EGR including internal lighting, outlets, air conditioners and other building services.
2) In the main line, Station electrical room equipment including cabling between the main LV Switchgear installed by the Contractor in RER, REM and the LV panels in RER, REM.
3) In the Mabalacat Depot, Low voltage electrical room equipment including cabling between the main LV Switchgear installed by the Contractor in HER and the LV panel in the low voltage electrical room.
4) The exhaust equipment in the exhaust stack shaft installed between the emergency generator room and the vent on the roof. (The Contractor shall install an exhaust pipe for the emergency generator between generator equipment and the exhaust stack shaft in the emergency generator room.)

5.1.3 Scope of Works

The Works to be performed by the Contractor shall include at least the following:

1) Design, supply, system quality management, installation, testing including integrated testing, and commissioning to complete the power distribution system;
2) Presentations, reviews and audit support as described in the Employer's Requirements;
3) Interface management with relevant Contractors;
4) Design, identification of locations for concrete foundations for supporting structures if necessary, floor cinder concrete, earthing terminals for RER, REH, HER and DB, concrete troughs along the track, buried pipe and manhole in the Mabalacat Depot and coordination and interfacing with relevant Contractors;
5) Decommissioning, removal and/or disposal of temporary works; and
6) Defects liability of Permanent Works after commissioning as stipulated in the Contract.

5.1.4 System Overview

(1) System Studies

The Contractor shall carry out and provide results including the following power related studies to the Engineer for Approval:

1) AC 6.6kV power demands study;
2) Short circuit current, voltage drop and permissible current study;
3) Protection relay setting and system protection coordination study;
4) Power supply design, including the whole system, each station, each building and DB the Mabalacat Depot;
5) Earthing study;
6) Illuminance calculation for outdoor lighting;
7) Transformer capacity study;
8) Emergency generator capacity study;
9) Cable trough study;
10) Buried pipe study; and
11) Manhole study

(2) Power Supply System General Requirements

1) Substation will receive AC 69kV power and step-down to AC 6.6kV for supplying the power to RER, HRR, and DB. 6.6kV.
2) At the RER, HER and DB, AC 6.6kV power will be supplied through loop distribution line under the following conditions;

The normal distribution direction in the main line is from the substation of the starting point and reverse distribution in the main line is from the substation of the terminal point.

In normal operation, all electrically utilization equipment of each RER shall be assigned to the normal distribution side line; and.

In case of failure of the normal distribution side line, 6.6kV distribution is changed over from the failed line to the remaining sound line.

3) The Contractor shall develop its own strategy for earthing and bonding in accordance with internationally recognized practices.

(3) System Integrity

1) The AC power distribution system shall be designed to ensure continuity of supply to the MCRP. System performance shall be maintained without load restriction under single outage conditions The AC power distribution system shall be provided with a protection system to ensure in the event that a faulty element is isolated; no other equipment is disconnected by the operation of such a protection device.

2) The power system design shall ensure that cables and equipment shall be separated and protected to ensure that;

3) A single failure of an element of the power supply system shall not affect the operation or result in failure of any other power supply system element or result in the total loss of power distribution to any part of the MCRP.

The opportunity for an incident external to the power supply system to affect the operation, or to result in failure of an element within the power supply system, or to result in a total loss of power distribution to any part of the MCRP shall be minimized.

(4) AC 6.6kV System

1) AC 6.6kV system shall be designed to ensure that voltage regulation under normal distribution and reverse distribution shall be maintained within 10% of normal voltage at any point on 6.6kV system.

2) All 6.6kV switchgear shall be designed and provided to support the ultimate capacity operation of MCRP, as well as the 6.6kV Loop Distribution System.

3) The normal distribution direction in the main line is from the substation of the starting point and reverse distribution in the main line is from the substation of the terminal point. In normal operation, all electrically utilization equipment of each RER shall be assigned to the normal distribution side line. In case of failure of the normal distribution side line, 6.6kV distribution is changed over from the failed line to the remaining sound line.

4) In the elevated section, 6.6kV cables shall be installed in cable containment provided by the Contractor.

5) In the embankment sections the contractor shall install cable containment for the 6.6kV cables and other cables.

6) In the Mabalacat Depot, 6.6kV cables shall be installed in buried pipes, concrete troughs and handholes. The Contractor shall coordinate with the relevant Contractors regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the Civil infrastructure.

7) AC 6.6kV/400-230V distribution transformer for loop distribution shall be provided in each SER, RER, HER and DB in each station and Mabalacat Depot.

Table 5.1.1: Distribution Transformer Capacity of Station

(Between Malolos and Clark, and Mabalacat Depot)

Station Name	Station Transformer, Signaling & Telecommunication Transformer (kVA)	Q'ty	Remarks
CALUMPIT	1,500	1	For Station Load
	200	1	For Signaling System and Telecommunications
APALIT	1,500	1	For Station Load
	200	1	For Signaling System and Telecommunications
SAN FERNANDO	1,500	1	For Station Load
	200	1	For Signaling System and Telecommunications
ANGELES	1,500	1	For Station Load
	200	1	For Signaling System and Telecommunications
CLARK	1,500	1	For Station Load
	200	1	For Signaling System and Telecommunications
CIA	2,000	2	For Station Load
	100	1	For Signaling System and Telecommunications
MABALACAT DEPOT	2,000	2	For Workshop
	2,000	2	For OCC Building

Station Name	Station Transformer, Signaling & Telecommunication Transformer (kVA)	Q'ty	Remarks
	750	1	For Light Repair Shop
	500	2	For DB (Oil)
	500	1	For Training Center

(5) Emergency Power Supplies

1) Low voltage emergency power supplies shall be installed in the stations, in the HER of the OCC building and the training center in Mabalacat Depot.

2) Low voltage emergency power supplies shall automatically start up in the event of absence of 6.6kV supplies to the emergency generator room for CIA, OCC building and Training Center. Emergency power supplies shall be capable of automatically delivering the vitally demanded power, up to the rated value, within 40 seconds of absence of voltage on both 6.6kV incoming feeders being verified.

3) In order to test the operation of the emergency power supply, the Contractor shall provide facilities to enable the emergency generators to be started and to be connected to necessary loads.

4) Changeover from power company power to emergency power shall be done automatically through switching schemes.

5) Changeover from emergency power to power company power shall be done manually by means of a remote command entered into the Power SCADA system, and/or manual operation of circuit breakers. The interlocking schemes and Power SCADA programs shall be provided to ensure that emergency power is not fed out to the power company power feeders and/or that there are no conflicts loop distribution supply.

(6) Low voltage distribution

Low voltage system shall be designed to ensure that voltage regulation under normal feeding is maintained within 5% of normal voltage at any point within the system.

(7) Supervisory Control and Data Acquisition

The power distribution system in each HRR, RER and HER in the OCC building shall be remotely controlled and monitored from the Power SCADA system within the OCC.

5.2 Definitions and Abbreviations

5.2.1 Definitions

In this Specification, the following defined terms shall have the meanings ascribed to them below:

Standard Terminology	In general definitions applied to traction power and protective relay function conforms to International Electrotechnical Commission (IEC) standards,the Philipine Electrical Code, American National Standards Institute (ANSI).
Earthing	The same as 'grounding'. The connection of equipment enclosures and noncurrent carrying metal parts to ground to provide safety to personnel, public and to the equipment.
High Voltage	As applied for this Contract, high voltage is over 600V AC.
Low Voltage	As applied for this Contract, low voltage refers to voltage not exceeding 600V AC.
Substation	Substation receiving incoming supply from utility companies.
Railway Electrical Room (RER)	Railway Electrical Room which is installed inside the station, receives 6.6kV power and transforms 6.6kV to 400-230V AC at each station for supplying power to each station.
High Voltage Receiving Room (HER)	High Voltage Receiving Room receives 6.6kV power and transforms 6.6kV to 400-230V AC for supplying power to depot facilities.
Distribution Board (DB)	Outdoor Distribution Board receives 6.6kV power and transforms 6.6kV to 400-230V AC in the Mabalacat Depot for supplying power to the depot.
Emergency Generator Room	Emergency Generator Room generates 400-230V AC power for supplying power to the vital loads.
Switchgear	Means Isolator Switches, Load Break Switches, Circuit Breakers, Cutouts Interrupters, and other apparatus used for the operation, regulation and control of electrical circuits.
Withstand Capability	Rated capability of equipment to survive without damage by the mechanical forces of a short circuit or the thermal effects 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.
Remote Terminal Unit	Interface unit between PCU and SCADA

5.2.2 Abbreviations

Common abbreviations used in PS shall have the following meanings:

ACB	Air Circuit Breaker
CB	Circuit Breaker
DB	Distribution Board Space
DC	Direct Current
EGR	Emergency Generator Room
EMC	Electro Magnetic Compatibility
ERG	General Requirements
ERT	Technical Requirements
FAT	Factory Acceptance Test
HER	High voltage Electrical Room
HRR	High voltage Receiving Room
LBS	Load Break Switches
LED	Light Emitting Diode
LV	Low Voltage
MCCB	Molded Case Circuit Breaker
REH	Railway Electric House
RER	Railway Electric Room
RLCSD	Rail Leakage Current Suppressing Device
Rms	Root Mean Square
SER	Station Electric Room
VCB	Vacuum Circuit Breaker

5.3 Design Criteria, Applicable Standards and Codes

5.3.1 Design Criteria

Design criteria of the Power Distribution System of this Project shall be as follows:

(1) The general system configuration of the power distribution system

Power distribution system is composed of 6.6kV switchgears, 6.6kV transformers, Main LV Switchgear, emergency generator, DC battery, 6.6kV cables, LV cables, cable trays, concrete troughs, cable separators, manholes, buried pipes, outdoor lighting, outlet for maintenance and their attachments.

(2) Railway Electrical Room and High Voltage Receiving Room equipment

6.6kV indoor cubicle type switchgears; 6.6kV indoor cubicle type resin mold insulated transformers; Indoor cubicle type low voltage panels including air circuit breakers and molded case circuit breakers.

(3) Distribution Board equipment

6.6kV outdoor cubicle type switchgears; 6.6kV cubicle type eco-friendly oil immersed transformers; Outdoor type cubicle type low voltage panels including air circuit breakers and molded case circuit breakers.

(4) Emergency Generator Room equipment

400V-230V indoor enclosed type low voltage diesel engine generator set including generator panel and batteries for starting generator; Fuel tank; Radiator cooling system; Exhaust duct; Mufflers.

(5) Applicable Standards

Standards to be applied shall be the following:

1) IEC 60038 for IEC standard voltage
2) IEC 60529
3) IEC 62271 for HV switchgear
4) IEC 60947 for LV switchgear
5) IEC 61869 for Instrument transformers
6) IEC 60831-1 for Shunt power capacitor
7) IEC 60289 for Reactors
8) IEC 60071 for Insulation Co-ordinations
9) IEC 60076 for Power transformers
10) IEC 60287 for cable current capacity calculation
11) IEC 60502 for 1~30kV cables
12) IEC 60754 for test on gases evolved during combustion of materials from cables.
13) IEC 60034 for generators

14) IEC 60598, for outdoor lighting

15) IEC 62278 for RAMS

The contractor can propose alternative standards which shall be submitted to the Engineer for Approval.

5.3.2 Proven Design

The Contractor shall develop the design based on these requirements and on proven and reliable engineering practices. The design details shall be submitted with technical data and calculations to the Engineer for Approval.

The system, including all sub-systems and equipment, shall be of proven design.

Where similar equipment or sub-systems of a different rating are already proven in service, the design shall be based on such equipment. In case these stipulations are not fulfilled, the Contractor shall furnish sufficient information to prove the basic soundness and reliability of the offered sub-system and compliance with the design criteria.

5.4 Performance Requirements

5.4.1 Service Life

The design philosophy shall meet but shall not be limited to the following criteria:

(1) Application of state-of-the-art Technology;

(2) Service proven design;

(3) Design life 30 years;

(4) Minimum life cycle cost;

(5) Low maintenance cost;

(6) Use of interchangeable, modular components;

(7) Extensive and prominent labeling of parts, cables and wires;

(8) Use of unique serial numbers for traceability of components;

(9) High reliability;

(10) Low energy loss;

(11) System safety;

(12) Fire and smoke protection;

(13) Use of fire-retardant materials;

(14) Environment friendly to avoid contamination by oil leakage in case of incident;

(15) Adherence to operational performance requirements; and

(16) Maximum utilization of indigenous materials and skills, subject to quality conformity.

5.5 Operational Requirements

5.5.1 General

The Contractor shall take into account the specific data relative to the Philippines environment when conducting his studies, so as to guarantee his equipment against any abnormal alteration, as well as proper operation and performance of his apparatus under the least favorable environmental conditions.

5.5.2 Supervisory Control and Data Acquisition

The power distribution systems installed in HRR, RER and HER in OCC building shall be controlled both from the Power SCADA system remotely and from local sites, monitored at the Power SCADA system in the OCC. The power distribution systems installed in HER in Workshop, Light repair shop and DB are controlled only locally.

5.6 Functional Requirements

5.6.1 6.6kV switchgear

6.6kV switchgear shall be designed and manufactured in accordance with the Philippine Electrical Code and applicable standards.

(1) General

1) In HRR, RER and HER, 6.6kV switchgear shall be indoor type.
2) In DB, 6.6kV switchgear shall be outdoor type.
3) 6.6kV switchgear shall be compact modules in design, a metal enclosed type and suitable for indoor or outdoor installation.
4) 6.6kV switchgear shall be designed with current ratings and interrupting capacities complying with the design requirements according to these intended functions.
5) The rated current shall be determined by the Contractor as part of its design of works.

(2) 6.6kV switchgear shall be equipped with the following components:

1) Load break switches without fuses (for cutting off the earth faults cable from the line in an earth fault accident)
2) Vacuum Circuit Breaker (for protecting transformers)
3) Current transformers
4) Voltage transformers
5) Indication lamps (open, close, local and remote)
6) Protection relays
7) Metering devices (Ammeter, Voltmeter, Wattmeter, Power factor meter)
8) Interlocking devices
9) Cubicle

(3) 6.6kV load break switches ratings:

1) Rated voltage: 7.2kV
2) Number of phases: 3
3) Rated frequency: 60Hz
4) Rated short circuit making current: to meet the 6.6kV system fault level
5) Rated insulation level: to meet the 6.6kV system fault level
6) Rated short-time withstand current: to meet the 6.6kV system fault level
7) Auxiliary power supply voltage for operating device: 110V DC

(4) 6.6kV vacuum circuit breaker ratings:

1) Rated voltage: 7.2kV
2) Number of phases: 3
3) Rated frequency: 60Hz
4) Rated short time withstand current: to meet the 6.6kV system fault level
5) Rated short circuit breaking and making current: to meet the 6.6kV system fault level
6) Rated insulation level: to meet the 6.6kV system fault level
7) Auxiliary power supply voltage for operating device: 110V DC

(5) Current transformer ratings:

1) Rated voltage: 7.2kV
2) Number of phases: 3
3) Rated frequency: 60Hz
4) Rated secondary current: 5A
5) Rated short time current: to meet the 6.6kV system fault level

(6) Voltage transformer ratings

1) Rated voltage: 7.2kV
2) Number of phases: 3
3) Rated frequency: 60Hz
4) Rated secondary voltage: 110V AC
5) Rated short time current: to meet the 6.6kV system fault level

5.6.2 6.6kV transformer

6.6kV transformer shall be designed and manufactured in accordance with the Philippine Electrical Code and applicable standards.

(1) General

1) In HRR, RER and HER, the 6.6kV transformer shall be mold type, indoor type and natural cooling type.

2) In DB, the 6.6kV transformer shall be oil immersed type, outdoor type and natural cooling type.

3) Two transformers (for main use and spare use) shall be installed in HER in the OCC building.

4) The primary and the secondary windings shall be capable of withstanding a symmetrical three phase short circuit regardless of the tapping selected.

5) The rated Capacity shall be determined by the Contractor as part of its design of works.

(2) 6.6kV transformer shall be equipped with the following components:

1) Mold type transformer (for HRR, RER, HER)

2) Eco friendly oil immersed type transformer

3) Protection relays

4) Metering devices (thermometer)

5) Cubicle

(3) 6.6kV mold type transformer ratings:

1) Rated primary voltage: 6.6kV (tap changing from +2.5% to -2.5%)

2) Rated secondary voltage: 400V-230V

3) Number of phases: 3 (3 phase-4wire method)

4) Rated frequency: 60Hz

5) Type: mold

6) Cooling: natural cooling type

7) Rated insulation level: to meet the 6.6kV system fault level

(4) 6.6kV eco-friendly oil immersed type transformer ratings:

1) Rated primary voltage: 6.6kV (tap changing from +2.5% to -2.5%)

2) Rated secondary voltage: 400V-230V

3) Number of phases: 3 (3 phase-4 wire method)

4) Rated frequency: 60Hz

5) Cooling: natural cooling type

6) Rated insulation level: to meet the 6.6kV system fault level

5.6.3 Main LV Switchgear

Main LV Switchgear shall be designed and manufactured in accordance with the Philippine Electrical Code and applicable standards.

(1) General

In HRR, REH, and HER, Main LV Switchgear shall be indoor type.

In DB, Main LV Switchgear shall be outdoor type.

Molded-case circuit breakers and Air circuit breakers shall have the design uninterrupted current rating when enclosed and in its operating environment with a rated operational voltage as specified for the switchgear. The circuit breaker shall meet the fault conditions specified for the panels.

Air circuit breakers shall be lockable at drawn in and drawn out positions or drawn in position when in the open state.

Air circuit breakers shall be moveable at drawn out position or drawn in position when in open state.

To prevent accidental contact with live parts, switches of the withdrawal chassis or insulating type shall have either fully shrouded fixed contacts or insulated cover plates.

Number and each electric system and capacity of low voltage circuits for main LV switchgear shall be given by interfacing contractors, except the circuits which are designed by others. The contractor shall design main LV switchgear according to this information.

(2) Main LV Switchgear shall be equipped with the following components:

1) 400V triple pole neutral molded-case circuit breaker or air circuit breaker
2) Indication lamps
3) Protection relays
4) APFC (Auto power factor control)
5) Metering devices Digital type (A, V, W, WH, kVar, pf)
6) Cubicle

(3) Main LV Switchgear for switching of the commercial power supply and the emergency power supply shall be equipped with the following components:

1) 400V Double throw triple pole molded-case switch
2) Indication lamps
3) Protection relays
4) Metering devices Digital type (A, V, W, WH)
5) Cubicle

(4) Main LV Switchgear for LV power capacitor equipment shall be equipped with the following components:

1) Electromagnetic Contactor
2) Power Capacitor with Protect devices
3) Series Reactors
4) Indicator
5) Cubicle

5.6.4 DC Battery and Charger

The DC battery and charger shall be designed and manufactured in accordance with the Philippine Electrical Code and applicable standards.

(1) General

1) The DC battery and charger shall be installed in the HRR, RER in stations and HER in the OCC building.
2) The battery type, rated capacity of battery, battery charger type shall be determined by the Contractor as part of its design of works.

(2) Battery Units (NiCad: Nickel-Cadmium rechargeable battery)

1) For the HRR, RER in stations and HER in the OCC building, the Contractor shall provide an 110V battery system for safety tripping, service current functions and power to the Power SCADA remote terminal units.
2) The battery system shall be rated to supply the standing loads for a minimum of 3 hours in the event of a charger supply failure, and at the end of that period the battery shall be capable of operating each item of equipment for one cycle, i.e., one cycle means one open and one closed.
3) The output voltage shall be within the tolerances defined for operation in the relevant equipment specifications.
4) The 110V batteries shall be of the sealed, maintenance free type and shall not emit hazardous gases.

(3) Battery Chargers

1) Battery chargers shall be provided with self-regulation and shall be capable of restoring a minimum of 80% of battery capacity within 4 hours of full discharge.
2) Sufficient indications shall be provided on the battery charger to provide status; thus, information shall be provided to the SCADA system.
3) Battery charger's information of the battery charger system, as a minimum this shall include battery voltage, trickle charge and booster charge currents, battery charge functioning and battery charge failure. In addition, status shall include measuring instruments such as ammeters and voltmeters as a minimum.

4) In the HRR, RER and HER in OCC building, AC auxiliary power for the battery charger shall be fed from the main LV Switchgear.

5.6.5 Emergency Power Supply System

Emergency power supply system shall be designed and manufactured in accordance with the Philippine Electrical Code, the Fire Code of the Philippines and applicable standards.

Emergency Power Supply

(1) General

Emergency power supplies shall be at the stations, OCC building and Training Centre.

Emergency power supplies shall automatically start up in the event of absence of incoming 6.6kV supply. Emergency power supplies shall be capable of automatically delivering the essential demanded power, up to the rated value, within 10 seconds of absence of voltage on both incoming 6.6kV supplies being verified. Prior to the starting of the generator all critical equipment shall remain in operation by means of individual UPS's.

Emergency power supply in the Mabalacat Depot shall supply low voltage power required for in the Mabalacat Depot including the OCC building through LV circuits directly.

Exhaust gas shall be controlled in accordance with regulations in the Philippines.

(2) Emergency Generators

Emergency generators shall be enclosed type diesel generators.

Emergency generators shall be of 400-230V AC rating and for using to 3 phases 4 wires system.

The Contractor shall determine the actual capacity of the emergency generators to cater for the starting and running of the equipment according to the operational scenarios as specified.

The essential load and the emergency load which required power supply in case of power supply failure shall be installed at CIA, OCC building and Training Centre.

The emergency generator equipment shall be completed with fuel storage facilities and shall be capable of providing the specified performance continuously for a minimum period of 48 hours, without the requirement for inspection or attention. The emergency generator facilities shall be designed to enable indefinite extension of this period by permitting refuelling of the fuel tank while the generator is running.

The emergency generator equipment shall be completed with fuel supplying facilities from the supplying outlet on the ground and exhaust air ducts to the outdoors.

The emergency generator equipment shall be capable of withstanding a sudden short circuit at the emergency generator terminals, whilst operating at rated load and maximum working temperature without any damage.

The emergency generator equipment shall also be capable of withstanding maximum over-speed without any damage, as defined in IEC 60034.

The emergency generators and exciters shall be of the totally enclosed, brushless type, and shall comply with the requirements of IEC 60034.

The line and neutral phase ends shall be brought out to separate terminal boxes.

The emergency generator and exciter winding insulation shall conform as a minimum to temperature 'Class F' in accordance with IEC 60034.

All necessary metering instruments, current and voltage transformers for protection, control and metering shall be provided.

The emergency generator equipment shall be complete with noise control facilities complying with local codes and with the environmental requirements for noise pollution.

Anti-vibration mounting for generator engines shall be provided.

(3) Emergency Generator Excitation

The emergency generator excitation system shall be of the fast-acting type to ensure rapid response during motor starting and sudden load change.

In the event of a fault at or near the emergency generator terminals, the excitation system shall maintain the generator fault current of not less than 3 times rated continuous current during the time required for the associated protection device to operate.

The rotating rectifier shall employ silicon diodes. The diodes shall be adequately rated to accommodate the steady state current, maximum voltage and environmental operating conditions and shall ensure satisfactory operation of the rectifier diodes in the event of surges.

(4) Protection and Monitoring

Protection shall be provided to trip the emergency generators in the event of rectifier failure.

The automatic voltage regulator shall be easily adjustable, for setting the reference voltage, gain and damping. The devices enabling adjustment shall not be mounted directly on the emergency generator, but in a separate control cubicle.

The automatic voltage regulators shall be responsive to three-phase terminal voltage. Circuits shall be provided to detect malfunction of the automatic voltage regulator and trip the emergency generator.

The necessary voltage transformer, arranged in single phase units, shall be provided and shall be used exclusively for the regulator.

Anti-condensation heaters shall be provided in the emergency generator and exciter units.

Emergency power supply shall be controlled and monitored both remotely and locally. The Contractor shall provide local control panel with a changeover switch, permitting local control or remote control. The local control panel shall include all necessary control and monitoring devices (e.g. voltage regulator, synchronism device, and so on), all protection systems and all metering devices, and interface with the SCADA to enable remote control and monitoring.

・Grounding

The low voltage generator's neutral point shall not be grounded. The earthing fault protection shall be limited during emergency generator operation.

・Starting

An auxiliary power supply shall be provided by means of appropriately sized battery to enable starting of the emergency generator.

After starting, the auxiliary power supply shall then be connected to the output of the emergency generator.

(5) Fuel

1) Fuel shall be considered from the viewpoint of eco-friendly.

2) Continuous operation time of a generator shall be not less than 48 hours.

3) Fuel tank capacity shall be as below.

Training Centre and OCC Building 3 ϕ 4W 400/230V 60Hz: not less than 4800L each.

CIA 3 ϕ 4W 400/230V 60Hz: not less than 900L

5.6.6 Cables

Cables shall be designed and manufactured in accordance with the Philippine Electrical Code and applicable standards.

All cables to be installed in the facilities shall be low smoke non-halogen compound (LSZH) type and fire retardant.

(1) All cables shall be sized to carry the continuous current required by the Specification and shall be also based on the Contractor's estimations. The cables shall be able to withstand the short circuit currents associated with the Contractor's design.

(2) The ratings applied to any cable shall be determined by the most onerous installation condition in any cable route.

(3) Termination and splicing shall be made by the qualified engineer. Each terminal of the cables shall be connected with respective power distribution panels and/or equipment.

(4) Cables for 6.6kV power distribution

1) The ratings of cables for the 6.6kV power supply system shall be determined by the calculation in accordance with IEC 60287 or Equivalent for a maximum operating conductor temperature of 90 degrees Celsius.

2) 6.6kV cables shall comply with IEC 60502 or Equivalent

3) Cables for 6.6kV distribution shall be provided with stranded copper conductor in trefoil formation sized to suit the power supply system design and to satisfy short circuit current requirements.

4) Cables for 6.6kV distribution shall be Cross-linked polyethylene insulated polyvinyl chloride sheathed (XLPE) cables.

(5) Cables for LV power distribution (CV) C: Crosslinked polyethylene V: PVC

1) The ratings of cables for the 400/230V power supply system shall be determined by the calculation in accordance with IEC 60287 or Equivalent for a maximum operating conductor temperature of 90 degrees Celsius.

2) Cables for 400/230V distribution shall be provided with stranded copper conductor sized to suit the power supply system design and to satisfy short circuit current requirements.

(6) 6.6kV Cables for Grounding

1) Grounding cables shall comply with the Philippine Electrical Code.

(7) Conductor size of Cable

1) Cable conductor sizes are indicated on the drawings for reference; actual conductor sizes shall be determined by the Contractor and shall be subjected to approval by the Engineer.

(8) Cabling

1) Elevated section and embankment section cables shall be installed in cable containment provided by the contractor.

2) The Contractor shall decide the appropriate access routes of the cables into the SS and HRR, RER; and shall provide cable trays for cabling. The Contractor shall coordinate with the relevant Contractors regarding the openings for cable entering on the building walls and/or floors.

3) All openings for cabling on the building walls and floors shall be filled with non-flammable materials, after all cables have been installed, to prevent fire extension. Non-flammable materials shall be given Notice of No Objection by the Engineer.

5.6.7 Earthing system

Earthing system shall be designed and manufactured in accordance with the Philippine Electrical Code, IEC, IEEE and other applicable international standards.

(1) The main earthing system for stations, OCC building, workshop, Light repair shop and DB shall be provided by the Civil Contractor.

(2) The earthing shall be laid from the main earthing system to the earthing terminal in HRR, RER, HER and DB by the Contractor.

(3) The earthing terminal box in RER, HER and DB shall be provided by the Contractor.

5.6.8 Outdoor lighting

Outdoor lighting shall be designed and manufactured in accordance with the Philippine Electrical Code, IEC and other applicable international standards.

(1) Outdoor lighting in main line

1) Outdoor lighting for the main line shall be provided near the point machines, access stairs, in tunnels and covered areas and other dark areas where there is no or limited ambient

lighting and at stabling sidings.

Lighting level shall be not less than 5 lux of the horizontal illumination at the track level.

2) Lamp of lighting fixtures shall be LED type.

3) An automatic control panel for outdoor lighting shall be provided. The panel shall be capable of operating based on setting of weekly schedule timer. The lighting shall also be switched according to the control signal from photo sensors. Local by-pass switches shall be provided for maintenance and a driver's walking path.

4) Outdoor lighting and the automatic control panel for outdoor lighting in the main line shall be mounted on the OCS poles and beams.

5) Electric power to the lighting circuits shall be supplied from the HRR near the station.

(2) Outdoor lighting in the Mabalacat Depot

1) Outdoor lighting shall be provided on a self-standing type pole with foundation for the access roads in the Mabalacat Depot.

2) Outdoor lighting shall be mounted on the OCS poles for the yards and point machines in the Mabalacat Depot.

3) Lighting level for the access roads and point machine shall be not less than 5 lux of the horizontal illumination at the track level, and not less than 20 lux for Mabalacat Depot yards respectively.

4) Lamp of lighting fixtures shall be LED type.

5) Automatic control panel for Mabalacat Depot yard lighting and point machine lighting shall be provided. This panel shall be capable of operating based on setting of weekly schedule timer. The lighting shall also be switched according to the control signal from photo sensors. Local by-pass switches shall be provided for maintenance.

6) Outdoor lighting for access roads is switched on/off by photo sensors automatically.

7) Electric power to the lighting circuits shall be supplied from the main LV Switchgear the HER or DB.

8) Outdoor lighting in the Mabalacat Depot shall be split into zones according to the area such as the stabling yard, access road and pavement, Mabalacat Depot yard, etc. The Contractor shall coordinate with interfacing parties on the zoning.

9) All the outdoor lighting poles shall be made into structures bearing a 44.4m/sec wind velocity.

10) Outdoor lighting apparatus shall comply with IEC60529,-and provide with an IP66 grade.

11) Solar street lighting system shall be adopted.

The solar street lighting system basically consists of:

a. Solar photo voltaic Module
b. Luminaire / LED streetlight
c. Low maintenance battery

d. Pole and solar panel bracket
e. Battery box
f. Interconnecting cables

The solar photovoltaic module is fixed firmly on top of the pole with suitable tilt and inclination so as to receive maximum sunlight throughout the day. The solar photovoltaic module. The solar battery is housed inside a battery box.

5.6.9 Outlet Box for Maintenance

Outlet boxes for maintenance shall be designed and manufactured in accordance with the Philippine Electrical Code, IEC and other applicable international standards.

(1) The outlet box shall be provided for portable electrical tools and lighting for maintenance work.

(2) The outlet box shall be outdoor type and provided on the wall near the point machine.

(3) The outlet box shall be able to supply 1kVA. However, maximum electric power supply simultaneously from one circuit of outlets shall not exceed 1kVA.

(4) In a case where 1kVA load is used at the end of the outlets box, voltage drop shall not exceed 5 %.

5.6.10 Power SCADA

(1) General

The power SCADA (microprocessor based Supervisory Control and Data Acquisition system for power supply system) shall be designed, supplied, installed, tested and commissioned by the Interfacing Contractor for the Substation System and overhead line for smooth operation, monitoring, control and logging of important features of the traction and auxiliary power supply system on the MCRP. The Contractor shall design, supply, install, test and commission only metallic wiring between RTU and electric equipment to be controlled and monitored in HRR, HER in the OCC building and low voltage power distribution circuits from the battery system to the RTU.

The Contractor shall make close coordination with Interfacing Contractors to resolve interface issues.

(2) Control and Monitoring Items of Power Distribution System

1) The Power SCADA system shall control and monitor the 6.6kV and LV power supplies in the HRR, RER, HER in OCC building, which shall include indications of the status of all electrically operated switching devices on the 6.6kV AC system, together with alarm and protective devices.

   The same requirement shall also apply to the main breakers and tie breakers of the main LV switchgear in the HRR, RER, HER in the OCC building.

Power SCADA monitoring facilities for power supplies shall include, but shall not be limited to:

a. Voltage of all 6.6kV;
b. Current of all 6.6kV;
c. Status of LBS and VCB;
d. Status of Emergency generator equipment;
e. Status of DC battery and charger equipment;
f. Status of all protection equipment;
g. Operation of LBS and VCB;
h. Operation of alarm and protection devices
i. Overhead Line isolator control and monitoring

(3) Power Supplies

Power supply to RTU shall be supplied from the 110V DC battery system of control source for HRR, RER or HER.

5.6.11 Drawings and lists for Approval

(1) Detailed design drawings, associated specifications and technical data/calculations shall be submitted to the Engineer for approval of the following:

1) Shop and/or manufacturers drawings;
2) Working/installation drawings;
3) Shop test reports; and
4) Manufacturers specifications.

(2) Drawings shall indicate legends for all symbols used in the drawings .

(3) Plans for cabling route on the main line and in Mabalacat Depot.

1) Single line diagrams of HRR, RER, HER, DB and EGR in the stations and the Mabalacat Depot.
2) Layout plan of the electrical equipment for HRR, RER, HER, DB and EGR in the stations and the Mabalacat Depot.
3) Cabling routes and methods between the main line and HRR, RER or Substation;
4) Cabling routes and methods in the Mabalacat Depot; and
5) Layout plan of outdoor Lighting and control panels which supply power to outdoor lighting in the main line and the Mabalacat Depot.
6) Distribution network diagram for outdoor lighting in the main line and the Mabalacat Depot
7) Standard mounting of outdoor lighting in the main line and Mabalacat Depot.

8) Cross section drawings indicating installation position of cables, outlet boxes and troughs;

9) Schematics for cable routing on the main line and in Mabalacat Depot.

(4) List of cables shall be submitted to the Engineer for his approval, and shall include the following information for each cable:

1) Cable identification number;

2) Type of cable;

3) Rated voltage;

4) Number of cores;

5) Cable size;

6) Overall diameter;

7) Cable termination at each end;

8) Location of Cable splicing;

9) Connection point at each end with equipment identification and terminal numbers; and

10) Cabling route.

5.7 Installation Requirements

5.7.1 General Requirements

The Contractor shall comply with all enactments in executing the works, at least including all statutory provisions on occupational health and safety.

The Contractor shall coordinate with the interfacing parties of this Contract and other Contractors in the execution of the works.

The Contractor shall also cooperate with all Relevant Authorities in the execution of the works.

The installation of all equipment shall be undertaken at all times by suitably trained and competent employees of the Contractor, to the satisfaction of the Engineer.

Only appropriate tools, plant, equipment and vehicles shall be used.

Installation of all equipment shall be in accordance with the coordinated installation plan described in the ERG.

Installation of all equipment shall conform to the best industry practices.

Precautions shall be undertaken to ensure the safety of personnel and equipment for all installation works.

The Contractor shall, prior to starting any installation work, identify any possible hazards, and implement measures of eliminating and/or controlling such potential hazards, in line with safe working practices.

Further details on the Site safety management are described in the ERG.

The Contractor shall coordinate with the relating Contracts regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the civil infrastructure.

The Contractor shall coordinate its requirements for earthing and bonding system with Interfacing Contractors, such as wiring routes and locations of ground rods installation.

The Contractor shall ensure that all areas of work are sufficiently illuminated for the Works to be undertaken and that a safe system of work is employed for all activities.

The Contractor shall operate a robust system for the control of persons entering or working upon the Site. The system shall include as a minimum:

(1) Register of all employees;

(2) Personal identification, with photograph;

(3) Levels of competency;

(4) Date of expiry;

(5) Date of issue;

(6) Signature; and

(7) Register of all visitors.

The Contractor shall co-operate, at all times, with the Engineer and other Contractors to ensure that the Site is protected from unauthorized admission, either willfully or otherwise.

The Contractor shall make due provision for the safe access and egress to the Site of Works for its staff and subcontractors. This access shall be maintained such that it is free of all hazards and is in a safe condition throughout the duration of the Works.

5.7.2 Specific Requirements

The installation work pertaining to this Contract shall at least include the following:

(1) Finalization of the Construction and Installation Program;

(2) Survey on the Site and review the technical requirements;

(3) Production of the calculation sheets and installation drawings for the Site installation;

(4) Installation in accordance with the finalized installation drawings;

(5) Co-ordination with other Contractors;

(6) Submission of the installation reports and records;

(7) Production of as built drawings, documents, calculation sheets, and records.

5.7.3 Installation of Cables

Laying of Cables

(1) Cable risers shall be protected with cable trays/ steel conduit pipes.

(2) Bending radius of low voltage cables shall be not less than 8 times for single core type and

6 times for multi core type the outside diameter of the cable respectively.

(3) Cable trays shall be fixed to the wall or the ceilings, fixing intervals shall be less than 1.5 m.

(4) Cables laying with cable trays on the vertical direction shall be bound tightly at the 1.5 m intervals.

(5) No tension is permitted for splicing of the cables.

(6) Openings for cables drawn into switchgear, switchboards and equipment shall be protected properly so that no pests or moisture can enter.

(7) Occupancy of cables in the trough shall be not more than 60 %

(8) The Contractor shall coordinate with Interfacing Contractors (CP N-01 to CP N-05) regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the civil infrastructure.

5.8 Interfacing Requirements

5.8.1 General

The Contractor shall liaise and coordinate with Interfacing Parties to ensure the effective and compatible coordination of all aspects of design, installation, testing and commissioning of work.

5.8.2 Contractor's Responsibility

(1) The Contractor shall ensure that all the interface items of this specification shall include in the interface management plan.

(2) Other items not mentioned in the interface items but are relevant to the design, installation, testing and commissioning of permanent works, shall also be included in the interface management plan.

5.9 Testing, Commissioning and Verification

5.9.1 General

The Contractor shall develop a full Test Plan which shall be submitted for approval by the Engineer. The tests mentioned herein are indicative and shall be the minimum requirement. The Contractor shall clearly categorize the types of tests required in this Part with the following in the Test Plan:

- Pre-commissioning tests,
- Commissioning tests, and
- Test Run and Trial Operation.

(1) Test Certificates

All principal test records and test certificates duly endorsed by the Contractor are to be submitted for the approval by the Engineer. These test records and certificates shall be supplied for all tests, whether or not the Engineer has witnessed them. The information given on such test certificates shall be sufficient to identify the materials or equipment to which the certificate refers.

(2) Cost of Tests

1) The Contractor must bear the cost of all necessary tests.

2) As for the cost of the test which is carried out outside Philippines, the Contractor must bear the expenses relating the witnessing and the verification by the Employer and the Engineer.

3) Test Plan and Procedures

All the test plans and procedures with the exact time and date shall be submitted for the approval of the Employer at least 30 days prior to any test's conduction.

5.9.2 Factory Acceptance Tests (FAT)

FAT shall comprise Type Tests, Sample Tests, Routine Tests, Life, Endurance and Destruction Tests, and any additional tests requested by the Engineer.

The testing shall be conducted such as to simulate the working conditions as closely as possible.

Upon the request of the Engineer, destruction tests shall be carried on components and assemblies to verify the design loading.

All the tests shall be conducted both on the assembly and on the members/components of each product in accordance with design specifications and applicable Standards.

5.9.3 Contractors Responsibilities for On-site Testing

(1) The Contractor shall implement all tests in accordance with the Test Plan. During the course accuracy as may be required. On completion of erection and prior to commissioning, all power cables shall be tested to the acceptance of the Engineer in accordance with an agreed Inspection and test plan to demonstrate that it is entirely suitable for commercial operation.

(2) The Contractor shall be responsible for providing temporary electricity supply, all instruments, gauges, test equipment, tools, accessories, personnel, services and necessary facilities required for the execution of all tests and inspection. Wherever necessary, the Contractor shall provide two or more sets of testing equipment, tools, and others to expedite testing. All test equipment shall be accompanied with the appropriate calibration certificate by a testing authority of the equipment.

(3) Test equipment, tools, and others necessary for subsequent preventive and corrective maintenance are to be provided to the Engineer as specified herein and shall be available to assist the tests. The use of these test equipment, tools and others shall be subject to approval by the Engineer.

(4) The Contractor shall be responsible for surveillance and security of the Electrical Room and Distribution downstream cables or other electrical equipment is energized before it has been tested and before the relevant Contractors or Sub-contractors' facilities are ready and secured. The Contractor's responsibility for surveillance and security of the system shall remain in force for each part of the system until such a time that the Engineer issues the appropriate certificate, and the Employer takes over the System.

5.9.4 Installation Tests

(1) Installation Tests

An inspection and visual verification of ratings and connections with equipment shall be carried out prior to installation tests.

Un-energized equipment shall be inspected for its visual and tested for operation after installation of equipment. Inspections and tests shall include the following:

a) Cleanliness,

b) Workmanship,

c) Confirmation of items conforming to ratings required,

d) Water and dust proofing,

e) Leveling, mounting and positioning,

f) Joints and connections tightness,

g) Cables – dressing, bending radii, jointing and finish at terminals,

h) Clearances and dimensions in conformity with drawings,

i) Earthing and bonding.

j) Functioning of circuit breakers, load break switches, isolating switches and their interlocks.

k) Protection devices, and

l) Phase sequence verification.

m) Ground resistance shall be measured individually, and for the subsystem and system.

n) Insulation Resistance

The insulation resistance of all 6.6kV circuits shall be tested with an insulation tester of 1.0kV rating. All LV circuits comprising ac and AC and DC auxiliary circuits shall be tested with a 500V insulation tester.

Tests on Current Transformers shall include the following:

a) Insulation resistance.

b) Winding resistance.

c) Polarity of Connections up to equipment terminals, and

d) Ratio and magnetization curve verification.

Tests on Voltage Transformers shall include the following:

a) Voltage ratio.

b) Insulation resistance, and

c) Polarity of connections up to the equipment terminals

Secondary and primary injection tests shall include the following:

Tests shall be carried out at a minimum of three settings if multiple settings are available. Test results of operation boundaries and operating times shall be recorded.

Batteries and Chargers

Discharge tests and charging tests shall be carried out to verify the capacity of the batteries and all functions available on the charger. Continuous measurements of battery voltages shall be made together with periodic readings of the electrolyte specific gravities and temperatures. No addition of electrolyte is permitted during discharge tests.

The operation of the boost charge facility and the effect of the voltage dropping diodes shall also be demonstrated.

Control, Indication and Alarm Functions shall include the following:

i. Insulation resistance and continuity of all cores of cables shall be identified and tested, and

ii. The correct functioning of all control, indication and alarm devices shall be verified.

Switchgear

All switchgear, including circuit breakers, load break switches and earthing switches, shall be operated to prove that the operating gear, tripping devices, protective gear and mechanical interlocking are satisfactory.

Metering Instruments and Transducers

All current and voltage transformers, metering instruments and transducers shall be calibrated by voltage and current injection to prove their accuracy classes.

5.9.5 Receiving Acceptance Test

The following tests shall form part of on-site and System Acceptance Tests as part testing of the equipment and system.

(1) Functional Tests and Interlock Tests shall include the following:

All control and protection functions and electrical/mechanical interlocks shall be tested.

(2) Primary Injection Tests shall include the following:

The Contractor shall carry out primary injection tests on each protective system, to prove the auxiliary circuit connections, the relay fault setting values, the correct metering indications and the stability limits.

(3) AC/DC Pressure Tests shall include the following:

The insulation resistance of all circuits shall be measured before and after the dc pressure test using a 500V insulation tester. The minimum phase-to-phase and phase-to-earth insulation resistance shall be 100 mega ohms. Pressure tests shall be carried out on completed cable lengths of high voltage cables in accordance with IEC 60502.

(4) Energization

The Contractor shall prepare operation safety rules and procedures for the approval by the Engineer before Energization.

The Contractor shall check all to ensure safe Energization.

All power equipment shall be subject to inspection by inspectors from the Electrical Inspectorate of the Employer before Energization.

The Contractor shall be responsible for the operation of traction and auxiliary power equipment. Upon request by the Engineer, the contractor shall be responsible for the disconnection and the subsequent reconnections of the power equipment.

5.9.6 Integrated Testing and Commissioning

(1) Integrated Testing and Commissioning refers to those tests undertaken in order to demonstrate that the various components of the systems operate satisfactorily between one another, and meet all specified requirements for design, operability, safety, and integration with other Works and systems. These tests shall be entirely within the requirements of one or more of the project contracts or they shall involve a multiplicity of contract procedure. The final Integrated Testing and Commissioning shall be conducted after the SCADA system and OCC have become operational.

(2) Systems that can be tested without depending on the running of trains, such as SCADA system, the emergency trip system shall have their integration tests scheduled to commence as early as possible. It is preferable that any interface problems associated with these "no train" system tests be identified and resolved prior to the test running.

(3) The following is an indicative listing of those Integrated Testing and Commissioning functions that necessarily to be integrated with others to demonstrate that the equipment and controls of the Power Distribution System meet the Contract Specifications and demonstrate a safe-to-operate condition.

This listing is not exhaustive and shall be updated by the appropriate contractor, to demonstrate functionality, completeness and safety of the installed works and shall be submitted to the Engineer for his approval.

a) HRR, RER, DB and Generator failure mode test.

b) Remote control and monitoring test through SCADA system at the OCC.

c) Emergency trip system tests.

d) Power system functional tests.

e) EMI/EMC tests.

f) Touch/step potential tests.

The Contractor shall provide attendance to the Engineer during integrated test in relation to the insulation of train station platforms provided by the other contractors.

(4) On-load Tests and Directional Tests

Once sufficient load current is established, voltages and currents into protection and metering equipment shall be verified to ensure correct operation of protection relays and accuracy of meter readings at local and remote locations.

5.9.7 Test Run and Trial Operation

The Contractor shall provide special and general attendance during the Test Run and Trial Operation period such that the persons who conduct the On-Site Testing and Commissioning are available on the Site to solve any problem arising from the Test Run and Trial Operation.

5.9.8 Performance Verification

(1) The Contractor shall carry out the pre-commissioning and commissioning tests to verify that the performance of the System meets the Employer's Requirements before the substantial completion of the Works.

(2) One of the Performance Tests which shall be conducted by the Contractor in conjunction with relevant Contractors, Sub-contractors and other Parties is the measurement of EMI levels at locations that have received a Statement of approval by the Engineer. Such measurements shall be conducted prior to Energization of the Traction Power System, and then during Service Trials and commercial operation of the train services to ensure that the EMI levels meet the Employer's Requirements and are in accordance with the Contractor's designs give Notice of No Objection by the Engineer.

(3) Should the performance of the System deviate from the Contractor's designs given Notice of No Objection by the Engineer, the Contractor shall rectify the deviation in the shortest possible time.

(4) The Contractor shall submit a certified report of the results of these Tests to the Engineer within 14 days from the date when the Engineer confirmed that the Contractor has passed each of the Tests.

5.10 Measuring and Special Tools

5.10.1 General Requirements of Measuring and Special Tools

Details of the measuring and special tools are described in the Employer's Requirements – General Requirements. The Contractor shall provide measuring and special tools for future commercial operation. . The Contractor shall submit the lists of those tools to the Engineer for his approval. The list shall include detailed description with references and correlation with the maintenance manuals.

5.10.2 Special Tools and Test Equipment

(1) The contractor shall provide the following special tools and test equipment as a minimum:

Test Equipment:

a) Analog Insulation Tester, M /. megohmmeter (DC 250, 500, 1000 V) : 1 set

b) Switchgear Testing Devise (Operating time, Lowest operating voltage, trip/input current wave measuring) : 1 set

c) Protection Relay Testing Devise (OMICRON OMC 356) : 1 set

d) PC for the Protection Relay operation (laptop type) : 2 sets

5.11 Training Requirements

5.11.1 General

The Contractor shall supply the appropriate training for the operation and maintenance staff of the Employer according to the General Requirements. The Contractor shall submit the training plan to the Engineer.

5.11.2 Scope of Training

The Contractor shall provide the theoretical and practical training for software and hardware used for the Power Distribution system to the Employer's staff and instructors.

5.11.3 General Requirements

The training shall be provided at the places where can achieve the great effect to the trainee. The training locations shall be at places with factory, domestic, overseas and at other required places. The optimum locations shall be proposed for the training.

5.11.4 Training Plan

The Contractor shall prepare and submit the training plan to the Engineer for Approval. The training plans shall include the purpose, contents, method, location, time and period.

5.11.5 Training Courses

(1) The Contractor shall at least prepare the training courses related to the operation and maintenance for train control and the distribution system (main line).

(2) The Contractor shall provide the training about train operation and the Distribution system (main line) for the normal and emergency situation.

(3) The training for emergency situation shall include the following:

a) Investigation method of failure point, effective and efficient handling of hardware and software at the emergency situation for train operation and the Distribution system (main line);

b) Recovering method from the emergency situation caused by system error or other cases;

c) Judgment procedure of transition to backup system and recovery;

d) Data recording, data recovering and data store;

e) Preparation for unexpected situation; and

f) Training of all the matters on the train operation.

(4) The Contractor shall supply the training of system design and configuration to the staff of the Employer. This training shall include the following:

a) The outline of the systems,

b) The system configuration and data configuration, and

c) The principle of train operation.

(5) The Contractor shall supply the following training to the system maintenance staff of the Employer:

a) The principle of train operation,

b) Prevention and repair of maintenance methods and duties,

c) Repair by unit change,

d) Direction for test device and investigation method, and

e) The software maintenance including data configuration, data preparation, data modification and debug of system software.

5.11.6 Maintenance Courses

(1) The maintenance courses shall be developed to acquire all necessary knowledge and skills for preventive maintenance and corrective maintenance for each system.

(2) The maintenance courses shall be developed to acquire all necessary knowledge and skills for adjustment and configuration of system parameter for new installing system and parts.

(3) Intended training maintenance staff shall include at least the following:

a) Distribution system maintenance staff;

b) Trainer and instructor of the Employer;

c) Manager; and

d) Any other defined person by the Employer.

(4) The contents for the maintenance training shall include the following:

a) Train operation principles;

b) Works and method of preventive maintenance and corrective maintenance;

c) Failure correction of unit exchange level;

d) Operation method for test equipment;

e) Failure investigation and maintenance support;

f) Reading of operating manual, maintenance manual, circuit diagram and wiring diagram;

g) Software maintenance for data modification, data generation, database configuration and system software configuration; and

h) Backup and load for data and software.

(5) Training plan submitted from the Contractor shall include the following:

a) Schedule of training course;

b) Purpose of training;

c) Curriculum of training;

d) Composition of training course;

e) Necessary or providing training facilities;

f) Training material and manual;

g) Qualification of instructor; and

h) Evaluation method for the training.

5.11.7 Training Materials

(1) The Contractor shall provide all necessary devices for training, special tools, training materials, training devices and training supplemental materials.

(2) Training supplemental materials and training devices shall be durable construction and become the Employer's property.

(3) The Contractor shall provide the computer-based training system.

(4) The Contractor shall prepare and submit training manual 60 days before start of the training to the Engineer for Approval.

(5) Modification and change of training manual throughout the contract period shall be responsible of the Contractor.

(6) Training manual shall become the Employer's property.

5.11.8 Qualification and Certification

(1) The Contractor shall record the attendance of trainee. The contractor shall submit details of evaluation criteria and compression authorization before start of the training course to the Engineer for Approval.

(2) The Contractor shall prepare an evaluation report regarding the degree of understanding and proficiency of each curriculum, and knowledge level for each trainee. The Contractor shall also submit this evaluation report to the Engineer.

5.12 Maintenance Requirements

The contractor shall submit a plan for Preventive Maintenance (PM) and Corrective Maintenance (CM).

Early failure is to be settled within the test period before operation.

The contractor shall provide operation and maintenance manual before the commencement of commercial operation. These manuals shall be given a Notice of No Objection by the Engineer. The updated manuals shall be provided in the case that operation and maintenance method had been changed due to modification of the equipment, etc.

The maintenance plan shall include the following:

a) Maintenance policy and organization;

b) Working description of maintenance;

c) The cycle of each maintenance works;

d) Annual periodic maintenance plan;

e) Equipment and subsystem related the tasks;

f) Operation methods of the tasks;

g) Devices and test equipment for implementation the tasks;

h) Flowcharts or illustrations for failure investigation;

i) Recovery method;

j) Prevention method; and

k) Estimation period and staff volume.

5.12.1 Software Support

(1) The Contractor shall submit software support plan to the Engineer for Approval.

(2) All Incompatible modifications, bug fixes, updates, revisions, changes and upgrades with the specifications shall not be performed.

(3) In order to continue proper operation, The Contractor shall provide software modifications, bug fixes, updates, revisions, changes and upgrades including database table configuration for all developed and supplied software.

(4) All the modification and revision for the software shall not give deterioration for system performance and harmful action.

(5) The Contractor shall retain backup copy of developed and supplied software.

(6) The Contractor shall secure proven validity, tested completely and Approval from the Engineer before loading the new version to the systems.

(7) The Contractor shall provide the education to the Employer's staff before loading new version to the systems.

(8) The Contractor shall provide software with sufficient security measures.

5.12.2 Software Obligations

For any software produced and modified for this contract the Contractor shall be submit two backup copy 14 days before commencing actual operation. The backup copy shall include the following:

(a) All source code, all execution code and all database configurations;

(b) The documents related to all the software; and

(c) Not only software development tool for the maintenance, but also editor, compiler and linker system.

5.12.3 Manuals

(1) The Contractor shall provide operation and maintenance manual. The latest version of manuals shall be supplied four weeks before the commencement of commercial operation. These manuals shall be given Notice of No Objection by the Engineer prior to provision.

(2) The updated manuals shall be supplied when operation and maintenance method had been changed by modifying the equipment.

i. Operation Manuals

The Contractor shall provide operation manuals regarding the purpose and operation for each equipment, sub system and system.

ii. Maintenance Manuals

The Contractor shall be provided maintenance manual described maintenance, the focal point of failure investigation, mounting equipment, demounting equipment, repair technique and all necessary items for maintenance for each system and its sub system.

The contractor shall submit 10 paper copies and 2 electronic copies maintenance manuals described maintenance, and language for the manuals shall be English.

II The North South Railway Project-South Line (Commuter) (NSRP-South)

5.1 Scope of Works

5.1.1 General

These requirements cover for the design, manufacturing, factory test, packing, delivery, installation, training, testing, commissioning, and interfacing works for completing the power distribution system on the NSRP-South.

The power distribution system are facilities for supplying electricity to railway facilities that require power, such as the stations, the depot, signaling system and telecommunications facilities, etc.

The power used by the stations, the depot, signaling system and telecommunications, etc. shall be supplied from the substation at high voltage (6.6 kV) and distributed via cables to each facility.

For the NSRP-South, it is necessary to supply distribution power to the line from the one power company, MERALCO. The Contractor shall apply to the power company for all temporary and permanent supplies to be utilized on this project.

The purpose of this design is to construct a reliable power distribution system.

(1) The work shall include the following:

Main line

1) 6.6kV distribution cable network in the main line to stations.
2) Low voltage cabling to ancillary buildings and battery posts, etc.;
3) Low voltage cabling for maintenance outlet and signaling equipment on the on the main line;
4) Low voltage cabling for outdoor lighting;
5) Outdoor lighting (including control panels) on the viaduct;

Stations and Depot

1) 6.6kV distribution cable network in the Banlic Depot;
2) Railway Electrical Rooms (hereinafter referred to as RER) and High Voltage Receiving Room (hereinafter referred to as HRR) in the stations and High voltage Electrical Room (hereinafter referred to as HER) in the Banlic Depot;
3) Distribution boards in the Banlic Depot;
4) Emergency Generators in the OCC building in Banlic Depot.;
5) DC battery chargers and the battery cubicles for HRR in the station and HER in the OCC building and Training Center;
6) Low voltage cabling for outdoor lighting, outdoor mechanical equipment and buildings which require electric power in the Banlic Depot;

7) Outdoor lighting (including control panels and concrete foundations) in the Banlic Depot;

8) Coordination with the interfacing Contractors (CP S-01 to CP S-07, CP04, CP05), regarding civil, structure, building service and architecture works including modifications required for installation of the requirement and restoring to final finishing;

9) Measuring and special Tools

10) Spare parts and consumables;

11) Documentation; and

12) Services

(2) The Services to be performed by the Contractor shall include the following:

1) Design, supply, system quality management, installation, testing including integrated testing and commissioning of the complete electrical distribution system;

2) Presentations, reviews and audit support as described in the General Requirements;

3) Interface management;

4) Decommissioning, removal and/or disposal of temporary works; and

5) Defects liability of the Permanent Works after commissioning as stipulated in the Contract.

All Employer's Drawings are conceptual design drawings and details shown on the drawings are for information only. The accuracy of preliminary details shown on the drawings cannot be guaranteed. The Contractor shall prepare detailed design drawings to achieve requirements of the ERT.

Where cable containment is not provided by others then cable containment shall be supplied by the Contractor which shall have 25% spare capacity for expansion works. All cable containment material, fixing methods, and routing shall be given Notice of No Objection by the Engineer

5.1.2 Scope of Supply

The Contractor shall supply all equipment necessary in order to accomplish the function required.

(1) Scope of works for 6.6kV Distribution systems

1) The Contractor shall provide all cables for 6.6kV power distribution systems.

2) The Contractor shall consider the effect of the induction voltage of the external transmission line (MERALCO) on the distribution line of this Project and shall coordinate with the relevant Contractors regarding the provision of study and measures.

3) In the embankment sections the contractor shall install cable containment for the 6.6kV cables and other cables.

4) In the Banlic Depot, 6.6kV cables shall be installed in buried ducts, concrete troughs, and manholes. The Contractor shall coordinate with the relevant Contractors regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the Civil infrastructure.

5) Riser cables from the substations and other buildings on the pillars in elevated sections shall be protected by galvanized steel pipes and/or covered cable trays.

6) In the station area, 6.6kV cables shall be installed on cable trays on the wall and/or on the ceiling.

(2) Scope of works for HRR and RER in the stations.

The Contractor shall provide all the equipment which enables work to be performed in accordance with the requirements of the contract. This includes the following:

1) 6.6kV Switchgear.

2) 6.6kV transformers.

3) Low voltage cables between transformers and switchgear.

4) Main switchgear.

5) Battery chargers, DC battery cubicles, earthing terminals, 6.6kV cables, low voltage cables and connection works.

6) Main earthing system with earthing rods and protecting conduits for stations shall be provided and installed by the Civil Contractor.

7) Earthing cables between main earthing system and earthing terminals.

(3) Scope of works for HER in the Banlic Depot

The Contractor shall provide all the equipment which enables work to be performed in accordance with the requirements of the contract. This includes the following

1) 6.6kV switchgear.

2) 6.6kV transformers.

3) Low voltage cables between transformers and switchgear.

4) Main LV Switchgear.

5) Battery chargers, DC battery cubicles, earthing terminals, 6.6kV cables, low voltage cables and connection works.

6) Main earthing system with earthing rods, and protecting conduits shall be provided and installed by the Civil Contractor.

7) Earthing cables between main earthing system and earthing terminal in HER.

(4) Scope of works for Emergency Generator Room (hereinafter referred to as EGR)

1) The Contractor shall provide all the equipment which enables work to be performed in accordance with the requirements of the contract.
2) Low voltage generator works.
3) Control equipment, low voltage cables, control cables and attachments work.

(5) Scope of works for DB in the Banlic Depot

1) The Contractor shall provide all the equipment which enables work to be performed in accordance with the terms of this Contract.
2) 6.6kV switchgear.
3) 6.6kV transformer.
4) Main LV Switchgear.
5) Low voltage cables between transformers and low voltage switchboards.
6) Main earthing system with earthing rods, earthing wires and protecting conduits shall be provided and installed by the Civil Contractor.
7) Earthing cables between main earthing system and earthing terminals in the DB.

(6) Scope of works for low voltage distribution in the main line

1) Low voltage cables in the main line shall be installed in cable containment provided by the contractor.
2) Low voltage cables work for outdoor lighting equipment, matching device box for track circuit (Signaling System equipment) and outlet for maintenance.
3) The Contractor shall provide outdoor lighting (including control panels) for emergency stairs etc.,
4) Protection devices for cable installation.

(7) Scope of works for low voltage distribution in the Banlic Depot

1) Low voltage cables in the Banlic Depot shall be installed in buried ducts, concrete troughs, and manholes respectively.
2) Low voltage cables work for outdoor lighting equipment, outdoor mechanical equipment and all buildings which require electric power
3) The Contractor shall provide outdoor lighting (including control panels) for emergency stairs etc.,
4) Outdoor lighting fixtures shall be mounted on poles.

(8) Scope of works for outdoor lighting in the Banlic Depot

1) The Contractor shall provide outdoor lighting (including control panels) in the Banlic Depot yard for maintenance works.
2) Outdoor lighting fixtures in the Banlic Depot yard shall be mounted on the poles and beams of the OCS.
3) Outdoor lighting on the road in the Banlic Depot shall be mounted on poles.

(9) Scope of works for outlets for maintenance

1) The Contractor shall provide outlets for maintenance on the main line, the locations and quantity of which shall be proposed by the contractor and approved by the Engineer.
2) Outlets for maintenance shall be mounted on the wall in the main line.

(10) Scope of works for earthing system

1) The main earthing system shall be provided by Civil Contractors.
2) The Contractor shall provide the earthing terminals in the RER and HER.
3) Contractor shall provide earthing cables between the main earthing system and earthing terminals.

(11) Out of Scope of works

1) Building works for RER, HRR and EGR including internal lighting, outlets, air conditioners and other building services.
2) In the main line, Station electrical room equipment including cabling between the main LV Switchgear installed by the Contractor in RER, REM and the LV panels in RER, REM.
3) In the Banlic Depot, Low voltage electrical room equipment including cabling between the main LV Switchgear installed by the Contractor in HER and the LV panel in the low voltage electrical room.
4) The exhaust equipment in the exhaust stack shaft installed between the emergency generator room and the vent on the roof. (The Contractor shall install an exhaust pipe for the emergency generator between generator equipment and the exhaust stack shaft in the emergency generator room.)

5.1.3 Scope of Works

The Works to be performed by the Contractor shall include at least the following:

1) Design, supply, system quality management, installation, testing including integrated testing, and commissioning to complete the power distribution system;
2) Presentations, reviews and audit support as described in the Employer's Requirements;
3) Interface management with relevant Contractors;
4) Design, identification of locations for concrete foundations for supporting structures if necessary, floor cinder concrete, earthing terminals for RER, REH, HER and DB, concrete troughs along the track, buried pipe and manhole in the Banlic Depot and coordination and interfacing with relevant Contractors;
5) Decommissioning, removal and/or disposal of temporary works; and
6) Defects liability of Permanent Works after commissioning as stipulated in the Contract.

5.1.4 System Overview

(1) System Studies

The Contractor shall carry out and provide results including the following power related studies to the Engineer for Approval:

1) AC 6.6kV power demands study;
2) Short circuit current, voltage drop and permissible current study;
3) Protection relay setting and system protection coordination study;
4) Power supply design, including the whole system, each station, each building and DB the Banlic Depot;
5) Earthing study;
6) Illuminance calculation for outdoor lighting;
7) Transformer capacity study;
8) Emergency generator capacity study;
9) Cable trough study;
10) Buried pipe study; and
11) Manhole study

(2) Power Supply System General Requirements

1) Substation will receive AC 69kV power and step-down to AC 6.6kV for supplying the power to RER, HRR, and DB. 6.6kV.
2) At the RER, HER and DB, AC 6.6kV power will be supplied through loop distribution line under the following conditions;

   The normal distribution direction in the main line is from the substation of the starting point and reverse distribution in the main line is from the substation of the terminal point.

In normal operation, all electrically utilization equipment of each RER shall be assigned to the normal distribution side line; and.

In case of failure of the normal distribution side line, 6.6kV distribution is changed over from the failed line to the remaining sound line.

3) The Contractor shall develop its own strategy for earthing and bonding in accordance with internationally recognized practices.

(3) System Integrity

1) The AC power distribution system shall be designed to ensure continuity of supply to the NSRP-South. System performance shall be maintained without load restriction under single outage conditions The AC power distribution system shall be provided with a protection system to ensure in the event that a faulty element is isolated; no other equipment is disconnected by the operation of such a protection device.

2) The power system design shall ensure that cables and equipment shall be separated and protected to ensure that;

3) A single failure of an element of the power supply system shall not affect the operation or result in failure of any other power supply system element or result in the total loss of power distribution to any part of the NSRP-South.

The opportunity for an incident external to the power supply system to affect the operation, or to result in failure of an element within the power supply system, or to result in a total loss of power distribution to any part of the NSRP-South shall be minimized.

(4) AC 6.6kV System

1) AC 6.6kV system shall be designed to ensure that voltage regulation under normal distribution and reverse distribution shall be maintained within 10% of normal voltage at any point on 6.6kV system.

2) All 6.6kV switchgear shall be designed and provided to support the ultimate capacity operation of NSRP-South, as well as the 6.6kV Loop Distribution System.

3) The normal distribution direction in the main line is from the substation of the starting point and reverse distribution in the main line is from the substation of the terminal point. In normal operation, all electrically utilization equipment of each RER shall be assigned to the normal distribution side line. In case of failure of the normal distribution side line, 6.6kV distribution is changed over from the failed line to the remaining sound line.

4) In the elevated section, 6.6kV cables shall be installed in cable containment provided by the Contractor.

5) In the embankment sections the contractor shall install cable containment for the 6.6kV cables and other cables.

6) In the Banlic Depot, 6.6kV cables shall be installed in buried pipes, concrete troughs and

handholes. The Contractor shall coordinate with the relevant Contractors regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the Civil infrastructure.

7) AC 6.6kV/400-230V distribution transformer for loop distribution shall be provided in each SER, RER, HER and DB in each station and Banlic Depot.

Table 5.1.2 Distribution Transformer Capacity of Station (Between Tutuban, Blumentritt-Calamba and Banlic Depot)

Station Name	Station Transformer, Signaling & Telecommunication Transformer (kVA)	Q'ty	Total Power (kVA)	Remarks
TUTUBAN	300	1	400	For Station Load
	100	1		For Signaling System and Telecommunications
BLUMENTRITT	1,000	1	1,850	For Station Load
	750	1		For Tenant
	100	1		For Signaling System and Telecommunications
ESPANA	750	1	850	For Station Load
	100	1		For Signaling System and Telecommunications
SANTA MESA	1,000	1	1,400	For Station Load
	300	1		For Tenant
	100	1		For Signaling System and Telecommunications
PACO	500	1	600	For Station Load
	100	1		For Signaling System and Telecommunications
BUENDIA	1,500	1	3,100	For Station Load

Station Name	Station Transformer, Signaling & Telecommunication Transformer (kVA)	Q'ty	Total Power (kVA)	Remarks
	1,500	1		For Tenant
	100	1		For Signaling System and Telecommunications
EDSA	500	1	600	For Station Load
	100	1		For Signaling System and Telecommunications
NICHOLS	750	1	850	For Station Load
	100	1		For Signaling System and Telecommunications
FTI	500	1	600	For Station Load
	100	1		For Signaling System and Telecommunications
BICUTAN	750	1	850	For Station Load
	100	1		For Signaling System and Telecommunications
SUCAT	750	1	850	For Station Load
	100	1		For Signaling System and Telecommunications
ALABANG	1,000	1	1,100	For Station Load
	100	1		For Signaling System and Telecommunications
MUNTINLUPA	750	1	850	For Station Load
	100	1		For Signaling System and Telecommunications
SAN PEDRO	1,000	1	1,100	For Station Load

Station Name	Station Transformer, Signaling & Telecommunication Transformer (kVA)	Q'ty	Total Power (kVA)	Remarks
	100	1		For Signaling System and Telecommunications
PACITA	1,000	1	1,100	For Station Load
	100	1		For Signaling System and Telecommunications
BINAN	1,000	1	1,100	For Station Load
	100	1		For Signaling System and Telecommunications
SANTA ROSA	1,000	1	1,100	For Station Load
	100	1		For Signaling System and Telecommunications
CABUYAO	1,000	1	1,600	For Station Load
	500	1		For Tenant
	100	1		For Signaling System and Telecommunications
BANLIC	1,000	1	1,100	For Station Load
	100	1		For Signaling System and Telecommunications
CALAMBA	1,000	1	1,600	For Station Load
	500	1		For Tenant
	100	1		For Signaling System and Telecommunications
Banlic Depot	2,000	2	2,000 x2	For OCC Building
	750	1	750	For Light Repair Shop

Station Name	Station Transformer, Signaling & Telecommunication Transformer (kVA)	Q'ty	Total Power (kVA)	Remarks
	1,000	1	1,000	For DB (Oil)

(5) Emergency Power Supplies

1) Low voltage emergency power supplies shall be installed in the the stations and in the HER of the OCC building in Banlic Depot.
2) Low voltage emergency power supplies shall automatically start up in the event of absence of 6.6kV supplies to the emergency generator room for CIA, OCC building and Training Center. Emergency power supplies shall be capable of automatically delivering the vitally demanded power, up to the rated value, within 40 seconds of absence of voltage on both 6.6kV incoming feeders being verified.
3) In order to test the operation of the emergency power supply, the Contractor shall provide facilities to enable the emergency generators to be started and to be connected to necessary loads.
4) Changeover from power company power to emergency power shall be done automatically through switching schemes.
5) Changeover from emergency power to power company power shall be done manually by means of a remote command entered into the Power SCADA system, and/or manual operation of circuit breakers. The interlocking schemes and Power SCADA programs shall be provided to ensure that emergency power is not fed out to the power company power feeders and/or that there are no conflicts loop distribution supply.

(6) Low voltage distribution

Low voltage system shall be designed to ensure that voltage regulation under normal feeding is maintained within 5% of normal voltage at any point within the system.

(7) Supervisory Control and Data Acquisition

The power distribution system in each HRR, RER and HER in the OCC building shall be remotely controlled and monitored from the Power SCADA system within the OCC.

5.2 Definitions and Abbreviations

5.2.1 Definitions

In this Specification, the following defined terms shall have the meanings ascribed to them below:

Standard Terminology	In general definitions applied to traction power and protective relay function conforms to International Electrotechnical Commission (IEC) standards,the Philipine Electrical Code, American National Standards Institute (ANSI).
Earthing	The same as 'grounding'. The connection of equipment enclosures and noncurrent carrying metal parts to ground to provide safety to personnel, public and to the equipment.
High Voltage	As applied for this Contract, high voltage is over 600V AC.
Low Voltage	As applied for this Contract, low voltage refers to voltage not exceeding 600V AC.
Substation	Substation receiving incoming supply from utility companies.
Railway Electrical Room (RER)	Railway Electrical Room which is installed inside the station, receives 6.6kV power and transforms 6.6kV to 400-230V AC at each station for supplying power to each station.
High Voltage Receiving Room (HER)	High Voltage Receiving Room receives 6.6kV power and transforms 6.6kV to 400-230V AC for supplying power to depot facilities.
Distribution Board (DB)	Outdoor Distribution Board receives 6.6kV power and transforms 6.6kV to 400-230V AC in the Banlic Depot for supplying power to the depot.
Emergency Generator Room	Emergency Generator Room generates 400-230V AC power for supplying power to the vital loads.
Switchgear	Means Isolator Switches, Load Break Switches, Circuit Breakers, Cutouts Interrupters, and other apparatus used for the operation, regulation and control of electrical circuits.
Withstand Capability	Rated capability of equipment to survive without damage by the mechanical forces of a short circuit or the thermal effects 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.
Remote Terminal Unit	Interface unit between PCU and SCADA

5.2.2 Abbreviations

Common abbreviations used in PS shall have the following meanings:

ACB	Air Circuit Breaker
CB	Circuit Breaker
DB	Distribution Board Space
DC	Direct Current
EGR	Emergency Generator Room
EMC	Electro Magnetic Compatibility
ERG	General Requirements
ERT	Technical Requirements
FAT	Factory Acceptance Test
HER	High voltage Electrical Room
HRR	High voltage Receiving Room
LBS	Load Break Switches
LED	Light Emitting Diode
LV	Low Voltage
MCCB	Molded Case Circuit Breaker
REH	Railway Electric House
RER	Railway Electric Room
RLCSD	Rail Leakage Current Suppressing Device
Rms	Root Mean Square
SER	Station Electric Room
VCB	Vacuum Circuit Breaker

5.3 Design Criteria, Applicable Standards and Codes

5.3.1 Design Criteria

Design criteria of the Power Distribution System of this Project shall be as follows:

(1) The general system configuration of the power distribution system

Power distribution system is composed of 6.6kV switchgears, 6.6kV transformers, Main LV Switchgear, emergency generator, DC battery, 6.6kV cables, LV cables, cable trays, concrete troughs, cable separators, manholes, buried pipes, outdoor lighting, outlet for maintenance and their attachments.

(2) Railway Electrical Room and High Voltage Receiving Room equipment

6.6kV indoor cubicle type switchgears; 6.6kV indoor cubicle type resin mold insulated transformers; Indoor cubicle type low voltage panels including air circuit breakers and molded case circuit breakers.

(3) Distribution Board equipment

6.6kV outdoor cubicle type switchgears; 6.6kV cubicle type eco-friendly oil immersed transformers; Outdoor type cubicle type low voltage panels including air circuit breakers and molded case circuit breakers.

(4) Emergency Generator Room equipment

400V-230V indoor enclosed type low voltage diesel engine generator set including generator panel and batteries for starting generator; Fuel tank; Radiator cooling system; Exhaust duct; Mufflers.

(5) Applicable Standards

Standards to be applied shall be the following:

1) IEC 60038 for IEC standard voltage
2) IEC 60529
3) IEC 62271 for HV switchgear
4) IEC 60947 for LV switchgear
5) IEC 61869 for Instrument transformers
6) IEC 60831-1 for Shunt power capacitor
7) IEC 60289 for Reactors
8) IEC 60071 for Insulation Co-ordinations
9) IEC 60076 for Power transformers
10) IEC 60287 for cable current capacity calculation
11) IEC 60502 for 1~30kV cables
12) IEC 60754 for test on gases evolved during combustion of materials from cables.
13) IEC 60034 for generators

14) IEC 60598, for outdoor lighting

15) IEC 62278 for RAMS

The contractor can propose alternative standards which shall be submitted to the Engineer for Approval.

5.3.2 Proven Design

The Contractor shall develop the design based on these requirements and on proven and reliable engineering practices. The design details shall be submitted with technical data and calculations to the Engineer for Approval.

The system, including all sub-systems and equipment, shall be of proven design.

Where similar equipment or sub-systems of a different rating are already proven in service, the design shall be based on such equipment. In case these stipulations are not fulfilled, the Contractor shall furnish sufficient information to prove the basic soundness and reliability of the offered sub-system and compliance with the design criteria.

5.4 Performance Requirements

5.4.1 Service Life

The design philosophy shall meet but shall not be limited to the following criteria:

(1) Application of state-of-the-art Technology;

(2) Service proven design;

(3) Design life 30 years;

(4) Minimum life cycle cost;

(5) Low maintenance cost;

(6) Use of interchangeable, modular components;

(7) Extensive and prominent labeling of parts, cables and wires;

(8) Use of unique serial numbers for traceability of components;

(9) High reliability;

(10) Low energy loss;

(11) System safety;

(12) Fire and smoke protection;

(13) Use of fire-retardant materials;

(14) Environment friendly to avoid contamination by oil leakage in case of incident;

(15) Adherence to operational performance requirements; and

(16) Maximum utilization of indigenous materials and skills, subject to quality conformity.

5.5 Operational Requirements

5.5.1 General

The Contractor shall take into account the specific data relative to the Philippines environment when conducting his studies, so as to guarantee his equipment against any abnormal alteration, as well as proper operation and performance of his apparatus under the least favorable environmental conditions.

5.5.2 Supervisory Control and Data Acquisition

The power distribution systems installed in HRR, RER and HER in OCC building shall be controlled both from the Power SCADA system remotely and from local sites, monitored at the Power SCADA system in the OCC. The power distribution systems installed in HER in Workshop, Light repair shop and DB are controlled only locally.

5.6 Functional Requirements

5.6.1 6.6kV switchgear

6.6kV switchgear shall be designed and manufactured in accordance with the Philippine Electrical Code and applicable standards.

(1) General

1) In HRR, RER and HER, 6.6kV switchgear shall be indoor type.
2) In DB, 6.6kV switchgear shall be outdoor type.
3) 6.6kV switchgear shall be compact modules in design, a metal enclosed type and suitable for indoor or outdoor installation.
4) 6.6kV switchgear shall be designed with current ratings and interrupting capacities complying with the design requirements according to these intended functions.
5) The rated current shall be determined by the Contractor as part of its design of works.

(2) 6.6kV switchgear shall be equipped with the following components:

1) Load break switches without fuses (for cutting off the earth faults cable from the line in an earth fault accident)
2) Vacuum Circuit Breaker (for protecting transformers)
3) Current transformers
4) Voltage transformers
5) Indication lamps (open, close, local and remote)
6) Protection relays
7) Metering devices (Ammeter, Voltmeter, Wattmeter, Power factor meter)
8) Interlocking devices
9) Cubicle

(3) 6.6kV load break switches ratings:

1) Rated voltage: 7.2kV
2) Number of phases: 3
3) Rated frequency: 60Hz.
4) Rated short circuit making current: to meet the 6.6kV system fault level
5) Rated insulation level: to meet the 6.6kV system fault level
6) Rated short-time withstand current: to meet the 6.6kV system fault level
7) Auxiliary power supply voltage for operating device: 110V DC

(4) 6.6kV vacuum circuit breaker ratings:

1) Rated voltage: 7.2kV
2) Number of phases: 3
3) Rated frequency: 60Hz
4) Rated short time withstand current: to meet the 6.6kV system fault level
5) Rated short circuit breaking and making current: to meet the 6.6kV system fault level
6) Rated insulation level: to meet the 6.6kV system fault level
7) Auxiliary power supply voltage for operating device: 110V DC

(5) Current transformer ratings:

1) Rated voltage: 7.2kV
2) Number of phases: 3
3) Rated frequency: 60Hz
4) Rated secondary current: 5A
5) Rated short time current: to meet the 6.6kV system fault level

(6) Voltage transformer ratings

1) Rated voltage: 7.2kV
2) Number of phases: 3
3) Rated frequency: 60Hz
4) Rated secondary voltage: 110V AC
5) Rated short time current: to meet the 6.6kV system fault level

5.6.2 6.6kV transformer

6.6kV transformer shall be designed and manufactured in accordance with the Philippine Electrical Code and applicable standards.

(1) General

1) In HRR, RER and HER, the 6.6kV transformer shall be mold type, indoor type and natural cooling type.
2) In DB, the 6.6kV transformer shall be oil immersed type, outdoor type and natural cooling type.
3) Two transformers (for main use and spare use) shall be installed in HER in the OCC building.
4) The primary and the secondary windings shall be capable of withstanding a symmetrical three phase short circuit regardless of the tapping selected.
5) The rated Capacity shall be determined by the Contractor as part of its design of works.

(2) 6.6kV transformer shall be equipped with the following components:

1) Mold type transformer (for HRR, RER, HER)
2) Eco friendly oil immersed type transformer
3) Protection relays
4) Metering devices (thermometer)
5) Cubicle

(3) 6.6kV mold type transformer ratings:

1) Rated primary voltage: 6.6kV (tap changing from +2.5% to -2.5%)
2) Rated secondary voltage: 400V-230V
3) Number of phases: 3 (3 phase-4wire method)
4) Rated frequency: 60Hz
5) Type: mold
6) Cooling: natural cooling type
7) Rated insulation level: to meet the 6.6kV system fault level

(4) 6.6kV eco-friendly oil immersed type transformer ratings:

1) Rated primary voltage: 6.6kV (tap changing from +2.5% to -2.5%)
2) Rated secondary voltage: 400V-230V
3) Number of phases: 3 (3 phase-4 wire method)

4) Rated frequency: 60Hz

5) Cooling: natural cooling type

6) Rated insulation level: to meet the 6.6kV system fault level

5.6.3 Main LV Switchgear

Main LV Switchgear shall be designed and manufactured in accordance with the Philippine Electrical Code and applicable standards.

(1) General

In HRR, REH, and HER, Main LV Switchgear shall be indoor type.

In DB, Main LV Switchgear shall be outdoor type.

Molded-case circuit breakers and Air circuit breakers shall have the design uninterrupted current rating when enclosed and in its operating environment with a rated operational voltage as specified for the switchgear. The circuit breaker shall meet the fault conditions specified for the panels.

Air circuit breakers shall be lockable at drawn in and drawn out positions or drawn in position when in the open state.

Air circuit breakers shall be moveable at drawn out position or drawn in position when in open state.

To prevent accidental contact with live parts, switches of the withdrawal chassis or insulating type shall have either fully shrouded fixed contacts or insulated cover plates.

Number and each electric system and capacity of low voltage circuits for main LV switchgear shall be given by interfacing contractors, except the circuits which are designed by others. The contractor shall design main LV switchgear according to this information.

(2) Main LV Switchgear shall be equipped with the following components:

1) 400V triple pole neutral molded-case circuit breaker or air circuit breaker

2) Indication lamps

3) Protection relays

4) APFC (Auto power factor control)

5) Metering devices Digital type (A, V, W, WH, kVar, pf)

6) Cubicle

(3) Main LV Switchgear for switching of the commercial power supply and the emergency power supply shall be equipped with the following components:

1) 400V Double throw triple pole molded-case switch

2) Indication lamps

3) Protection relays

4) Metering devices Digital type (A, V, W, WH)

5) Cubicle

(4) Main LV Switchgear for LV power capacitor equipment shall be equipped with the following components:

1) Electromagnetic Contactor

2) Power Capacitor with Protect devices

3) Series Reactors

4) Indicator

5) Cubicle

5.6.4 DC Battery and Charger

The DC battery and charger shall be designed and manufactured in accordance with the Philippine Electrical Code and applicable standards.

(1) General

1) The DC battery and charger shall be installed in the HRR, RER in stations and HER in the OCC building.

2) The battery type, rated capacity of battery, battery charger type shall be determined by the Contractor as part of its design of works.

(2) Battery Units (NiCad: Nickel-Cadmium rechargeable battery)

1) For the HRR, RER in stations and HER in the OCC building, the Contractor shall provide an 110V battery system for safety tripping, service current functions and power to the Power SCADA remote terminal units.

2) The battery system shall be rated to supply the standing loads for a minimum of 3 hours in the event of a charger supply failure, and at the end of that period the battery shall be capable of operating each item of equipment for one cycle, i.e. one cycle means one open and one closed.

3) The output voltage shall be within the tolerances defined for operation in the relevant equipment specifications.

4) The 110V batteries shall be of the sealed, maintenance free type and shall not emit hazardous gases.

(3) Battery Chargers

1) Battery chargers shall be provided with self-regulation and shall be capable of restoring a minimum of 80% of battery capacity within 4 hours of full discharge.

2) Sufficient indications shall be provided on the battery charger to provide status; thus, information shall be provided to the SCADA system.

3) Battery charger's information of the battery charger system, as a minimum this shall include battery voltage, trickle charge and booster charge currents, battery charge functioning and battery charge failure. In addition, status shall include measuring

instruments such as ammeters and voltmeters as a minimum.

4) In the HRR, RER and HER in OCC building, AC auxiliary power for the battery charger shall be fed from the main LV Switchgear.

5.6.5 Emergency Power Supply System

Emergency power supply system shall be designed and manufactured in accordance with the Philippine Electrical Code, the Fire Code of the Philippines and applicable standards.

Emergency Power Supply

(1) General

Emergency power supplies shall be at the stations and the OCC building.

Emergency power supplies shall automatically start up in the event of absence of incoming 6.6kV supply. Emergency power supplies shall be capable of automatically delivering the essential demanded power, up to the rated value, within 10 seconds of absence of voltage on both incoming 6.6kV supplies being verified. Prior to the starting of the generator all critical equipment shall remain in operation by means of individual UPS's.

Emergency power supply in the Banlic Depot shall supply low voltage power required for in the Banlic Depot including the OCC building through LV circuits directly.

Exhaust gas shall be controlled in accordance with regulations in the Philippines.

(2) Emergency Generators

Emergency generators shall be enclosed type diesel generators.

Emergency generators shall be of 400-230V AC rating and for using to 3 phases 4 wires system.

The Contractor shall determine the actual capacity of the emergency generators to cater for the starting and running of the equipment according to the operational scenarios as specified.

The essential load and the emergency load which required power supply in case of power supply failure shall be installed at the OCC building.

The emergency generator equipment shall be completed with fuel storage facilities and shall be capable of providing the specified performance continuously for a minimum period of 48 hours, without the requirement for inspection or attention. The emergency generator facilities shall be designed to enable indefinite extension of this period by permitting refuelling of the fuel tank while the generator is running.

The emergency generator equipment shall be completed with fuel supplying facilities from the supplying outlet on the ground and exhaust air ducts to the outdoors.

The emergency generator equipment shall be capable of withstanding a sudden short circuit at the emergency generator terminals, whilst operating at rated load and maximum working temperature without any damage.

The emergency generator equipment shall also be capable of withstanding maximum over-speed without any damage, as defined in IEC 60034.

The emergency generators and exciters shall be of the totally enclosed, brushless type, and shall comply with the requirements of IEC 60034.

The line and neutral phase ends shall be brought out to separate terminal boxes.

The emergency generator and exciter winding insulation shall conform as a minimum to temperature 'Class F' in accordance with IEC 60034.

All necessary metering instruments, current and voltage transformers for protection, control and metering shall be provided.

The emergency generator equipment shall be complete with noise control facilities complying with local codes and with the environmental requirements for noise pollution.

Anti-vibration mounting for generator engines shall be provided.

(3) Emergency Generator Excitation

The emergency generator excitation system shall be of the fast-acting type to ensure rapid response during motor starting and sudden load change.

In the event of a fault at or near the emergency generator terminals, the excitation system shall maintain the generator fault current of not less than 3 times rated continuous current during the time required for the associated protection device to operate.

The rotating rectifier shall employ silicon diodes. The diodes shall be adequately rated to accommodate the steady state current, maximum voltage and environmental operating conditions and shall ensure satisfactory operation of the rectifier diodes in the event of surges.

(4) Protection and Monitoring

Protection shall be provided to trip the emergency generators in the event of rectifier failure.

The automatic voltage regulator shall be easily adjustable, for setting the reference voltage, gain and damping. The devices enabling adjustment shall not be mounted directly on the emergency generator, but in a separate control cubicle.

The automatic voltage regulators shall be responsive to three-phase terminal voltage. Circuits shall be provided to detect malfunction of the automatic voltage regulator and trip the emergency generator.

The necessary voltage transformer, arranged in single phase units, shall be provided and shall be used exclusively for the regulator.

Anti-condensation heaters shall be provided in the emergency generator and exciter units.

Emergency power supply shall be controlled and monitored both remotely and locally. The Contractor shall provide local control panel with a changeover switch, permitting local control or remote control. The local control panel shall include all necessary control and monitoring devices (e.g., voltage regulator, synchronism device, and so on), all protection systems and all metering devices, and interface with the SCADA to enable remote control and monitoring.

・Grounding

The low voltage generator's neutral point shall not be grounded. The earthing fault protection shall be limited during emergency generator operation.

・Starting

An auxiliary power supply shall be provided by means of appropriately sized battery to enable starting of the emergency generator.

After starting, the auxiliary power supply shall then be connected to the output of the emergency generator.

(5) Fuel

1) Fuel shall be considered from the viewpoint of eco-friendly.

2) Continuous operation time of a generator shall be not less than 48 hours.

3) Fuel tank capacity shall be as below.

・OCC Building 3 ϕ 4W 400/230V 60Hz: not less than 4800L

5.6.6 Cables

Cables shall be designed and manufactured in accordance with the Philippine Electrical Code and applicable standards.

All cables to be installed in the facilities shall be low smoke non-halogen compound (LSZH) type and fire retardant.

(1) All cables shall be sized to carry the continuous current required by the Specification and shall be also based on the Contractor's estimations. The cables shall be able to withstand the short circuit currents associated with the Contractor's design.

(2) The ratings applied to any cable shall be determined by the most onerous installation condition in any cable route.

(3) Termination and splicing shall be made by the qualified engineer. Each terminal of the cables shall be connected with respective power distribution panels and/or equipment.

(4) Cables for 6.6kV power distribution

1) The ratings of cables for the 6.6kV power supply system shall be determined by the calculation in accordance with IEC 60287 or Equivalent for a maximum operating conductor temperature of 90 degrees Celsius.

2) 6.6kV cables shall comply with IEC 60502 or Equivalent

3) Cables for 6.6kV distribution shall be provided with stranded copper conductor in trefoil formation sized to suit the power supply system design and to satisfy short circuit current requirements.

4) Cables for 6.6kV distribution shall be Cross-linked polyethylene insulated polyvinyl chloride sheathed (XLPE) cables.

(5) Cables for LV power distribution (CV) C: Crosslinked polyethylene V: PVC

1) The ratings of cables for the 400/230V power supply system shall be determined by the calculation in accordance with IEC 60287 or Equivalent for a maximum operating conductor temperature of 90 degrees Celsius.

2) Cables for 400/230V distribution shall be provided with stranded copper conductor sized to suit the power supply system design and to satisfy short circuit current requirements.

(6) 6.6kV Cables for Grounding

1) Grounding cables shall comply with the Philippine Electrical Code.

(7) Conductor size of Cable

1) Cable conductor sizes are indicated on the drawings for reference; actual conductor sizes shall be determined by the Contractor and shall be subjected to approval by the Engineer.

(8) Cabling

1) Elevated section and embankment section cables shall be installed in cable containment provided by the contractor.

2) The Contractor shall decide the appropriate access routes of the cables into the SS and HRR, RER; and shall provide cable trays for cabling. The Contractor shall coordinate with the relevant Contractors regarding the openings for cable entering on the building walls and/or floors.

3) All openings for cabling on the building walls and floors shall be filled with non-flammable materials, after all cables have been installed, to prevent fire extension. Non-flammable materials shall be given Notice of No Objection by the Engineer.

5.6.7 Earthing system

Earthing system shall be designed and manufactured in accordance with the Philippine Electrical Code, IEC, IEEE and other applicable international standards.

(1) The main earthing system for stations, OCC building, workshop, Light repair shop and DB shall be provided by the Civil Contractor.

(2) The earthing shall be laid from the main earthing system to the earthing terminal in HRR, RER, HER and DB by the Contractor.

(3) The earthing terminal box in RER, HER and DB shall be provided by the Contractor.

5.6.8 Outdoor lighting

Outdoor lighting shall be designed and manufactured in accordance with the Philippine Electrical Code, IEC and other applicable international standards.

(1) Outdoor lighting in main line

1) Outdoor lighting for the main line shall be provided near the point machines, access stairs, in tunnels and covered areas and other dark areas where there is no or limited ambient lighting and at stabling sidings.

Lighting level shall be not less than 5 lux of the horizontal illumination at the track level.

2) Lamp of lighting fixtures shall be LED type.

3) An automatic control panel for outdoor lighting shall be provided. The panel shall be capable of operating based on setting of weekly schedule timer. The lighting shall also be switched according to the control signal from photo sensors. Local by-pass switches shall be provided for maintenance and a driver's walking path.

4) Outdoor lighting and the automatic control panel for outdoor lighting in the main line shall be mounted on the OCS poles and beams.

5) Electric power to the lighting circuits shall be supplied from the HRR near the station.

(2) Outdoor lighting in the Banlic Depot

1) Outdoor lighting shall be provided on a self-standing type pole with foundation for the access roads in the Banlic Depot.

2) Outdoor lighting shall be mounted on the OCS poles for the yards and point machines in the Banlic Depot.

3) Lighting level for the access roads and point machine shall be not less than 5 lux of the horizontal illumination at the track level, and not less than 20 lux for Banlic Depot yards respectively.

4) Lamp of lighting fixtures shall be LED type.

5) Automatic control panel for Banlic Depot yard lighting and point machine lighting shall be provided. This panel shall be capable of operating based on setting of weekly schedule timer. The lighting shall also be switched according to the control signal from photo sensors. Local by-pass switches shall be provided for maintenance.

6) Outdoor lighting for access roads is switched on/off by photo sensors automatically.

7) Electric power to the lighting circuits shall be supplied from the main LV Switchgear the HER or DB.

8) Outdoor lighting in the Banlic Depot shall be split into zones according to the area such as the stabling yard, access road and pavement, Banlic Depot yard, etc. The Contractor shall coordinate with interfacing parties on the zoning.

9) All the outdoor lighting poles shall be made into structures bearing a 44.4m/sec wind velocity.

10) Outdoor lighting apparatus shall comply with IEC60529,-and provide with an IP66 grade.

11) Solar street lighting system shall be adopted.

The solar street lighting system basically consists of:

a. Solar photo voltaic Module
b. Luminaire / LED streetlight
c. Low maintenance battery
d. Pole and solar panel bracket

e. Battery box

f. Interconnecting cables

The solar photovoltaic module is fixed firmly on top of the pole with suitable tilt and inclination so as to receive maximum sunlight throughout the day. The solar photovoltaic module. The solar battery is housed inside a battery box.

5.6.9 Outlet Box for Maintenance

Outlet boxes for maintenance shall be designed and manufactured in accordance with the Philippine Electrical Code, IEC and other applicable international standards.

(1) The outlet box shall be provided for portable electrical tools and lighting for maintenance work.

(2) The outlet box shall be outdoor type and provided on the wall near the point machine.

(3) The outlet box shall be able to supply 1kVA. However, maximum electric power supply simultaneously from one circuit of outlets shall not exceed 1kVA.

(4) In a case where 1kVA load is used at the end of the outlets box, voltage drop shall not exceed 5 %.

5.6.10 Power SCADA

(1) General

The power SCADA (microprocessor based Supervisory Control and Data Acquisition system for power supply system) shall be designed, supplied, installed, tested and commissioned by the Interfacing Contractor for the Substation System and overhead line for smooth operation, monitoring, control and logging of important features of the traction and auxiliary power supply system on the NSRP-South. The Contractor shall design, supply, install, test and commission only metallic wiring between RTU and electric equipment to be controlled and monitored in HRR, HER in the OCC building and low voltage power distribution circuits from the battery system to the RTU.

The Contractor shall make close coordination with Interfacing Contractors to resolve interface issues.

(2) Control and Monitoring Items of Power Distribution System

1) The Power SCADA system shall control and monitor the 6.6kV and LV power supplies in the HRR, RER, HER in OCC building, which shall include indications of the status of all electrically operated switching devices on the 6.6kV AC system, together with alarm and protective devices.

The same requirement shall also apply to the main breakers and tie breakers of the main LV switchgear in the HRR, RER, HER in the OCC building.

Power SCADA monitoring facilities for power supplies shall include, but shall not be limited to:

a. Voltage of all 6.6kV;

b. Current of all 6.6kV;
c. Status of LBS and VCB;
d. Status of Emergency generator equipment;
e. Status of DC battery and charger equipment;
f. Status of all protection equipment;
g. Operation of LBS and VCB;
h. Operation of alarm and protection devices
i. Overhead Line isolator control and monitoring

(3) Power Supplies

Power supply to RTU shall be supplied from the 110V DC battery system of control source for HRR, RER or HER.

5.6.11 Drawings and lists for Approval

(1) Detailed design drawings, associated specifications and technical data/calculations shall be submitted to the Engineer for approval of the following:

1) Shop and/or manufacturers drawings;
2) Working/installation drawings;
3) Shop test reports; and
4) Manufacturers specifications.

(2) Drawings shall indicate legends for all symbols used in the drawings.

(3) Plans for cabling route on the main line and in Banlic Depot.

1) Single line diagrams of HRR, RER, HER, DB and EGR in the stations and the Banlic Depot.
2) Layout plan of the electrical equipment for HRR, RER, HER, DB and EGR in the stations and the Banlic Depot.
3) Cabling routes and methods between the main line and HRR, RER or Substation;
4) Cabling routes and methods in the Banlic Depot; and
5) Layout plan of outdoor Lighting and control panels which supply power to outdoor lighting in the main line and the Banlic Depot.
6) Distribution network diagram for outdoor lighting in the main line and the Banlic Depot
7) Standard mounting of outdoor lighting in the main line and Banlic Depot.
8) Cross section drawings indicating installation position of cables, outlet boxes and troughs;
9) Schematics for cable routing on the main line and in Banlic Depot.

(4) List of cables shall be submitted to the Engineer for his approval, and shall include the following information for each cable:

1) Cable identification number;

2) Type of cable;
3) Rated voltage;
4) Number of cores;
5) Cable size;
6) Overall diameter;
7) Cable termination at each end;
8) Location of Cable splicing;
9) Connection point at each end with equipment identification and terminal numbers; and
10) Cabling route.

5.7 Installation Requirements

5.7.1 General Requirements

The Contractor shall comply with all enactments in executing the works, at least including all statutory provisions on occupational health and safety.

The Contractor shall coordinate with the interfacing parties of this Contract and other Contractors in the execution of the works.

The Contractor shall also cooperate with all Relevant Authorities in the execution of the works.

The installation of all equipment shall be undertaken at all times by suitably trained and competent employees of the Contractor, to the satisfaction of the Engineer.

Only appropriate tools, plant, equipment and vehicles shall be used.

Installation of all equipment shall be in accordance with the coordinated installation plan described in the ERG.

Installation of all equipment shall conform to the best industry practices.

Precautions shall be undertaken to ensure the safety of personnel and equipment for all installation works.

The Contractor shall, prior to starting any installation work, identify any possible hazards, and implement measures of eliminating and/or controlling such potential hazards, in line with safe working practices.

Further details on the Site safety management are described in the ERG.

The Contractor shall coordinate with the relating Contracts regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the civil infrastructure.

The Contractor shall coordinate its requirements for earthing and bonding system with Interfacing Contractors, such as wiring routes and locations of ground rods installation.

The Contractor shall ensure that all areas of work are sufficiently illuminated for the Works to be undertaken and that a safe system of work is employed for all activities.

The Contractor shall operate a robust system for the control of persons entering or working upon the Site. The system shall include as a minimum:

(1) Register of all employees;

(2) Personal identification, with photograph;

(3) Levels of competency;

(4) Date of expiry;

(5) Date of issue;

(6) Signature; and

(7) Register of all visitors.

The Contractor shall co-operate, at all times, with the Engineer and other Contractors to ensure that the Site is protected from unauthorized admission, either willfully or otherwise.

The Contractor shall make due provision for the safe access and egress to the Site of Works for its staff and subcontractors. This access shall be maintained such that it is free of all hazards and is in a safe condition throughout the duration of the Works.

5.7.2 Specific Requirements

The installation work pertaining to this Contract shall at least include the following:

(1) Finalization of the Construction and Installation Program;

(2) Survey on the Site and review the technical requirements;

(3) Production of the calculation sheets and installation drawings for the Site installation;

(4) Installation in accordance with the finalized installation drawings;

(5) Co-ordination with other Contractors;

(6) Submission of the installation reports and records;

(7) Production of as built drawings, documents, calculation sheets, and records.

5.7.3 Installation of Cables

Laying of Cables

(1) Cable risers shall be protected with cable trays/ steel conduit pipes.

(2) Bending radius of low voltage cables shall be not less than 8 times for single core type and 6 times for multi core type the outside diameter of the cable respectively.

(3) Cable trays shall be fixed to the wall or the ceilings, fixing intervals shall be less than 1.5 m.

(4) Cables laying with cable trays on the vertical direction shall be bound tightly at the 1.5 m

intervals.

(5) No tension is permitted for splicing of the cables.

(6) Openings for cables drawn into switchgear, switchboards and equipment shall be protected properly so that no pests or moisture can enter.

(7) Occupancy of cables in the trough shall be not more than 60 %

(8) The Contractor shall coordinate with Interfacing Contractors (CP N-01 to CP N-05) regarding the provision of cable routes and installation, including methods of mounting the cable containment systems to the civil infrastructure.

5.8 Interfacing Requirements

5.8.1 General

The Contractor shall liaise and coordinate with Interfacing Parties to ensure the effective and compatible coordination of all aspects of design, installation, testing and commissioning of work.

5.8.2 Contractor's Responsibility

(1) The Contractor shall ensure that all the interface items of this specification shall include in the interface management plan.

(2) Other items not mentioned in the interface items but are relevant to the design, installation, testing and commissioning of permanent works, shall also be included in the interface management plan.

5.9 Testing, Commissioning and Verification

5.9.1 General

The Contractor shall develop a full Test Plan which shall be submitted for approval by the Engineer. The tests mentioned herein are indicative and shall be the minimum requirement. The Contractor shall clearly categorize the types of tests required in this Part with the following in the Test Plan:

- Pre-commissioning tests,
- Commissioning tests, and
- Test Run and Trial Operation.

(1) Test Certificates

All principal test records and test certificates duly endorsed by the Contractor are to be submitted for the approval by the Engineer. These test records and certificates shall be supplied for all tests, whether or not the Engineer has witnessed them. The information given on such test certificates shall be sufficient to identify the materials or equipment to which the certificate refers.

(2) Cost of Tests

1) The Contractor must bear the cost of all necessary tests.

2) As for the cost of the test which is carried out outside Philippines, the Contractor must bear the expenses relating the witnessing and the verification by the Employer and the Engineer.

3) Test Plan and Procedures

All the test plans and procedures with the exact time and date shall be submitted for the approval of the Employer at least 30 days prior to any test's conduction.

5.9.2 Factory Acceptance Tests (FAT)

FAT shall comprise Type Tests, Sample Tests, Routine Tests, Life, Endurance and Destruction Tests, and any additional tests requested by the Engineer.

The testing shall be conducted such as to simulate the working conditions as closely as possible.

Upon the request of the Engineer, destruction tests shall be carried on components and assemblies to verify the design loading.

All the tests shall be conducted both on the assembly and on the members/components of each product in accordance with design specifications and applicable Standards.

5.9.3 Contractors Responsibilities for On-site Testing

(1) The Contractor shall implement all tests in accordance with the Test Plan. During the course accuracy as may be required. On completion of erection and prior to commissioning, all power cables shall be tested to the acceptance of the Engineer in accordance with an agreed Inspection and test plan to demonstrate that it is entirely suitable for commercial operation.

(2) The Contractor shall be responsible for providing temporary electricity supply, all instruments, gauges, test equipment, tools, accessories, personnel, services and necessary facilities required for the execution of all tests and inspection. Wherever necessary, the Contractor shall provide two or more sets of testing equipment, tools, and others to expedite testing. All test equipment shall be accompanied with the appropriate calibration certificate by a testing authority of the equipment.

(3) Test equipment, tools, and others necessary for subsequent preventive and corrective maintenance are to be provided to the Engineer as specified herein and shall be available to assist the tests. The use of these test equipment, tools and others shall be subject to approval by the Engineer.

(4) The Contractor shall be responsible for surveillance and security of the Electrical Room and Distribution downstream cables or other electrical equipment is energized before it has been tested and before the relevant Contractors or Sub-contractors' facilities are ready and secured. The Contractor's responsibility for surveillance and security of the system shall remain in force for each part of the system until such a time that the Engineer issues the appropriate certificate, and the Employer takes over the System.

5.9.4 Installation Tests

(1) Installation Tests

An inspection and visual verification of ratings and connections with equipment shall be carried out prior to installation tests.

Un-energized equipment shall be inspected for its visual and tested for operation after installation of equipment. Inspections and tests shall include the following:

a) Cleanliness,

b) Workmanship,

c) Confirmation of items conforming to ratings required,

d) Water and dust proofing,

e) Leveling, mounting and positioning,

f) Joints and connections tightness,

g) Cables – dressing, bending radii, jointing and finish at terminals,

h) Clearances and dimensions in conformity with drawings,

i) Earthing and bonding.

j) Functioning of circuit breakers, load break switches, isolating switches and their interlocks.

k) Protection devices, and

l) Phase sequence verification.

m) Ground resistance shall be measured individually, and for the subsystem and system.

n) Insulation Resistance

The insulation resistance of all 6.6kV circuits shall be tested with an insulation tester of 1.0kV rating. All LV circuits comprising ac and AC and DC auxiliary circuits shall be tested with a 500V insulation tester.

Tests on Current Transformers shall include the following:

a) Insulation resistance.

b) Winding resistance.

c) Polarity of Connections up to equipment terminals, and

d) Ratio and magnetization curve verification.

Tests on Voltage Transformers shall include the following:

a) Voltage ratio.

b) Insulation resistance, and

c) Polarity of connections up to the equipment terminals

Secondary and primary injection tests shall include the following:

Tests shall be carried out at a minimum of three settings if multiple settings are available. Test results of operation boundaries and operating times shall be recorded.

Batteries and Chargers

Discharge tests and charging tests shall be carried out to verify the capacity of the batteries and all functions available on the charger. Continuous measurements of battery voltages shall be made together with periodic readings of the electrolyte specific gravities and temperatures. No addition of electrolyte is permitted during discharge tests.

The operation of the boost charge facility and the effect of the voltage dropping diodes shall also be demonstrated.

Control, Indication and Alarm Functions shall include the following:

i. Insulation resistance and continuity of all cores of cables shall be identified and tested, and

ii. The correct functioning of all control, indication and alarm devices shall be verified.

Switchgear

All switchgear, including circuit breakers, load break switches and earthing switches, shall be operated to prove that the operating gear, tripping devices, protective gear and mechanical interlocking are satisfactory.

Metering Instruments and Transducers

All current and voltage transformers, metering instruments and transducers shall be calibrated by voltage and current injection to prove their accuracy classes.

5.9.5 Receiving Acceptance Test

The following tests shall form part of on-site and System Acceptance Tests as part testing of the equipment and system.

(1) Functional Tests and Interlock Tests shall include the following:

All control and protection functions and electrical/mechanical interlocks shall be tested.

(2) Primary Injection Tests shall include the following:

The Contractor shall carry out primary injection tests on each protective system, to prove the auxiliary circuit connections, the relay fault setting values, the correct metering indications and the stability limits.

(3) AC/DC Pressure Tests shall include the following:

The insulation resistance of all circuits shall be measured before and after the dc pressure test using a 500V insulation tester. The minimum phase-to-phase and phase-to-earth insulation resistance shall be 100 mega ohms. Pressure tests shall be carried out on completed cable lengths of high voltage cables in accordance with IEC 60502.

(4) Energization

The Contractor shall prepare operation safety rules and procedures for the approval by the Engineer before Energization.

The Contractor shall check all to ensure safe Energization.

All power equipment shall be subject to inspection by inspectors from the Electrical Inspectorate of the Employer before Energization.

The Contractor shall be responsible for the operation of traction and auxiliary power equipment. Upon request by the Engineer, the contractor shall be responsible for the disconnection and the subsequent reconnections of the power equipment.

5.9.6 Integrated Testing and Commissioning

(1) Integrated Testing and Commissioning refers to those tests undertaken in order to demonstrate that the various components of the systems operate satisfactorily between one another, and meet all specified requirements for design, operability, safety, and integration with other Works and systems. These tests shall be entirely within the requirements of one or more of the project contracts or they shall involve a multiplicity of contract procedure. The final Integrated Testing and Commissioning shall be conducted after the SCADA system and OCC have become operational.

(2) Systems that can be tested without depending on the running of trains, such as SCADA system, the emergency trip system shall have their integration tests scheduled to commence as early as possible. It is preferable that any interface problems associated with these "no train" system tests be identified and resolved prior to the test running.

(3) The following is an indicative listing of those Integrated Testing and Commissioning functions that necessarily to be integrated with others to demonstrate that the equipment and controls of the Power Distribution System meet the Contract Specifications and demonstrate a safe-to-operate condition.

This listing is not exhaustive and shall be updated by the appropriate contractor, to demonstrate functionality, completeness and safety of the installed works and shall be submitted to the Engineer for his approval.

a) HRR, RER, DB and Generator failure mode test.

b) Remote control and monitoring test through SCADA system at the OCC

c) Emergency trip system tests.

d) Power system functional tests.

e) EMI/EMC tests.

f) Touch/step potential tests.

The Contractor shall provide attendance to the Engineer during integrated test in relation to the insulation of train station platforms provided by the other contractors.

(4) On-load Tests and Directional Tests

Once sufficient load current is established, voltages and currents into protection and metering equipment shall be verified to ensure correct operation of protection relays and accuracy of meter readings at local and remote locations.

5.9.7 Test Run and Trial Operation

The Contractor shall provide special and general attendance during the Test Run and Trial Operation period such that the persons who conduct the On-Site Testing and Commissioning are available on the Site to solve any problem arising from the Test Run and Trial Operation.

5.9.8 Performance Verification

(1) The Contractor shall carry out the pre-commissioning and commissioning tests to verify that the performance of the System meets the Employer's Requirements before the substantial completion of the Works.

(2) One of the Performance Tests which shall be conducted by the Contractor in conjunction with relevant Contractors, Sub-contractors and other Parties is the measurement of EMI levels at locations that have received a Statement of approval by the Engineer. Such measurements shall be conducted prior to Energization of the Traction Power System, and then during Service Trials and commercial operation of the train services to ensure that the EMI levels meet the Employer's Requirements and are in accordance with the Contractor's designs give Notice of No Objection by the Engineer.

(3) Should the performance of the System deviate from the Contractor's designs given Notice of No Objection by the Engineer, the Contractor shall rectify the deviation in the shortest possible time.

(4) The Contractor shall submit a certified report of the results of these Tests to the Engineer within 14 days from the date when the Engineer confirmed that the Contractor has passed each of the Tests.

5.10 Measuring and Special Tools

5.10.1 General Requirements of Measuring and Special Tools

Details of the measuring and special tools are described in the Employer's Requirements – General Requirements. The Contractor shall provide measuring and special tools for future commercial operation. The Contractor shall submit the lists of those tools to the Engineer for his approval. The list shall include detailed description with references and correlation with the maintenance manuals.

5.10.2 Special Tools and Test Equipment

(1) The contractor shall provide the following special tools and test equipment as a minimum:

Test Equipment:

a) Analog Insulation Tester, M /. megohmmeter (DC 250, 500, 1000 V) : 1 set

b) Switchgear Testing Devise (Operating time, Lowest operating voltage, trip/input current wave measuring) : 1 set

c) Protection Relay Testing Devise (OMICRON OMC 356) : 1 set

d) PC for the Protection Relay operation (laptop type) : 2 sets

5.11 Training Requirements

5.11.1 General

The Contractor shall supply the appropriate training for the operation and maintenance staff of the Employer according to the General Requirements. The Contractor shall submit the training plan to the Engineer.

5.11.2 Scope of Training

The Contractor shall provide the theoretical and practical training for software and hardware used for the Power Distribution system to the Employer's staff and instructors.

5.11.3 General Requirements

The training shall be provided at the places where can achieve the great effect to the trainee. The training locations shall be at places with factory, domestic, overseas and at other required places. The optimum locations shall be proposed for the training.

5.11.4 Training Plan

The Contractor shall prepare and submit the training plan to the Engineer for Approval. The training plans shall include the purpose, contents, method, location, time and period.

5.11.5 Training Courses

(1) The Contractor shall at least prepare the training courses related to the operation and maintenance for train control and the distribution system (main line).

(2) The Contractor shall provide the training about train operation and the Distribution system (main line) for the normal and emergency situation.

(3) The training for emergency situation shall include the following:

a) Investigation method of failure point, effective and efficient handling of hardware and software at the emergency situation for train operation and the Distribution system (main line);

b) Recovering method from the emergency situation caused by system error or other cases;

c) Judgment procedure of transition to backup system and recovery;

d) Data recording, data recovering and data store;

e) Preparation for unexpected situation; and

f) Training of all the matters on the train operation.

(4) The Contractor shall supply the training of system design and configuration to the staff of the Employer. This training shall include the following:

a) The outline of the systems,

b) The system configuration and data configuration, and

c) The principle of train operation.

(5) The Contractor shall supply the following training to the system maintenance staff of the Employer:

a) The principle of train operation,

b) Prevention and repair of maintenance methods and duties,

c) Repair by unit change,

d) Direction for test device and investigation method, and

e) The software maintenance including data configuration, data preparation, data modification and debug of system software.

5.11.6 Maintenance Courses

(1) The maintenance courses shall be developed to acquire all necessary knowledge and skills for preventive maintenance and corrective maintenance for each system.

(2) The maintenance courses shall be developed to acquire all necessary knowledge and skills for adjustment and configuration of system parameter for new installing system and parts.

(3) Intended training maintenance staff shall include at least the following:

a) Distribution system maintenance staff;

b) Trainer and instructor of the Employer;

c) Manager; and

d) Any other defined person by the Employer.

(4) The contents for the maintenance training shall include the following:

a) Train operation principles;

b) Works and method of preventive maintenance and corrective maintenance;

c) Failure correction of unit exchange level;

d) Operation method for test equipment;

e) Failure investigation and maintenance support;

f) Reading of operating manual, maintenance manual, circuit diagram and wiring diagram;

g) Software maintenance for data modification, data generation, database configuration and system software configuration; and

h) Backup and load for data and software.

(5) Training plan submitted from the Contractor shall include the following:

a) Schedule of training course;

b) Purpose of training;

c) Curriculum of training;

d) Composition of training course;

e) Necessary or providing training facilities;

f) Training material and manual;

g) Qualification of instructor; and

h) Evaluation method for the training.

5.11.7 Training Materials

(1) The Contractor shall provide all necessary devices for training, special tools, training materials, training devices and training supplemental materials.

(2) Training supplemental materials and training devices shall be durable construction and become the Employer's property.

(3) The Contractor shall provide the computer-based training system.

(4) The Contractor shall prepare and submit training manual 60 days before start of the training to the Engineer for Approval.

(5) Modification and change of training manual throughout the contract period shall be responsible of the Contractor.

(6) Training manual shall become the Employer's property.

5.11.8 Qualification and Certification

(1) The Contractor shall record the attendance of trainee. The contractor shall submit details of evaluation criteria and compression authorization before start of the training course to the Engineer for Approval.

(2) The Contractor shall prepare an evaluation report regarding the degree of understanding and proficiency of each curriculum, and knowledge level for each trainee. The Contractor shall also submit this evaluation report to the Engineer.

5.12 Maintenance Requirements

The contractor shall submit a plan for Preventive Maintenance (PM) and Corrective Maintenance (CM).

Early failure is to be settled within the test period before operation.

The contractor shall provide operation and maintenance manual before the commencement of commercial operation. These manuals shall be given a Notice of No Objection by the Engineer. The updated manuals shall be provided in the case that operation and maintenance method had been changed due to modification of the equipment, etc.

The maintenance plan shall include the following:

a) Maintenance policy and organization;

b) Working description of maintenance;

c) The cycle of each maintenance works;

d) Annual periodic maintenance plan;

e) Equipment and subsystem related the tasks;

f) Operation methods of the tasks;

g) Devices and test equipment for implementation the tasks;

h) Flowcharts or illustrations for failure investigation;

i) Recovery method;

j) Prevention method; and

k) Estimation period and staff volume.

5.12.1 Software Support

(1) The Contractor shall submit software support plan to the Engineer for Approval.

(2) All Incompatible modifications, bug fixes, updates, revisions, changes and upgrades with the specifications shall not be performed.

(3) In order to continue proper operation, The Contractor shall provide software modifications, bug fixes, updates, revisions, changes and upgrades including database table configuration for all developed and supplied software.

(4) All the modification and revision for the software shall not give deterioration for system performance and harmful action.

(5) The Contractor shall retain backup copy of developed and supplied software.

(6) The Contractor shall secure proven validity, tested completely and Approval from the Engineer before loading the new version to the systems.

(7) The Contractor shall provide the education to the Employer's staff before loading new version to the systems.

(8) The Contractor shall provide software with sufficient security measures.

5.12.2 Software Obligations

For any software produced and modified for this contract the Contractor shall be submit two backup copy 14 days before commencing actual operation. The backup copy shall include the following:

(a) All source code, all execution code and all database configurations;

(b) The documents related to all the software; and

(c) Not only software development tool for the maintenance, but also editor, compiler and linker system.

5.12.3 Manuals

(1) The Contractor shall provide operation and maintenance manual. The latest version of manuals shall be supplied four weeks before the commencement of commercial operation. These manuals shall be given Notice of No Objection by the Engineer prior to provision.

(2) The updated manuals shall be supplied when operation and maintenance method had been changed by modifying the equipment.

i. Operation Manuals

The Contractor shall provide operation manuals regarding the purpose and operation for each equipment, sub system and system.

ii. Maintenance Manuals

The Contractor shall be provided maintenance manual described maintenance, the focal point of failure investigation, mounting equipment, demounting equipment, repair technique and all necessary items for maintenance for each system and its sub system.

The contractor shall submit 10 paper copies and 2 electronic copies maintenance manuals described maintenance, and language for the manuals shall be English.

End of Section

6 OVERHEAD CONTACT LINE SYSTEM

6.1 Scope of Works

6.1.1 General

The works include the Overhead Contact Line System (OCS) for the Malolos Clark Railway Project (MCRP) and the North South Railway Project - South Line (Commuter) (NSRP-South).

This specification covers the whole works with respect to the detailed design, installation, testing, commissioning, maintenance tools for electrification supplied with standard voltage 1500V dc. The OCS shall have a capability to supply electric power to the different rolling stock running at the maximum speeds of 160km/h and 120km/h. The requirement for either compound catenary or simple catenary shall be determined by the contractor following a detailed analysis considering the train consists using the line, conductor sizes, pantograph parameters and rolling stock speed, etc.

The design should take into consideration the following:

a) The future connections to the extension to New Clark City and between Solis and Tutuban that will not be constructed under this Contract.

b) The connection to the Manila Metro Subway Project (MMSP) at Bicutan.

c) The connection to the NSCR north of Malolos

d) The connection with the NSCR between at 200m south of Solis Stations.

e) The NSRP-South also includes the spurs from Blumentritt and Solis stations and from Blumentritt to to Tutuban Station.

6.1.2 Operations Regulations

The OCS shall be designed based on the Traffic Operations Procedures (TOP) set by the Employer. For Example, on LRT Line 2, the TOP was established in order to operate or not to operate the OCS under different conditions such as typhoon, earthquakes, strong winds, etc. The Contractor shall ensure adherence to the TOP provided by the Employer.

1) Example of operation regulations for wind speed:

   a) Normal train speed for wind speed of less or equal to 72 km/h.

   b) 30 km/h or less train speed for wind speed between 72 km/h and 108 km/h.

   c) Train operation stopped for wind speed of more than 108 km/h

   Note: The nominated Operation and Maintenance personnel shall decide on the appropriate application of the train speed criteria

2) Example of operation regulations related to seismic conditions:

   a) Normal operation shall continue in case the seismic intensity is less than level 3 based on the Figure 6.1.1 Diagram of Seismic Acceleration Versus Seismic Period for Each Seismic Intensity Level.

   b) If seismic intensity is from level 3 to level 4, the dispatcher assigned in the OCC must order the train drivers to operate at reduced speed and shall observe the conditions of all systems along the viaduct; and

   c) If the operation dispatcher assigned in the OCC observes seismic intensity beyond level 4 in any section, the dispatcher must order all train drivers in the affected sections to stop all train movements as soon as possible.

Note: The nominated Operation and Maintenance personnel shall decide on the appropriate application of the seismic criteria.

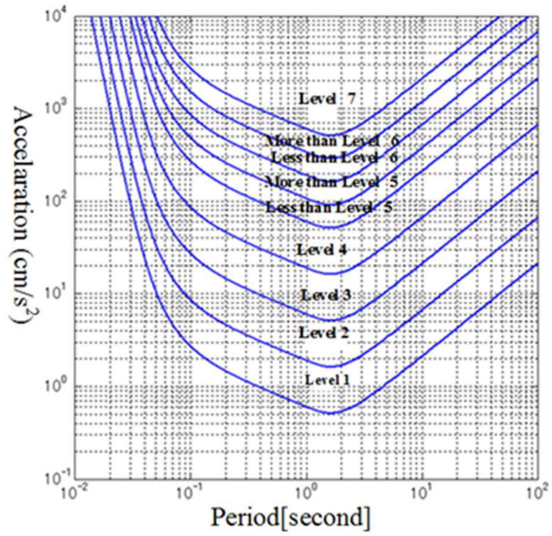


Figure 6.1.1 Diagram of Seismic Acceleration Versus Seismic Period for Each Seismic Intensity Levesl

6.1.3 Normative References

The following standards shall be used in the design and installation of the OCS:

1) Main Technical Terminology

- JIS E 2001-2002: Electric traction contact lines –Vocabulary
- IEC 60050 (811): 1991 International Electrotechnical Vocabulary−Chapter 811: Electric traction
- IEC 60913: 1988 Electric traction overhead lines
- JIS C 3803: 1977 Glossary of Terms for Insulator and Bushing
- JIS E 4001: 2011 Railway Rolling Stock-Vocabulary

2) Technical Regulatory Standards on Japanese Railways (TRSJR)

- Technical Regulatory Standards on Japanese Railways (TRSJR): 2012
- The Interpretation of the Technical Regulatory Standards on Japanese Railways: 2005

3) Japanese Technical Standards of Electrical Equipment (JTSEE) and the Concerning regulations

- Japanese Technical Standards of Electrical Equipment (JTSEE): 2016
- The interpretation of JTSEE: 2016
- Commentary of JTSEE: 2016

4) Japanese Electrical Appliances and Materials Safety Act (JEAMS) and the Concerning Regulations

- Electrical Appliances and Materials Safety Act: 2014

- The Technical Standards of Electrical Appliances and Materials Safety Act: 2016
- The Interpretation of the Technical Standards of Electrical Appliances and Materials Safety Act:2016

5) Japan Electrotechnical Standards and Codes Committee Norm (JESC)
    - JESC E7001: 2015 Method of electrical safety testing between line and earth

6) Japanese Electrotechnical Committee in the Institute of Electrical Engineers of Japan (JEC)
    - JEC-2374: 2015 Gapless Metal Oxide Arrester

7) Japanese Industrial Standards (JIS)
    - JIS A 1412-1: 1999 Test method for thermal resistance and related properties of thermal insulations −Part 1: Guarded hot plate apparatus
    - JIS A 5308: 2014 Ready-Mixed Concrete
    - JIS B 1180: 2014 Hexagon head bolts and hexagon head screws
    - JIS C 3105: 1994 Hard-drawn copper stranded conductors
    - JIS C 3316: 2008 Polyvinyl chloride insulated wires for electrical apparatus
    - JIS C 3364: Control Cables
    - JIS C 3362: 2009 600 V Cross-linked polyethylene insulated cables (Ref. IEC 60502-1)
    - JIS C3605-2002: 600 V Polyethylene insulated cables
    - JIS C3606: 2003 High-voltage cross-linked polyethylene insulated cables
    - JIS C 3810: 1999 Normal type and anti-pollution type suspension insulators
    - JIS C 3818: 1999 Station Post Insulators
    - JIS C 6302: 2004 Pantographs for Rolling Stock
    - JIS C 8430-1999: Unplasticized Polyvinyl Chloride (PVC-U) Conduits
    - JIS E 2101-1990: Hard−Drawn Grooved Trolley Wires
    - JIS E 2201: 2013 Electric traction overhead lines –Fittings
    - JIS E 2219: 2001 Electric traction overhead lines −Section insulators
    - JIS E 2220: 2001 Electric traction overhead lines −Connecting sleeves of stranded conductors
    - JIS E 2301: 1992 Insulator for electric overhead line
    - JIS E 6302: 2015 Rolling Stock-Pantographs
    - JIS G 3101: 2010 Rolled steels for general structure
    - JIS G 3106: 2008 Rolled steels for welded structure
    - JIS G 3192: 2014 Dimensions, mass and permissible variations of hot rolled steel sections
    - JIS G 3537: 2011 Zinc-coated steel wire strands
    - JIS G 4303: 2012 Stainless steel bars

- JIS H 3100: 2012 Copper and copper alloy sheets, plates and strips
- JIS H 3140: 2012 Copper bus bars
- JIS H 5120: 2009 Copper and copper alloy castings
- JIS H 8641: 2007 Hot dip galvanized coatings
- JIS K 6911-1995: Testing methods for thermosetting plastics
- JIS Z2246: 2000 Shore hardness test−Test method
- JIS Z 3211: 2008 Covered electrodes for mild steel, high tensile strength steel and low temperature service steel
- JIS Z 3312: 2009 Solid wires for MAG and MIG welding of mild steel, high strength steel and low temperature service steel

8) Japan Switchboard & Control System Industries Association (JSIA)

- JSIA-T1014: 2010 A short circuit electric current in switchboards
- JSIA-T2001: 2010 Guideline of replacement of power distribution cabinet

9) Technical Report of Japan Electronics and Information Technology Industries Association (JEITA)

- JEITA RCR -1001A: 2007 Safety application guide on components for use in electronic and electrical equipment

10) European Standards (EN for European Norms)

- EN 1536: Execution of special geotechnical work - Bored piles
- EN 1537: Execution of special geotechnical work- Ground anchors
- EN 1991-1-4:2005, Eurocode 1: Actions on structures- Part 1-4: General actions- Wind actions
- EN 1991-2-4: 1995, Eurocode 1: Basis of design and actions on structures - Part 2-4: Actions on structures - Wind actions
- EN 1992 (all parts): Eurocode 2-: Design of concrete structures
- EN 1993-1-1(all parts) :2005, Eurocode 3: Design of steel structures- Part 1-1: General rules and rules for buildings
- EN 10025 (all parts): Hot rolled products of structural steels
- EN 10149 (all parts): Hot-rolled flat products made of high yield strength steels for cold forming
- EN 10164: Steel products with improved deformation properties perpendicular to the surface of the product- Technical delivery conditions
- EN 10210 (all parts): Hot finished structural hollow sections of non-alloy and fine grain steels
- EN 12699: Execution of special geotechnical work- Displacement piles
- EN 20898-2: Mechanical properties of fasteners - Part 2: Nuts with specified proof load values - Coarse thread (ISO 898-2)
- EN 50119:2009+2013 Railway applications - Fixed installations: Electric traction overhead contact lines for railways and all relevant normative references in EN 50119

- EN 50122:2011: Railway applications - Fixed installations and the series
- EN 50124 (all parts):2001-2005: Railway applications - Insulation coordination and the series
- EN 50162:2004 Protection against corrosion by stray current from direct current systems
- EN 50163:2004: Railway applications supply voltages of traction systems and the series
- EN 50178:1998: Electronic equipment for use in power installations and the series
- EN 50122 (all parts 1): Railway applications- Fixed installations- Electrical safety, earthing and bonding
- EN 50125-2: Railway applications - Environmental conditions for equipment- Part 2: Fixed electrical installations
- EN 50149: Railway applications- Fixed installations - Electric traction - Copper and copper alloy grooved contact wires
- EN 50151: Railway applications - Fixed installations - Electric traction - Special requirement for composite insulators
- EN 50152-2: Railway applications - Fixed installations – Requirement for a. c. switchgear- Part 2: Single-phase disconnectors, earthing switches and switches with Un above 1 kV
- EN 50182: Conductors for overhead lines - Round wire concentric lay stranded conductors
- EN 50189: Conductors for overhead lines - Zinc coated steel wires
- EN 50206-1: 1998, Railway applications - Rolling Stock - Pantographs: Characteristics and tests - Part 1: Pantographs for main line vehicles
- EN 50317: Railway applications - Current collection systems - Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line
- EN 50318: Railway applications - Current collection systems - Validation of simulation of the dynamic interaction between pantograph and overhead contact line
- EN 50345: Railway applications - Fixed installations - Electric traction - Insulating synthetic rope assemblies for support of overhead contact lines
- EN 50367:2006: Railway applications - Current collection systems - Technical criteria for the interaction between pantograph and overhead line (to achieve free access)
- EN 60071 (all parts): Insulation co-ordination (IEC 60071, all parts)
- EN 60099 (all parts): Surge arresters (IEC 60099, all parts, mod.)
- EN 60168: Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1 kV (IEC 60168)
- EN /IEC/ 62305: 2011 Lightning protection standard and the series
- EN 60265-1: High-voltage switches - Part 1: Switches for rated voltages above 1kV and less than 52 kV (IEC 60265-1)

- EN 60305: Insulators for overhead lines with a nominal voltage above 1 kV - Ceramic or glass insulator units for. AC systems - Characteristics of insulator units of the cap and pin type (IEC 60305)
- EN 60383 (all parts): Insulators for overhead lines with a nominal voltage above 1kV (IEC 60383, all parts)
- EN 60433: Insulators for overhead lines with a nominal voltage above 1 kV - Ceramic insulators for AC systems - Characteristics of insulator units of the long rod type (IEC 60433)
- EN 60529: Degrees of protection provided by enclosures (IP Code) (IEC 60529)
- EN 60660: Insulators - Tests on indoor post insulators of organic material for systems with nominal voltages greater than 1 kV up to but not including 300 kV {IEC 60660)
- EN 60672 (all parts): Ceramic and glass insulating materials (IEC 60672, all parts); EN 60889, Hard-drawn aluminum wire for overhead line conductors (IEC 60889)
- EN 60947-1: Low-voltage switchgear and contra/gear- Part 1: General rules (IEC 60947-1)
- EN 61109: Insulators for overhead lines - Composite suspension and tension insulators for AC systems with a nominal voltage> 1 000 V - Definitions, test methods and acceptance criteria (IEC 61109)
- EN 61284:1997: Overhead lines- Requirements and tests for fittings (IEC 61284:1997)
- EN 61325: Insulators for overhead lines with a nominal voltage above 1 kV - Ceramic or glass insulator units for DC Systems - Definitions, test methods and acceptance criteria (IEC 61325)
- EN 61773: Overhead lines - Testing of foundations for structures (IEC 61773)
- EN 61952: Insulators for overhead lines - Composite line post insulators for A. C. systems with a nominal voltage> 1 000 V - Definitions, test methods and acceptance criteria (IEC 61952)
- EN ISO 898-1: 1999 Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs (ISO 898-1:1999)
- EN ISO 1461:1999, Hot dip galvanized coatings on fabricated iron and steel articles- Specifications and test methods (ISO 1461:1999)

11) IEC - International Electrotechnical Commission

- IEC 60059: 1999 standard current ratings and the series
- IEC 60287: 2015 Calculation of permissible current in cables at steady state rating and the series
- IEC 60494: 2013 Rolling stock pantographs and the series
- IEC 60913: 1988 Electric traction overhead lines
- IEC 61140: 2016 Protection against electric shock – Common aspects for installation and equipment and the series

- IEC 62278: 2002 Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS) and the series
- IEC 62561: 2012 Lightning protection system components (LPSC) and the series

12) Additional Codes and Standards

- American Society for Testing and Material (ASTM)
- American Welding Society (AWS)
- American Institute of Steel Construction (AISC)
- Philippine Electrical Code (PEC)
- National Structural Code of the Philippines

These standards and codes shall be taken as minimum requirements for compliance. In case of conflict between cited standards or codes in this Employer's Requirements, the stiffer requirements shall apply.

6.1.4 Main Terms and Abbreviated Terms

The terms and definitions given in JIS E 2001-2002, JIS C 3803, IEC 60050-811, IEC 60913, JIS E 40001 are referred as follows:

6.1.4.1 Main Terms

1) Wind

a) Gust Response Factor (GRF): Dynamic wind loads on these structures result from two components: wind loads on the pole and beam for supporting the OCS and feeders, and wind loads on the conductors.

b) Solar irradiance: the power per unit area received from the sun

2) Lightning

a) Keraunic: the audible detection of thunder

b) Keraunic number: The keraunic number is a system to describe lightning activity in an area based upon the audible detection of thunder

c) IKL: An isokeraunic map plots contours of equal keraunic number

d) Lightning protection system (LPS): Complete system for lightning protection of structure. Includes internal and external lightning protection measures

e) Lightning protection zone (LPZ): Zone where lightning electromagnetic environment is defined

f) Surge protective device (SPD): Device for protecting electrical/electronic equipment from transient over-voltage damage

3) Overhead Catenary Systems

a) Contact line system: support network for supplying electrical energy from substations to electrically powered traction units, which covers overhead catenary line systems; the electrical limits of the system are the feeding point and the contact point to the current collector

Note: The mechanical system may comprise of:

i) The catenary line,

ii) The structures and foundations,

iii) The supports and any components supporting or registering the conductor,

iv) The tensioning devices,

v) The feeders, return conductors/cables and structure supporting them, and

vi) Any other equipment necessary for operating the contact line,

b) Catenary Line: conductor system for supplying traction units with electrical energy via current-collection equipment

Note: This includes all current-collecting conductors, conducting bars, including the following:

i) Disconnectors,

ii) Cross track feeders,

iii) Section insulators,

iv) Supports that are not insulated from the conductors,

v) Insulators connected to live parts, and

vi) Return conductors

c) Overhead Catenary Line System: contact line system using an overhead contact line to supply power via the pantograph for traction units

d) Overhead Catenary Line: catenary line placed above the upper limit of the vehicle gauge, supplying traction units with electrical energy via roof-mounted current collection equipment

e) Supporting Assembly: assembly of components attached to the main support structure that supports and registers the overhead contact line

f) Static Load Gauge: maximum cross-sectional profile of the vehicles using the railway line

g) Pantograph Clearance Envelope: The combined vehicle envelope applied to the pantograph plus lateral running allowance for safety and vertical allowance above static contact wire level. Only steady arms and registration arms are permitted within this envelope.

h) Tensioning Device: device to maintain the tension of conductors within the system design parameters

4) Conductors

a) Feeder: overhead conductor mounted on the same structure as the overhead contact line to supply successive feeding points

b) Contact wire: the part of the overhead contact line system serving to establish contact with the current collector.

c) Return current line: negative current line flowed from positive feeder line, through train load, track rail, neutral point of impedance bond, negative current bus bar, up to TSS.

d) Bus conductor: Type of conductor that distribute and collect current a) positive feeder bus bar and b) negative bus bar.

e) Running Rail.

5) Electrical

a) Nominal voltage: voltage by which an installation is designated

b) The voltage of the catenary line may differ from the nominal voltage by a quantity within permitted tolerances given in EN 50163.

c) Feeding section: electrical section of the route fed by individual track feeder circuit breakers within the area supplied by the substations

d) Fault current: maximum current passed through the overhead contact line system under fault conditions between live equipment and earth, within a short-defined period

e) Short-circuit: accidental or intentional conductive path between two or more points in a circuit forcing the voltages between these points to be relatively low. Any such conductive path whether between conductors or between conductor and earth is regarded as a short-circuit

f) Short-circuit current: electric current flowing through the short circuit

g) Continuous current rating: permanent rated current carrying capacity of the overhead contact line within the system operating parameters

h) Feeding point: point at which the feeding system is connected to the contact line. All feeding and section isolators in the depot and main line shall be motorised. The purpose of the by-pass isolator shall be to feed adjacent sections in the event of an infeed outage.

All infeed connections from the substation shall be made using sheathed cables that shall comply to industry standards and practices. The cables shall be protected by antivandal screens.

i) Isolation: disconnection of a section of overhead catenary line from the source of electrical energy, either in an emergency or to facilitate maintenance activities

j) Section insulator: sectioning point formed by insulators inserted in a continuous run of a contact line, with skids or similar devices to maintain continuous electrical contact with the collector

6) Geometry

a) Cantilever: It is an insulated swiveling type structure member, comprising of assorted sizes of metal tubes (lightweight and non-corrosive), to support and to keep the OCS in position to facilitate current collection by pantograph at all speed without doing the structural member damage. It consists of the following structural members:

i) Stay arm: it comprises of lightweight and non-corrosive metal tube and an adjuster at the end to keep the bracket tube in position. It is insulated from compression type of a long-rod insulator

ii) Bracket tube: It comprises of bracket lightweight and non-corrosive metal tube and a long-rod insulator of an extension type. Catenary is supported from the member by catenary suspension bracket and catenary suspension clamp.

iii) Registration arm: It comprises of lightweight and non-corrosive metal tube to register the contact wire in the desired position through the steady arm and drop bracket suppressing within the prescribed uplift of catenary.

iv) Steady arm assembly: It comprises of lightweight and non-corrosive metal tube to resister the contact wire to the required stagger, pulling off contact wire and taking the push up of contact wire under tensile force.

b) Catenary angle: an angle between a plane connected catenary and contact wire and a plane perpendicular to the track, the angle should be less than 10 degrees.

c) Contact wire height: distance from the top of the rail to the lower face of the contact wire, measured perpendicular to the track

d) Contact wire uplift: vertical upward movement of the contact wire due to the force produced from the pantograph

e) Crossing: the electrical live member (or conductor) passing over another electrically live member (or conductor), without contact. In principle, power line crossings are not allowed to pass over OCS.

f) Dropper: a fitting used in overhead equipment for supporting the contact wire from catenary and keeping contact wire height to be constant as possible at straight line and curve line with no gradient.

g) Electrical clearance: the distance in air between the nearest earthed part or objects and live line or equipment

h) Encumbrance: the axial distance on vertical plane between the catenary and the contact wire at support

i) Feeder: a conductor connecting (a) a TSS (Traction substation) with a feeding point, or (b) with each contact wire through jumpers at the feeding point, connected each feeder separately for each track, independently right and left direction of track

j) Gradient (Contact wire): the slope of the contact wire between two adjacent OCS supports relative to the track

k) Height of contact wire: the distance from the top of rail to the bottom surface of contact wire

l) Jumper: A conductor or an arrangement of conductors for electrical continuity not under tension, which forms electrical connection between two conductors or equipment

m) Nominal contact wire height: nominal value of the contact wire height at a support in the normal conditions

n) Maximum contact wire height: maximum possible contact wire height which the pantograph is required to reach, in all conditions

o) Maximum design contact wire height: theoretical contact wire height taking into account of the tolerances, movements etc., designed to ensure the maximum contact wire height is not exceeded

p) Minimum contact wire height: minimum value of the contact wire height in the span to avoid the arcing between one or more contact wires and vehicles in all conditions

q) Minimum design contact wire height: theoretical contact wire height including tolerances, designed to ensure that the minimum contact wire height is always achieved

r) Overlap: an arrangement of OCS over a track where two sets of traction contact wire are run parallel to each other for short distance over three spans providing a smooth passage for the pantograph of an electrical multiple units. In uninsulated overlaps, two sets of contact wires are separated by 150 mm and connected by a jumper. In standard insulated overlaps, two sets of contact wires are separated by 300 mm in air.

s) Pole: in principle, a single vertical tubular steel pole embedded in the foundation or otherwise rigidly fixed in vertical position to support the OCS with cantilever assembly

t) Stagger: deflection of contact wire with the horizontal distance of the contact wire from the vertical plane through the center of track, on sections for trains to run at maximum speed in main line and depot. The standard deflection per a half span shall be computed (midspan, cross overs, tangent and curve portion, cross over, push off, pull off, etc.) The stagger shall be designed to maintain the uniformly distributed wearing of the pantograph's carbon strip even under strong wind and typhoon.

u) Suspension distance: the horizontal distance from the center of the eye supporting of catenary suspension bracket to the face of the pole for a single cantilever assembly or multiple cantilever assembly

v) Setting distance: the horizontal distance from the nearest face of traction pole to the center of track for a single cantilever assembly or multiple cantilever assembly

w) Span: the distance between the center lines of the adjacent supporting poles for OCS

x) Midpoint: when OCS lines move with variable ambient temperature, the OCS should be fixed at a midpoint from a point of maintainable view so that the move of lines are limited along one directional way.

y) Tension device: a device used to maintain the constant tension of conductors in OCS under all ambient temperature conditions. Installation of spring device will keep it constant. In addition, this device applies to feeder lines

z) Tensile force: force via a tension device

   i) Tension length: length between midpoint and the farthest terminal from a tension

   ii) Current collection system: a combination of overhead contact line and pantograph equipment. The quality of the current collection system depends on the characteristics of both. The design shall take cognizance of the compatibility with each other.

7) Electrical Safety

   a) Electric shock: pathophysiological effect resulting from an electric current passing through a human or animal body

   b) (Effective) touch voltage (Ute): voltage between conductive parts when touched simultaneously by a person or an animal

Note 1: The value of the effective touch voltage can be practicably influenced by the impedance of the person or the animal in electric contact with these conductive parts

Note 2: The conductive path through the body is conventionally from hand to both feet (horizontal distance of 1 m) or from hand to hand. [Source: IEC 60050-195:1998. 195-05-11]

c) Prospective touch voltage (Utp): voltage between simultaneously accessible conductive parts when those conductive parts are not being touched by a person or an animal [Source: IEC 60050-195:1998, 195-05-09]

d) Body voltage (Uh): product of the current through true body and the body impedance

e) Standing surface: any point on a surface where persons may stand or walk about without great effort

f) Protective boarding: non-conducting barrier to protect persons from coming into direct contact with the live conductor rail

g) (Electrically) Protective obstacle: part preventing unintentional direct contact, but not preventing direct contact by deliberate action

h) (Electrically) Protective barrier: part providing protection against direct contact from any usual direction of access

i) Anti-trespassing guard: equipment provided to deter entry to a restricted area, structure or building by an unauthorized person

8) Earthing and Equipotential Bonding

a) Earth: conductive mass of the earth, whose electric potential at any point is conventionally taken as equal to zero

b) Earthing: connection of conductive parts to an appropriate earth electrode

c) Earth electrode: conductor or a group of conductors in intimate contact with and providing an electrical connection to earth

d) Structure earth: construction made of metallic parts or construction including interconnected metallic structural parts, which can be used as an earth electrode

Note: Examples are reinforced railway structures such as bridges, viaducts, tunnels, mast foundations and reinforced track bed.

e) Rail to earth resistance: electrical resistance between the running rails and the earth or structure earth

f) Equipotential bonding: provision of electric connections between conductive parts, intended to achieve equipotentiality

g) Main equipotential busbar (MEB): busbar where the equipotential conductors terminate

h) Cross bond: electrical connection intended to connect in parallel the conductors of the return circuit

i) Rail-to-rail cross bond: electrical bond that interconnects the running rails of the same track

j) Track-to-track cross bond: electrical bond that interconnects two tracks

k) Rail joint bond: conductor ensuring the electrical continuity of rails at a joint

9) Return Circuit

a) Return circuit: return circuit: all conductors which form the intended path for the traction return current

b) The conductors may be:

i) Running rails,

ii) Return conductors, return overhead wires, and

iii) Return cables.

c) Track return system: system in which the running rails of the track form a part of the return circuit for the traction current

d) Return cable: conductor connecting the running rails or other parts of the return circuit to the substation

Note: e.g. IEC 60050-811-35-04

e) Traction return current: sum of the currents returning to the supply source, the substation or regenerative braking vehicles

f) Rail potential (URE): voltage occurring between running rails and earth

g) Closed formation: area where the top of the running rails is at the same level as the surrounding surface

h) Open formation: area where the running rails are laid above the surrounding surface

i) Conductance per length (GRE): reciprocal value of the rail to earth resistance per length (S/km)

j) Insulating rail joint: mechanical rail joint which longitudinally separates the rail electrically

k) Track circuit: electrical circuit of which the rails of a track section form a part, with usually a source of current connected at one end and a detection device at the other end for detecting whether this track section is clear or occupied by a vehicle

Note: In a continuous signaling system, the track circuit may be used to transmit information between the ground and the train.

l) Top of rail level (TOR): common rail level tangent

10) Corrosion and Corrosion Protection

a) Corrosion: electrochemical reaction of a metal with its environment, resulting in its progressive degradation or destruction

Note: This standard deal with corrosion caused by stray currents.

b) Leakage current: current which, in the absence of a fault, flows to earth or to extraneous conductive parts in a circuit

c) Stray current (Is): part of the current caused by a DC traction system which follow the paths other than the return circuit

d) Cathodic protection: electrochemical immunity produced by an appropriate cathodic polarization

11) Electric Traction System

a) Electric traction system: railway electrical distribution network used to provide energy for Rolling Stock

Note: The system includes items below:

i) Catenary line systems,

ii) Return circuit of electric traction systems,

iii) Running rails of non-electric traction systems, which are near, and conductively connected to the running rails of an electric traction system,

iv) Electrical installations, which are supplied from contact lines directly,

v) Electrical installations in substations (TSS), which are utilized solely for distribution of power directly to the contact line, and

vi) Electrical installations of switching post (SP) in depot

b) Traction substation: installation to supply a contact line system and at which the voltage of a primary supply system, and in certain cases the frequency, is transformed to DC voltage of the contact line

c) (Traction) switching post (SP): installation from which electrical energy can be distributed to different feeding sections or from which different feeding sections can be switched on and off or can be interconnected

d) Feeding section: electrical section of the route fed by individual track feeder circuit-breakers within the area supplied by the substation

e) Fault condition: non-intended condition caused by short-circuit. The time duration is terminated by the correct function of the protection devices and circuit breakers

Note: For any relevant fault duration, the correct operation of protection devices and circuit breakers is considered.

f) Short-circuit: accidental or intentional conductive path between two or more conductive parts forcing the electric potential differences between these conductive parts to be equal to or close to zero

g) Expected prospective short-circuit current: short-circuit current in DC traction systems that is expected to be reached at the time to switch off under fault condition

12) Current Collection

a) Pantograph: apparatus that collects current on one or more contact lines. It consists of:

i) Base frame,

ii) Operating system,

iii) Frame, and

iv) Collector head

It is of variable geometry. It is electrically insulated only at its interfaces, on the vehicle roof. It enables current to be supplied from the overhead line to the vehicle electrical system frame articulated structure which enables the collector head to move in a vertical direction with respect to the base frame of the pantograph.

b) Base frame: fixed part of the pantograph which supports the frame and is mounted on insulators fixed to the vehicle roof collector head

c) Current collection: Current transmission from contact line to a vehicle;

d) Current collector: Equipment fitted to the vehicle and intended to collect current from a contact wire or conductor rail;

e) Base frame: fixed part of the pantograph which supports the frame and is mounted on insulators fixed to the vehicle roof;

f) Working range: Working range of pantograph;

g) Upper position: Upper operating position of pantograph;

h) Lower position: Lower operating position of pantograph;

i) Collector head: part of the pantograph supported by the frame which includes contact strips, horns and may include a suspension;

j) Contact strip: replaceable wearing part of the collector head which interfaces with the overhead line;

k) Horns: ends of the collector head which ensure smooth engagement with the contact wire;

l) Collector head length: dimension of collector head measured horizontally transversely in relation to the vehicle;

m) Collector head width: head measured longitudinally in relation to the vehicle;

n) Collector head height: the vertical distance between the lowest point of the horns and the upper most point of the contact strips;

o) Height at lower operating position: vertical distance between the pantograph mounting plane on the top of insulators and the upper surface of contact strips, the pantograph being raised to the lowest level at which it is designed to collect current;

p) Height at upper operating position: vertical distance between the pantograph mounting plane on the top of the insulators and the upper surface of the contact strips, the pantograph being raised to the highest level at which it is designed to collect current;

q) Working range: difference between the upper operating position height and the lower operating position height;

r) Housed height: vertical distance between the pantograph mounting plane on the top of insulators and the upper surface of the contact strips or any other part of the pantograph structure if higher (pantograph being in the housed position);

s) Pantograph electrical thickness: vertical distance between the highest live part and the lowest live part of the pantograph at housed position

t) Operating system: device which provides a force to raise or to lower the pantograph;

u) Maximum extension: maximum extended height to mechanical stops (without any device which will limit the pantograph extension within the working range);

v) Limited maximum extension: reduced extension allowed by intermediate mechanical stops;

w) Rated voltage, vehicle at standstill: the voltage at which the pantograph is designed to function;

x) Rated current, vehicle at standstill: average value of that current withstood for 30 min by the pantograph at standstill;

y) Maximum current, vehicle at standstill: maximum value of that current withstood by the pantograph at standstill for a time given in the customer specification; and

z) Rated current, vehicle running: current collected via the pantograph from standstill to maximum speed of the vehicle

Static force: vertical force exerted upward by the collector head on the catenary, and caused by the pantograph raising device, whilst the pantograph is raised and the vehicle is at standstill

i) Nominal static force: average of the actual values of static forces evaluated as follows: the static forces are measured continually within the working range during raising (Fr) and lowering (Fl) operation. By convention, the nominal static force at any point is equal to (Fr + Fl)/2

ii) Total mean uplift force: vertical force measured at the collector head, the latter not touching the contact line. It is equal to the sum of static force and the aerodynamic force caused by the air at the considered speed for a given collector height, the results being referred to zero ambient wind conditions.

iii) Total contact force: the total force between collector head and contact line while running

iv) Housing force: the force applied vertically to the collector head to maintain the whole pantograph in its housed position

13) Foundations

a) Pile foundation: foundation which is flexible enough to show both rotation and deformations in the pile element itself subjected to horizontal loading or overturning moments. The cross section may be circular or non-circular and shall be installed by boring and/or ramming.

b) Side bearing foundation: relatively short, rigid foundation installed by excavation or boring which is subjected to horizontal loading or overturning moments. The cross section may be circular or rectangular.

c) Sand packed foundation: sand packed gap between the diameter of a pole and the bare-hole in elevated and embankment section

14) Public Safety

a) Authorized trackside walking route: safe path alongside the track for use only by authorized persons

b) Public area: area to which the public has unrestricted access

c) Restricted area: area for which access is only permitted for authorized persons

d) Height barriers shall be provided at road crossings over the tracks to ensure a safe clearance is maintained between any crossing vehicles and the overhead contact system.

15) Protection by Clearance

Geometrical and electrical clearances of conductors to other parts of the railway infrastructure, when subject to wind, shall similarly be verified.

16) Contact Line Zone and Current Collector Zone

a) Overhead contact line zone (OCLZ)

Zone whose limits are in general not exceeded by a broken overhead contact line

b) Current collector zone (CCZ)

Zone whose limits are in general not exceeded by an energized collector no longer in contact with the contact line or broken collector and its fragments

17) Inspection

The Engineer shall conduct the necessary inspections during OCS installation, testing, commissioning and associated test acceptance of OCS products, materials, tools and equipment, and others relevant for acceptance of the same.

6.1.4.2 Abbreviation

AC	Alternating Current
BIL	Basic Impulse Insulation Level
C	Compression amplitude for dropper test Cc drag factor of a structure
Cstr	Drag factor for lattice structures Cstr
CA	Catenary wire
Cins	Drag factor for insulators
CLD	Contact line disconnector
CW	Contact wire
DC	Direct Current
EN	European standard
Fmax	Maximum or failure force for test specimens from nominal force
Fperm	Permissible operating force
Fsmin	Minimum breaking load of stranded conductors
Fw	Permissible tensile loading of stranded conductors
Gpt	The horizontal distance between centers of the pole and the track

Gq	Gust response factor characteristic value of permanent actions
GRE	Conductance per length
GRF	Gust response factor
Hca	Catenary wire tensile force
Hcw	Contact wire height
Hcw-mn	Minimum contact wire height
Hcw-max	Maximum contact wire height
Hcwd-min	Minimum design contact wire height
Hcwd-max	Max maximum design contact wire height
IEC	International Electrotechnical Commission
JESC	Japan Electrotechnical Standards and Codes committee norm
JIS	Japanese Industrial Standard
JTSEE	Japan technical standards of electrical equipment
LPS	Lightning protection system
LPZ	Lightning protection zone
MC	Maintenance car for overhead contact line
Mp, Mb	Design bending moments with respect to pole and beam
OCL	Overhead Catenary Line
OCS	Overhead Catenary System
PVC	Polyvinyl chloride insulated and sheathed cables round shape
QcK	Conductor tensile forces depending on the temperatures and climate related loads
Qpk	Construction and maintenance loads
Qw	Wind load
Qwc	Wind load on conductors
Qwstr	Wind load on structures
R	Radius
RC	Return cable
RCB	Return current bus bar
Rk	Characteristic value of the foundation ultimate resistance
RLCSD	Rail Leakage Current Suppressing Device
RSM	Remote control module
Sf	Safety factor for calculating the permissible loading in each wire of overhead contact line system
SPD	Surge protective device

TE	Transition curve end
TRSJR	Technical Regulatory Standards on Japanese Railways
Tmax	Maximum permissible working tensile stress of a contact wire
Tmin	Minimum failing tensile stress of the contact wire
TP	Top of pole
TPLH	Distance between upper swiveled bracket and suspension or termination of traction power lines
TOR	Top of rail
TS	Transition curves start
TSS	Traction substation
TU	Traction unit
U	The nominal line-to earth voltage
URE	Rail potential
Uss	Substation voltage at the bus bar
Vc	Wave propagation velocity of the contact wire
VHLD	Upper voltage-limiting device
VLLD	Lower voltage-limiting device
Vr	Reference wind velocity

6.1.4.3 Units of Measurement

Table 6.1.3 Units of Measurement

Units	Meaning	Units	Meaning	Units	Meaning
A	Ampere	kHz	Kilo Hertz	m/s^2	Meters per second squared
°C	Degree Celsius	km	Kilo meter	MHz	Mega Hertz
cm	Centimeter	km/h	Kilo meters per hour	MPa	Mega Pascal
cm^2	Square centimeter	km/h/s	Kilo meters per hour per second	mm^2	Square millimeters
g	Gram	kN	Kilo Newton	N	Newton

Units	Meaning	Units	Meaning	Units	Meaning
G Pa	Giga Pascal	kN/m	kilo Newton per meter	N-m	Newton-meter
Hz	Hertz	kPa	Kilo Pascal	N/mm²	Newton's per square millimeter
h	Hour	kWh	Kilo Watt-hour	Pa	Pascal
µm	Micrometer	kW/m²	Kilo Watts per square meter	S	Second
J	Joule	m	Meter	T	Tesla
K	Kelvin	m²	Square meter	µT	Micro Tesla
kg	kilogram	m³	Cubic meter	tf	Tone force
kgf	kilogram force	m³/h	Cubic meter per hour	V	Volt
kg/m²	Kilo gram per square meter	m/s	Meters per second	hPa	hecto Pascal

6.1.5 Scope of Work of the Contractor

1) The Contractor shall submit a detailed design for the whole OCS installation. The data and locations specified in this specification are all approximate and shall be used as reference only. This design shall include a computer simulated operational analysis of the dynamic performance of the pantograph/OCS interface for all rolling stock to be used on the line. This simulation shall be based on highest operating speed plus 10% margin. Detailed plots showing system configuration, train speed, pantograph oscillation, contact pressure, position of pantograph shall be produced. The conductor sizes specified are for reference only and they shall be verified and revised as necessary through undertaking a detailed power simulation using data from the ultimate timetable and parameters of all rolling stock to operate on this line. The power simulation shall take into account worn contact wire conditions.

2) The design shall include geographical layout drawings showing support locations, conductor positions and registration arrangements. For each support location and switching location cross sections shall be prepared which detail all equipment used at the location, setting out of equipment and support loading. Details of mast positions and loading shall be provided in advance of the layout drawings in a sequence to match the viaduct design and construction.

3) The Contractor shall select and develop a full range of OCS components and shall demonstrate by means of engineering calculations that all elements of the selected system are capable of meeting the operational, safety, maintenance and aesthetic requirements of the line.

4) Other design requirements, including calculations, not specifically mentioned in this Technical Requirements but found and deemed necessary by the Contractor for the complete and efficient completion of the project shall be presented/submitted to the Engineer for Approval. All used design criteria, data, calculations and the resulting designs shall be submitted for Approval.

5) The Contractor shall provide and maintain tools and equipment, including delivery and transport of all the necessary materials for the completion of the scheduled work required. These items except for the tools to be used for installation shall be inspected by the Engineer for Factory Acceptance at manufacturer's site and also upon delivery at job site for approval. OCS components including tools and equipment to be turned over to the Employer for the Defects Notification Period shall be give a Notice of No Objection by the Engineer.

6) The Contractor shall submit the following detailed design and location drawings but not limited to:

a) Catenary poles and down guys (tie back guys),

b) Pole Foundations,

c) Contact Wire Stagger, Anchoring and Suspension Assembly,

d) Contact Wire Height and Tension Length,

e) Messenger Cables, Feeder Cables, Anchoring and Suspension Assembly,

f) Electrical Feeding Connections Assembly,

g) Positive power feeder and negative return cable connections at traction substation,

h) Grounding System: Earthing connection between a pole earthing wire and an earthing wire on elevated and embankment sections. The Contractor shall supply and install earthing electrodes with resistance prescribed by the provisions and regulations. The Contractor shall coordinate with the civil Contractors regarding the design and installation of OCS grounding cables inside the PVC Conduit embedded in every concrete pier column.

i) Cable wiring for earthing devices of grounding wire and surge arrester for lightning,

j) Connection between lead wire from surge arrester and ground wire along pier elevated section and earthing pole at surface and the installation of attached plate on the beam of station structure in elevated stations and in the inspection shop at depot,

k) Mechanical and Electrical Sectioning Assembly,

l) Contact Wire Jumpers and Cross Bar Assembly,

m) Double-Track Pull-Off Assembly,

n) Single track Pull-off Assembly,

o) Disconnector Switch Assembly/ OCS Isolator,

p) LV power supply to motorised isolators

q) Remote control of isolators via SCADA System.

r) Pull-off and Push off Cantilever,

s) Suspension Assembly for Section Insulator,

t) Heavy Load Registration Arrangement (single and double steady arms),

u) Loading Diagram and Table,

v) OCS wiring layout and terminations,

w) Supporting structure for feeders and return cables in elevated, embankment section and depot. The cable containment shall be secure and vandal proof.

x) Supply and Installation of return cables fixed with a fire proofed cleat with high resistivity at railway side wall in elevated and embankment section.

y) Supply and Installation of additional cable containment at viaduct locations that would require such (i.e. single track, sidings), in coordination with Civil Contractor.

z) Crossing conduit for return cables passed through under the plinth,

aa) Steel tubular pole foundation and guy anchor in elevated and embankment section,

bb) Excavation, backfill, compacting, and finishes of concrete cable trough, hand-holes, and pipe conduit for feeders, overhead return wire and return cable in depot, and

cc) Pole schedules that show the following:

Pole reference, orientation of major axis, foundation reference, location, pole and down guy number, contact wire height, H-span bracket height, x- span bracket height, termination and backbone bracket height, wiring support reference, wiring assembly reference, anchoring poles, OCS Technical Sheet of Vertical Wind and Radial Load; Computed Working Load OCS Technical Sheet of Conductor Particulars and Structure Spacing also shall be submitted by the Contractor.

7) The design for contact wire suspension, anchoring and sectioning assemblies and others, shall meet the minimum required clearances and structural gauge. The Contractor should coordinate/interface with the civil Contractors for the attachment and fixation of poles and anchoring assembly in the beginning and end of tension length of messenger cable and contact wires in all affected columns and steel structures of any stations.

8) Methodologies and Work Procedure

The Contractor shall submit method statements that shall include but not be limited to the following:

a) Proposed sequence and staging work whether in energized or de-energized condition,

b) Proposed bare conductor handling and wire stringing method,

c) Proposed method of anchoring and termination

d) Proposed catenary pole and portal erection procedures,

e) Proposed cable splicing and connection between the feeder cables and the positive cables coming from the substation,

f) Proposed safety procedures in the assembly and installation of the following catenary components,

g) Hanger clips and registration arms,

h) Wire cross assemblies and, knuckles and jumpers,

i) Insulators and section insulators,

j) Steady arms, head span support, cross span wire pulls off registration assemblies,

k) Pole numbering – The OCS poles at mainline and depot shall be identified by putting a number on both sides (considering bi-directional train movement). Said pole numbers shall be painted using a reflectorized and all-weather type of paint to be easily seen even at night. At least the pole numbers shall be readable 30 m to 40 m by the approaching train driver.

l) The number scheme, size and colour of the paint shall be proposed by the Contractor and give a Notice of No Objection by the Engineer.

m) Final measurement of OCS

9) Inspection Records

a) Acceptance measurements and inspection of completed Overhead Catenary System. This shall include but not limited to the following:

i) contact wire, messenger and feeder cable height, sag and tension

ii) mid span height,

iii) contact wire stagger,

iv) section insulator height,

v) pole horizontal and vertical alignment, and

vi) torques of anchor and termination bolts and nuts.

b) Clearance envelope tests for pantograph and vehicle

c) Pantograph Test on Contact Wires

d) Sectionalizing Test

e) Test Run of Rolling Stock on energized OCS at depot and mainline

f) Others

10) Cable Containment

Where cable containment is not provided by others then cable containment shall be supplied by the Contractor which shall have 25% spare capacity for expansion works. All cable containment material, fixing methods, and routing shall be given a Notice of No Objection by the Engineer.

6.2 Fundamental Design Data

6.2.1 General

The function of the Overhead Catenary Line System is not only to transmit energy from fixed substations to the vehicle but also from vehicles back to substations in using regenerative braking. To fulfil this function, the principal features of the contact line system shall be designed in accordance with the requirements set out in this clause. The integration of the overhead contact line design with the corresponding features of other interconnected systems, the power supply system, the traction system, and return current system with track rail and return current cables, earth from electrical system aspect, shall be considered. In addition, transverse support and registration, poles, beams, automatic tension devices in mechanical aspect, foundations, soil characteristics from civil structure aspect, shall be considered. Furthermore, the requirements for overhead contact lines shall also apply to feeder lines. The requirement for either compound catenary or simple catenary shall be determined by the contractor following a detailed analysis considering the train consists using the line, conductor sizes, pantograph parameters and rolling stock speed, etc.

The current collection system is a combination of overhead contact line and pantograph equipment, and the quality of the current collection system depends on the characteristics of both whilst the return current systems depends mainly on the resistance characteristics of rail and return current cables. Both systems equipment shall be designed with compatibility with each other.

The electrification system shall take into consideration the seismic measurement in accordance with the Japan Railway Standard and if necessary, should also employed other standard of the Employer, IEC, EN and others as supplemental standards.

The detailed data listed in Table 6.2.1 are normally specified by the contractors, however, as a reference only, some of the proven specifications based on proven technology are described as follows.

6.2.2 Line Characteristics

Standard specification of wires in the OCS is shown below.

Table 6.2.1 Standard Wire Characteristics Example

Application		Catenary/other Overhead Wire		Overhead Ground Wire	Contact	Feeder	Return	
Nominal Name		St.135		St.55	GT 170	PH 356	600V CE Cu 400	Cu 325
Class		Class 1	Class 2	Class 2	-	-	-	-
Figure	Unit	Bare	Bare	Bare	Bare	Bare	Insulated	Bare
Cross-section calculated	mm^2	137.5	137.5	56.3	170.0	356	325	323.8
Diameter	mm	17.5	17.5	9.6	15.49	24.5	31	23.4
Weight	kg/m	1.45	1.45	0.446	1.511	3.218	3.36	2.937
Temp. coefficient Resist	1/K	-	-	-	0.00381			
Electric resistance at 20˚C	Ω/km	-	-	-	0.1040	0.0051	0.0568	0.0560
Electric resistance at 90˚C	Ω/km	-	-	-	0.1319	0.0646	0.0719	0.0709

Application		Catenary/other Overhead Wire		Overhead Ground Wire	Contact	Feeder	Return	
Electric resistance at 100˚C	Ω/km	-	-		-	0.0663	-	-
Permissible Temperature	Continuous rating	-	-	-	90˚C	-	90˚C	90˚C
	Instantaneous rating	-	-	-	-	100˚C	-	-
Nom. Break strength	kN	112.7	115.6	46.7	57.8	136.2	-	126.4
Mechanical safety factor		2.5	2.5	2.5	2.2	2.2	-	2.2
Permissible loads	kN	45.1	46.2	18.7	26.3	61.9	-	57.5
Modulus of elasticity	GPa	196	196	196	117.6	117.6	-	117.6
Coefficient of thermal expansion	-	12E (-6)	12E (-6)	12E (-6)	17E (-6)	17E (-6)	17E (-6)	17E (-6)
Standard Length	m	1500	1500	1500	1500	500	150	300
Standard tensile force per wire	kN	-	-	-	14.7	19.6	-	-

Note 1. E (-x) means 10^{-x}, that is, denotes negative exponents with base 10, 10^{-6} means one-millionth.

Note 2. Size in the table is approximate and might be different per each manufacturing company.

6.2.3 Electrical Power System Design

The OCS in the depot shall be similar to that on the main line but have the following features:

The principal components shall include but shall not be limited to the following:

1) Overhead Catenary System's facilities, devices and equipment that related to supporting structure, overhead contact line, earthing catenary line, feeder wire, assemblies and associated facilities.
2) Positive power feeder and negative return cable connections at traction substation.
3) Lightning/Surge Arrester, devices.

As certain works are closely related to civil, architecture, track works, signaling system, Communications System, power delivery system, traction substation, rolling stock, water drain system, water delivery system for firefighting, depot inspection, and operation system, the Contractor shall coordinate with interfacing Contractors for installation works including but not limited to:

a) Supporting structure for feeders and return cables in elevated, embankment section and depot;

b) Installation of return cables fixed with a high resistivity fire-proofed cleat.

c) Crossing conduit for return cables passed through under the plinth, or between plinth gaps or sleeper gaps;

d) Steel tubular pole foundation and guy anchor in elevated and embankment section;

e) Earthing connection between a pole earthing wire and earthing wire on elevated sand embankment sections. The Contractor shall install earthing electrode with resistance prescribed by the provisions and regulations;

f) Connection between lead wire from surge arrester and grounding wire inside PVC conduit embedded along every concrete pier, or at every other concrete pier (depends upon the design of the Contractor to be Approved by the Engineer);

g) Cable wiring for earthing devices of grounding wire and surge arrester for lightning;

h) Excavation, backfill, compacting, and finishes of trough, hand-holes, and pipe conduit for feeders, overhead return wire and return cable in depot; and

i) Furthermore, any matter not stipulated herein shall be determined through mutual consultation between the Engineer and Contractor, with the Engineer's consent ultimately.

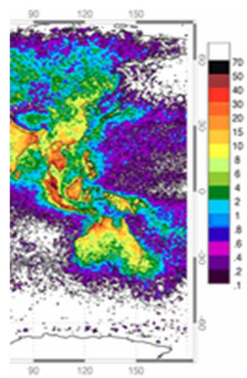
4) Sectioning and feeding in the depots shall be designed to suit the various stages of construction and operation up to completion. The sectioning shall be designed to minimize disruption to operation during isolations for maintenance work.

6.2.4 Environmental Conditions

1) Ambient conditions and usage environments

Table 6.2.2 Ambient Conditions and Usage Environments

No.	Circumstance conditions		
	Items	Values	Notes
1.1	Quake-resistance standards	Level 2	In accordance with seismic standards in buildings and civil engineering works Reference: Note 1 and Note 2
1.2	Max. Wind power	54m/s	Equivalence 53.8m/s at the same humidity and at 950hPa as per the National Structural Code of the Philippines 2010 with 56m/s (200km/h) at 1013hPa and humidity 100%

No.	Circumstance conditions		
	Items	Values	Notes
1.3	Max. solar irradiance	0.1 W/cm^2	Standard value on surface irradiation at equatorial line area
1.4-1	Max. Ambient temp.	40°C	
1.4-2	Min. ambient temp.	15°C	
1.5	Design ambient pressure	1013 hPa	Note. Without ambient pressure in typhoon
1.6	Precipitation	N/A	Reference: Note 2
1.7	Chloride damage area	N/A	No description same with LRT2 doc.
1.8	Sea level	Below 100m	Addition: maximum height of the overhead ground wire in elevated and embankment section on surface ground measured from sea level
1.9	Isokeraunic number (IKL) per year	Over $25/km^2/year$	EN61400-24  EN 61400-24 Lightning protection Map Where Lightning Strikes

Note 1-1: Guideline of a seismic design for overhead catenary systems, issued by the Japanese Railway Technical Research Institute (RTRI) in March, 2013

Note 1-2: Design guidelines of support systems for overhead catenary system, issued by Japan Railway Electrical Engineering Association (JREEA) in October 2010

Note 2-1: During the design of the OCS, the Contractor should be in close coordination with the civil/structural Contractor to address any precipitation problem.

Note 2-2: Quake resistance design in the OCS shall adhere to the criterion of Japanese standards described above and the National Structural Code of the Philippines 2015.

2) Wind Loads

In the ambient conditions and usage environments, wind loads shall be calculated based on the speed of wind prohibited below.

Table 6.2.3 Example of Wind loads at the wind speed of 54m/s against structures, etc.

Lines and equipment		Values	Note
Supports	Steel pipe pole	1,500 N/m^2	Qwstr
Lines	Two feeders bundled	2,200 N/m^2	Qwc
	Others	1,800 N/m^2	Qwc
Porcelain insulator	Suspension insulator	2,500 N/m^2	
	Long- rod Insulator	1,300 N/m^2	
Steel arm	Single structure	2,900 N/m^2	
	Others	4,000 N/m^2	

Note 1: The speed of wind prescribed by National Structural Code of the Philippines 2010 is 56 m/s under the atmosphere. If the atmosphere in typhoon reached 950 hPa, the wind speed of 54m/s under the 950 hPa will be equivalent to 56m/s with 1013 hPa as wind loads.

Note 2: Values in the table is rounded off by two-digit number.

For the CIA tunnel section, the design shall take into account the maximum velocity of air being blown by the tunnel fans.

6.2.5 Design Life

Standard Life Expectancy:

1) The Contractor shall select wires and parts with life expectancy over 30 years under standard and normal condition and circumstances. The environmental condition such as ambient temperature in the Philippines shall be the basis of evaluating and selecting wires and parts' life expectancy.

2) Special consumable components

The Contractor shall consider the actual performance data based on different operating conditions and the most onerous conditions of railway systems in the Philippines, to establish an ideal design life specifications of OCS components and entire system.

3) Tolerance controls and limits relating to design life in construction and maintenance

Parameters which are capable of being influenced by construction and maintenance shall be limited by tolerance controls and limits.

The tolerance controls and limits depend on the type of contact line, especially in overlap section and insulator section which shall be defined in accordance with the requirements for:

a) Safety

b) Quality and material of current collection

c) Speed and electrical capacity of the pantograph

d) Compatibility to interfaces, quality and frequency of maintenance

e) Aesthetic aspects.

The interdependencies between the individual values shall be considered as well as the relationship between the tolerances and limits and external effects like climate, pantograph design, power supply and regeneration.

For parameters which are susceptible to change during operation, and so influence the system performance, e.g., due to the shift of track position, sharp gradient and curve in track, operational limits shall be additionally defined. The service life shall also consider the relationship between the tolerance control and limits for construction and the limits for operation shall consider the possible changes of parameters over time between inspection and maintenance periods.

4) Design Life

Under normal operating conditions and maintenance, the equipment of the overhead contact line system shall have a design life at least equal to the design life of the system, in general, in accordance with the Arrhenius equation; that is, the equipment will deteriorate more quickly than the design life under ambient temperature conditions higher than 25 degrees Celsius.

6.3 System Requirements

6.3.1 System Overviews

1) Basic system overviews

   a) Voltage

      i) Voltage Rating 1500 VDC;

      ii) Minimum voltage more than 1000 V should not exceed 2 minutes; and

      iii) Maximum voltage less than 1850 V (in regenerating).

2) The main Overhead Catenary System for the requirements above is made up of principal components as follows:

   a) The complete overhead catenary system, the devices and the equipment related to supporting structures, the overhead contact lines, the feeder wires, other assemblies and the associated facilities

   b) Positive power feeds and negative returns shall be supplied from the traction substation (TSS). All connections from the substation shall be made using sheathed cables that shall comply to industry standards and practices. All cables shall have mechanical covers to protected them from vandalism.

   c) Negative current returned via both rails in track and negative return cables installed at both railway-sides for mitigation of cathodic erosion in the main line

   d) Lightning arrester of feeder at both railway-sides for mitigation of lightning damage

   e) Earthing system for all metallic devices and equipment, maintained a minimum of 1-meter clearance with the other earthing system (i.e., signaling, comms, etc.)

   f) Steel tubular beam supports comprising of suspension pole with single cantilever, drop supports with single cantilever at the island platform and twin cantilever only at the side platform in station and midpoint

   g) Midpoint anchor poles with guy wires to stop swivelling of midpoint cantilever in a tension length.

h) Steel tubular beams supporting the OCS equipment and drop supports with single or twin cantilever installed to play a role of mitigating lateral swivelling due to lateral force in seismic conditions, buildings and other civil works.

i) Works in the OCS design and construction which are closely related to civil, architecture, track works and the other electric works, mechanical works, drain works, distinguishing works, etc., shall meet each design requirements, to avoid conflicts.

j) Installation of foundation for supporting structures for supporting the OCS, feeders, guys and overhead return wires.

k) Electric clearances between the OCS, feeders and return cables and the earthed structures

l) 30cm cathodic erosion clearance between the rail carrying return current and the metal structure line parallel to the rail

m) Return cables in cable containment shielded with segmented galvanized metal. The Contractor shall require civil works Contractor to bore holes with 800mm wide and 300 mm high in lateral wall of trough with center 50mm above viaduct slab, one meter away from impedance Bond (ZB) edge which is parallel to the track.

n) Linking-up return cables passed through both plinths of the track and connected to the neutral terminal of the impedance bond at the special extended area outside of pathway in the elevated and embankment section.

o) Installation of lightning arrester positioned at less than 500m apart and the earthing wire connected to the negative terminal of the lightning arrester installed along the pillar and embedded into the of ground with the prescribed length and depth and earth resistance. The grounding electrode encasement shall be designed to be protected from theft but shall be accessible for maintenance and periodic resistance measurement.

p) Installation of overhead ground wire supported with an insulator with an arcing horn and a surge arrester for lightning protection for the OCS and feeders; the span shall be less than 200 m.

q) Connecting terminal with parts of metallic structures of embankment, and viaduct for mitigation of electrical shock as equipotential system for all metallic structures.

Note: Separation of earthing points for the lightning line from the other points of the other lines earthing for mitigating electric shock shall be over 1 meter.

r) Installation of terminating link and supports holding the OCS on structure of station and shop in depot.

s) For the OCS maintenance car shop, installation of track, pavement, interior accessories, air conditioner, etc.

t) Installation of turnout and mechanical tools for the maintenance car.

u) Earthing connection between pole earthing wire and earthing wire on elevated and embankment sections. The Contractor shall install an earthing electrode with resistance prescribed by the current provisions and regulations.

3) The major materials and equipment for the OCS to be provided shall conform to the following requirements.

a) Structures for overhead catenary line shall be designed and constructed in such a way that during the expected design life, OCS should serve its purpose within the acceptable levels of reliability.

b) Regarding reliability requirements, there should be no progressive collapse of any structure or facilities during the construction and installation period, if a failure is triggered in a defined component.

c) Regarding safety requirements, all action shall be undertaken to minimize risk of injury or loss of life during construction, installation and maintenance period.

d) The overhead catenary line shall also be designed, constructed and maintained in such a way that due regard is given to safety of the public, durability, robustness, maintainability and environmental considerations.

The above requirements shall be met by the choice of a knowledgeable and experienced Contractor specifying suitable materials, by appropriate design and detailing, and by specifying control procedures for design and construction.

6.3.2 Temperature Concerning Wires and Fittings

1) Permissible Temperature

The maximum temperature rises due to load currents, solar irradiation, wind power, ambient temperature shall lead under the normal condition rather than the prescribed conductor temperature at which the mechanical properties of the material are unduly impaired.

2) For feeder and the auxiliary connective wires, permissible temperature: less than 100 degrees under supplying trains via the feeders at headway of 5 minutes between trains.

3) Permissible Temperature for Contact Wire.

Table 6.3.1 Example of Permissible Temperature for Contact Wire and Feeder Wire

Material	Temperature		
	Instantaneous term less than 1s	Up to 30 min.	Continuous rating
Example	In short-circuit current	At pantograph standstill	Rush-hour
Normal copper for contact wire	200	120	90
Silver copper alloy	200	150	100
Copper for feeder wire	200	N/A	100

When calculating for Joule heat due to current flow, the temperature rises in a conductor the following conditions should be considered:

i) The heating caused by current,

ii) The heating caused by environmental conditions,

iii) The radiant heat emitted from the conductor, and

iv) The heat loss from the conductor by convection depending on the wind speed

The values of the environmental parameters shall take into consideration to ambient temperature, wind speed and solar irradiation.

4) Maximum Temperature, K (temp)

The tensile strength and creep behavior of contact wires depends on the maximum working temperature. The factor, K (temp) expresses the relationship between the permissible tensile stress and the maximum working temperature of a contact wire and is shown in the Table below.

Table 6.3.2 Factor, K (temp) for Contact Wires and Feeder

Contact wire material	K (temp) for max. temperature		
Temperature	≤ 80 °C	≤ 90 °C	= 100 °C
Cu	1.0	0.9	0.8
Cu-Ag	1.0	1.0	1.0

6.3.3 Basic Mechanical Design of Contact Wire Loads

The maximum permissible working tensile stress of a contact wire depends on the parameters of a seamless new contract wire under maximum temperature of 90 degrees, wind loads, pantograph uplift force.

6.3.4 Basic Mechanical Design of Catenary Wire Loads

The maximum permissible working tensile load of catenary wire depends on the parameters, contact wire loads, wind loads, geometrical factor like lateral tensile force due to a sharp curve.

6.3.5 Mechanical Design of other Stranded Wire Loads

Other stranded wires shall have the following characteristics.

1) Stay wires with 135 sq.mm prescribed by JIS G 3537 and JIS H 8641
2) Overhead ground wire with 55 sq. mm prescribed by 2 class in JIS G 3537 and JIS H 8641
3) The substitute wire with 135 sq.mm prescribed by JIS G 3537 and JIS H 8641 for a part of contact wire insulated with insulator at the end terminal,

6.3.6 Mechanical Design of Wires of Non-Conducting Materials

Materials shall be designed in such a way that the end portion of the stranded wire shall be insulated through an insulator in an overlap section for various size of contact wires to meet the required creepage distance.

6.3.7 Tensioning Systems

A tensioning system consists of a tension device, pole band, supports and the fittings.

A Tension device for the OCS and feeders should be employed with spring type for small range within 25 kN. Furthermore, constant adjustment of tensile force, the feeders can mitigate amplitude of swing line of dip under the effect of making the dip larger due to ambient temperature.

1) Tension length in standard tension devices should be a maximum length of approximately 1500 m. except on short tension length like in turnouts, etc. The standard tension length shall employ a mechanical midpoint system to maintain the tension. The standard tension device to be installed shall be bundled, strong enough in pulling both the catenary wire (19.6 kN per wire) and contact wire with 14.7 kN tensile force.

2) Feeder wires in the depot shall use a tension device with 19.6 kN per wire tensile force for securing enough safe electrical clearance with earthed structures when swinging due to strong winds.

3) Tensioning equipment shall not be be wider than the support mast so as not to reduce the usable width of the walkway.

4) Safety cages and barriers shall be installed to prevent any tensioning system equipment falling to the ground below or into the structure gauge in the event of an equipment failure.

6.3.8 Geometrical Overhead Catenary System and Equipment

1) Standard height in contact wire

a)	Standard height	:	4,800 mm
b)	Maximum height	:	5,400 mm
c)	Minimum height	:	4,400mm

Note: Maximum height in the OCS should be 5400 (margin 15mm) for working range is from 4400 mm to 5415 mm in the Rolling Stock

2) Limitation of contact wire inclination and staggers

The maximum angle of inclination of droppers along the track should be less than 10 degrees.

Standard deviation of staggers is 150 mm and shall return at 2 spans

Note 1. In curved section, the maximum deviation is permissible up to 250 mm.

3) Limitation of contact wire gradient and the transition between gradients

Any change in the height of the contact wire should be made gradually and the slope should not normally exceed 3 mm/m on the main line (the gradient is permissible at 5 mm/m only at the low-speed section less than 100 km/h) and 15 mm/m on sidings. In no case shall the relative gradient of the contact wire in two adjacent spans be greater than 1.5 mm/m on main lines and 5 mm/m on sidings.

4) Separation of Lines

The regulated dynamic electric clearance shall be maintained between feeders with difference source or feeding system.

5) Protection by Clearance

Protection by clearance must be in accordance with the provisions of Japanese Railway (TRTRS) and European Standards (EN) in conjunction with partial factors as defined in the Japanese Railway and European Standard, in JTSEE, JEAMS, JESC and JEC, EN 1992 series, EN 1993 series, EN 1995 series, EN 1997 and EN 1998 series. However, if the circuit concerned is connected to the traction return circuit, these provisions shall not apply.

- Protection by line clearance between OCS live lines from the same power source

- Protection by line clearance between OCS live lines from the different power source
- Protection by line clearance between OCS live line and other line without power

Example:

a) Clearance between far live lines supplied from the same power source

b) Clearance between live power lines and earthing obstacles

c) Clearance between live lines supplied from the different power sources

d) Clearance between live power lines and low voltage lines less than 30 V

e) Clearance between live power lines and obstacles

6.3.9 The Contact Line Arrangement above Turnout and Crossing

The contact lines above turnouts and track crossings shall be designed such that they can be traversed in all directions at the maximum speed of 120 km/h. The design of crossing points and the configuration and geometry of tangential contact lines shall ensure that no contact wire is able to slip below the pantograph contact strips. The sway and skew of the pantograph shall be considered as well as contact wire uplift and lateral deflection due to wind. At the point where the incoming contact wire touches the pantograph head, both contact wires shall be placed on the same side of the pantograph head related to its central axis. Suitable remedies, e.g. cross clamps, shall be employed to guarantee that both contact wires are lifted when being traversed by a pantograph. The temperature-related longitudinal expansions of contact wires shall be considered when adopting such remedies.

1) Main contact line shall locate under the other contact line,
2) Cross contact bar should be installed at crossing point, and
3) In the installation of cross contact bar, geometric clearance between the bar and the other should be retained

Table 6.3.3 Example of Prohibited Area and Measurements with Exceptions

Prohibited Area / Items	Installation		Exceptional measurements to apply in the area: Categorical exclusion
	Right under beam	Others	
	Unit: mm		
Pull-off arm	300～1000	300～1200	To employ Arm type at the outward direction against the fitting point. If the outward does not use, special arm shall be employed in taking the measurement.
Steady arm	300～1000	300～1200	Arm shall be installed at the outward direction against the fitting point.
Feed jumper, connector, double ear	300～1000		

Note. Dropper ear in the prohibited area above (300mm～1000mm) shall install at the outward direction against the fitting point.

6.3.10 Overlap Arrangement

Overlaps shall enable the pantograph to pass from one tension length to the next without speed reduction or interruption ·of the power supply to the traction unit. The number and lengths of spans including the differences in the length of adjacent spans and the contact wire gradients within overlaps shall be designed such that the permissible range of contact forces and the permissible differences in elasticity are met. The maximum running speeds and track radii need to be taken into account.

In Uninsulated, the supports of both contact line equipment shall enable the unrestricted movement of the contact line due to the temperature related longitudinal expansion.

For insulated overlaps the minimum dynamic electrical clearance of parallel conductors shall, under the specified environmental conditions, be maintained. The required static electric clearance in air shall be met.

Uninsulated overlaps should be permanently connected by a jumper. During emergency situation or when necessary, insulated overlaps should be connected through by pass isolators or via the substation.

6.3.11 Electric Clearance and Induced Voltage Regulations

1) Standard Electrical Clearance

Table 6.3.4 Standard Electrical Clearance

Items	Live OCS	Live overhead feeders	Note
Static clearance between catenary wire and feeder with the same potential, and object connected with earth	150	150	
Dynamic clearance between catenary wire and feeder with the same potential, and object connected with earth, example for pantograph in motion and tunnel surface in case of overvoltage in lightning surge wave.	70	70	electric clearance between lines swinging due to wind and close proximity to structure earthed

2) Electrical Safety Clearance

Table 6.3.5 Example of Electrical Safety Clearance between the Live OCS and Live Feeder and Other Structures/Facilities etc.

Items	Directions	Live OCS (mm)	Live overhead feeders (mm)	Note
Building structure	Up-side	1200	1200	
	Lateral side	1200	1200	
	Down- side	1200	2000	
Road, pedestrian bridge, railway located upward the OCS and feeders	Up-side	1200	1200	
	Lateral side	1200	1200	
	Down- side	1200	1200	
Road located upside of railway	Up-side	1200	1200	
	Lateral side	800	800	
Road located downside and lateral of relevant railway	Down- side	3000	3000	
	Lateral side	2500	2500	
Plant	All directions	600	600	
Return current wire loading at the same pole	Down-side	500	500	viewed as low voltage line
Height of wire from TOR in exclusive railway with signs banned trespassers, protection barrier and fence unable to entry easily	Verticalness	4800	5500	
Height of wire from TOR, crossing over road	Verticalness	5500	6000	
Height of feeder wire from TOR at platform	Verticalness	N/A	4000	refer to note 1
Clearance between feeder and the other feeder	Verticalness	N/A	600	

Items	Directions	Live OCS (mm)	Live overhead feeders (mm)	Note
Clearance between contact wire and housed height of pantograph at a point of lifting operation	Verticalness	250	N/A	

Note 1: In principle, installation of feeders is prohibited on the platform in every station.

The OCS design shall take into consideration the geometrical allowances for electrical clearances between overhead lines and the piers of the expressway, or transmission lines.

For limited electrical clearances, the Contractor shall seek approval for the Engineer for any concessions to the requirements of the Contract.

When the feeder wires swing due to strong wind it is possible that a midpoint of the wires will swing close to the pier of the expressway. The Contractor shall see to it that safe proximity of OCS poles and midspan wires shall be met.

3) Imposed fields and induced voltage regulations

Under the live OCS lines with 1500 VDC, the live lines affecting human objects and other equipment through the imposed electric and magnetic fields shall consider the table below.

Table 6.3.6 Regulations of the Induction Voltage, Electric and Magnetic Fields on OCS, etc.

No.	Items	Values		Unites	Note
1	Electric field	3		kV/m	Observation at height of 1m from normal foundation like pathway
2	Magnetic field	200		μT	
3	Static induction potential under transmission lines	430V within 0.1s 650V within 0.06s			The voltage between metallic objects induced and earth as per JTSEE
4	Permanent touch voltage induced (at	60		V	Refer to JTSEE, IEC 62128-1

Note 1: This value for this OCS project: If transmission line near the OCS is located, the value that superposed the effect of transmission line will have to be less than this value.

Note 2: The value is observed at height of 1 m from surface or platform in station.

Note 3: The induced potential is observed between metallic object and earthing electrode in elevated and embankment sections.

Note 4: The touch voltage is observed between rail and electrode probe set in surface.

Note 5: In special case of platforms in the stations, the electric and magnetic field shall not exceed the criteria in the table 6.3.7. The Contractor shall set the feeder catenary wire at the position with enough geometrical clearance and employ the insulated dropper insulated with an insulator at both end sides of station.

4) Electrical Safety Voltage

a) Basic values of the body voltage

Table 6.3.7 Maximum Permissible Body Voltages (Ub-max) in D.C. Traction Systems

Long-term		Short-term	
Time duration [s]	Ub-max	Time duration [s]	Ub-max
t >300	120V	0.5	190 V
300	150V	0.4	205 V
1	160V	0.3	220 V
0.9	165V	0.2	245 V
0.8	170V	0.1	285 V
0.7	175V	0.05	325 V
0.6	180V	0.02	370 V

Table 6.3.8 Maximum Permissible Effective Touch Voltage (Ute, max) in D.C. Traction System

Long-term		Short-term	
Time duration [s]	Ub-max	Time duration [s]	Ub-max
t >300	120V	t < 0.7	350V
300	150V	0.6	360V
1	160V	0.5	385V
0.9	165V	0.4	420V
0.8	170V	0.3	460V
0.7	175V	0.2	520V
		0.1	625V

Note 1: Ute, max: Maximum permissible effective touch voltage.

Note 2: In workshops, the effective touch voltage shall not exceed 60 V.

6.3.12 Safety Factor, Tolerance and Limits for Main Equipment

Table 6.3.9 Example of Safety Factor for Main Equipment

No	Equipment	provision	Safety factor
1	Hard-drawn Copper	Tensile force	Not less than 2.2
2	The others wire	Tensile force	Not less than 2.5
3	Supporting material	Breakdown point	Not less than 1.5
4	Foundation for Steel tube poles, beams and Guys	Withstand load	Not less than 2.0
5	Lines for stay	Tensile force	Not less than 2.5
			Note: Minimum tensile force more than 4.9 kN
6	Stem insulators	Bending fracture load	Not less than 2.5
		Tensile force	Not less than 2.5
7	Suspension insulators	Electro-mechanical failing load	Not less than 3.0
8	Others	Breakdown point	Not less than 2.0

6.3.14 Insulation Coordination

Insulation coordination between TSS, the OCS and Rolling Stock must have concerned with the selection, dimensioning and correlation of insulation both within and between items of equipment. In dimensioning insulation, electrical stresses and environmental conditions should be taken into account. For the same conditions and stresses, these dimensions are the same. An objective of insulation coordination is to avoid unnecessary over dimensioning insulation. This standard specifies a) the requirements for clearances and creepage distances for equipment; b) general requirements for tests pertaining to insulation coordination. The term equipment may apply to a system, a sub-system, an apparatus, a part of an apparatus or a physical realization of an equipotential line. This standard does not deal with a) distances through solid or liquid insulation; -distances through gases other than air: b) distances through air not at atmospheric pressure; and c) equipment used under extreme conditions. Product standards have to align with this generic standard. This is necessary for safety and/or reliability reasons, and/or particular operating conditions of the equipment itself, e.g., overhead lines which have to comply with EN50119. This standard also gives provisions for dielectric test (type tests, etc.

Table 6.3.10 Example of Insulation Coordination for the OCS with 1500 VDC

Classifications	Items		Installation		
			TSS*	The OCS	Vehicle*
Insulating strength	Lightning Impulse withstand voltage		20 kV	50 kV	20 kV
	Power-frequency withstand voltage		5.4 kV	20 kV	5.4 kV
Surge arrester characteristics	Nominal Voltage		1.5 kV	1.5 kV	1.5 kV
	Rating Voltage		2.1 kV	2.1 kV	2.1 kV
	Starting discharge voltage		2.6 kV	9 kV	2.6 kV
	Discharge voltage	2 kA	4.5 kV	25 kV	4.5 kV
		5kA	5 kV	28 kV	5 kV
		10 kA	5.5 kV	-	5.5 kV
	Standard point of installation		Supplying point	Refer to note	Receiving point
Lightning Impulse withstand voltage	Two suspension Insulators		–	150 kV	–
	A long-rod insulator for DC electrification		–	180 kV	–

Note: *Receiving point on the Insulation Coordination between OCS and TSS, OCS and Rolling Stocks. In case of OCS and TSS, it means the demarcation point and for OCS and Rolling Stocks, receiving point of power supply from OCS to pantograph.

6.4 Standard Equipment Requirements

6.4.1 General

a) Equipment identification

If there are no other requirements in the relevant product standards and the size and shape of the component is large enough, all equipment shall be marked with a supplier's identification, date of manufacturing and equipment identification, in accordance with JIS or approved equivalent standards.

The form of marking shall be agreed with the purchaser.

b) Corrosion and cathodic erosion

In general, surface corrosive protection shall be provided on equipment made of/from ferrous material by means of zinc galvanizing. For equipment made of corrosion resistant materials, a surface protection is not necessary.

In general, metal tube distributed in parallel to rail flowing DC current, cathodic erosive protection shall be provided on the tube by means of coating for insulation. In the depot, for mitigating the tube and metal equipment from cathodic erosion, rail leakage current suppressing device shall be installed at the place envisaged.

c) Additional protection shall be considered for internal strands of ferrous multi-stranded wires (e.g. greasing).

d) Equipment shall be designed in such products that the danger of stress corrosion cracking does not occur as much as possible.

e) For installation of lines, cantilevers and others on the OCS pole, the Contractor shall prepare an advance schedule and set up necessary equipment and tools, etc., prior to installation right after the curing period of mortar and concrete is completed.

Documentary photographs of pole installation per location shall be provided by the Contractor.

6.4.2 Pole Structure

Supports shall typically be poles with portal type structures being used in multi-track areas in accordance with the following:

a) Steel tubular pole

Main tubular pole for supporting the OCS, a beam and feeders are specified as follows:

i) Standard diameter: 269.4 mm, 318.5 mm, 355.6 mm, 406.4mm;

ii) Material Grade: STK 400, STK 490, STK 500, STK 540 prescribed by JIS G 3444-2010;

iii) Pole surface: A class 50 under hot dip galvanized coatings prescribed by JIS H 8641: 2007;

iv) Standard: JIS G 3444-2010;

v) Thickness: Base on the supporting loads, and seismic loads the thickness shall meet the appropriate strength necessary in material grade selection;

vi) In principle, all poles should have scaffolds with the span to meet the size for standard worker to go up and down along the pole;

vii) The inclination of the top of support should be less than 50 mm on a vertical plane of rail track center along a track under the maximum loads;

viii) The pole should be attached diverse signs to request by operation and for public caution and dangerous electric clearance; and

ix) When contact wire is subjected to its normal tension and must be stretched under a sustained tension, to draw off their initial creep extent through temporally excess tension as follows:

As the pre-stretch, for contact wire with Cu 170 sq.mm, excess tensile force: 29.4 kN for 30 minutes

Note. If extent of the line become to be in a stage of saturation or in excess tensile force, the operation must be stopped.

x) All poles should have pole caps.

b) Steel tubular beam

Main tubular beam for supporting the OCS is specified as follows:

i) Standard diameter: 216.3 mm, 267.4 mm, 318.5 mm;

ii) Material Grade: STK 400, STK 490, STK 500, STK 540 prescribed by JIS G 3444-2010;

iii) Pole surface: A class 50 under hot dip galvanized coatings prescribed by JIS H 8641: 2007;

iv) Standard: JISG 3444-2010 and JIS H 8641: 2007;

v) Thickness: Base on supporting loads and seismic loads the thickness shall meet the appropriate strength necessary in material grade selection;

vi) In the depot at the inert end of contact system, a track number sign shall be installed as precaution sign;

vii) In principle, no equipment and lines shall be installed above the beam, except on the beam over two tracks, the overhead ground wire to be installed and pass through along the beam shall be fixed by insulator holder;

viii) Connection between the pole and the beam shall have a small drain hole for flowing dew condensation water, if needed, flange connection between poles, between beams shall have the same hole; and

ix) When catenary is subjected to its normal tension, and must be stretched under a sustained tension, to draw off their initial creep extent through temporally excess tension as follows:

As the pre-stretch, for catenary wire with St. 135 sq.mm, excess tensile force: 19.6 kN for 10 minutes

Note: If extent of the line become to be in a stage of saturation or in excess tensile force, the operation must be stopped.

c) Pole Gauge

Table 6.4.1 Example of Pole Gauges Crossing Two Tracks in case of Pole with Standard Diameter of 318.5 mm

No.	Section	Bore Hole	Pole Diameter	Unit mm Gauge						Note
1	Sign	BH	PD	COT/ OW	COT/ COP	COT/ COP	COT/ SOP	COC	WOW	
2	Elevated	450	318.5	3150	425	2725	2565.75	4000	10300	
3	Embankment	450	318.5	3600	425	3175	3015.75	4000	11200	

Note 1: BH: Bore-hole

Note 2: PD: Pole diameter

Note 3: COT: Center of track

Note 4: OW: Outside of wall in elevated or embankment section

Note 5: COP: Center of pole

Note 6: SOP: Surface of pole

Note 7: COC: Length between centers of track

Note 8: WOW: Length between outside walls at the center

Note 9: In depot, max. COC between center of end side track in four tracks and the other center is 4500 mm, so that if pole install at the center, gauge between COP and COT is 2250 mm

d) Pole Locations and Span

This Contract is based around a design / build concept, where the information supplied to the Contractor defines the required performance requirements from the system and subsystems. The only 'technical information' supplied in the bidding documents are technical samples / examples 'for information only' with drawings supplied in the same way. Thus, the Contractor, within their scope, shall use their own independent means to execute the said design and build, ultimately delivering a safe and efficient railway.

Notwithstanding this underlying design / build philosophy, due to the need of the civil works Contractors for certain key interface information with respect to E&M and Track work subsystems, coupled with the fact that the contractor has not been appointed and thus there is no E&M / Track works design in existence yet, it was found necessary to generate this interface information from a number of qualified sources, thus allowing the civil works Contractors to progress in their work.

For the OCS in particular, a key interface was identified as the pole positions, whereby the civil works Contractors are required to have a PC box segment with a reinforcement to support the OCS poles. Thus, it became necessary to generate and supply these pole positions in order to allow the civil contractors to progress in their design of molds and fabrication of the segments.

1) Tangent track: poles erected at the end of each viaduct with a maximum span of 40 meters;
2) Tangent track: viaduct more than 40 meters span, one additional pole erected at the middle of the viaduct span;
3) Traction Substations (TSS): additional two (2) poles erected for feeder cables immediately above the TSS;
4) Turnout / Crossover Locations: One additional OCS pole erected at the middle of the viaduct span;
5) Horizontal Curve Sections: For a radius 650m or less an additional pole shall be erected at the middle of the viaduct span;
6) Gradient Changing Sections: Shorter pole spans to ensure the contact wire adapts to the change in gradient with standard of 3 ‰ to a maximum of 5 ‰ in the contact wire;
7) Station Locations: Nearest pole to the station no more than 20m from the station edge.

8) The following viaduct operation loads are taken as permanent loads in the design of the viaduct:

Table 6.4.2 Superimposed Dead Loads (Permanent) Summary

Load Case	Description	Loading
Weight of OHS poles	75 kN/pole each side = 150 kN total For girder design – adopt 150 kN located at mid span of girder. For pier design – adopt 150 kN located at center line of pier	75 kN/150 kN
OHS Imposed loadings due to tensioning of electrical supply wires	OHW moment of axis transverse to track OHW concentrated load acting longitudinally to track. OHW concentric load acting transfer to track. OHW moment about axis longitudinal to track	+/- 450 KNm at 2m c/c 4 no.s per span +/- 70 kN +/- 30 kN +/- 180 kNm

e) Steel drop support

Main tubular drop support for supporting the OCS and feeders is specified as follows:

a) Standard diameter: 216.3 mm, 267.4 mm, etc.,

b) Material Grade: STK 400, STK 490, STK 500, STK 540 prescribed by JIS G 3444-2010,

c) Pole surface: A class 50 under hot dip galvanized coatings prescribed by JIS H 8641: 2007,

d) Standard: JIS G 3444-2010, and

e) Thickness: Dependence on supporting loads, should meet load thickness with considerable strength in selecting a material grade.

6.4.3 Foundations

For the elevated and embankment section, the pole foundation of bore-holes and drain holes shall be prepared with the civil work. Filters for the drain holes shall be installed by the Contractor to prevent erosion of materials inside the foundation. The foundation and pile shall be designed to withstand the weight and tension of the OCS, wires and other components. If the OCS design shall be based on the Japanese design, the guidelines in note 1 and 2 below, they need to closely coordinates in advance with the civil works regarding the design data in coordination with the quake resistance parameters below:

a) Equivalent period of proper oscillation,

b) The ratio of breakdown load of the pier to total elevation structure weight,

c) The ground classification,

d) The ratio of breakdown rotation angle [rad] to breakdown displacement,

e) The data of response function via non-linear response spectrum method, and

f) The data needed to design the quake resistance for the OCS

If the design will be based in the Philippines (National Structural Code of the Philippines 2015) there is a need to calculate the quake resistance and shall fill the blank in table below and shall interface with the civil team.

Any exceeded values obtained, the Contractor shall take the following countermeasures:

a) Reduction of pole span,

b) Moving parts of loads to the other pole, and

c) Installation of new pole

The Contractor shall design the best suited quake resistance plan. This concept shall apply to foundation and beam in the other sections and depot.

a) In the embankment section, the Contractor shall obtain the ground classification in order to design the best suited quake resistance.

b) In the depot, the Contractor must design a plan to meet between the loads and the stress of foundation.

c) The Contractor should request the party in charge of the structural works to calculate the best seismic design in the OCS. The Contractor should check the seismic design guidelines below and shall design Level 2 in Quake-resistance standards.

Note 1-1: Guideline of a seismic design for overhead catenary system, issued by Railway Technical Research Institute (RTRI) on March, 2013

Note 1-2: Design guidelines of support systems for overhead catenary system, issued by Japan Railway Electrical Engineering Association (JREEA) on October 2010

The Contractor shall take countermeasure to address the possible deformation, overturning and untoward incidents during the installation of pole foundation.

Table 6.4.3 Example of Interfaces between Civil Works and the OCS with Respect to the Seismic Loads, Strength and Moment at Boundary Conditions

Item	Horizontal direction against the track				Parallel direction against the track		Vertical load		Notes
	Outside		Inside				Gravitational force	Drawing direction	
	Moment	Force	Moment	Force	Moment	Force			
	Bending	H.	Bending	H.	Bending	H.			
Sign	Mo	Ho	Mi	Hi	Mp	Mp	Vd	Vu	

Unit	kNm	kN	kNm	kN	kNm	kN	kN	kN	
Max. values	325	45	325	45	285	40	45	45	
	As the result of collaborative works, each value above shall be determined and fill in the blank above.								

Note 1: Horizontal is abbreviated as H. for narrow column.

Note 2: M and F is, respectively, is momentum and force, each value in a line of the max. values will be at maximum in any point as the demarcated interfaces under understands and agreements together.

6.4.4 Feeder

Feeder is a conductor delivered per track per direction from a connecting terminal bar supported with a feeding pole at a substation.

a) Standard feeder system consists of two wires of PH 356 sq. mm with feeding pole on elevated section and feeder jumper between the feeder and contact wire.

b) The maximum temperature rises in the conductors, due to load currents, shall not lead to conductor temperatures at which the mechanical properties of the material are unduly impaired.

c) The temperature rise caused by current heating shall be used in addition to the maximum ambient temperature and solar irradiance in determining the mechanical and dimensional allowances to be made for the maximum expansion of the conductor, and geometrical allowances for electrical clearance and contact wire height prescribed by the provisions and regulations. The design shall accommodate the pantograph current at standstill.

d) The temperatures above which may impair the mechanical properties of the wires are given in Table 6.3.1 for material compositions used in contact line systems.

e) In a standard feeder system comprising of two feeders combined with a fitting clamp bundled with two wires with aspen less than 10 m; an end clamp for two wires and spring type tension device shall be installed with the tension length of less than 1500m.

f) Standard tensile force is 19.6 kN per wire.

6.4.5 Feeder Jumper

a) Standard span of a jumper as a short conductor installed to provide electrical continuity is less than 250 m. In a one-way feeding scheme, as a fundamental rule, a jumper span should not exceed more than 125 m.

b) Full Current: A jumper should be able to carry full line current from one contact wire to another longitudinally at tensioning overlaps and track turnouts.

6.4.6 Contact Wire

a) Seamless structure of contract wire shall be selected.

b) Standard contact wire system consists of a wire with of GT 170 sq.mm with feeding pole on elevated section and feeder jumper between the feeder and contact wire, prescribed by JIS. E. -1990 Hard −Drawn Grooved Trolley Wires or Copper Alloy.

c) The maximum temperature rises in the conductors, due to load currents, shall not lead to conductor temperatures at which the mechanical properties of the material are unduly impaired.

d) The temperature rise caused by current heating shall be used in addition to the maximum ambient temperature and solar irradiance in determining the mechanical and dimensional allowances to be made for the maximum expansion of the conductor system, and geometrical allowances for electrical clearance and contact wire height. The design shall accommodate the pantograph current at standstill.

e) The temperatures above which the mechanical properties might be impaired are given in Table 6.3.1 for material compositions used in contact line systems.

i) Gradient

The gradient is defined as the difference in height of the overhead contact line above top of rail at two successive supports to the length of the span contact wire.

The gradient must be 3 mm/m below, however, the ratio can be allowable 5mm/m under the section running, at the speed of the train at less than 100 km/h.

ii) Minimum contact wire height

The minimum contact wire height is defined as the minimum value of the contact wire height in the span to avoid the arcing between one or more contact wires and the vehicles in all conditions.

The value is 4400mm.

iii) Standard contact wire height

The standard value is 4800 mm of the contact wire height at support under normal conditions

iv) Maximum contact wire height

The maximum possible contact wire height which the pantograph is required to reach, in all conditions, maximum contact wire height shall not exceed 5400 mm.

6.4.7 Catenary Wire

a) Size: St. 135 sq. mm or PH 356 sq. mm

b) Material Grade: steel class 2 or 3 Zinc-coated steel wire strands prescribed by JIS G3537 ︰2011, or Copper alloy

c) Wire surface: super A or A class under hot dip galvanized coatings prescribed by Zinc-coated steel wire strands by JIS G3537 ︰2011

6.4.8 Electrical connections in the overhead catenary system

a) Equalizing: An equalizing jumper in the catenary connecting the catenary to the contact wire or between the contact wires proximity to each other for electrical continuity.

b) Material Grade: class 2 or 3 Zinc-coated steel wire strands prescribed by JIS G3537: 2011, or Copper alloy

c) Wire surface: super A or A class under hot dip galvanized coatings prescribed by Zinc-coated steel wire strands by JIS G3537:2011

6.4.9 Droppers

A fitting used in overhead equipment construction for supporting the contact wire from catenary. The dropper span is previously described. In case of single or double feeder catenary system, insulated dropper shall employ.

6.4.10 Protection Covers for Catenary Wire

As protection from wearing the catenary wire due to lifting of the dropper and swinging by wind power a protection cover should be installed, made of Nylon or polycarbonate resin, at a position based in the table below.

Table 6.4.4 Example of Standard Way Putting Catenary Wire Protector (bobbin type)

Application	Positions	Note
Straight line R≧ 1600 m	The first dropper and the end in catenary wire at the support	
1600＞R>800 m	The first and second dropper, and the end and second in catenary wire at the support	
R≦800 m	All points setting catenary wire	
Turnout section	All points setting catenary wire	
Parallel section	All points setting catenary wire	Each first and second point of catenary wire outward at available parallel section, included Nullity lines.

6.4.11 Limitation of maximum length of single contact wire in feeding of the train.

a) The maximum length should be less than 125 m in an insulated overlaps and crossing points.

b) In every shop with the OCS at the depot, for low frequent of feeding power current to the train, the jumper span rules out.

6.4.12 Equalizing line between contact wire and catenary wire

As an electrical equalizing connection in the OCS, a short conductor should be installed to provide electrical continuity on one contact wire to another.

The light jumper in the OCS is by connecting the catenary wire to contact wire to equalize the two wires for mitigating different voltage between them.

6.4.13 Cantilever

Cantilevers shall be determined by summing up the wind actions, pole gauge and ambient temperature variance on the individual elements. The cantilevers carry the overhead contact line of two tracks for side platform in station section or one track for the other section. They may be fixed to the supports by hinges allowing the cantilevers to rotate around a vertical axis, providing no resistance to longitudinal loads from the overhead contact line. Alternatively, cantilevers fixed rigidly to the structures offer resistance against longitudinal forces created by the overhead contact lines. Parts of the cantilever with pull-off contact wire support are specified as follows:

a) Standard diameter and others
   i) Main horizontal top and cantilever tubes: 60.5 mm;
   ii) Registration arm tube: 48.6mm;
   iii) Insulated pull-off (steady) arm tube: 29 mm for L=900 mm; 32 mm for L=1200 mm; and
   iv) Insulated pull-off arm with FRP length of 200 mm.
b) Material Grade: STK 490, SS400, CAC 702 (pull-off arm & ear), SS400 (drop bracket), SUS304 (fitting);
c) Pole surface: Hot dip galvanized;
d) Standard: JIS G 3444-2010;
e) Thickness: The load to be supported shall be one of the basis in selecting the material, thickness of the cantilever; and
f) Drop bracket fitting attached to the underside of a cantilever registration pipe that carries the steady arm or registration arm: The load to be supported shall be one of the basis in selecting the material and thickness of the drop bracket fitting.

6.4.14 Pull-off Arm

Registration placing the conductors to the specified wire heights and staggers is laterally to stabilize (with or without support), conductors to maintain a fixed horizontal location relative to the center line of the track. The registration arm or steady arm plays a role of restraining laterally on the contact wire at a structure or other point of registration, such as at a wire pull-off due to pull-off arm. The heel setting is designed to minimize uplift of the contact wire due to the radial load in the registration arm caused by contact wire deviation.

Point of pull-off arm ear produce current collector. The hard spots should be the eliminated or minimized as much as possible.

6.4.15 Steady Arm

The steady arm plays a role of pivoting and supporting the contact wire. Standard angle of the arm with standard length of 900 mm should be installed at 11 degrees at the horizontal axis on a line of connection between surface rails.

Steady arm shall be installed in case of straight or in curve section with radius of more than 1600 m.

Steady arm shall have an insulated portion at the end where a swivel clamp shall be attached to hold the contact wire.

6.4.16 Spring Tensioning Systems

The tensions in the contact and catenary wires shall be maintained within the system design parameters. To ensure satisfactory current collection at the design speeds, the contact and catenary wires shall be automatically tensioned.

For automatically tensioned equipment, local tension in the overhead contact line may vary, because of the movement of registration arms or cantilever frames. The maximum acceptable variation of tension in the overhead contact line shall be considered.

The standard tension device shall be installed at the successive side poles overlap section, the standard devices is specified as follows.

Table 6.4.5 Example of Tension Devices

Application	Tensile force	Stroke	Diameter	Total length in manufacture	Weight
Unit	kN	mm	mm	mm	kg
Feeder with single wire (Depot)	11.76	430 590 730	241.8	1264 1569 1874	140 180 224
Single Feeder Catenary wire	19.6	500 630 760 880	241.8	1621 1939 2257 2593	220 370 310 365
Double Feeder Catenary wires	39.2	650 790	318.5	2318 2693	530 620
Contact wire	14.7	420 560 700	241.8	1324 1649 1974	160 200 245

6.4.17 Midpoint and the Anchor Structure

a) A midpoint supports poles with each guy and anchor.

b) A midpoint anchor structure is designed to resist the termination forces of the midpoint anchor in addition to other functions such as carrying cantilevers.

6.4.18 Stays (guys)

Anchor supports are structural elements to resist the tensile forces of stay wires supporting structures of contact line, catenary line and feeder wires. The type of load shall be selected according to the type of anchored structure:

a) Standard depression angle between pole and stay is 45 degrees, minimum angle is 30 degrees;

b) Standard stay wire shall use 135 sq.mm, 90 sq. mm, 55 sq. mm in Zinc-coated steel wire strands prescribed by JIS G3537-2011 with Zinc-coated level more than A class, selecting 2 class or 3 class;

c) The exclusive band for the stay shall be separated from the other;

d) Standard stay shall have an anchor insulator and install V type (reference below) structure for the OCS;

e) Standard separation between the relevant block and others shall be installed more than 3.5 m; and

f) In unavoidable cases, stay pole shall be employed.

Figure 6.4.1 Schematic V Type Stay

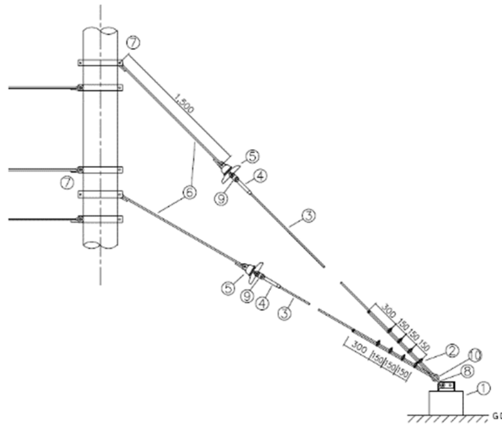


Table 6.4.6 Example of Specifications of V Type Stay

No.	Name	Detailed	Unit	Nos	Notes
1	F type stay foundation		l.s.	1	• Stay rod prescribed by JIS G3537：2011 Zinc-coated steel wire strands • Standard depression angle with 45 degrees
2	Stay block		l.s	1	
3	Wire clip		Nos	8	
4	Zinc-coated steel wire strand with 135 sq.mm	2 class A class	Nos	1	
5	Suspension insulator	250EP-J	Nos	2	
6	Connection rod made of SS400	Diameter:19 mm. Length: 1500	Nos	2	
7	Band for pole	1 class B	Nos	2	• Coating prescribed by JIS H8641：

		type			2007 Hot dip galvanized coatings
8	Connecting fitting	Clevis for stay		1	SS400
No.	Name	Detailed	Unit	Nos	Notes
9	Connecting fittings	Clevis for stay		2	
10	A ring for stay	Two wire type		1	For 135 sq. mm

Figure 6.4.2 Schematic F Type Foundation

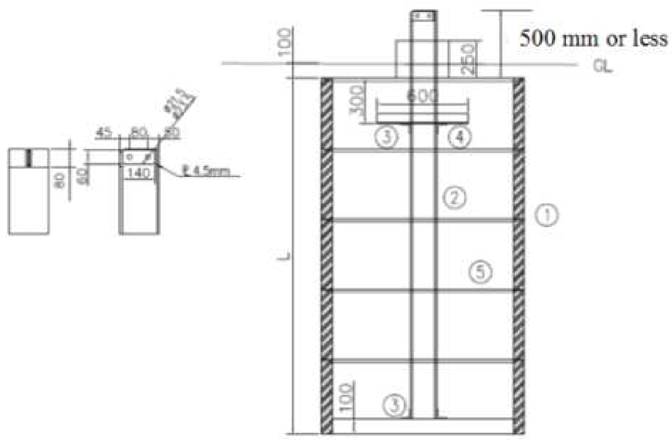


Table 6.4.7 Example of Specifications of F Type Foundation for the Stay

No.	Name	detailed	Unit	Min.	Max.	Notes
1	Foundation	Type		1	5	Type 5: bore hole with
	Frame number		Nos	4	5	
2	H type steel	SS400	mm	6	6	Width:175, hieght:175, vertical thickness:7.5 Upper and lower thickness: 10
3	Equal angle steel	SS400	mm	6	6	Width:65, hieght:65, thickness:8
4	Hexagon head bolt					M16 ×14mm by JIS B 1180：2014 Hexagon head bolts and hexagon

No.	Name	detailed	Unit	Min.	Max.	Notes
5	Ready Mixed Concrete	18-8-25	m^2	0.98	2.7	Nominal strength＝18 N/cm^2, concrete Slump size＝8 cm, max. diameter in coarse aggregate＝25 mm, prescribed by JIS A 5308 ：2014 Ready-mixed concrete. Circular decorative concrete
6	Steel plate	Welded	Nos	2	2	Thickness: 4.5 mm, 140 mm×60 mm

6.4.19 Bolts and nuts

Example of bolts and nuts shows below.

Table 6.4.8 Example of Methods of Bolts and Nuts Locking under Multimodal Vibrations

Locking / Item	Locking tools				Stop loosening		Locking method	
	Single nut	Double nut	High strength Bolt	self-locking nuts	Painted lock nut	Thin sheet metal nut	Spring lock washer	Cotter pin
Beam	○	●	—	○●	—	○	—	—
Flange connected with a part of pole	—	—	○		—	○	—	—
Flange connected with beams	—	○	○	○	—	○	—	—
Bracket・dropper・paralleled frame	○	●	—	○●	—	○	—	—
Cantilever	—	○	—	○	—	○	—	○
Band for pole	○	—	—	—	—	—	○	—
Fitting for insulator	○	—	—	—	—	—	○	○

Locking / Item	Locking tools				Stop loosening		Locking method	
	Single nut	Double nut	High strength Bolt	self-locking nuts	Painted lock nut	Thin sheet metal nut	Spring lock washer	Cotter pin
Insulator	○	–	–	–	–	–	–	○
Bolt fixed the foundation	–	○	–	○	–	○	–	–
Bolt for fixation in or out the equipment	–	○	–	○	–	○	–	–
General point on the surface	–	–	–	–	–	○	–	–
Bolt in the structure unable to fasten as locking nut	○	–	–	–	○	–	–	–

Note 1: "●" sign means to apply them under the condition of high fluctuation rate;

Note 2: In the other case, the measurement shall be taken as may be necessary;

Note 3: In double nuts, a thicker upside nut installs a thinner nut downward; and

Note 4: Beyond items above, an appropriate measure shall be taken for the issues.

6.4.20 Turnouts and Crossings

Contact lines above turnouts and track crossings shall be designed such that they can be traversed in all directions at the planned speeds whilst still meeting the requirements of the permissible range of contact forces. The design of crossing points and the configuration and geometry of tangential contact lines shall ensure that no contact wire is able to slip below the pantograph contact strips. The sway and skew of the pantograph shall be considered as well as contact wire uplift and lateral deflection due to wind. At the point where the incoming contact wire touches the pantograph head, both contact wires shall be placed on the same side of the pantograph head related to its central axis. Suitable remedies, e.g. cross contact bars, shall be employed to guarantee that both contact wires are lifted when being traversed by a pantograph. The temperature-related longitudinal expansions of contact wires shall be considered when adopting such remedies.

a) Main contact line shall be located under the other contact line,

b) Cross contact bar shall be installed at crossing point,

c) In the installation of cross contact bar, geometric clearance between the bar and the other wires should be maintained and remain unchanged under different conditions, and

d) Pole span with section insulator shall be installed within 30 m to address the effect of wind power, etc.

Table 6.4.9 Example of Prohibited Area and Measurements with Exceptions

Prohibited area / Items	Installation		Exceptional measurements to apply the area: Categorical exclusion
	Right under beam	The other	
	Unit: mm		
Pull-off arm	300～1000	300～1200	To employ Arm type at the outward direction against the fitting point. If the outward does not use, special arm shall be employed to take the measure.
Steady arm	300～1000	300～1200	Arm shall install at the outward direction against the fitting point.
Feed jumper, connector, double ear	300～1000		

Note: Dropper ear in the prohibited area above (300 mm～1000 mm) shall install at the outward direction against the fitting point.

6.4.21 Sectioning

a) Insulated overlap section

For insulated overlaps the minimum dynamic electrical clearance of parallel conductors shall depend on specified environmental conditions.

It maintains the standard electric clearance of 300 mm and both insulated parallel lines shall keep the height equal to and from TOR for 2 pole span less than 40 m.

b) Uninsulated overlap section

In Uninsulated overlaps, the supports of both contact line equipment shall enable the unrestricted movement of the contact line due to the temperature related longitudinal expansion.

Uninsulated overlaps should be permanently connected by a jumper, It shall maintain the mechanical clearance of 150 mm to ensure the acceptable dynamic performance of the pantograph and overhead contact line system both parallel lines shall keep height equal to (from TOR) for 2 pole spans under the standard pole span less than 40 m. The required static geometrical clearance in air shall be met for the pantograph to smoothly run on a contact wire to the other wire parallel to it.

c) Section insulator

A section insulator shall be designed to withstand arcing caused by the passing of pantographs with no reduction in its mechanical integrity. A load current flow across a section insulator caused by a pantograph running into an isolated section shall not damage the sectioning device so as not to jeopardize its mechanical integrity. The current shall be limited to the maximum operational current of the sectioning device, as defined by the supplier. A voltage shall be applied to the sectioning device. The flashover shall occur on the intended parts and be extinguished by the device. The flashover shall not affect the mechanical integrity of the section insulator. The geometrical and electrical clearance values given as the value of 300 mm should also be applied for clearances between adjacent live parts of contact lines of different electrical sections of the same voltage. The section insulators shall be positioned such that the pantographs on both 8 and 10 car consists are not directly under sections insulators when trains are stopped in sidings or at signals.

Table 6.4.10 Example of Classification of Sections and Applications

Items	Material	Applications	Limitation of the train speed	Not
Insulated overlap section	—	Section separated two directions in main line	130 [km/h]	Installed at TSS
Insulator section	FRP	Section separated Up and down lines	85 [km/h]	Turnout
Uninsulated overlap section	—	Section separated two directions in main line	130 [km/h]	Installed at a tension length

6.4.22 Feeding Sectionalizing

Sectioning points in the OCS are formed by cutting insulation into the out-of-running sections of the two overlapping catenaries with at least minimum electrical clearance between them, which provide a continuous powered path for pantographs.

In main line, feeding sectionalizing shall feed the directional track and individual track with each feeder circuit breaker supplied by the substation.

6.4.23 Insulators

Insulators are classified mainly into the three types below:

a) Suspension insulator;

b) Long rod insulator; and

c) Support insulator.

A set of two combined with suspension insulators shall be used for the feeders.

Each long rod insulator should combine with main pipe and bent pipe in the cantilever.

These insulators with appropriate insulation level are essentially important for the insulation coordination between the insulation in equipment of TSS and Rolling Stock.

Table 6.4.11 Example of Insulators and the Applications

Places \ Classifications		Suspension Insulator										
		Porcelain					Polymer		Long Rod		Support insulator	
		100	100	180	250	250	P180	P180	Porcelain	Polymer		
		C	EP	EP-Z EP-EC Z, C	T-W	EP-J	TNEP, TNE, TNCP, TNC	2C	DC type	PDC	SP20	DC-FP
Catenary/ Feeder	General	—	—	2	—	—	—	1	—	—	—	—
Bare return line		—	—	1	—	—	—	1			(1)	(1)
The OCS, feeders, anchored points, section insulators	General	—	—	2	—	—	—	—	—	—	—	—
	Bunched with two wires	—	—	—	—	2	—	—	—	—	—	—
	Under high tensile force	—	—	—	—	2	—	—	—	—	—	—
Insulated overlap section	General	—	—	2	—	—	—	—	—	—	—	—
	Special anchored	—	4	—	—	—	—	—	—	—	—	—
Steady arm	General	—	—	2	—	—	—	—	—	—	—	—
	Hinged pipe	—	—	—	—	—	—	—	—	—	—	—
Pull-off arm		—	—	2	—	—	—	—	—	—	—	—
Insulated dropper		1	—	—	—	—	—	—	—	—	—	—
Cantilever	Top tube	—	—	—	—	—	—	—	1	1	—	—
	Cantilever tube	—	—	—	—	—	—	—	1	1	—	—
Live beam		—	—	2	—	—	—	—	—	—	—	—
Stay	General	—	—	1	—	—	—	—	—	—	—	—
	Under high tensile force	—	—	—	—	1	—	—	—	—	—	—

Classifications / Places	Suspension Insulator										
	Porcelain					Polymer		Long Rod		Support insulator	
	100	100	180	250	250	P180	P180	Porcelain	Polymer		
	C	EP	EP-Z EP-EC Z, C	T-W	EP-J	TNEP, TNE, TNCP, TNC	2C	DC type	PDC	SP20	DC-FP
Disconnector	—	—	—	—	—	—	—	—	—	1	
Overhead Ground Wire	—	—	1	—	—	1	—	—	—	1	—

Note 1: In case of st.135, under high tensile force, the insulator is employed 250 EP-J types.

Note 2: Sign in Polymer insulator denotes polymer support insulator p180, long rod insulator is PDC

Note 3: The other sign refers to JIS overhead catenary insulator terminology.

6.4.24 Section Insulators

A section insulator is a device for isolating two electrical sections from each other. Section insulator provided by a physically separated insulator, to create a safe working zone for maintenance staff between energized equipment and grounded equipment. A separation of at least 1080 mm is preferred. The section insulator shall have equivalent characteristics prescribed by JIS E 2219-2001. Section insulator shall be installed in accordance with the manufacturer's instructions. Section Insulators shall be provided at all cross overs.

6.4.25 Insulated Overlap Section

Overlaps shall enable the pantograph to pass from one tension length to the next without speed reduction or interruption of the power supply to the traction unit. The number and lengths of spans including the differences in the length of adjacent spans and the contact wire gradients within overlaps shall be designed such that the permissible range of contact forces and the permissible differences in elasticity are met. Overlap shall not be installed at sharp horizontal curve and steep gradient in track, horizontal and longitudinal inflection point.

For insulated overlaps the minimum dynamic electrical clearance of parallel conductors shall, under the specified environmental conditions, be maintained. The insulated overlap shall be required static electric clearance with 300 mm in air.

Section area entrance sign and section area exit sign shall be installed on a feeder pole. Installation location on feeder for Insulated Overlap Section shall include the following:

a) Between supply border of different power supply company.

All feeding points in the depot and main line shall have a motorized isolator positioned adjacent to the infeed connection to the OCS. On the mainline adjacent infeed points shall both connect to a motorized by-pass isolator. The purpose of the by-pass isolator shall be to feed adjacent sections in the event of an infeed outage.

6.4.26 Uninsulated Overlap Section

For uninsulated overlaps in automatically tensioned equipment, the supports of both contact line equipment shall enable the unrestricted movement of the contact line due to the temperature related longitudinal expansion. The uninsulated overlap shall be required static electric clearance with 150 mm in air, connecting the parallel contact wires and catenary wires.

Installation location on main feeder for Uninsulated Overlap Section shall include the following:

a) Between high speed circuit breaker (HSCB) F1 and F3, F2 and F4, Depot and SP.

Installation location on depot feeding branch for Uninsulated Overlap Section shall include the following:

a) Between depot and main feeder (two locations)

6.4.27 Shutter Insulator

A shutter insulator is a device use to isolate a catenary or contact wire below the roll up door (at open position). It will be utilized when there is a strong wind with rain showers which need to utilize the roll-up door to protect the equipment inside the workshop. The shutter insulator comprises of reinforced wood insulator, a disconnecting blade, insulators, sliders, protective plate, auxiliary plate and fittings. The design is shown below:

Figure 6.4.3 Schematic View of a Shutter Section

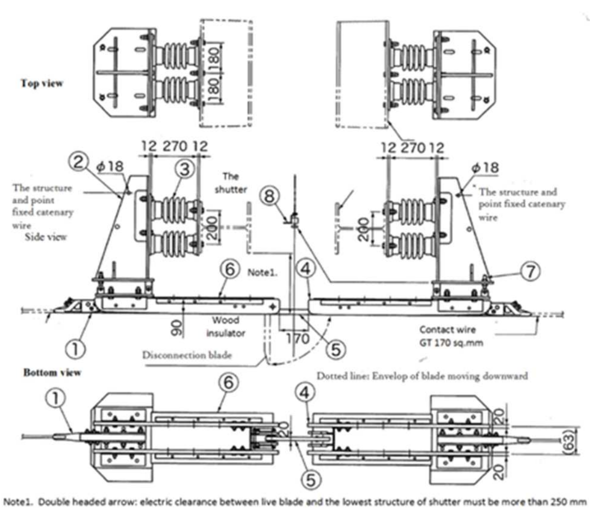


Table 6.4.12 Example of Specifications of a Shutter Section

No.	Name	Material	Note
1	Main insulator made of reinforced wood insulator	CAC702 reinforced wood	
2	Support plate for fixing catenary wire with 19.7 kN	SS400	
3	Support porcelain insulator	HSP-10	JIS C 3818
4	Auxiliary sliders	reinforced wood	
5	Disconnected blade	FRP & SS400	
6	Protective plate	Insulating plate, SS400	
7	Adjustment bolts	SS400	
8	Ancillary plate	SUS 304	

Note 1: CAC702 is prescribed by Copper and copper alloy castings in JIS H 5120-2009; and

Note 2: For design and installation of this item, the Contractor shall have a close coordination and interface with architectural and civil team.

6.4.28 Disconnector and the controlled, equipment in the shop

a) Disconnector and with Motor Controlled (Remote)

A motor driven disconnector has a current capacity of 3000A and with earthing pole connected in disconnecting, is figured below.

Figure 6.4.4 Outline View of Remote Motor Driven Disconnector with Earthing Pole and Motor Driven Box

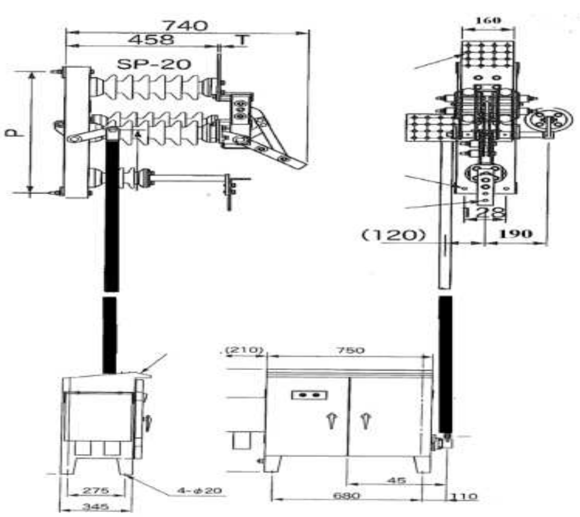


Table 6.4.13 Example of Specifications of Remote Motor Driven Disconnector with Earthing Pole and Motor Driven Box

Table Main Specifications of Motor Driven Disconnector				
Ratting		Terminal blade		
Current	Voltage	Span between centers of hole	Size	Total holes
3000A	1500 VDC	40 mm	14 mm	Total 16 holes: • 4 holes/per horizontal direction • 4 holes/per vertical direction

Note 1: The motor driven equipment shall be a single phase of 220V, 60 Hz. Interface close coordination is required with the power supply system,

Note 2: Length of working pipe depends on the height of the disconnector.

b) Equipment in Shops

Equipment in the shops, is written in tabulated form below.

Table 6.4.14 Example of Specifications of Equipment in the Shops

Place / Equipment	Unit	Light Repair Shop	Wheel Re-profiling Line	Fine Adjustment Track	Unscheduled Repair Track	Car Washing Track	Access line
Number of tracks	line	3	1	1	1	1	1
Remote disconnector	Nos	3	1	1	1	—	—
Rail Leakage Current Suppressing Device (RLCSD)	Nos	1	1	1	1	1	1
Return jumper cable (a bundle of 4 lines/track)	Nos	12	4	4	4	4	4
Shutter sections	Nos	3	2	1	2	—	—
Locking controlled door for stairs	Doors	3	0	1	0	—	—

LED Display	Outdoor type	Nos	3	2	1	2	—	—
	Indoor type	Nos	15	2	3	2	—	—
	On surface type	Nos	12	0	0	0	—	—
revolving light warning		Nos	6	1	2	1	—	—
Buzzer for alarm		Nos	6	1	2	1	—	—
Deflection 250 mm from a center of track		L.S.	—	—	—	1	—	—
Return cross-bonding		L.S.	—	1	1	1	—	—

Note 1: Return cross-bonding shall be installed in case of track with no signal circuit and with overhead catenary line.

Note 2: The design and installation of OCS in the workshop area at depot shall consider the safe working vertical and horizontal clearance required and the operational and maintenance activities to maintain a safe and reliable OCS system.

6.4.29 Moveable Conductor Rail in Work Shops

The contractor shall install movable conductor rail systems in the unscheduled repair shops at both Mabalacat and Banlic depots to permit safe and unhindered roof access for the maintenance of pantographs, air-conditioners and other equipment.

The conductor rail shall be positioned at the track center line of the tracks and be retracted from the center line through the rotation of the suspension arms. In the retracted position the conductor rail shall be automatically earthed.

The conductor rail system shall comprise of all fixings to buildings structures, conductor rail, motorized and slave arms, control panel, a facility within the control panel to hold and release interlocking keys that will be used to restrict the operation of the isolators feeding the tracks and operation of other equipment, and all necessary LV and control cables.

6.4.30 Overhead Ground Wire

The route will have a high incidence of lightning as depicted by isokeraunic thunder year map as described previously, so that overhead ground wire should be installed along each track in the main line.

Note: the overhead ground wire is designed to minimize impacts of lightning and other surges to feeders and the OCS, and the surrounding equipment.

a) Standard size: st.55 sq. mm equal to or more than the value determined by the effect of calculation under wind loads with the average speed of 54 m/s;

b) Material Grade: class 2 or 3 Zinc-coated steel wire strands prescribed by JIS G3537 ：2011;

c) Wire surface: super A or A class under hot dip galvanized coatings prescribed by Zinc-coated steel wire strands by JIS G3537：2011;

d) Standard tensile force 2.94 kN; and

e) The protective angle effect of overhead ground wire to a protected equipment from lightning can be at 45 degrees for the OCS and feeders based on Japanese railway standard.

6.4.31 Earthing Lines and Earthing Electrodes

For protection against electric shock, any of exposed conductive parts shall have an appropriate earth electrode providing an electrical connection to earth.

a) Earthing lines of surge arrester for lightning protection of the feeders and overhead ground wire shall be fixed along the pier in elevated section with an independent earth electrode from the other.

b) In elevated section, the other earthing lines should be connected to a reinforcing rod made of metallic parts at the structure earth or construction including interconnected metallic structural parts, which can be used as an earth electrode in the elevated section.

Note. The Contractor shall install earthing electrode with resistance prescribed by the provisions and regulations based from the Philippine Electrical Code in the embankment section.

Table 6.4.15 Example of Specifications Earthing Resistance

Items	Earthing resistances
Ground wire	30 Ω or below
General earthing independent from the other	10 Ω or below
Surge arrester	30 Ω or below
Metal structure in building under induction potential circumstance	100 Ω or below
Steel tube or pipe	100 Ω or below
Metal structure supported the OCS and feeders in building of station	100 Ω or below
Equipment or metal objects unable for human to touch with ease for enough clearance	100 Ω or below

Items	**Earthing resistances**
Equipment or metal objects able for human to touch easily for enough clearance	100 Ω or below

6.4.32 Return Cables

Return cables shall be connected to a neutral terminal of an impedance bond with no bridge and bridged an insulated rail joint for negative return for substation that allows passage of traction return current while preventing passage of signaling current. With close coordination and interface with signaling, civil works at main line, the return cables shall connect to a neutral terminal of the impedance bond installed at a midpoint between substations. Furthermore, the other return cables shall be installed at the other neutral terminal in main line and at the end of track in the sideline and depot, for mitigating cathodic erosion, voltage dip and keeping high sensibility to trip in case of fault.

The return cable should employ cable prescribed by JIS C 3605: 2002 600 V Cross-linked polyethylene insulated cables in the table 6.2.1.; in addition, the cable shall comply with non-brominated, flame retardant and rodent proof.

The return cables should be fixed with fire proof cleats for mitigating voltage drop and induction voltage to lines in the duct, and the effects of stray currents caused by DC traction systems.

Table 6.4.16 Example of Specifications of a Fire Proofed Cleat Lapped with Semi-Cylinders

Items	Testing	Unit	Values	Note
Specific weight		kg/kg	0.8	
Shore hardness	JIS Z 2246		72	Shore D by shore durometer
Water absorption	JIS K 6911	%	0.4	Submerge for 24 hours
Bending strength	JIS K 6911	MPa	29.4	
Bending elastic modulus	JIS K 6911	GPa	0.690	
Compressive strength	JIS K 6911	MPa	12.7	
Linear thermal coefficient	JIS K 6911	1/K	0.0001	
Heat conductivity	JIS A 1412	W/mK	0.105	
Burning resistance	JIS K 6911			Non-inflammable in A type
Dielectric break down	JIS K 6911	Ωcm	$6*10^{12}$	
Arc resistance	JIS K 6911	s	83	

Note 1: JIS Z 2246: 2000 Shore Hardness Test−Test method

Note 2: JIS K 6911-1995 Testing Methods for Thermosetting Plastics

Note 3: JIS A 1412-1: 1999 Test Method for Thermal Resistance and Related Properties of thermal insulations −Part 1: Guarded hot plate apparatus

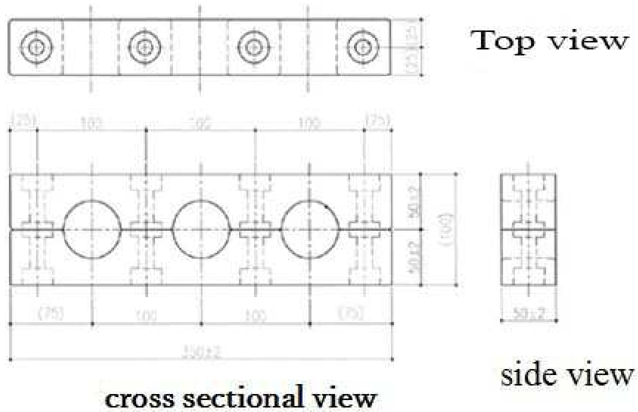


Fig. 6.4.5 Schematic View of Cleat

6.4.33 Overhead Return Line

In the depot with complicated pipe arrangement, an overhead return line should be installed for mitigating the stray current caused by cathodic erosion as negative line connected to the impedance bond.

6.4.34 Return Busbar

For mitigating the stray current in the depot, a return busbar shall be installed to be positioned with appropriate clearance from surface when current is present.

6.4.35 Rail Leakage Current Suppressing Device (RLCSD)

For mitigating the stray current and touch voltage between metal structures in shop, a RLCSD shall be installed with the specifications as follows:

Table 6.4.17 Example of Specifications of RLCSD

Items	Specifications	Example
General	Circumstance	Outdoor
	Cooling way	Natural cooling
	Paint reduced solar irradiance	Outside surface painting
	Maximum ambient temperature	40 degrees or below under no anti-irradiance painting
	Estimated mass	350 kg
	Structure of under foundation	Structure able to approach lines

	Prohibited structure for pest to break in	Structure unable for pests to invade into the equipment, able to ventilate air.
Temp.	Limitation of semiconductor junction temperature	75°C degrees or below
Electric	Continuous rating current	1200 A
	Rating current in short time	3000 A for 1 minute
	Withstand reverse voltage for equipment	500 V
	Withstand reverse voltage for devices	2000 V or over
	Backward flow current for devices	100 mA or less at 500 VDC imposed load
	Insulation resistance	5 MΩ or over under measurement-imposed load with 1000 V instrument
	Voltage proof	2000 V for 1 minute

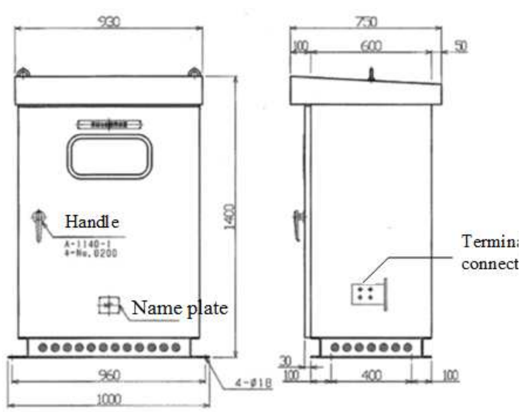


Figure 6.4.6 External Appearance

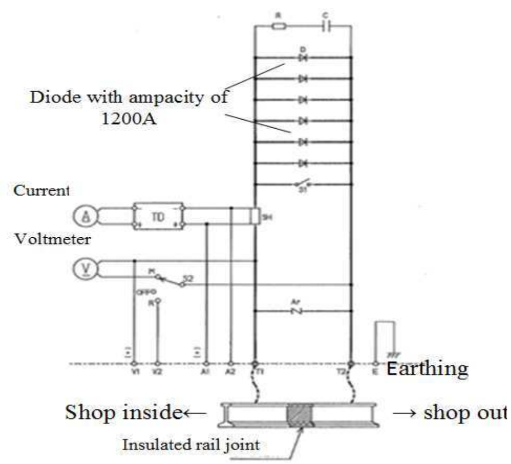


Figure 6.4.7 Outline of Circuit

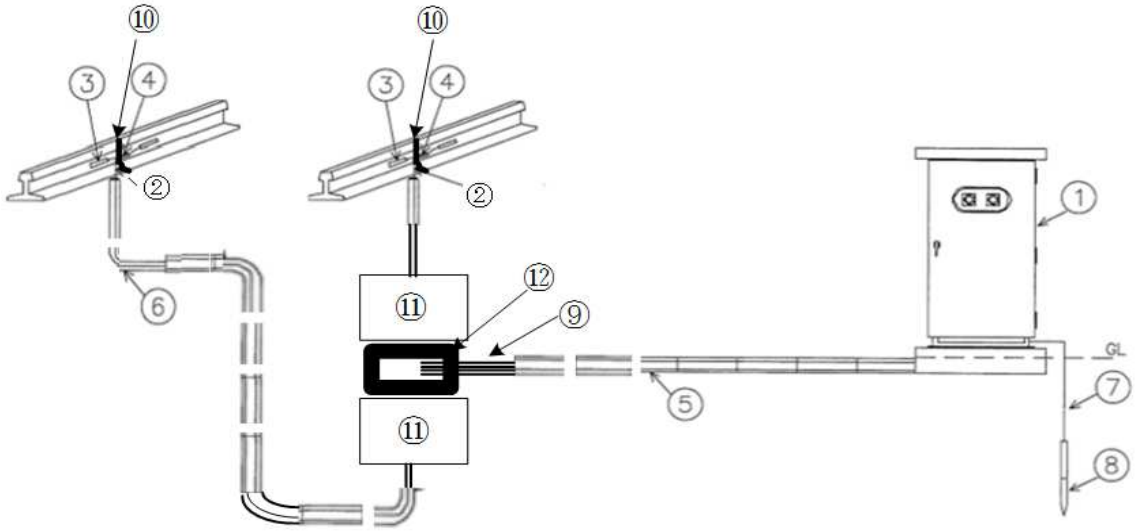


Figure 6.4.8 Schematic View of the RLCSD

Table 6.4.18 Example of Specifications in Installation of the RLCSD

No.	Name	Specifications	unit	Nos	Notes
1	RLCSD	Rating current 2000 A type	l.s.	1	Signaling engineer design and constructor installed
2	Power cable	Reference signaling specifications of Impedance bond and rail bond etc.	Nos	-	
3	Rail bond connected between insulated rails		Nos	-	
4	Jumper line		Nos	-	
5	Return cable tube		Nos	-	
6	Impedance bond		Nos	-	
7	Neutral terminal of impedance bond		Nos	-	
8	Return cable containment		Nos	1	Architecture side interfaced
9	Vinyl insulated lines	IV 22 sq. mm	Nos	1	
10	Earthing rod	Diameter 10 mm	Nos	1	Earthing resistance 100 Ω or less

No.	Name	Specifications	unit	Nos	Notes
11	Return cable	200 sq.mm	Nos	4	
12	Insulated rail joints		Nos	2	Track side installed

6.4.36 Cross Bonds

Cross bond means electrical connection intended to connect in parallel conductors of the return circuit.

The Contractor shall design a cross bond system to mitigate high potential voltage between rail and surface when trains start running under traction.

In the shop, for the OCS on track without signaling circuit, rail-to-rail cross bond shall employ electrical bond that interconnects the running rails of the same track.

6.4.37 Temperature Indicator Stickers

Adhesive Temperature Indicator Strips shall be installed to detect limitation temperature at the supposed points changing from health to fault condition in the table below.

Table 6.4.19 Example of Temperature Indicator Stickers

Classification	Sub-classification	Max. allowable working temperature	Operating indicator temperature	Nos
Feeder wire	Wire	100°C	—	—
	Compressed tension sleeve, end clamp and fitting	90°C	70°C	2
	Compressed T- sleeve	90°C	70°C	2
	Compressed jumper sleeve	90°C	70°C	2
	Compressed end clamp	90°C	70°C	2
	Connector between wires	75°C	65°C	2
Feeder jumper	Compressed feeder branch	90°C	70°C	1
	Feeder ear	90°C	70°C	2

Classification	Sub-classification	Max. allowable working temperature	Operating indicator temperature	Nos
Contact wire	Compressed connection part	90°C	70°C	1
	Connector	90°C	70°C	2
Disconnector	Blade	65°C	55°C	2
	Terminals	75°C	65°C	2
Return cable and return wire	Compressed connection part	90°C	70°C	2
	Compressed T- sleeve	90°C	70°C	2
	Jumper connection part	90°C	70°C	2
	Compressed end clamp	90°C	70°C	2
	Terminals	75°C	65°C	2

6.4.38 Inclination and Stagger

a) Inclination between an axis of connection between the first / end dropper and contact wire and a vertical axis on the track should be less than 10 degrees at the support.

b) Under defined environmental conditions and mechanical tolerances, the horizontal deflection of the contact wire and the pantograph shall be considered such that it is not possible for the contact wire to slide off the pantograph head unless specifically designed to do so at contact wire takeover points. A minimum stagger value shall be specified to maintain adequate mechanical clearances and to minimize wear of contact wire and pantograph strip. Under normal operational conditions, the contact wire shall be contained within the pantograph working width. For calculation of deflection of the contact wire, wind forces shall be applied to the contact and catenary wires. Dropper wires may also be considered. The resulting contact wire movement, together with the structure deflection, shall result in contact wire deviation within the maximum values permitted by the system design when added to the contact wire stagger in air at any point along track. Mechanical and electrical clearances of conductors to other parts of the railway infrastructure, when subject to wind, shall similarly be verified.

The stagger should be in less than 150 mm at the non-curve section, be permissible up to 250 mm or higher but must consider the uniformly and safe wearing of the pantograph collector against the contact wire.

6.4.39 Surge arrester with gap as protection devices with interfacing requirements

Surge arrester with gap consists of the following such as: arrester, LA connector, life limiter that able to disconnect automatically in fault by itself, knife switch, connecting soft wire with KIV (by JIS C 3316) of diameter from 2.6 sq. mm to 22 sq. mm, fittings and lead wire to earthing pole.

Furthermore, the surge arrester is designed to minimize impacts to surrounding equipment.

The devices to be installed shall have coordination between the OCS, TSS and Rolling Stock in Table below.

a) Insulation Coordination

Insulation coordination is the selection of the dielectric strength of equipment in relation to the operating voltages and overvoltage which can appear on the system for which the equipment is intended and considering the service environment and the characteristics of the available preventing and protective devices.

In the OCS with 1500 VDC, example of insulation co-ordination between TSS, the OCS and rolling stock is showed as table below.

Table 6.4.20 Example of Insulation Coordination for the OCS with 1500 V

Classifications	Items		Installation		
			TSS	OCS	Vehicle
Insulating Strength	Lightning Impulse withstand voltage		20 kV	50 kV	20 kV
	Power-frequency withstand voltage		5.4 kV	20 kV	5.4 kV
Surge arrester characteristics	Nominal Voltage		1.5 kV	1.5 kV	1.5 kV
	Rating Voltage		2.1 kV	2.1 kV	2.1 kV
	Starting discharge voltage		2.6 kV	9 kV	2.6 kV
	Discharge Voltage	2 kA	4.5 kV	25 kV	4.5 kV
		5 kA	5 kV	28 kV	5 kV
		10 kA	5.5 kV		5.5 kV
	Standard point Insulators		Supplying Port	Note	Receiving Point
Lightning Impulse Withstand voltage	Two suspension Insulators			150 kV	
	A long-rod insulator for DC electrification			180 kV	

Note: Adjacent section between live lines in the OCS and artifact structure, point receiving from TSS, and so forth.

b) Surge Protection Devices

Surge protection devices specify the procedure for the selection of the rated withstand voltages for the phase-to-earth. Overvoltage limiting device is a device which limits the peak values of the overvoltage or their durations or both. For surge arrester, the required withstand voltages of the insulating housing are based on the protective levels in the table below. Protection devices, such as surge arrestors and spark gaps, shall be designed for the corresponding rated current of the system and voltage.

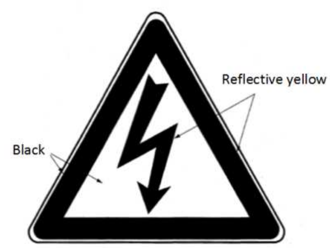
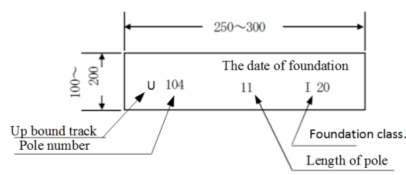
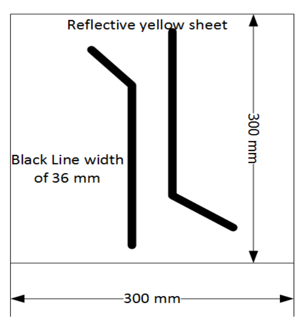
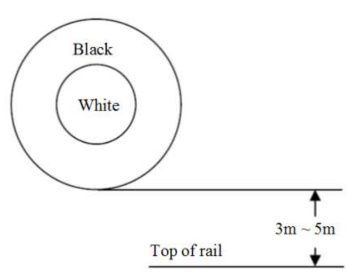
Table 6.4.21 Example of Specifications of Surge Arrestor with Gap

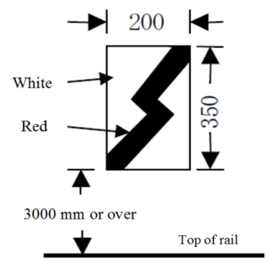
Items		Specifications	Note
Type		GL-15DR	
Rated voltage		1500 V	
Permissible voltage Break down voltage		1800 V	
Rated voltage	At 1 mA	9 kV	
Lightning discharge break down voltage	Standard	25 kV or less	
	0.5μs	29 kV or less	
Power frequency withstand voltage	1.2/50μs	50 kV	
	Only part of porcelain	20 kV	
Voltage under lightning impulse condition Operating duty	At 8/20μs	3000 V	
	At 8/20μs	3000 A	
Discharge withstand current rating	At 4/10μs	30 kA 2 times	Under lightning impulse condition
	At 2 ms	100 A 100 times	Under lightning impulse condition
Mass		About 2 kg	
Range of temperature to use		-20 to 40 degrees	
Attitude		1km or less	

6.4.40 Signage

Signs shall be installed based on Internationally accepted design. The design shall be given a Notice of No Objection by the Engineer.

Table 6.4.22 Example of Precaution / Warning Signs

Items	Objective	sign	Application	Note
Electric warning sign	Caution, risk of electric shock	 Warning sign	• Place with enough clearance prescribed by regulation • Crossing in the depot	ISO 3864-1
Operation	Guidance board		Pole number plate	Installation height from TOR: 2.5 m
	Advanced notice for insulated section		Prohibition for train to stop and power at insulated section, as section insulator and insulated overlap section.	
	Starting point to power		After the last pantograph of train passed through the Insulation section, train can start powering at a point of the passing	

Items	Objective	sign	Application	Note
			point plus 10 m	
	Dead-end of OCS		For siding track and tracks in the depot, this sign shall be installed upside of the beam at the dead overhead catenary.	

6.4.41 Machines

Machines for the OCS maintenance workshop are as detailed below:

Table 6.4.23 Example of Machines Installed in the OCS Workshop

Items	Nos
Drilling machine	1
Grinder	1
Vice	1
Spare parts for the tools above	1
Portable Generator Set Min. 5 kVA	1

6.4.42 Instruments and Test Apparatus (Minimum Requirements)

Instruments and test apparatus shall be supplied for installation and maintenance of OCS.

Table 6.4.24 Example of instruments

Name	Nos	Main specifications	Note
Catenary measuring Instrument for height from top of rail and deviation from track center (height and stagger measuring device)	8	(1) Max. extension length: 5500 mm (2) Folded length 1650 mm (3) Track Gauge: 1435 mm	
Resistance Tester	5	(1) Voltage range: DC 2000V (2) Detector to check whether a line is live or not (3) Capability of checking resistance for section insulator at turn-out under live line (4) Leakage current indicator (5) With terminal earthing to top of rail to be clamped through a magnetic force or mechanical device. (6) A lead wire	
Earthing device	60	(1) Hook made with SUS304 (2) An earthing fastening for attachment to rail base with appropriate clamps and bolts. (3) A lead wires (4) A storage bag for the tools	
Withstand voltage tester	2	(1) Capacity: 20 kVA (2) Range of voltage: 0~5kVa.c. or 10 kV DC (3) Rating current 4A (4) Power: single phase, 220V, 50Hz/60Hz (5) Communication tool: GP-IB/RS232C	
Thermography	2	Main Specifications (1) IFOV (spatial resolution) 2.0 m Rad (2) Detector resolution 320x240 (3) Field of view 35.7 ° x 26.8 ° (4) Distance to spot 504:1 (5) Wireless connectivity Yes	
Digital multi-meter	6	(A) Voltage (1) Range............................ 90 – 240 V ac 50/60 Hz (2) Accuracy........................ ±3 % of reading, ±1 LSD	

Name	**Nos**	**Main specifications**	**Note**
		(B) Loads (1) Range........................... 0 – 19.99 A (2) Accuracy...................... ±5 % of reading, ±1 LSD	
Earth ground tester	2	(1) Earth Ground Resistance 1.000 to 9.999 Ω (2) Accuracy 1.000 to 9.999 Ω ± 1.5 % + 0.01 Ω	
Insulation resistance tester	2	(1) Range: from 0.1 MΩ to 10GΩ (2) Test Voltage: 50 V、100 V、250 V、500 V、1000 V	
Insulation resistance tester	4	(A)Test Voltage: 250 V,500 V,1000 V,2500 V,5000 V,10000 V	
DC Hotstick Tester	8	Telescopic type, min. adjustable at 8-10 meters min of 3kV; heavy duty with voltmeter and LED light	

6.5 Testing, Inspection and Commissioning

6.5.1 General

The Contractor shall prepare and submit to the Engineer its format for recording each test, verification and performance test for all equipment and systems.

Test procedures should include, but not be limited to the following:

a) Measuring and Test

- i) Measuring and objectives;
- ii) Required safety methods and prerequisite training required;
- iii) Associated tests and pass/fail criteria;
- iv) Reference specifications /standards and supporting literature;
- v) Staffing required, including requirements from the authority;
- vi) Measuring and tests of methods;
- vii) Observation on equipment, jigs and supporting systems required;
- viii) Tests and measuring schedule;
- ix) Tests and measuring location;
- x) Identification of professional and qualified personnel and resumes of those responsible for signoff; and
- xi) Tests and measuring with results and recommendations.

b) Contractor's Inspection Team

Inspectors must have a minimum of five years' experience working with electrical systems. All inspectors must be familiar with the installation and repair of the components associated with the electrical systems, and OCS.

c) Photography: The commissioning activities and important activities shall be recorded during construction/installation for record purposes.

d) Commissioning

The Contractor shall be responsible for preparing and executing a Verification, Test, Acceptance and Commissioning Plan required to successfully demonstrate the performance of the System Infrastructure in accordance with the Contract.

The commissioning will include, but not be limited to:

i) The demonstration of the functional capability, completion and safety of the OCS and test track.

ii) The demonstration that System Infrastructure have been installed and are operating in accordance with the requirements of the Contract, and that its performance meets or exceeds the requirements of the Contract.

The Contractor is solely responsible for all checking and verification activities relating to individual components, sub-systems, systems, all associated equipment and facilities required prior to the formal testing and commissioning and acceptance testing programs necessary to demonstrate completion of the OCS.

The Contractor shall create a commissioning schedule and shall incorporate this into the works schedule. The Contractor shall submit monthly reports to the relevant authority regarding progress of project commissioning.

Training, operating and maintenance manuals, and as-built drawings shall be provided to meet or exceed the requirements of the Contract. The Contractor shall provide OCS for maintenance, operation and emergency procedures in OCS system infrastructure orientation and training to emergency service.

The Contractor shall prepare a brief description on the OCS systems infrastructure design and performance requirements, including the requirements of the output prior to beginning the construction process.

e) Cost of Tests

i) The Contractor must bear the cost of all necessary tests.

ii) As for the cost of the test which is carried out outside the Philippines, the Contractor must bear the expenses related to witnessing and verification by the Employer and the Engineer.

6.5.2 Third Party Inspection

If inspection is necessary to comply with regulations or Employers requirements, then such inspection shall be carried out by the independent third party. In such case all relevant cost to be borne by the Contractor. However, the Contractor shall submit all necessary documents describing related accreditation and experience in similar works to the Engineer prior to engaging any such agency.

6.6 Documentation

The Contractor shall provide documentation to include, but not limited to, the following:

1) System specification;

2) Basic design including simulation reports

3) Installation design;
4) Installation and maintenance and repair;
5) Equipment and tools for major replacement of OCS wires;
6) Instruments and tools for maintenance;
7) Construction record and photographs of OCS activities from the start of installation, testing, commissioning and test run;
8) Data gotten through testing, inspections and commissioning; and
9) As-built drawing

6.7 Quality Assurance and Control

The Contractor's management system shall emphasize quality assurance and controls. The program shall be adequate to ensure an acceptable level of quality of the materials and workmanship delivered. The concept of total quality assurance shall be based on the principle that quality is a basic responsibility of the Contractor's organization, and shall be evidenced by:

1) designs for proven production process and inspectional procedure;
2) firm procurement and job performance specifications;
3) firm procedures for transmission of information and data to sub-contractors and ensuring their compliance;
4) adequate testing to ensure repetitive product conformity to design requirements; and
5) total program of surveillance and verification of physical performance and configuration accountability.

Adequate records shall be kept by the Contractor to provide evidence of quality and accountability. These records shall include results of inspections, tests, process controls, certification of processes and personnel, discrepant materials; and other quality control requirements.

In the same manner, monitoring records of works performance and quality shall also indicate deficiencies found and the action undertaken for correction.

6.8 Overhead Line Inspection Vehicle

1) Quantity: Two (2) number.

2) Functional Requirements: Self-propelled, multi-purpose infrastructure maintenance vehicle. Maintenance work will involve:
   a. Catenary system – Inspection, adjustment and testing of catenary installation, and replacement of contact wire and associated components and
   b. Transport of OCS equipment to and from stations/depots.

3) Design: The Catenary Maintenance Vehicle shall be a multi-purpose, diesel-powered vehicle to be used as single vehicle as well as motive power for work trains along the entire main line system, comprising tunnel, elevated structures, and depot. The Catenary Maintenance Vehicle shall consist of loading platform, crew cab, catenary maintenance platform and hydraulic crane. The major structures of vehicle shall be designed for 30 years design life.

4) Performance:
   a. It must be capable of hauling a closed flat car and open flat car simultaneously.
   b. Operating on 15.0 ‰ gradient more than 50 km/h with 2 flat cars, each with maximum 20T gross weight;
   c. Empty vehicle more than speed 80 km/h on level track;
   d. Curves in depot minimum R 100 m;
   e. Equal operation in forward and reverse directions.

5) Vehicle Dimension:
   a. Standard gauge, 1,435 mm;
   b. Wheel Profile: The wheel profile shall be compatible with the rail profile and wheel back to back dimension shall be 1359mm-1362mm
   c. Vehicle length approximately 10-12 m, width maximum 2.80 m, height maximum 3.80 m;
   d. Maximum axle load 16 t (fully equipped and loaded).
   e. Vehicle shall comply with Rolling Stock Gauge.

6) Loading Platform:
   a. Loading platform with non-slip surface, approximately 16 m^2, accessible from ground level via steps, platform height 1.0 – 1.3 m above rail level, folding type hinged boards (approximately 400 mm high) around the periphery of the vehicle;
   b. Platform load capacity 5-t.

7) Drive Train:
   a. Self-propelled, diesel powered, emission-optimized, exhaust with catalytic converter and silencer;
   b. Running gear shall comprise bogies or single axles, or a combination;
   c. Hydrostatic drive;
   d. Wheels monobloc type, with same wheel profile as passenger car wheels.

8) Cab:
   a. The cab shall be equipped for bi-directional operation with driver in seated position, including space for 6-person crew, large window panes for visibility, windshield wipers and washer, sun visors/blinds, access to cab via sliding door from loading platform, steps to loading platform on each side from ground level, air-conditioning, and space for test equipment cabinet;
   b. Cab shall be mounted on resilient supports for attenuation of vibration;
   c. Adequate lighting shall be provided for night work. Working light shall be equipped to each end the vehicle with at least 1000 lumens and rated at IP66.

9) Operating Equipment:
   a. The vehicle shall be designed for ease of maintenance and convenience of component access for servicing and repair;
   b. The vehicle shall have couplers provided by the CP NS-02 contractor. These couplers once received from the CP NS-02 contractor shall be installed on the maintenance vehicles at their place of manufacture. The coupler height shall match the CP NS-02 coupler height.
   c. An adapter for tight lock train couplers shall be included on the vehicle;
   d. Pneumatic brakes shall be provided, spring on/air off type, emergency brake, and mechanical parking brake;
   e. Mechanical parking brake, applied via hand wheel from either side of vehicle;
   f. On-board electrical power generation for work lights and power tools;

g. On-board air compressor to supply brakes, including brakes on two flat cars, as well as power tools;
h. Equipped with effective illumination for night work, including two headlights and two red tail lights at each end of the vehicle ends controllable and adjustable from cab for the performance of inspections. An amber flashing light shall be fitted at each end of the vehicle.
i. Fuel capacity for 8 hours operation;
j. Fitted with 4 jacking pads to lift vehicle.
k. Air horn;
l. Tool kit, fire extinguisher, first aid kit;
m. Wheel chocks (2), one attached to each side of vehicle.

10) Crane:
a. Hydraulic crane, lifting capacity 6T and 5.0 m reach;
b. Highest reach for maintenance work at 7.6 m above top-of-rail level
c. Outriggers for crane operation;
d. Crane shall be suitable for operation in tunnel.

11) Catenary Inspection Platform:
a. Hydraulically operated catenary inspection platform;
b. Platform size 3.0 m x 2.5 m, hand railing 1.1 m high;
c. Platform shall be laterally adjustable for OCS maintenance work. The bucket/platform shall be capable of rotating or swing at 180 degrees horizontally. The vertical adjustment and swinging of the platform shall be done thru a remote control
d. Maximum platform height from top-of-rail 4.0 m.
e. Safe Working Load (SWL) shall be painted to the bucket/platform.
f. The bucket/platform shall be fitted with anchor point for personnel fall arrest system.

12) The vehicle shall be equipped with fully working pantograph which shall be comparable to the units used on the rolling stock fleet.

13) Overhead Line Inspection Vehicle shall be fitted with Overhead Catenary System (OCS) Inspection Module. Inspection module shall be supplied, complete with the necessary software, hardware, display screen, and data storage for download at the depot/workshop. OCS Inspection module requirements are indicated but not limited to below:

a. Measurement of catenary height, stagger and size (diameter);
b. This equipment shall be powered from the Overhead line inspection vehicle;
c. Measurement data shall be displayed real-time on inspection vehicle monitor and shall be stored for review and transfer via USB or WiFi to a data base at the depot;
d. Measured data shall be recorded relative to track sections, chainage, stationing and travel direction.
e. An alternative may be considered for installation/integration of inspection modules in Overhead Line Inspection Vehicle by mounting inspection module on a trailing vehicle drawn by maintenance vehicle. The trailing vehicle shall be part of the inspection equipment supply.

In addition, the Overhead Line Inspection Vehicle shall be equipped with on-board signaling and telecommunications equipment together with an intercom or radio system to enable the driver to communicate with the personnel on the elevated platform.

6.9 Special Tools

6.9.1 Tools (Minimum Requirements)

Tools shall be provided in accordance with the Installation, Maintenance and Operational Manual.

Table 6.9.1 Example of Tools

Items	Nos	Items	Nos
Dies	5	Hydraulic Cutter	2
Low noise engine driven	2	Electrical Tool Box	2
Compression with Titanium	2	Mechanical Tool Box	2
Handy hydraulic compressor	2	Insulated Telescopic Ladder 12 feet	2
Crimping Tools (hydraulic)	2		

6.9.2 Working wares (Minimum Requirements)

Working wares shall be prepared with the approval of the Engineer.

Table 6.9.2 Example of Working Wares

Terms	Nos	Terms	Nos
Dropper bender device	2	Binocular	1
Device for replacement of suspension insulator	2	Safety Belt (heavy duty)	15
Low deck trolley for line drum	1	Device for joining contact wire	2
Low deck trolley for pole	1	Device for replacement of section insulator	2
Low deck trolley for the OCS inspection	1	Measuring Tape (10 meters)	4
Tools for electric protection		Grounding Clusters for Rail to OCS wires	6 sets
Electric rubber boots	10	Complete set of tools and equipment for major replacement of OCS wire	2
Electric protection gloves	10		
Insulated trousers	10		
Bag for electric protection tools	10		

Terms	Nos	Terms	Nos
Insulated jackets	10		
Electric protective helmet included guests	50		

6.10 Training Program

DC Electric traction system with OCS is a specialized field in railway. The Contractor is required to submit a suitable training program for the Engineering Team and/or other personnel to be responsible for maintenance of OCS. Listed below is the minimum training program but not limited to:

1) Basic Knowledge and Orientation to system of operation;
2) Basic of knowledge on Traction Power System;
3) Basic Knowledge on OCS System;
4) OCS Maintenance Program;
5) OCS Methodology (Theory and Practical) on Installation and Repair;
6) Methodology (Theory and Practical) on Major Replacement of all OCS wires, Tensioning Spring, Section Insulators, Cable Splicing, Cantilevers, Pull-offs, etc;
7) OCS Team Staffing and Management;
8) OCS Safety Procedures;
9) Knowledge and using OCS Tools Equipment, Measuring Devices, and Maintenance Vehicles (Theory and Practical);
10) OCS Materials, Safekeeping, Re-ordering, and Inventory (consumables and capital spares); and
11) Others

    Other Training Requirements for OCS:

    a) Planning of Training and Advance;
    b) Categories to be trained;
    c) Initial Training;
    d) Promotional Courses;
    e) Refresher Courses;
    f) Facilities for Training;
    g) Training in General and Subsidiary Rules;
    h) Responsibility of Officers and Supervisors;
    i) Examination at the End of the Training;
    j) Specialized Training;
    k) Syllabi;
    i) Theoretical

ii) Practical

l) Authorized Personnel;

m) Competency Certificates;

n) Qualified Person in charge of Motor Trolley, etc.;

o) Period of Training;

p) The OCS Inspection Car Drivers;

q) Knowledge of Rules & Regulations;

r) Register of Certificates;

s) Service Record; and

t) Inspections.

End of Section

7 Automatic Fare Collection (AFC) System

7.1 Scope of Works

7.1.1 General

7.1.1.1 The AFC System installed on the Malolos-Clark Railway Project (MCRP) and the North South Railway Project – South Line (Commuter)(NSRP-South) shall cover the different commuter trains and the Limited Express services.

7.1.1.2 The system shall be capable of being interoperable with the existing LRT 1, LRT 2, and MRT 3 AFC systems and the AFC system being installed on the North South Commuter Railway Project (NSCR) under Contract CP04 and Metro Manila Subway Project (MMSP) under Contract CP106.

7.1.1.3 The AFC system shall be compatible and support interoperability with EMV and comply with Philippine National Common mobility standard. It shall adopt Near Field Communication (NFC) and Quick Response (QR) code tickets. Paid-to-paid interchanges shall be possible between services on MMSP and NSCR by use of interoperable fare media.

7.1.1.4 The AFC system shall be robust, flexible, and capable for future extensions and interchanges. Therefore, the mutual issuance and mutual settlement of tickets and cards shall be considered between this system and the other railway lines.

7.1.1.5 The AFC system shall utilize contactless fare media for all types of fare products.

7.1.1.6 The Central Clearing House System and Card 1st Issuer are prepared at the Level 4 of this system for financial settlement and 1st Issue of the common use cards. Therefore the system must receive the information from the interface with the clearing house and the card from the clearing house operator side and card issuer side and obtain the necessary cooperation.

7.1.1.7 The AFC system performance shall conform to the AFC National Standard.

7.1.1.8 The AFC Central Computer (AFC-CC) of MCRP section shall act as Master Central Computer for MCRP, NSCR and NSRP-South line for collection of revenue, traffic and diagnostics transactions. The AFC-CC of MCRP section will present the total NSCR Line AFC reports to the O&M concessionaire at IOCC. The AFC-CC of NSRP South shall be installed at Banlic depot temporarily and will be migrated to Malabacat Depot after Integrated OCC is commissioned. Similarly for the AFC-CC of NSCR installed at Malanday depot. The Contractor shall perform the necessary interface works for Sectional Completion and migration works once Civil works for Integrated OCC is completed.

7.2 Limited Express Ticket System

7.2.1 General

7.2.1.1 The Limited Express Train Service will connect the Metro Manila and Clark International Airport with stops at Alabang and Buendia.

7.2.1.2 The AFC system shall cover the Limited Express Service however unlike the commuter services, the passengers for Limited Express shall be required to validate their SJT and SVC prior to boarding. Ticket validator shall be mounted on Limited Express Platform Screen doors, or any other location proposed by the Contractor, and approved by the Engineer. This validator will ensure that SJT's are valid tickets being used on the Limited Express whilst in the case of SVC's the validator will deduct the fare for taking the Limited Express service.

7.2.1.3 The system performance shall conform to the AFC National Standard.

7.3 Definitions and Abbreviations

7.3.1 Definitions

Table 7-1 Definitions

Antenna	Unit for data communication with contactless IC card
Blacklist	List of cards deemed to be rejected by the system
Card	In this specification, the word "card" stands for contactless IC card.
Clearing house	An organization to collect and distribute information to settle payment between member of organizations
Contractor	The person(s) named as Contractor in the Letters of Technical Bid and Price Bid accepted by the Employer and the legal successor in title to this person(s)
Employer	Department of Transportation
Interface Contractor	Means contractors other than the Contractor, engaged by the Employer, which are undertaking works on the other NSCR Contract Packages. The Contractor shall identify all such Interface Management Plan
O&M Concessionaire	Responsible party that undertakes to operate and maintain the AFC system, within the overall railway operation
Security access module	A module that contains key data for encryption and mutual authentication for communication between the card and devices

7.3.2 Abbreviations

Table 7-2 Abbreviations

AFC-CC	Automatic Fare Collection Central Computer
AFC-BCC	Automatic Fare Collection Backup Central Computer
AFC(S)	Automatic Fare Collection (System)
AG	Automatic Gate
BMS	Building Management System
BSP	Banko Sentral ng Pilipinas
CCS	Central Computer System
CCHS	Central Clearing House System
CSC	Contactless Smart Card
CSR	Customer Service Room

CSM	Contactless Smart Media
CSM-EM	Contactless Smart Media Electronic Module
DOTr	Department of Transportation
EMV	Europay, Mastercard & Visa
ENT	Entry
EXT	Exit
FTP	Foiled Twisted Pair
GC	General Consultants
HT	Handheld Terminal
ID	Identification
IPC	Illustrated Parts Catalogue
LAN	Local Area Network
MCBF	Mean Cycle Between Failure
OCC	Operations Control Center
ODU	Operator Display Unit
OS	Operating System
PEC	Philippine Electrical Code
PET	Polyethylene Terephthalate
PDU	Passenger Display Unit
POS	Point of Sales Terminal
QR	Quick Response
SAM	Security Access Module
SAC	Station Accounting Computer
SJT	Single Journey Ticket
SVC	Stored Value Card

TCP/IP	Transmission Control Protocol/Internet Protocol
TOC	Taking Over Certificate
TVM	Ticket Vending Machine
UPS	Uninterruptible Power Supply

7.3.3 Related Rules and Standards

The contractor should conform to the following standards, but not limited to:

Table 7-3 Rules and Standards

AFC National Standard	National Standard for Interoperable Automatic Fare Collection System
Business Rules	A document designed for an interoperable transit network which accommodates multiple Automatic Fare Collection System (AFCS) operators and multiple Contactless Smart Medium (CSM) ISSUERs.
National QR Code Standard	Banko Sentral ng Philipinas (BSP) Standard on QR code
ISO/IEC 14443	Identification Cards – Contactless Integrated Circuit Cards – Proximity Cards
ISO/IEC 15408	Information Technology -- Security Techniques -- Evaluation Criteria for IT Security
ISO 24014-1	Public Transport – Interoperable Fare Management System – Part 1 Architecture
IEEE802	A standard for local area network
PEcC	Philippine Electronics Code
RFC 4301	Security Architecture for the Internet Protocol
TIA/EIA 5688	Commercial Building Telecommunications Cabling Standard
Republic Act No.7277	The Magna Carta for Disabled Persons of the Philippines
(confidential)	TranspoTM Automatic Fare Collection Scheme – Core Operating Rules

7.4 Scope of Equipment Supply

The contractor shall supply the following but not limited to:

7.4.1.1 System Components

a) Station accounting computer, including all of its constituent components
b) Normal Automatic Gate
c) Wide Automatic Gate
d) Ticket Vending Machine
e) Point of Sales, including all of its constituent components
f) Handheld Terminal
g) Uninterruptible Power Supply
h) Central Computer System, including all of its constituent components
i) Cash Handling System
j) Card Handling System
k) Contactless Card
l) Contactless Card Reader
m) QR Code Reader

7.4.1.2 Station AFC Facilities

a) Station accounting computers
b) Normal Automatic Gates
c) Wide Automatic Gates
d) Ticket Vending Machines
e) Point of sales
f) Handheld Terminals
g) Special Tools for cash counting
h) Special Tools for card counting
i) Furniture within AFC Rooms, Customer Service Room
j) Uninterruptible Power Supplies in AFC UPS Rooms
k) Power Supply distribution facilities
l) Cables, cable containment and earthing
m) Local Area Network (LAN) and Interfaces to the Communication Backbone Network

7.4.1.3 OCC AFC Facilities

a) AFC Central Computer
b) AFC Backup Central Computer
c) Special Tool for card counting
d) Local Area Network (LAN) and Interfaces to the Communication Backbone Network
e) Cables, cable containment and earthing
f) Card personalization equipment
g) Furniture within AFC rooms
h) Uninterruptible Power Supply for AFC equipment

7.4.1.4 Maintenance Workshop and Training Room

a) Maintenance equipment and facilities
b) Training equipment and facilities
c) Software Development equipment and facilities
d) LAN and Interfaces to the Communication Backbone Network
e) Cables, cable containment and earthing

7.4.1.5 AFC OCC Interface to External Locations

The contractor shall supply, as a minimum, all equipment, tools and resources necessary for the successful installation, testing, commissioning and operation for interfaces to external networks for the following.

a) Central Clearing House
b) Off-Site Sales Terminals (in future)
c) Commercial Banks and Credit Card Agencies
d) Future AFC systems provided by other Service Provider

7.4.1.6 AFC Ticket Media

a) The Contractor shall provide the initial quantity of SJT and SVC, subject to the approval of the Engineer. The Contractor shall ensure that the SJTs and SVCs provided are certified in accordance with the National Standard Specification of Transit Card (NS TC).
b) Additional cards will be procured separately by the Employer as and when required.
c) The Contractor shall supply cards that are necessary for testing and training, as required for this project.
d) The Contractor shall provide the CSM-EM for revenue operation for one year and the initial minimum quantity of 1,000 CSM-EM for test purposes (equal number of each type of media). The Contractor shall ensure that the CSM-EM provided are certified in accordance with the National Standard Specification of Transit Card Reader (NS TCR).

7.4.1.7 Software

a) The Contractor shall supply the following software for AFC system including but not limited to:
   i. Development system software
   ii. Application software and firmware licenses
   iii. Operating system software
   iv. Application Programming Interface (API) software
   v. Software source code
   vi. Simulator software
   vii. Antivirus software
   viii. CSM initialization and personalization software
   ix. Key management software
   x. SAM initialization and personalization software

7.4.1.8 The contractor shall supply all software with the necessary licenses relevant to all of the AFCS for the Client's own use with no license or cost implication.

7.4.1.9 Each software shall be downloadable from the AFC-CC. The design shall include provision for centralized access from Central Server for upload and download of data and software, maintenance diagnostic, etc.

7.4.1.10 Any software produced and modified for this contract shall be submitted with two backup copies 14 days before commencement of actual operation and shall be under the possession of the Employer. The backup copy shall be included the following:

a) All source code, all execution code and all database configurations;
b) The documents related to all the software; and
c) Software development tools for the maintenance and editor, compiler, and linker system

7.4.1.11 The contractor shall store generic software of AFC system in an Escrow account.

7.4.1.12 It shall be possible to download data like equipment operating data, parameters, fare tables, calendar, keys, blacklists, software upgrades, etc. from central repository to individual equipment automatically. It shall also be possible to download data and software selectively to some equipment. At least two versions of fare, operating parameters, and software shall be managed by system. All equipment shall upload the transactions, audit registers, diagnostics, and performance data at not more than 5 minutes periodicity to Central system.

7.5 Equipment Environmental Conditions

7.5.1 General Requirements

7.5.1.1 The AFC System shall be able to withstand at a minimum the environmental conditions stipulated below in Table 7-4:

7.5.1.2 All enclosures for indoor equipment shall be to IP 54. Equipment that shall be exposed to the external weather elements shall be to IP 65.

Table 7-4 AFC Equipment Environmental Conditions

1)	Conditions for interior/indoor Equipment	
	a) Temperature Range (open Area):	0 to 40°C
	b) Equipment Room and Control Room:	25 to 30°C
	c) Relative Humidity:	Maximum 90%
2)	Conditions for exterior/outdoor Equipment	
	a) Temperature Range:	0 to 45°C
	b) Relative Humidity:	Maximum 90%
	c) Solar radiation (heat-up and aging/deterioration)	1120 Watt/sqm
3)	Train-borne equipment	
	a) Temperature Range:	0 to 60°C

	b) Relative Humidity:	Maximum 90%
4)	Altitude:	100m or lower
5)	Reference Wind Velocity:	40m/sec
6)	Lightning Area:	Severe Lightning Area
7)	Salt Damage District:	Around 10 km from coastline
8)	Vibration and shock	See Note 1 below
9)	Flood and Earthquake	Action Required

Note 1: All equipment shall be protected from damage or performance degradation due to shock or vibration experienced in the railway environment as stated below:

- Vibration: Mil-Std-810D, Method 514.3, Category 8, 0.25g (RMS) all axes 5 to 25 Hz at 0.5 octaves per minute; and
- Shock: Mil-Std-810D, Procedure I, half-sine pulse, 5g peak (X and Y axes),1g peak (Z axis), 10ms.

7.5.1.3 The AFC equipment shall be positioned so as not to be exposed to outdoor environmental conditions.

7.5.1.4 The equipment supplied shall not generate noise higher than 45 dB(A) with access door measured at 1-meter distance from the source with the exception of the audio tone generated in normal operation.

7.5.1.5 The equipment housing shall be hermetically sealed at the joints on equipment plinths during installation. Grouting shall be applied to any joints on equipment plinths during installation.

7.5.1.6 Rubber sealing gaskets shall be fitted to the mating surfaces of all equipment doors and covers.

7.6 Documentation

The Contractor shall submit the following documents:

a) Detailed engineering design, system specification, software specification, hardware specification, software source code;
b) Interface documents (Civil, system and external parties)
c) Operation manuals;
d) Maintenance manuals;
e) Installation related drawings;
f) Equipment manufacturing related drawings;
g) Consumables list, maintenance parts list;
h) As built drawings;
i) Spare parts list manual, illustrated parts catalogue (IPC);
j) Special test and tools equipment manuals;
k) Test plans and procedures
l) Method Statements
m) Training Manuals; and
n) Any other documentation deemed necessary by the Engineer.

7.7 System Operational Requirements

7.7.1 General

7.7.1.1 Common Use Card

a) Cards used in this system shall be mutually usable with LRT and MRT in Greater Capital Region. Similarly, cards used in this system shall be mutually usable with the north - south commuting line. That is, cards issued in this system are valid for LRT, MRT, the north - south commuting line and the reverse is also true.

b) The system must be considered in advance to enable mutual issue and mutual settlement of transfer tickets and cards between other railways and this system in the future.

c) For the financial reconciliation of common usage cards, it shall be the responsibility of the Central Clearing House System at the Level 4 of this system. In addition to this, the scope of work for Central Clearing House System shall include card history management, security management, blacklist management, etc.

d) All the card media of this AFC system shall be contactless IC cards.

e) All the card media of this AFC system shall be compliant to the AFC National Standard and Business Rules issued by Department of Transportation (DOTr).

f) General Requirements

i. The card media shall be the same media used in the system of LRT1,2, MRT3 (ISO/IEC14443 Type A or B)

ii. Shape of the card shall be credit card size;

SJT: (85.47-85.72mm) × (53.92-54.03mm) × (0.50±0.05mm)

SVC: (85.47-85.72mm) × (53.92-54.03mm) × (0.80±0.05mm)

iii. Base material of the card shall be PET or other types of that are environmentally benign when incinerated.

iv. Data retention period shall be at least 10 years for SVC and 5 years for SJT in normal use.

7.7.1.2 There shall be at least 2 types of tickets as listed below:

a) Single Journey Ticket (SJT)

b) Stored Value Card (SVC)

7.7.1.3 Personalized staff SVC will be used by the staff of the O&M Concessionaire.

7.7.1.4 At the commencement of revenue service, SJT and SVC shall be anonymous however the contractor shall take into consideration personalized card service for the SVC in system design. This means that the system shall be able to accept these new cards without any system modification when personalized cards are newly issued in the future under the condition no discount applied to these cards.

7.7.2 General Operation

7.7.2.1 Recycle and Deposit

a) All types of anonymous ticket shall be recycled.

b) SVC shall require specified deposit amount which will be determined by the O&M concessionaire. The deposit amount shall be able to be changed by the O&M concessionaire without software modification and shall be encoded within each card. The contractor shall propose minimum and the maximum limit for the deposit amount.

c) Measures shall be taken to prevent any fraud activities including deposit return using false or copied card, including claims of fake damaged cards. The contractor shall propose these preventive measures and submit to the Engineer for Approval.

7.7.2.2 Card issuance and Card Status

a) Card issuance is defined by the procedure to write secure information within the cards.

b) Card issuance shall be conducted in 3 steps.

   i. (zero)th issuance

      0th issuance is to format the card, encode unique serial ID number and manufacture's transportation security key in the card. Transportation security key or some other measures for transportation security shall be proposed by the 1st issuer.

   ii. First (1st) issuance

      1st issuance is to release manufacture's transportation key (or some other transportation security), encode using the 1st issuer's format on the card. The card shall not be used yet at this step.

      The 1st issuer shall be responsible for 1st issuance, excluding testing card, training card, and maintenance card. 1st issuance of testing card, training card, and maintenance card shall be handled by the contractor.

   iii. Second (2nd) issuance

      The O&M Concessionaire shall be responsible for 2nd issuance, excluding testing card, training card, and maintenance card. 2nd issuance of SJT and SVC shall be handled at station machines.

      2nd issuance of testing card, training card, and maintenance card shall be handled by the contractor.

      Cards which are not 2nd issued shall not be used by passengers.

      When returned, cards shall be encoded with card return information, in order to deactivate and to avoid faulty use.

      Card status shall be able to be checked by every related machine included in the system. Information of card status change shall be collected to the central server to be referred by AFC machines when required.

7.7.2.3 Generate the O&M Concessionaire's Security Key

a) The O&M Concessionaire's security key data shall be decided with approval from the card 1st issuer and the central clearing house operator.

b) The contractor shall propose how to generate the O&M Concessionaire's security key and submit to the Engineer for Approval.

7.7.2.4 Card Printing

Card printing for SJT and SVC shall be conducted by the card 1st issuer.

7.7.2.5 Unique Card Identification Number

a) Every card shall be numbered uniquely for system identification and card stock management.

b) This unique card identification number shall be able to be printed or engraved on the card. The printing, engraving or other method shall be resistant to scratching.

c) This unique card identification number shall include the following information.

i. Issue data

ii. Issue operator code

iii. Issue machine number

iv. Serial number

v. The contractor shall propose card identification alphanumerical format, coordinating with the card 1st issuer. It shall be approved by the Employer or the Engineer in coordination with the O&M Concessionaire.

7.7.2.6 Confirmation of Card Information

a) Information within the card can be read and displayed at TVM, POS and HT.

b) The AFC equipment shall be able to check the integrity of the data on the card as it is processed. Any CSM no longer capable of being accurately encoded shall be detected and rejected.

c) The AFCS shall include anti-fraud facilities to check irregular usage of the cards.

d) The AFCS shall track the usage of the cards and flag any cards that does not follow the normal expected decremented values.

7.7.2.7 Revenue Closing

a) TVM and POS terminal shall include revenue closing function.

b) Revenue closing shall include the following functions

i. Cash collection

ii. Cash reload (for cash float)

iii. Card collection

iv. Card reload

v. Consumables reload (if required)

c) Data shall be uploaded to AFC-CC through the SAC.

d) Time required for revenue closing shall be no more than ten (10) minutes for each machine.

e) AG shall not require manned revenue closing.

7.7.2.8 Refunds

a) The contractor shall provide methods to refund unused SJT and SVC.

b) The contractor shall provide methods to refund used SJT and SVC through station POS.

c) The refund system shall consider preventive measures against fraud for both passengers and staff.

d) The refund system shall consider collecting handling fee.

7.7.2.9 Pricing

a) Final ticket pricing will be fixed and presented to the contractor 24 months prior to the start of revenue service.

b) The contractor shall submit plans for finalization of fare to the O&M Concessionaire.

c) It shall be possible for the Operator to change fares and business rules overnight.by downloading relevant data to all AFC machines from AFC-CC or AFC-BCC.

7.7.3 Single Journey Ticket

7.7.3.1 Fare Structure

Requirements for the fare structure of the system include the following:

a) The system shall support graduated fare structure. It shall be flexible enough to support zone (or partly zoned) fare structure.
b) The system shall be able to provide fare discount.
c) The system shall be able to change the fare version easily, for example but not limited to, holding at least two fare versions which can be switched by date and time.
d) The system shall be able to support at least 16 types of fare within one version for SJT, which is for future discount. Each type of fare shall be able to support 256 fare stages, which is for future increase of lines or stations including operated by another business operator.
e) The system shall have provisions to issue transfer tickets for other railways and to accept tickets from other railways in the future.

7.7.3.2 Issue (including 2nd issuance)

a) Normal SJT shall be issued by the TVM. Station POS shall also be equipped to issue SJT but main functionality will be for issuance of Concession SJT.
b) TVM shall indicate on the display names of stations for passengers' convenience when purchasing.
c) Person to travel single journey shall purchase an SJT with amount of necessary fare. Purchased amount of fare shall be encoded within SJT card.
d) TVM shall be able to return change to passengers.

7.7.3.3 Payment for limited express ticket purchase

SJT can be used for paying for limited express tickets.

7.7.3.4 Validity

SJT is valid only for the purchased fare amount without exit from any gate during the date and time specified by the system.

7.7.3.5 Entry Gate

a) The SJT holder shall touch their ticket on the read / write antenna unit of the entry AG. The entry AG shall acknowledge the transaction both audibly and visually. The AG shall be able to distinguish discounted tickets.
b) The AG shall check the validity of the ticket.
c) When a ticket was detected as invalid, the entry AG shall close and prevent the ticket holder to proceed within the paid concourse, and the AG shall display the appropriate message with visual and audible indication . The location and method by which this message is displayed to station staff shall be Approved by the Engineer.

7.7.3.6 Exit Gate

a) The SJT holder shall insert their ticket into the ticket insert slot. The exit AG shall acknowledge the transaction both audibly and visually. The AG shall be able to distinguish discounted tickets.
b) The AG shall check the validity of the ticket.
c) When a ticket holder alights at a station where the fare is equal or less than the purchased amount, the gate shall allow the ticket holder to pass through the gate and the ticket shall be captured. The ticket holder renounces their right for further riding even if the trip was under fare and without any refund.

d) When a ticket holder alights at a station further than their planned destination exceeding their purchased amount, they must adjust their fare before exiting the gate. The gate will remain closed and appropriate message will be displayed until the SJT contained fare has been adjusted.

e) The AG shall encode exit information within the card.

f) When an inserted ticket was detected as invalid, the exit AG shall close and prevent the ticket holder from exiting, and the gate shall display a visual and audible message to the station staff and passengers, and the ticket shall be returned to the passengers.

7.7.3.7 Adjust Fare

a) When a ticket holder needs to adjust fare, they shall pay the balance amount required for the journey taken which will be handled by POS terminal at customer service room.

b) The updated fare amount shall be encoded onto the SJT card. It shall be encoded separately from the initially purchased amount.

7.7.3.8 Recycle

a) Cards captured and collected in the exit gate or at the POS terminal shall be able to be recycled.

b) A common SJT media should be used between interfacing railway lines in compliance with the Business Rules. If the design of the SJT of this system and the other railway system is different, the contractor to propose method for SJT card handling.

c) The contractor shall propose detailed procedures for recycling cards which will be detailed in the operations manual.

7.7.3.9 Deactivate or Damage

a) When SJT is deactivated or damaged, it shall be handled by POS terminal.

b) Handling fee for card reissuance shall be imposed based on the reason of deactivation or damage.

c) When AG detects a deactivated or damaged SJT, the exit AG shall close and prevent the ticket holder from exiting, and the gate shall display a visual and audible message to the station staff and the passenger, and the ticket shall be returned to the passengers. The location and method by which this message is displayed to station staff shall be Approved by the Engineer.

7.7.4 Stored Value Card

7.7.4.1 Fare structure

Requirements for the fare structure of the system are as follows.

a) The system shall support graduated fare structure.

b) The system shall be able to provide discount fares.

c) The system shall be able to change the version of fare data table easily, for example, holding at least two fare versions which can be switched by date and time.

d) The system shall be able to support at least 16 types of fare within one generation for stored fare. Each type of fare shall be able to support at 256 fare stages.

e) It should be considered that a mutual direct train operation is carried out with routes operated by other carriers in the future and fares are spanning two routes.

7.7.4.2 Issue (including 2nd issuance)

a) Normal SVC shall be issued by the TVM. Station POS shall also be equipped to issue SVC but main functionality will be for issuance of concession SVC.
b) The TVM shall indicate on the display the fixed amount of top-ups for new SVC issuance.
c) The fees for new SVC shall be inclusive of selected top-up amount and deposit. The top-up amount and deposit paid shall be encoded separately within SVC.
d) The TVM shall be able to return change to passengers.

7.7.4.3 Top-ups

a) SVC can be topped-up.
b) Top-ups of the SVC shall be completed by TVM or POS terminal.
c) Normal SVC top-ups shall be done by the TVM. Station POS shall serve for concession SVC top-ups.

7.7.4.4 Payment for limited express ticket purchase

SVC can be used for paying for limited express tickets.

7.7.4.5 Validity

SVC is valid until the card expiration date, or specified period from the last time used, whichever comes earlier. The specified period shall be able to be changed by the O&M Concessionaire.

7.7.4.6 Entry Gate

a) The SVC holder shall touch the SVC on the read / write antenna unit of the entry AG. The entry AG shall acknowledge the transaction both audibly and visually. The AG shall be able to distinguish discounted tickets.
b) The AG shall check the validity of the card. The AG passenger information display shall display the fare balance in the card.
c) When a SVC was detected as invalid , the entry AG shall close and prevent the card holder to proceed into the paid concourse, and the gate shall display the appropriate message with visual and audible indication to the station staff and the card holder. The location and method by which this message is displayed to station staff shall be Approved by the Engineer.

7.7.4.7 Exit Gate

a) The SVC holder shall touch the card on the card antenna unit of the exit AG. The exit AG shall acknowledge the transaction both audibly and visually. The AG shall be able to distinguish discounted tickets.
b) The exit AG shall check the card balance. When the card balance is sufficient for the journey fare, the exit gate deducts the fare between the origin and the destination. When the card balance is not sufficient for journey fare, the exit AG shall prevent the card holder from exiting. The card holder must proceed to the POS to top-up the required journey fare amount before exiting the AG.
c) The AG shall be able to read and validate SVC cards from other interfacing railway lines.
d) The gate shall encode exit information within the card.
e) When a touched card was detected as invalid, the exit gate shall close and not allow the card holder to proceed out of the paid concourse. The location and method by which this message is displayed to station staff shall be Approved by the Engineer.

7.7.4.8 Adjust Fare

a) When a card holder needs to adjust fare, SVC top-up option should be made available at the CSR.
b) The updated fare amount shall be encoded in the SVC. It shall be encoded separately from the top-up amount.

7.7.4.9 Return

a) SVC can be returned at POS terminal in CSR. Upon return, deposit plus the balance amount in SVC is returned to the card holder, deducting handling fee.
b) The handling fee for returning of SVC shall be able to set and changed easily by O&M concessionaire.
c) The system shall be able to handle multiple types of handling fee, depending on the reason.
d) Due date for the deposit return shall be able to be set and changed easily by the O&M concessionaire.

7.7.4.10 Recycle

a) Cards collected at the POS terminal shall be able to be recycled.
b) The contractor shall propose detailed procedures for recycling cards which shall be included in the operations manual.

7.7.4.11 Deactivate or Damage

a) When SVC is deactivated or damaged, it shall be handled by the POS terminal.
b) Handling fee for card reissuance shall be imposed based on the reason of deactivation or damage.
c) When the AG detects a deactivated or damaged SVC, the exit AG shall close and prevent the ticket holder from exiting, and the gate shall display a visual and audible message to the station staff and the passenger, and the ticket shall be returned to the passenger. The location and method by which this message is displayed to station staff shall be Approved by the Engineer.

7.7.5 Contactless Smart Media Electronic Module (CSM-EM)

7.7.5.1 General requirements

a) The CSM-EM is a microprocessor-based module that is used in conjunction with a contactless smart media to process SJT and SVC tickets.
b) The CSM-EM shall be designed to be a common module that can be exchanged between TVMs, AGs, POS etc.
c) The CSM-EM shall support periodic symmetric mutual authentication with the backend or as defined in the finalized Business Rules.

7.7.5.2 Performance

a) The CSM-EM when installed in the respective equipment shall be able to process SJT and SVC up to a minimum of 5cm.
b) The CSM-EM shall complete the total validation time including recovery time of a SJT/SVC within 300ms.
c) The CSM-EM host interface shall support full-duplex communication with the host.

d) The CSM-EM shall provide two types of electrical communication interface to support full duplex communication as follows:
   i. For short distance it shall be possible to connect to the CSM-EM with an RS232 interface
   ii. For long distance or electrically noise environments, it shall be possible to connect to the CSM-EM with a RS422 or dual RS485 interface.

7.7.6 Card Lifecycle

The card lifecycle is shown in Figure 7-1

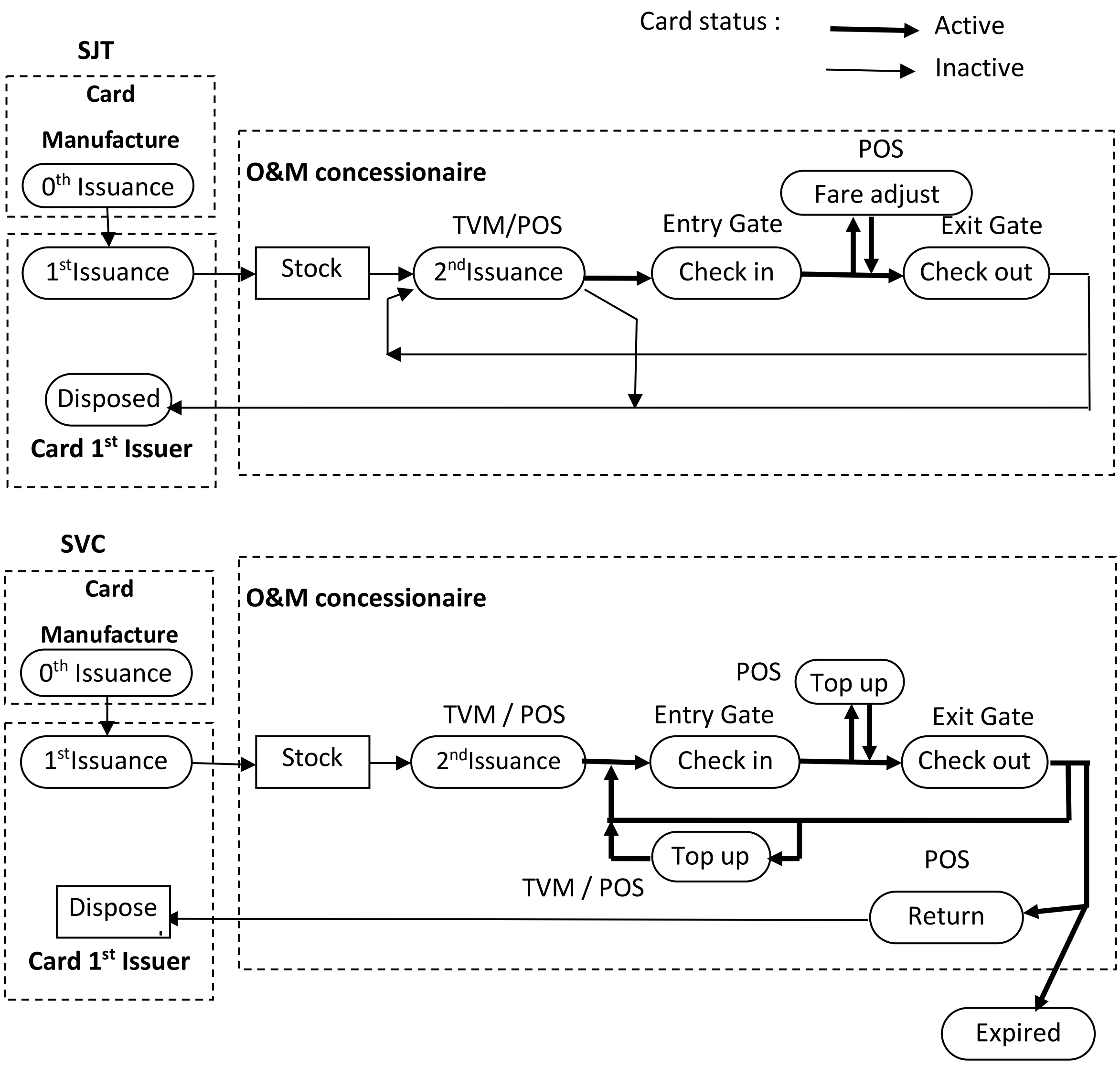


Figure 7-1 Card Lifecycle

7.7.7 Card Handling

7.7.7.1 General Requirements

a) Card handling shall be conducted in the AFC Room of each station.

b) The cards shall be supplied by the 1st issuer outside this contract and be recycled as shown in Figure 7-1 Card life cycle

c) The card stock, the cards in the equipment, the number of cards temporarily stored in the AFC room for recycling, the cards recovered due to defects, and the cards returned must always be clearly managed.

d) The cards shall be kept in a safe or locker with key and can be taken out only by authorized persons.

e) Machines such as TVM shall be designed so that station staff do not need to touch card, unless equipment fault such as jamming occurs. Card cassettes of AFC machines shall be locked. The number and variation of locks shall be Approved by the Engineer. Each cassette shall be labeled with its own identification number. This identification number shall be identified electronically by machine. The station staff shall input his / her identification number removing the card cassette, in order to record card handling operation.

f) Machines such as TVM and POS terminal shall be designed so that can count the number of cards inside the machine.

g) Only authorized personnel to have access to the inside of the TVM and TVM will be equipped with two stage authentications comprising of staff card configured as a pass and PIN entry. In either case, the identity of the person facilitating entry shall be recorded and shall appear in relevant reports/event log.

h) All components shall be easily accessible and shall be mounted on withdrawable sliders where possible to achieve this.

i) All removable components including cash boxes, fare ticket containers and change hoppers shall be sized, positioned and provided with lifting handles such that they can be removed and inserted without requiring more than average strength or dexterity of a normal able-bodied person.

j) For mutual direct train operation with other railway in the future, a common card media should be used for interfacing railway lines. If the design of the SJT of this system and the other railway system is different, the SJT of the other railways collected by this system must be separated and returned to the other railways operator, the Contractor shall propose method for SJT card recycle handling.

7.7.8 Cash Handling

7.7.8.1 General Requirements

a) Cash handling shall be conducted in the lockable Strong Room of each station.

b) Cash handling equipment shall include, but not limited to, the following:

   i. Coin sorting and counting equipment
   ii. Safe for storing cash
   iii. Cash bagging equipment
   iv. Bill sorting and counting equipment; and
   v. Money trolley.

c) Consumables for cash counting and handling are not included in the contract.

d) The contractor shall propose the following with approval by the Engineer together with the coordination of the O&M concessionaire.

   i. Operation of cash handling
   ii. Quantity of cash handling equipment at each station

e) Cash counting equipment shall be able to distinguish the types of bills or coins.

f) Money trolley shall be designed for one-manned operation.

g) Cash handling is shown in Figure 7-2.

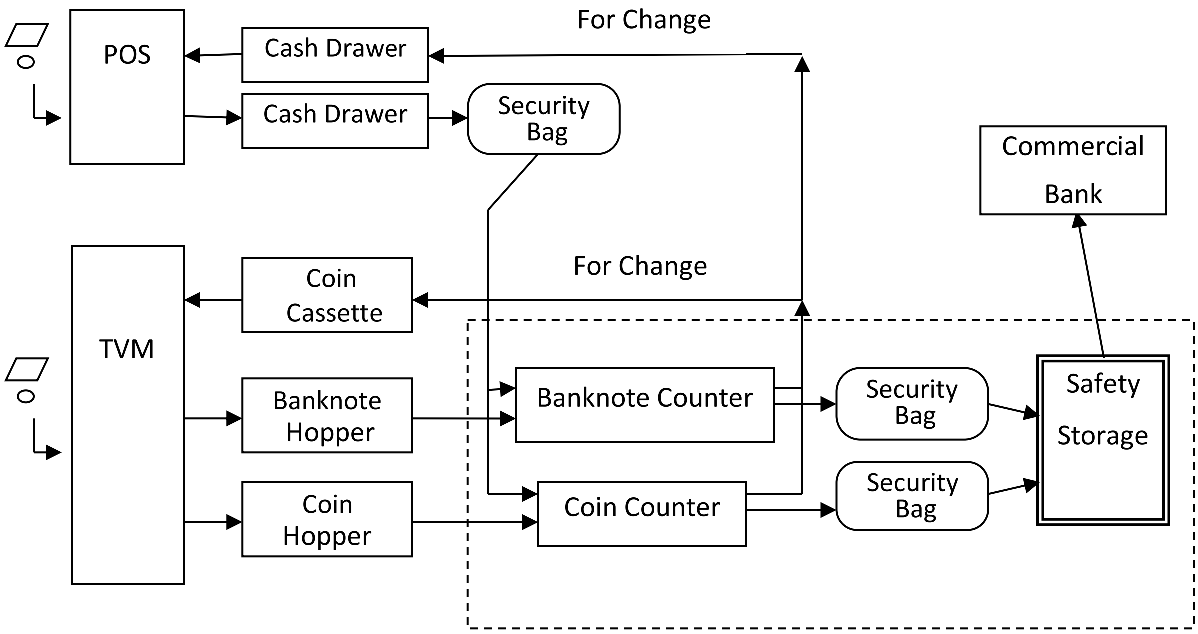


Figure 7-2 Cash Handling

h) The TVM shall accept Philippines banknotes and coins. Acceptable types of banknotes and coin shall be proposed by the contractor and Approved by the Engineer in coordination with the O&M Concessionaire.

i) Acceptable bills and coins shall be finalized 24 months prior to the start of revenue service. Finalization cost shall be included in the contract. Cost to handle new bills or coins issued after finalization is not included in the contract and shall be discussed with the Engineer in coordination with the O&M Concessionaire.

j) The contractor shall report to the Engineer and the O&M Concessionaire the acceptance rate of Philippines bills and coins before start of the static commission. The acceptance rate shall be measured by:

   i. Fresh bills and coins; and

   ii. Used (circulating) bills and coins.

k) Rejected bills and coins and the reason shall be approved by the Engineer and the O&M Concessionaire.

7.7.9 QR Code Payment

7.7.9.1 The AFC system shall include a QR code payment system. The QR code system provisions shall include, but shall not be limited to, the following facilities:

a) AFC gates are able to scan and validate QR codes on paper and mobile applications.
b) Provide customer service room equipment to scan and validate QR codes on paper and mobile applications.
c) AFC Central Computer shall capture all QR transaction records generated in the AFC equipment which shall be forwarded to CCHS for clearing and settlement. Transaction reversal and refund records shall also be captured.

7.7.9.2 The QR code payment system shall comply to Banko Sentral ng Philipinas (BSP) Standard on QR and AFC National Standard.

7.7.9.3 Mobile based ticketing shall be used by commuters to book their tickets via mobile phone application. Mobile based tickets shall be based on secure QR code technology & NFC. The mobile application shall be integrated with a mobile walled linked to the pre-paid account. The Contractor shall provide necessary software and interface to meet this requirement.

7.7.9.4 The system shall allow for the integration and operation of a mobile application-based ticketing. This shall be implemented & demonstrated in Test lab on one of the entries and one of the exit gates first before implementation at all stations. The Contractor shall be responsible for developing an end-to-end Issuance and Acceptance ecosystem including back end processing required for such ticketing needs.

7.7.10 Monitoring

7.7.10.1 Equipment Monitoring

a) Station accounting computer shall monitor real time status of at least following AFC equipment.
   i. Ticket vending machine
   ii. Automatic gate
   iii. Point of Sales
   iv. Handheld Terminal
b) AFC-CC and AFC-BCC which will be placed in OCC building, shall monitor real time status of at least the following AFC equipment.
   i. Ticket vending machine
   ii. Automatic gate
   iii. Point of Sales
   iv. Station accounting computer
   v. Handheld Terminal

c) Assist terminal shall be included as a part of the AFC-CC and AFC-BCC, which will be placed in OCC building.

d) AFC-CC shall be able to extract transaction data of specific card from clearing house system. The result shall be able to output by data or by printing.

e) The operator shall be able to receive the real time status of at least the following AFC equipment on AFC-CC.

   i. Ticket vending machine
   ii. Automatic gate
   iii. Point of Sales
   iv. Station accounting computer
   v. Handheld Terminal

7.7.10.2 Card Status Monitoring

a) The card status information shall be transmitted to the AFC-CC and be sent to the clearing house. Card status includes, but not limited to, the following:

   i. 2nd issue
   ii. Enter gate
   iii. Exit gate
   iv. Top-ups
   v. Fare adjustment
   vi. Return
   vii. Payment for tickets or items
   viii. The card's status and its past records can be confirmed on the POS terminal.

7.7.10.3 Card Stock Management

a) All returned cards excluding SJT card shall be sent to AFC Server Room in the OCC building. SJT card shall be able to be recycled within the station, which means to be re-issued from the TVM or the POS terminal.

b) AFC-CC shall produce card stock management data. This data shall include, but not limited to:

   i. 2nd issued card
   ii. Returned card
   iii. Damaged card
   iv. Deactivated card
   v. Expired card (Past due date of deposit return)
   vi. Theoretical amount of valid card shall be calculated in the central clearing house system.

7.7.11 Calendar and Operating Day

7.7.11.1 Operating Day

a) The AFC system shall have at least two dates, calendar date and operational date. The operational date and time shall be used for judging tickets and separating revenue and be adjusted to AFC regulation.

b) The Calendar date means the Gregorian calendar date.

c) Calendar

   i. The AFC system calendar date and time shall have real-time synchronization.
   ii. The AFC system shall have real-time synchronization with the Master Clock.

7.7.12 Data Transmission

7.7.12.1 General Requirements

a) The contractor shall consider high-level security for all data transmission. Data transmission related to revenue data shall employ high-level security encryption to prevent data modification.
b) The contractor shall consider ease of maintenance for system parts replacement for the O&M concessionaire in the future.
c) The contractor shall consider preventive measures against data loss.

7.7.12.2 Transmission data

a) AFC-CC shall receive through SAC the transaction data from AFC machines at station level for the following equipment:
   i. TVM
   ii. AG
   iii. POS
   iv. HT
   v. SAC
b) Transaction data shall be made whenever there is a change in the status of the card. The AFC-CC shall transfer the data to the central clearing house.
c) For any interchange paid-to-paid links, the transaction data for the passenger from other railways must include both the fare for this system and for the other railway system separately.
d) If there is a possibility that the transaction might be incomplete, machines shall send temporary transaction data, in order to avoid the loss of data.
e) The contractor should consider that the AFC-CC is able to exchange data with other servers, such as server for bus service, or e-cash server.
f) Transaction data shall be able to be retained in each Tier 1 machine and in SAC at least seven (7) days, considering issues such as network failure. The contractor shall propose offline data collection as well.
g) Transaction data shall be transferred and stored in financial system of the O&M Concessionaire NOT included in this contract for at least ten (10) years.

7.7.12.3 Revenue Data

a) AFC-CC shall receive revenue (including accounting information, cash amount, and stocktaking of the cards) data through SAC.
b) For any interchange paid-to-paid links, the revenue data shall be considered to show the amount of the other railway separately.
c) Revenue data shall indicate sum for each calendar date.
d) The AFC-CC shall transmit revenue data to financial server of the O&M Concessionaire.
e) Each SAC shall be able to print out the revenue data of each station.
f) Each SAC shall be able to print out the summary revenue data of each station.
g) Preventive measures shall be taken to monitor loss or lack of revenue data in each station.

7.7.12.4 Traffic Data

a) AFC-CC shall receive traffic data through SAC.
b) AFC-CC shall transmit traffic data to financial server of the O&M Concessionaire.
c) Each SAC shall be able to print out the traffic data of each station.
d) SAC shall be able to print out the summary traffic data of each station.

7.7.12.5 Operation and Maintenance Data

a) Each SAC shall be able to collect and output the operation and maintenance data of each station.
b) AFC-CC shall receive operation and maintenance data through SAC upon request.
c) Assist terminal in maintenance shop shall be able to output operation and maintenance data received by the AFC-CC.

7.7.12.6 Downloads

a) The AFC-CC shall download to the SAC all fare tables, operating parameters, commands, blacklist and software upgrades for AFC equipment including at least the following. The operating parameters shall include the release range of SJT (e.g. restriction on sale of other railways SJT etc.).
    i. TVM
    ii. AG
    iii. POS
    iv. SAC
    v. HT
b) SAC, installed at all stations, shall perform data and software transfer function for AFC equipment including at least the following:
    i. TVM
    ii. AG
    iii. POS
    iv. SAC
    v. HT
c) At least two generation of fare, operating parameters, and software shall be managed by system.

7.7.13 Others

7.7.13.1 The contractor shall propose operation procedure for card and system security and obtain Approval from the Engineer in coordination with the O&M Concessionaire.

7.8 System Requirements

7.8.1 General Requirements

7.8.1.1 Design approach

a) The AFC system shall be of a mature and flexible, field proven design, but modern in appearance and updated with state-of-art technology, it shall be designed for a maintained service life (with periodic upgrades as required) of not less than thirty (30) years, with minimum lifecycle cost.

b) The AFC system shall be the product of at least ten (10) years of ongoing development and refinement, fully exploiting the benefits of full colour GUI's and touchscreen technology to ensure intuitive ease of use by the O&M concessionaire's non-technical employees and by passengers.

c) The AFC system shall incorporate a flexible and user-friendly facility to create ticket products and loyalty products and to create associated business rules to determine validity rules for these.

d) The AFC system shall be field-proven to operate in rail-based, closed systems where passengers can transfer between the services of different transit operators without the need to check out of one system and into another.

e) All servers and other CPU's deployed within the AFC system shall not exceed 50% loading of the processors under full load conditions.

f) Where there are applicable International Standards, these shall be complied with.

g) In order to avoid vendor lock-in, the AFC system shall deploy an open systems architecture that enables the Devices of competing vendors to be integrated into the AFC systems.

h) All proprietary interfacing information shall be properly and fully documented and supplied by the Contractor for the express purpose of conveyance of such information to other suppliers, so that their components can be integrated into the AFC system at the level of an Line Replaceable Unit (LRU), AFC device or AFC workstation.

i) All equipment shall operate without degradation of quality, performance or loss of function in the electromagnetic environment of the railway line.

j) Black-and-while/color Laser printers shall be supplied by the Contractor for the purpose of normal operation, as deemed necessary by the Engineer.

k) Devices shall be resilient against scratching, fingerprints, breaking and graffiti and, where necessary shall use stainless steel to resist deliberate and accidental damage and general wear and tear.

l) Devices located on public concourses shall be able to withstand hosing down with water, without sustaining damage or creating any electrical hazard and shall meet IP 54.

m) The design shall pay attention to safety, including the avoidance of creating a safety hazard during shipment, installation commissioning, operation and maintenance. The AFC equipment shall not create a safety hazard, even during fault conditions, and shall fulfil the design intent in respect of facilitating emergency evacuations.

n) The AFC system hall be of good ergonomic design. An ergonomic study shall be included in the Preliminary Design and reviewed as part of the Preliminary Design Review.

7.8.1.2 Software Requirements

a) The contractor shall submit to the Engineer a list of all software.

b) The contractor shall consider software to be easy maintainable and re-configurable by the O&M Concessionaire.

c) The contractor shall submit security design for data transmission with coordination with the O&M Concessionaire to be Approved by the Engineer.

d) Software design shall be considered with preventive measures against virus threat, data hacking, vandalism, or fraud.

7.8.1.3 Hardware Requirements

a) Hardware design of AFC machines shall consider preventive measures for the following:

i. Vandalism (including force-open equipment or damage on touch-panels)
ii. Fraud
iii. Dust
iv. Water Ingress

b) The AFC system shall be designed to consider passengers' safety and convenience, especially senior citizens, children, expecting mothers, and people with disability (PWD).

c) The AFC system shall be designed to consider the safety and convenience of operating staff.

d) The Contractor shall provide the size and weight of all AFC equipment.

7.8.1.4 Reliability, Availability, Maintainability and Safety (RAMS) Requirements

a) The Contractor shall comply with EN50126 and EN50128 or equivalent standards for the system assurance process to be implemented to ensure the achievement of the Reliability, Availability, Maintainability and Safety (RAMS) targets of AFC system.

b) The Contractor shall conduct RAMS analysis at design stage to verify the system and equipment design to meet the RAMS targets.

c) The Mean-Cycle-Between-Failure (MCBF) is the arithmetic mean of the equipment operating cycles or transactions between successive independent failures, which is the mean equipment operating cycle per independent failure. MCBF shall be converted into Mean-Time-Between-Failure (MTBF) when the average operating cycles or transactions over a stated period of time is determined.

d) The Mean-Time-To-Repair (MTTR) is the mean active repair time required, after arrival of the maintenance team, to locate and isolate the fault, make repairs, and perform a functional checkout to verify that the equipment has been restored to operational status.

e) Availability shall be calculated based on the converted MTBF and MTTR achieved, e.g.

$$\text{Availability} = \text{MTBF} / (\text{MTBF} + \text{MTTR}) \times 100\%$$

f) The calculated figures are the inherent availability, which excludes the time to mobilize the operation and maintenance staff to fault location.

g) The Contractor shall ensure the system and equipment design to be complied with the RAM targets at the design stage through RAM analysis. The achievement of the RAM targets shall be demonstrated by RAM demonstration Tests. The Contractor shall provide a report describing details of the principle, method, and results of the tests.

h) The Contractor shall ensure the system and equipment design shall comply with the Reliability, Availability and Maintainability targets as specified in Table 7-5 below through RAM analysis. The targets are based on an assumed operational day of 19 hours per day, seven days a week, 365 days a year (leap year 366 days), unless otherwise specified.

Table 7-5 Reliability, Availability and Maintainability Targets

Equipment	**Reliability (MCBF)**	**Minimum Availability**	**Maintainability (MTTR)**
Ticket Vending Machine (TVM)	No more than 1 failure in 25,000 transactions	99%	Less than 30 minutes to replace module on site
Automatic Gate	No more than 1 failure in 100,000 transactions	99%	Less than 30 minutes to replace module on site
Point of Sales (POS)	No more than 1 failure in 40,000 transactions	99%	Less than 10 minutes to replace module on site
Handheld Terminal (HT)	No more than 1 failure in 100,000 transactions	99%	Less than 10 minutes to replace the failed unit and restore
Station Accounting Computer (SAC)	-	99.5% (based on 24 hours per day)	Less than 30 minutes to replace the failed unit and restore
AFC Central Computer (AFC-CC)	-	99.9% (based on 24 hours per day)	Less than 45 minutes to replace the failed unit and restore
AFC Backup Central Computer (AFC-BCC)	-	99.9% (based on 24 hours per day)	Less than 45 minutes to replace the failed unit and restore
Card Personalization Machine (CPS)	No more than 1 failure in 50,000 transactions	99%	Less than 15 minutes to replace the failed unit and restore

7.8.1.5 Climate Conditions

a) AFC equipment shall consider hot and humid climate conditions in Greater Capital Region. The climate condition shall be referred to ERG (General Requirements).

b) The contractor shall specify the limit of climate conditions (including temperature and humidity) for the AFC equipment to operate normally.

c) AFC equipment installed shall not lose or corrupt data that is stored or under processing, or suffer damage as a result of ambient temperatures exceeding normal operating temperatures.

d) The contractor shall be responsible to coordinate with other contractors on architecture, installation, power supply, wiring and other civil services required for related rooms and areas.

7.8.1.6 People with Disability (PWD)

a) The contractor shall ensure that the design of AFC equipment is compliant to Republic Act No.7277
b) The design of AFC equipment shall consider the following disabilities:
   i. Total blindness
   ii. Partial visual impairment
   iii. Color blind
   iv. Use of wheelchair
   v. Hearing impaired

7.8.1.7 Design Life

a) The AFC system shall be of a mature and flexible, field proven design, but modern in appearance and updated with state-of-the-art technology. It shall be designed for a maintained service life of not less than 10 years, with minimum lifecycle cost.
b) Life expectancy of total AFC system shall be at least 10 years from the commencement of revenue service.
c) These 10 years does not include years for development or testing.

7.8.1.8 Data Backup

a) The AFC system shall consider preventive measures against any damage or loss of data. The measurements shall include for both software and hardware.
b) The AFC system shall consider preventive measures against power failure.
c) The AFC system shall consider preventive measures against network failure.
d) The AFC system shall retain backup data of not less than 30 days. This shall be included in the following AFC equipment, but not limited to:
   i. TVM
   ii. POS terminal
   iii. AG
   iv. HT
   v. SAC
   vi. AFC-CC
   vii. AFC-BCC

7.8.1.9 Power Supply and Grounding

a) Power supply is 60Hz, 230V AC single phase or 400V three phase. Voltage varies ±5%
b) The contractor shall provide a UPS in the AFC-UPS room and guarantee the operation of station level equipment for at least 3 hours against power failure.
c) The contractor shall consider preventive measures against data loss or power failure for station level equipment.
d) AGs, TVMs and POS terminals in stations shall not start shutting down unless power failure is $\geqslant$ 1 minute.
e) The contractor shall consider the same design requirements as listed above for depot level AFC equipment.

7.8.1.10 Maintenance Requirements

a) All AFC equipment shall be provided with a diagnostic menu for use in conjunction with the Maintenance Manuals, to enable rapid fault diagnosis, repair, and verification

b) The AFC system design should consider only a maximum of one maintenance person required to repair the following equipment, but not limited to:
   i. TVM
   ii. AG
   iii. POS terminal
   iv. SAC
   v. Cash handling equipment
   vi. Money trolley
   vii. HT
   viii. Card Personalization machine

c) The contractor shall consider measures to reduce repair time for the following equipment, but not limited to:
   i. TVM
   ii. AG
   iii. POS terminal
   iv. SAC
   v. HT

7.8.2 Security

7.8.2.1 The AFC system shall be secured from the following, but not limited to:

a) Forgery, modification, misappropriation of tickets
b) Equipment malfunction, mis-operation, illegal operation, violent destruction
c) Loss, damage, alteration of data in equipment, data on communication line
d) Any damage to equipment due to power failure, voltage transients, lightning surge, malfunction

7.8.2.2 The data retained in each Tier 1 equipment shall be kept for at least 7 days if SAC cannot receive it.

7.8.2.3 The data retained in each Tier 2 equipment shall be kept for at least 30 days if AFC-CC/AFC-BCC equipment cannot receive it.

7.8.3 Auditability

7.8.3.1 The AFC system shall provide fully auditable accounting records and shall be able to store Transaction Records and all other usage data (including, but not limited to, Device status messages), securely and indefinitely.

7.8.4 Passenger Demand Forecast

7.8.4.1 MCRP and NSRP-South Commuter

a) The Contractor shall propose the equipment quantity for each station, taking into consideration the passenger demand forecast, station space capacity and the equipment requirements stated in Section 7.9. The AFC system proposed shall be able to process passengers on weekday peak hour at each station smoothly.

b) The passenger demand forecast data for peak 1(one) hour until 2045 are shown in Table 7-6

Table 7-6 Peak Hour Passenger Demand

Station	2045	
	Boarding	Alighting
CIA	490	490
Clark	5,846	5,846
Angeles	1,778	1,778
San Fernando	4,247	4,247
Apalit	1,646	1,646
Calumpit	1,800	1,800
Tutuban	1,133	1,133
Blumentritt	2,911	2,911
Espana	4,134	4,134
Santa Mesa	4,996	4,996
Paco	1,202	1,202
Buendia	5,200	5,200
EDSA	2,006	2,006
Nichols	1,862	1,862
FTI	6,445	6,622
Bicutan	7,538	7,691
Sucat	2,992	3,048
Alabang	5,817	5,932

Muntinlupa	3,454	3,506
San Pedro	3,338	3,394
Pacita	781	794
Binan	2,503	2,536
Santa Rosa	1,141	1,154
Cabuyao	1,798	1,822
Banlic	3,529	3,544
Calamba	5,902	5,973

7.8.4.2 Limited Express Train Service

Prediction of the number of passengers at each station of the limited express train is as shown in Table 7-7. (forecast for 2023)

Table 7-7 Prediction of the Number of Boarding Passengers

Station		Passengers/Train/Peak hour (Assumed five times average)	
		North Bound	South Bound
MCRP section	CIA		33
NSRP-South section	Buendia		143
	Alabang	32	
Total		32	176

7.9 Equipment, Design and Materials Requirements

7.9.1 Automatic Gate

7.9.1.1 General

a) This section defines requirements for Automatic Gate (AG).

b) An AG comprises of an aisle, enclosed by two stanchions, one of which is the master controller of the aisle and the other, the slave. Therefore, an AG is split between two stanchions, always providing a smart media interface to a passenger's right.

7.9.1.2 Type of AG

a) The contractor shall consider the following two types of AG.
   i. Normal gate
   ii. Wide gate

b) Wide gate shall be able to be used by wheelchairs and be installed 1 aisle for each gate array.

c) Normal gate shall have 3 types of traffic directions.
   i. Entry Gate which is specially for entry aisle
   ii. Exit Gate which is specially for exit aisle
   iii. Reversible Gate which is bi-directional aisle

d) Wide gate shall be bi-directional.

7.9.1.3 Automatic Gate Housing and Gate Barrier

a) All AG shall be reversible in direction and be able to work in a bi-directional mode.

b) The width of the normal- type automatic gate shall be at 550mm wide between stanchions. The width of the wide-type automatic gate shall be at 900mm wide between stanchions, to cater for passengers with wheelchairs. The width of each stanchions shall be 300mm or less, unless coordination with the other contractors requires otherwise, then this will be Approved by the Engineer and the O&M Concessionaire.

c) The gate shall pass at least sixty (60) passengers per minute (counted in the testing condition).

d) The barrier and stanchions shall not be capable of being jumped over by passengers.

e) AG shall be with flap type glass barriers. The glass barrier type shall be made of certified, laminated safety glass which will not create shards if broken or shed beads of glass, which could create a trip hazard. The barriers shall be free of sharp edges, sharp corners, and abrasive surfaces. There shall be no gaps where a finger could be trapped. Design of the gate shall be Approved by the Engineer in coordination with the O&M Concessionaire.

f) The AG barrier shall be illuminated with 3 color (white, red and green or any other colors) LED indicator and shall be able to cater for laser printing on the glass barrier, the design for laser printing shall be subject to approval by the Engineer.

g) Noise generated during closing or opening of AG barriers shall not exceed 40 dB(A) when measured at the center of the aisle and 1 meter above ground.

h) The AG shall include preventive measures against tailgating. The AG shall use scanning technology as a means of monitoring persons and objects in an aisle.

i) The design of AG shall take into consideration the safety of children, pregnant women, senior citizen, and PWD.

j) The contractor shall ensure that tactile strips to Wide AG shall be coordinated with Civil contractor.

k) The AG shall have visual indicators which include, but not limited to:

i. A Concession LED indicator lamp near to each end of the top surface of every stanchion to indicate Blacklisted, Concession type SJT/SVC, Corporate Passes and Maintenance Passes. The AFC System shall allow the concession indicators to activate on any other type of SJT or SVC.
ii. A gate end display at the right side of each aisle, in each direction, to indicate whether the aisle is in service in the particular direction.

l) The AG shall have audible indicators which include, but not limited to:
i. An alarm annunciator to draw attention to a suspected unauthorized passage or unauthorized opening of an access door or panel.
ii. A variable frequency tone generator to indicate a successful or unsuccessful validation.

7.9.1.4 Maintenance

a) The maintenance panel or equivalent shall be provided within the AG which shall contain an LCD or similar display to allow O&M concessionaire personnel to login to perform maintenance and diagnostic functions.
b) The maintenance panel shall provide an interface for O&M concessionaire personnel to connect a notebook computer or similar to run diagnostics and retrieve data.
c) The AG shall incorporate a series of diagnostic tests to be used to examine hardware and software performance. All diagnostic commands are entered from the maintenance input device.
d) All components shall be easily accessible and shall be mounted on movable slides if possible.
e) Every AG shall provide a maintenance power socket within the stanchion to be used by O&M concessionaire personnel for connection of power tools.

7.9.1.5 Passenger Information Display

a) The PID shall be capable of displaying graphic and character text in English and Filipino as messages to the passengers.
b) The PID shall be a backlit anti-glare TGT display or acceptable equivalent integrated into the cover on top of the AG at good ergonomic viewing angles.
c) The PID shall be anti-glare and capable to display configurable greeting messages in color. All messages in all languages shall be configurable as part of operation parameter.
d) The output intensity of the PID shall be adjustable inside the AG housing and shall be legible at a distance of 2 meters from the equipment by a person with average vision under all ambient lighting or sunlight conditions.
e) The PID shall have audible indicator and the noise level shall be software configurable by local maintenance per machine.

7.9.1.6 Emergency Mode

a) The gate shall be normally closed. In the event of station emergency, the AG can be set to Emergency mode which opens every gate for unrestricted exit.
b) The speed and torque of the barriers shall be controlled such that no passenger could be harmed by the force applied by them or because of the combination of weight, torque, and speed.
c) The Contractor shall consider including an emergency mode for all AG. In an emergency mode, AG shall be opened for passengers to exit without tickets.
d) The AG shall be hard wired to the Fire Alarm Panel. When a fire alarm is activated, the Fire Panel shall disconnect power from AG barrier control system to allow the AG to open.

e) The Contractor shall propose an alternative Emergency Push Button method to set all AG to emergency mode allowing the AG to open. This shall not depend on the availability of the AFC-CC, AFC-BCC, the SAC, network connection, nor the power supply. This method shall consider preventive measures against fraud.

7.9.1.7 System Requirements

a) The gate shall be capable of being operated in the following configurations.
   i. Controlled entrance, locked exit
   ii. Controlled exit, locked entrance
   iii. Free Exit, Free entrance
   iv. Locked entrance, locked exit
   v. Controlled entrance, controlled exit

b) The differing configurations indicated above shall be determined by SAC, which transmits the necessary commands to set the AGs in their preselected mode.

c) The gate shall collect the SJTs at the exit and store them in the cassette. The cassette is carried to TVM and it shall be able to be used for the next SJT issue. A visual alarm shall appear on the monitor of SAC when the capture bin is at 85% capacity.

d) Should a ticket-capture-bin in the exit gate be full, the exit gate shall perform the below actions, but not limited to:
   i. The exit gate shall not shut down but shall automatically switch to degraded mode and shall display a message to the passenger that only SVC can be accepted.
   ii. Notification that the bin is full of SJT cards should be sent to the POS as well as the SAC.

e) The ticket insertion slot of exit gate shall be designed to allow SJTs to be inserted easily.

f) The AG shall be able to accept payment methods of EMV-compliant cards with contactless interfaces. The contractor shall be responsible for interfacing and setting up hardware and software firewall and secure data connectivity to the approved gateway/Bank/s. The contractor shall obtain approval for the firewall and interface arrangement from the engineer.

g) The AG shall comply with the requirements as listed below, but not limited to:

i.	Minimum passengers per minute:	60
ii.	End display reading distance:	15m
iii.	Passenger information display reading distance:	1.5m
iv.	Max ambient light level for all displays to be clear:	500 Lux
v.	Max opening time (emergency mode):	300ms (standard) 500ms (wide)
vi.	Equipment initialization	60 seconds
vii.	Upload of transaction records to SAC	Real-time
viii.	Upload of event log to SAC	Real-time
ix.	Command response time	<2 seconds
x.	Status changes response time	<1 second
xi.	Fare table, blacklist, and application programme download time	<1 minute
xii.	Application programme download time	<5 minutes (all AG) <1 minute (1 AG)

xiii.	Time synchronization – synchronization	<1 second
xiv.	Time synchronization – accuracy	+/-1 second in 30 days
xv.	Complete SJT/SVC/QR code validation processing time	<300 ms

7.9.2 Ticket Vending Machine

7.9.2.1 General

a) This section defines requirements for Ticket Vending Machine (TVM).

b) The TVM shall be a rugged and rigid device, which is free from vibration when it is in service. It shall enable customers to buy SJTs & SVCs and top-up SVCs as well as other services.

7.9.2.2 Basic Functions

a) TVM shall have at least the following functions for passengers.

   i. Issue Stored Value Card (SVC) and Single Journey Ticket (SJT).

   ii. Collect deposit for SVC.

   iii. Top-up SVC.

   iv. Enquiry of SJT and SVC history.

   v. Shall accept both coins and banknotes as payment and shall give change in coins and banknotes

   vi. Shall accept credit/debit card as payment

b) The TVM shall issue receipts on passenger's demand.

7.9.2.3 Requirements

a) Enclosures shall be rugged and vandalism and abrasion resistant, with an alarm which is automatically activated when a door or panel is forced open.

b) The external appearance of the TVM, the ergonomics of the passenger/machine interface ad the graphics for the front panel shall be submitted to the Engineer for review before manufacturing is commenced.

c) TVM shall be rear-opened type, but front-opened type can be considered, subject to approval of the Engineer.

d) The TVM shall report security alarms to SAC and AFC-CC, if an unauthorized access attempt is detected. An audible siren, or other approved tone sounder, shall also be triggered, subject to the Engineer's approval.

e) The TVM shall be accessible to wheelchair users compliant with Republic Act No.7277.

f) The TVM shall be equipped with an overhead display. The overhead display shall be dynamic dot graphic LED display in bright blue green color or other color as approved by the Engineer.

g) The overhead display of the TVM shall provide suitable indication to the passenger about the mode of operation of the machine.

h) The TVM shall be able to display greeting/advertisement video with audio messages in English or Filipino. The audio messages shall have programmable volume adjustment.

i) The cancel function shall be provided to allow any transaction to go back to the previous step and/or cancel the transaction, provided that the encoding cycle has not commence. Upon cancellation, the inserted banknotes and/or coins shall be returned from the Escrow. The activation of the cancel function shall have no effect if the encoding process has commenced.

j) The TVM shall have the provision to accept and be configured to allow acceptance of future denominations of coins and banknotes.

k) The TVM shall be designed so that station staff do not need to touch money unless component issue such as jamming occur. Cash cassette of AFC machines shall be locked. The number and variation of locks shall be Approved by the Engineer in coordination with the O&M Concessionaire. Each cassette shall be labeled with its own identification number. This identification number shall be identified electronically by machine. The station staff shall input his / her identification number before removing the cash cassette, for cash handling recording purposes.

l) The TVM shall include automatic recirculating change facilities and shall normally give change. If sufficient coins are not available for change, the TVM shall automatically go into "EXACT FARE" degraded mode. In "EXACT FARE" mode, the TVM shall:

   i. Display prominently a notice in Filipino and English reading "EXACT FARE ONLY".

   ii. Be able to perform the issuing of tickets (SJT and SVC) and add fare (SVC) functions with the insertion of the exact number of coins that are required to fulfill the function.

m) Once a configurable predetermined number of coins have been accumulated, the TVM shall automatically revert to "CHANGE GIVING" normal mode. Alternative approaches to automatic switching between "CHANGE GIVING" normal mode and "EXACT FARE" degraded modes may be proposed by the Contractor.

n) Banknote Handling System

   i. The banknote handling system shall be a proven device already in use in similar railway environment for minimum 5 years.

   ii. The banknote handling system shall consist of banknote acceptor, banknote escrow, banknote cashbox and banknote change cassette. Indication light shall be illuminated at the banknote acceptor to indicate banknote can be inserted.

   iii. The banknote acceptor shall exhibit an accuracy of at least 99.9% on identifying valid or forged banknotes.

   iv. The banknote acceptor shall not accept forged banknotes, color photocopy of any banknotes and foreign banknotes.

   v. The banknote escrow shall hold at least 15 banknotes. Banknotes returned shall be the same ones inserted by the passenger.

   vi. The banknote cashbox shall hold at least 2000 banknotes and weigh less than 6 Kg when full.

   vii. Banknote changes shall be dispensed from banknote change cassettes. The banknote change cassettes shall be programmable to dispense any of the banknote denominations accepted by the banknote acceptor.

   viii. The banknote change system shall be capable of dispensing three (3) denominations of banknotes, each shall have a capacity of at least 2000 banknotes and dispense banknote in a speed of at least 3 banknotes per second.

o) Coin Handling System
   i. The coin handling system shall be a proven device already in use in similar railway environment for minimum 5 years.
   ii. The coin handling system shall consist of coin acceptor, coin escrow, re-circulating coin change cassettes, coin box and reserve coin change hoppers.
   iii. The coin acceptor shall be able to differentiate between at least 8 different denominations of coins. The coin validating and sorting functions shall be fully configurable and field re-programmable.
   iv. The coin acceptor shall verify one (1) coin in less than 1.0 second and exhibit an acceptance rate of at least 95% on first insertion of valid coins.
   v. The coin acceptor shall exhibit an accuracy of at least 99.9% on identifying valid and forged coins.
   vi. The coin acceptor shall not accept metal tokens of the same size or foreign coins as valid coins.
   vii. The coin escrow shall hold at least 20 coins of any coin types to be accepted. Any coins returned to the passenger shall be from the coin escrow.
   viii. Coins collected shall be re-circulated to fill up the coin change cassette and surplus coins shall be banked into the coin cashbox.
   ix. Coin change cassettes shall dispense coins in a speed of at least 2 coins per second.
   x. The coin cashbox shall hold minimum 3000 valid coins and can be set parameterized by quantity or weight.

p) Credit/Debit Card
   i. The TVM shall be able to accept payment methods of EMV-compliant payment cards with contact interfaces and EMV-compliant cards with contactless interfaces.
   ii. The contractor shall be responsible for interfacing and setting up hardware and software firewall and secure data connectivity to the approved gateway/Bank/s. The contractor shall obtain approval for the firewall and interface arrangement from the Engineer.
   iii. The shutter of the credit/debit card reader shall open for acceptance of payment when transaction value is displayed and close after completion of payment and return credit/debit card to the passenger.
   iv. The TVM system shall ensure that all approved credit/debit card transactions are reversed and that the debited amount is credited back to the user should the TVM fail to complete the transaction requested or purchased by the user.

q) Human Machine Interface
   i. The Human Machine Interface (HMI) shall be intuitive and optimized for efficient use to enable a simple transaction, such as buying a SJT, to be completed in 15 seconds. Destination selection shall be from a route map, a list of stations and locations or a combination of these. The Contractor may propose alternative formats, subject to the Engineer's approval.
   ii. The HMI shall include paid-to-paid link interchanges with other railway lines.
   iii. Messages shall be displayed in English by default and may be switched to Filipino language. Number of languages can be expanded further which will be subject to approval of the Engineer.
   iv. HMI design of the TVM shall be Approved by the Engineer and the O&M Concessionaire.

v. All TVM on MCRP, NSRP-South, NSCR and MMSP shall have a common HMI design. The Contractor shall perform the necessary coordination with CP04 and CP106 contractor regarding the this common HMI.

r) Maintenance

i. The TVM shall have a maintenance panel complete with built-in keyboard and display to show the machine status, fault codes and to accept operator inputs.

ii. The maintenance panel shall be easily accessible and visible upon opening the equipment door.

iii. All components shall be easily accessible and shall be mounted on movable slides if possible. All removable components shall be sized, positioned such that it can be removed and inserted without requiring more than the average strength or dexterity of a young Filipino female.

iv. Lighting shall be provided inside each TVM and shall turn on automatically when the door is open and turn off when the door is closed.

s) The TVM shall comply with the requirements as listed below, but not limited to:

i.	Minimum average transaction rate per minute:	4
ii.	Touch screen LCD display	50,000 hours
iii.	Equipment initialization	<2 minutes
iv.	Upload of transaction records to SAC	Real-time
v.	Upload of event log to SAC	Real-time
vi.	Command response time	<2 seconds
vii.	Status changes response time	<1 second
viii.	Fare table, blacklist and application programme download time	<1 minute
ix.	Application programme download time to all TVMs	<5 minutes
x.	Time synchronization – maintain synchronization	<1 second
xi.	Time synchronization – accuracy	<+/- 1 second in 30 Days
xii.	Accounting accuracy:	100%
xiii.	Alarm sound level at 1 meter high from face of TVM when door is closed	90dB

7.9.3 Point of Sales

7.9.3.1 General

a) This section indicates requirements for Point of Sales (POS).

b) The POS shall be operated only in a CSR. It is not a portable device and it shall be permanently wired to its lockable cash drawer.

7.9.3.2 Basic Functions

a) POS shall be the window machine which is operated by a station staff and shall have the following functions but not limited to:

   i. Issue, analyze, compute excess fares, revalidate, cancel, refund, repair, enquire card history and issue replacements for SJT

   ii. Issue with stored value, compute excess fare, add value to, analyze, replace, deduct penalty fares, revalidate, cancel, refund, repair, enquire card history, print card history and issue replacements for SVC

   iii. Collect deposit for SVC

   iv. Renew SVC

   v. Release automatic gates

7.9.3.3 Requirements

a) The POS shall consist of a Personal Computer complete with a touch-screen display, keyboard and mouse, CSM-EM, Passenger Information Display, receipt printer, credit/debit card reader and QR code reader. The touchscreen shall be durable and have a contrast ratio that is not materially degraded by the addition of the touchscreen technology.

b) POS shall have a passenger information display to convey to passengers all information that is relevant to the transaction in hand, including but not limited to price of the ticket, the remaining value inside the card, excess fare and so on.

c) The Human Machine Interface design of POS shall be submitted to the Engineer for review and approval.

d) The POS shall be accessed by authorized O&M concessionaire, whose identity shall be recorded in relevant reports and event log. The operator shall be able to log in using two-stage authentication (staff card plus PIN) to start his shift.

e) The POS shall be capable of accepting cash and credit/debit cards for transaction payments.

f) POS shall include secure cash drawers where the O&M concessionaire shall be responsible of the contents of a lockable cash drawer insert tray which he can install in the automatic cash drawer before unlocking it and removing the lid. At the start of a shift, the cash drawer will contain a float of cash. The value of the float as recorded on the SAC, shall be downloaded to the POS when the operator logs in.

g) At the end of a shift, the O&M concessionaire shall log off and receive a printed shift report, which shall include a record of cash taken during the shift plus the value of the initial float. It shall be possible to reprint the shift report in the future without any time limit. The O&M concessionaire shall be able to open the cash drawer to obtain access to his lockable cash tray, which he is required to lock and take to the Strong Room.

h) One unit of Black-and-white/color Laser printer for each Customer Service room shall be supplied by the Contractor as part of the components of POS.

i) The POS shall be able to top-up passenger's SVC. For top-ups, all payment means are accepted, including EMV-compliant contactless cards, shall be accepted, plus cash in notes and coins, and EMV-compliant credit and debit cards with contactless interfaces.

j) POS shall be able to request card information to the AFC-CC.

k) The information of processed card shall be sent to the AFC-CC.

l) The POS configuration and application for Sale and EFO shall be same. It shall be possible to configure machine by parameter as EFO or as POS.

m) The POS shall comply with the requirements as listed below, but not limited to:

i.	Reading distance for passenger information display:	>1.5m
ii.	Passenger Information display	50,000 hours
iii.	Equipment initialization	<1 minute
iv.	Accounting accuracy:	100%
v.	Upload of transaction records to SAC	Real-time
vi.	Upload of event log to SAC	Real-time
vii.	Command response time	<2 seconds
viii.	Status changes response time	<1 second
ix.	Fare table, blacklist and operation parameter download time	<5 minutes
x.	Minimum average transaction rate per minute	24 seconds
xi.	Time synchronization – maintain synchronization	<1 second
xii.	Time synchronization – accuracy	+/- 1 second in 30 days

7.9.4 Station Accounting Computer

7.9.4.1 General

a) This section indicates requirements for Station Accounting Computer (SAC).
b) SAC shall be installed in the AFC equipment room (AFCER) of each station.
c) The SAC shall provide a HMI via touchscreen workstation to enable an authorized cashier to record movements of cash from and to a safe. It shall also provide control and monitoring functions for equipment at the station where it is installed. The touchscreen shall be durable and have a contrast ratio that is not materially degraded by the addition of the touchscreen technology.

7.9.4.2 Requirements

a) The SAC shall exchange information with the AFC equipment through the LAN in the station. It shall also exchange information with AFC-CC through communication backbone network between stations and OCC.
b) The main function of SAC is as follows.
   i. Transaction data and event data collection and transmission
   ii. Cash data and Card data collection and transmission
   iii. Ticket recycle management
   iv. Ticket data inquiry
   v. Passenger flow data generation and transmission
   vi. Process traffic data from AG
   vii. Station equipment status monitoring and control
   viii. Data and parameter management
   ix. Blacklist management
   x. Time management
   xi. Staff account management
   xii. Data input/output management
   xiii. Log data/ maintenance record management
c) Black-and-white/color Laser printers shall be supplied by the Contractor as part of the components of each SAC.
d) The SAC shall be able to function in all respects when data connection is unavailable.
e) In the event of a failure of either the SAC or the local station data transmission network, each item of station level equipment shall operate independently and record all transaction and alarm data. All data stored shall be transmitted automatically to the SAC once the System is recovered from failure.
f) The SAC shall provide fallback facilities in the event of prolonged communication failure with the station AFC equipment. The station configuration data files on the SAC shall be copied onto a backup media and downloaded to the station AFC equipment if necessary. The revenue and transaction data stored in the station AFC equipment shall be copied onto a backup media and hand carried to the SAC or AFC-CC for input. The SAC or AFC-CC shall be able to read the station data from the backup media such as certified USB keys and merge the data with other station data.
g) In the event of failure of either AFC-CC or both AFC-CC and AFC-BCC, the SAC shall be able to operate the station AFC equipment. The SAC shall also be able to export equipment transaction data manually to reconcile the daily settlement.
h) The authorization and authentication processes to enable an authorized cashier to log in the SAC and to log out again shall be identical to the equivalent processes that apply to POS.

i) The SAC shall be capable of processing data to print selected reports at the station for use by O&M concessionaire. The system shall have provision for making modifications in the final format of various report and preparing new reports.

j) Audit reports and detailed transaction logs shall be available on demand and download from AFC-CC as required in order to resolve disputes with passengers.

k) The SAC shall have different levels of access control, subject to approval by the Engineer. Each O&M concessionaire personnel shall be assigned an access control level which allows them to perform selected functions of the SAC.

l) The SAC shall manage the synchronization of date and time with the station AFC equipment.

m) SAC shall have security protection for data and user access.

n) The SAC shall track and record the cash floats for each TVM and POS of the station that it is being installed.

o) The SAC shall comply with the requirements as listed below, but not limited to:

i.	Design duty	400,000 transactions per day per station
ii.	Start of day processing	< 2 minutes
iii.	Upload of transaction records to AFC-CC	Real-time
iv.	Upload of event log to AFC-CC	Real-time
v.	Command response time to equipment	< 2 seconds
vi.	Blacklist, fare table, operational parameters download time to all equipment	< 1 minute
vii.	Programme download time to all equipment subject to network constraints	< 5 minutes
viii.	Programme download time to 1 equipment	< 1 minute
ix.	Time synchronization	< 1 second
x.	Time synchronization accuracy	+/- 1 second in a month

7.9.5 Central Computer System

7.9.5.1 General

a) This section indicates requirements for Center Computer System (CCS).
b) CCS are placed in the in OCC building at Malabacat Depot.
c) The primary function of the CCS shall be to secure revenue from fare-paying passengers, facilitate day to day train and station operation, management of incidents, operation during periods of reduced service and emergencies.

7.9.5.2 Requirements

a) The CCS shall comprise of AFC-CC and AFC-BCC where both shall have up-to-date (mirrored) databases.
b) AFC-CC design shall be able to cater for passenger ridership up till year 2045 including future expansion or interchanges with other railway lines.
c) The CCS shall include preventive measures for power loss and data connection loss.
d) Security features shall be incorporated into softwares installed in AFC-CC and AFC-BCC to prevent tampering with any data, programmes, or any facilities of the CCS.
e) In the event of a failure of either AFC-CC or both AFC-CC and AFC-BCC, each SAC shall operate independently and record all transaction and alarm data. All data stored shall be transmitted automatically to the AFC-CC once the system is recovered from failure.
f) The AFC-CC shall provide fallback facilities in the event of prolonged communication failure with the SAC. The AFC-CC operation parameters shall be copied onto a backup media and downloaded to the SAC manually if necessary. The revenue and transaction data, operation and maintenance information stored in the SAC shall be copied onto a backup media and hand carried to the AFC-CC for input.
g) The AFC-CC and AFC-BCC shall be equipped with UPS with sufficient capacity for two (2) hours operation with warning at 15 minute intervals and automatic shutdown with 10 minutes to spare.
h) The AFC-CC shall automatically account for all transaction details to compile revenue collected, finance reconciliation, operation and maintenance reports for the system as a whole.
i) The AFC-CC shall be capable of checking and handling exceptions, missing, duplicate, delayed, and fabricated transaction data.
j) The main function of CCS is as follows. (*) Sign means sending and/or receiving the data with the central clearing house.
   i. Transaction data and event data collection and transmission (*)
   ii. Cash data and card data collection and transmission (*)
   iii. Ticket inventory management
   iv. Ticket data inquiry (*)
   v. Passenger flow data generation and transmission
   vi. Machine status monitoring and control
   vii. Data and parameter management
   viii. Blacklist management (*)
   ix. Time management
   x. Staff account management
   xi. Data input/output management
   xii. Log data/ maintenance record management

xiii. SAM authentication and transaction authentication (*)

k) The AFC-CC shall have hierarchical access controls by means of log-in ID and password, subject to approval by the Engineer. The AFC-CC shall allow the System Administrator to add/edit/delete any users. The AFC-CC shall allow the System Administrator to add/delete a station in the system for the group control.

l) Hierarchical access control, and other security measures, shall be applied to ensure that all data are protected from unauthorized access, alteration, retention of deletion of records, ensuring full, system-wide compliance with The Data Privacy Act 2012.

m) AFC-CC shall be equipped with a convenient means of capturing diagrammatic, not to scale representations of AFC equipment layouts and configurations in stations and depots directly from electronic drawings and then maintaining these drawings. These drawings will be used in stations and depots to monitor and control the status of AFC equipment.

n) AFC-CC shall capture and store all AFC equipment generated Usage Data. Usage Data shall mean Transaction Records and all equipment generated messages, including device status. From the time it is created, at no time shall a transaction record exist without a back-up, or duplicate copy.

o) The AFC-CC shall track each of the SJT and SVC with a unique identification number and shall be tracked from its initialization until its termination. On termination the unique identification number shall be purged from the database.

p) At the end of each operating day, the AFC-CC shall consolidate data received for the day and perform the End of Day process which shall include summarization of data, generation of reports and backing up of data.

q) The AFC-CC shall maintain a security management to properly monitor the security of the entire AFC system including the operation system, database, application software and network to prevent unauthorized access, external threat and alteration of the database.

r) The AFC-CC shall obtain the standard date and time and synchronize its clock automatically from the Master Clock System. The SAC shall synchronize its clock with AFC-CC. The SAC shall in turn synchronize with all other AFC equipment.

s) The communication network shall be equipped with built-in error detection and transmission retried to ensure accuracy and dependability of data transmission.

t) The contractor shall be responsible for obtaining the necessary approvals for the merchant bank contact interface, EMV-compliant bank card readers.

u) The contractor shall be responsible for obtaining the necessary approvals for the Central Clearing House interface.

v) AFC-CC shall distribute the fare data to the AFC equipment via the SAC. The fare data shall include paid-to-paid interchanges with other railway lines.

w) AFC-CC Application and Database Servers

i. The AFC-CC application and database servers shall be mainstream products that conform to the current industrial standards.

ii. Server computers shall have high performance, high speed and high reliability characteristics.

iii. High End based CPU architecture with Unix or Windows Operating System.

iv. Server computers shall have sufficient memory and internal hard disk capacity to meet all current requirements and provide one hundred percent (100%) capacity.

v. Internal hard disk shall be RAID 5 configured to meet operating requirements and shall be extendable.

vi. Support for back-up media.

vii. One super Digital Linear Tape (DLT) or Linear Tape Open (LTO) or other suitable format tape driver with a tape autoloader and necessary automated backup software shall be installed within the Database Server.

x) Data Storage

i. The design of the database system shall be arranged to keep track of all valid SJT and SVC in circulation. This information shall aid in reporting any abnormal usage of the stored value or trips and in providing refunds for corrupted SJT/SVC.

ii. The database system shall satisfy the following requirements:

- Full function, RDBMS based on SQL or Oracle
- Support complicated data structure, multi-user, multi-processing, large capacity.
- Offer data integration, data recovery and security
- Support parallel processing
- Provide disk mirroring functions
- Authority control shall be independent of that of the operating system
- Offer multilevel safety management of database

iii. The data storage capacity shall be sufficient to maintain seven years (7) transaction data available online for ad hoc report generation and other investigations. The volume of data to be calculated for this requirement shall assume two (2) million transaction a day.

iv. To maximize the utilization of the disk space of the system, the system data shall undergo a regular housekeeping process. The housekeeping shall cover the files created by the AFC-CC and the files relative to each subsystem. Any outdated or invalid files shall be archived. The duplicated records in the database and records where only the latest data needs to be retained shall be merged and archived.

y) Reporting

i. AFC-CC shall be designed to provide comprehensive report generation facilities to generate and enable printing all sorts of reports based on collected data from the entire AFC network.

ii. The AFC-CC shall produce operational reports, revenue and audit reports, management information reports, accounting reports, reliability reports and any other additional reports as defined by the Engineer during design phase. The list of reports, report specifications, report types and report formats required will be proposed by the Contractor and subject to the approval by the Engineer.

iii. The AFC-CC shall provide scheduled and ad hoc management information reports concerning patronage and revenues. The O&M concessionaire shall be able to configure and schedule such reports by means of an intuitive and flexible HMI. In addition, ad hoc enquiries shall be supported.

z) Central Clearing House System

i. The CCHS is the archival and computational facility for settlement and apportionment of the transit fare transactions, generated by multiple participants in the multiple transit networks. The following functions are performed by the central clearing house:

- Financial reconciliation function

- Blacklist generation management
- Card status (including balance information) management
- Security key management
- SAM management

ii. The AFC-CC shall track the parameters and rules set by CCHS for the purpose of financial reconciliation with CCHS and substantiation/revocation of claims against or from CCHS and shall include, but not limited to:

- Definition of fare matrices, which may be different depending on the type of ticket used and different against for passengers using Stored Value or EMV Contactless Payment, QR code payment.
- Definition of apportionment rules for integrated journeys, including the quantum and apportionment of any fare foregone due to inter-modal discounts.
- Conditions of use for ticket products
- Commercial rules for transit operators, including customer service, security, privacy, accounting, liquidity, and reporting practices.

aa) The Contractor shall support the Engineer to study, evaluate, analysis and liaise directly with other Card Managers such as AF Payments Inc, other interfacing Transit Lines etc. for ticket integration and revenue apportionment and settlement through a CCHS.

bb) The Contractor shall provide all the interfaces capable of interfacing with the CCHS for interoperability.

cc) The AFC-CC and AFC-BCC shall comply with the requirements as listed below, but not limited to:

i.	Design Duty	2,000,000 transactions per day
ii.	Generate End of Day reports	< 1 hour
iii.	Generate any single ad-hoc report	< 1 minute
iv.	Command response time to SAC request	< 2 seconds
v.	Blacklist, fare table, operational parameters download time to all SAC	< 1 minute
vi.	Programme download time to all SAC	< 5 minutes
vii.	Programme download time to one (1) SAC	< 1 minute
viii.	Time synchronization	< 1 second
ix.	Time synchronization accuracy (standalone)	+/- 1 second in a month
x.	System spare processing power and memory	> 100%

7.9.6 Handheld Terminal

a) HT shall be placed at each station and is a lightweight, durable, battery-operated, portable computer used by train attendants and station staff for ticket issuing and inspection, card information checking, entrance / exit processing in a car or a station.

b) When fully charged it shall be possible for the HT to be used normally for a minimum of eight (8) hours without recharging. The full recharging time shall not be more than four (4) hours. The battery level shall be indicated on the HT display and a battery low status warning shall be displayed to alert the ticket inspector for replacement.

c) The Contractor shall provide two (2) sets of battery for each HT and one (1) battery charger for every two (2) HTs.

d) HT shall accommodate changes to the functional and interface specifications.

e) The Contractor shall design the HT to include preventive measures against data connection loss while being used on a train travelling in speeds ≤ 160 km / h. The screen should be designed to run smoothly without delay, e.g. screen time-out, screen freeze, during operation due to communication failure.

f) The Contractor shall consider utilizing the public network of the mobile phone operating company along the railway for data communication between HT and AFC-CC. It is necessary for the radio system and frequency band to be able to correspond to LTE B1, B3, B5, B7, HSPA+ B1, B5, B8, at a minimum.

g) The HT shall be capable to utilize the Wireless LAN within station building. Therefore, the terminal should be able to support 802.11 a/b/g/n which is the wireless LAN standard, at a minimum.

h) The HR shall be able to read/write a SJT and SVC by placing the fare media in close proximity to the CSM-EM.

i) The HT shall be able to display SJT and SVC information according to the business rules. The information shall be displayed in English or Filipino language.

j) The HT shall analyze the SJT/SVC according to the Business Rules and display a relevant blinking message to alert the inspector when abnormality such as date expiration, time expiration, blacklisted etc. is detected.

k) When a fare rule violation is encountered, the ticket inspector shall be able to impose penalty to be paid either in cash or out of the stored value purse.

l) The HT shall comply with the requirements as listed below, but not limited to:

i.	Design duty	7,500 transactions per shift
ii.	Minimum average transaction rate per minute	45 transactions per minute
iii.	Equipment initialization	< 1 minute
iv.	Command response time	< 2 seconds
v.	Upload transaction and audit registers to SAC and download blacklist, fare tables and operation parameters update	< 5 minutes
vi.	Time synchronization	< 1 second
vii.	Time synchronization accuracy (standalone)	+/- 1 second in a month
viii.	Equipment memory spare capacity	> 100%

7.9.7 Card Personalization Machine (CPM)

a) The Contractor shall provide two (2) CPMs to generate small quantities of personalized Passes with special graphics and photographs.
b) The CPM shall have edge to edge printing and lamination (if required) with at least 300 dots per inch resolution and be capable to print a full color SVC within 25 seconds. The CPM shall have an input cartridge with a capacity of at least 50 cards for batch processing. The CPM shall be able to initialize SJT and SVC.
c) The CPM shall have facilities to receive from a third party database digital images of photographs and digital input of individual's particulars as required for the personalization of the Passes. It shall also be able to receive and process custom designed graphics for the promotional SVC. The Contractor shall define the data interface to the third party interface.
d) The CPM shall have operator functions to read all card data and verify against the AFC-CC records.
e) The CPM shall have a suitable printer for printing the end of shift report for each operator when logging out.
f) In the event CSMs are not successfully encoded, prompts to highlight to operator on the display shall be available and the event shall be included in the local shift reports and AFC-CC reports. The prompts displayed and the report generated shall contain sufficient details for identifying the CSM for which encoding has failed and for monitoring and audit purposes. Failed CSMs shall be discarded into reject magazines.
g) The CPM shall utilize the system-level security to allow authentication of operators and controls access to data, applications and specific jobs.

7.9.8 Data Reporting

7.9.8.1 The report format to be aligned with the AFC National Standard and Business Rules and requires approval from the Engineer and O&M concessionaire to proceed.

7.9.8.2 The report/receipt to be printed out in this system are shown in Table 7-8.

Table 7-8 Data Reporting

No	Report Name	Report Type				
		Daily	Monthly	Yearly	Snapshot	History or Log
TVM/ POS	Sales / Refund Report	●	●	●	●	
	Box Plugging Report	●	●	●	●	
	Transaction Receipt	●	●	●	●	
	Maintenance Report	●	●	●	●	
SAC	Revenue Report	●	●	●	(●)	
	Passenger Flow Report		●	●	●	●
	Cash Report	●	●	●	(●)	●

No	Report Name	Report Type				
		Daily	Monthly	Yearly	Snapshot	History or Log
	Card Report	●	●	●	(●)	●
	Blacklist Report		●	●	●	
	Ticket Allocation Report	●	●	●	●	(●)
	Maintenance Report	●	●	●	(●)	(●)
	Other Report		●	●	(●)	●
CCS	Revenue Report	●	●	●		
	Passenger Flow Report	●	●	●	●	●
	Cash Report	●	●	●		●
	Card Report	●	●	●		●
	Blacklist Report	●	●	●	●	
	Ticket Allocation Report	●	●	●	●	(●)
	Maintenance Report	●	●	●	(●)	(●)
	Other Report	●	●	●	(●)	●
●: applicable (●): Partly applicable						

7.10 Interfaces

7.10.1 General Requirements

7.10.1.1 The Contractor shall be responsible for the Interface design and support for AFC interface activities by providing all necessary information with respect to the design and construction of the AFC system to facilitate design and on-site interface coordination.

7.10.1.2 The Contractor shall be responsible for developing the relevant Interface Management Plans and Interface Documents during design stage.

7.10.2 Interface with Third Parties

7.10.2.1 The AFC System shall interface with the following Third Parties external to this project, the list shall include but not limited to:

a) Commercial Banks and Credit Card Agencies
b) Central Clearing House
c) Off-site Sales Terminals (in future)
d) Future AFC systems provided by other Service Provider

7.10.2.2 All interface issues between AFC system and any third party shall be satisfactorily identified, captured, and resolved.

7.10.3 Interface with Civil

7.10.3.1 The Contractor shall coordinate with Civil Contractor to satisfactorily identify, capture and resolve all interface issues.

7.10.3.2 The Contractor shall ensure that all civil works provisions related to the design, supply, installation and testing of the AFC system are fully coordinated.

7.10.3.3 The Contractor shall identify and coordinate with Civil Contractor on the facilities/provisions supplied under this document and Civil & Building Works are fully compatible with each other.

7.10.3.4 The Contractor and Civil Contractor shall exchange the design information and identify all interface requirements including but not limited to space proofing, quantity of equipment, power ratings, heat dissipation from equipment, equipment loading, interface points, cable containment routes and requirements, spatial room requirements for equipment, equipment delivery, replacement strategies and testing plans.

7.10.3.5 All information exchange between the Contractor and the Civil Contractor shall be copied to the Engineer for information.

7.10.4 Interface with Communication Network

7.10.4.1 Data communication network shall be provided for station level and depot level AFC equipment. Cash counting equipment is not required to be connected to the network.

7.10.4.2 Optical fiber cables between stations and the OCC building shall be prepared by the Telecommunications.

7.10.4.3 The Contractor shall provide the network facilities required for backbone network connectivity for AFC equipment in stations and depot.

7.10.4.4 Network facilities shall consider preventive measures against power failure to protect or conserve data.

7.10.4.5 Network engineering shall be proposed to and be approved by the Employer or the Engineer. Network engineering includes the following:

a) Protocol used for all data communication, such as TCP/IP, and addresses
b) Network components and their performance
c) Operating speed of LAN in stations and OCC building
d) Measures against illegal access to LAN
e) Measures against data loss in case of power failure

7.10.4.6 All interface issues between AFC system and Communications Network shall be satisfactorily identified, captured, and resolved.

7.10.5 Interface with Power Supply and Distribution

7.10.5.1 UPS power supply shall be provided for station level and depot level AFC equipment.

7.10.5.2 The power supply shall consider preventive measures against power failure to protect or conserve data.

7.10.5.3 All interface issues between AFC system and Power Supply and Distribution shall be satisfactorily identified, captured, and resolved.

7.10.6 Power and Communication Network Cable Requirements

7.10.6.1 Requirements for cable are as follows.

a) The cable shall meet the Philippines Electrical Code and Philippines Electronic Code or any other national or international standards appropriate to data processing and data transmission required.
b) The contractor shall propose cable labeling with labeling format to differentiate between other system cables. This shall be subject to the Engineer's approval.
c) The cable shall be manufactured from fire retardant, low smoke, halogen free materials (LSZH) compliant to BS EN 61034 and BS EN 60754.
d) The cable shall be sufficiently shielded to minimize its susceptibility to external noise and compliant to relevant EMC standards
e) The cable shall be anti-termite, rodent and pest resistant. If chemicals are used, those shall conform to the requirements of related Philippines regulation.

7.10.6.2 Installation of the cable shall be carried out in accordance with requirements of Philippines laws, regulations, and standard. The contractor shall pay special attention to, but not limited to, the cable installation through fire protection wall.

7.11 Packaging, Shipping, Storage and Delivery

7.11.1 General requirements

7.11.1.1 The Contractor shall submit a Packaging, Shipping, Storage and Delivery Plan and Procedure to the Engineer Approval prior to any of these activities being conducted.

7.11.1.2 The Contractor shall ensure that the quality will not be impaired in the packing, shipping, transportation and storage of equipment, units, and parts. In particular, they shall not be affected by long-term high temperature and a high humidity environment by shipping service and vibration during transportation, etc.

7.11.1.3 Quality shall not be impaired during storage on site(s).

7.11.1.4 The Civil Contractor shall make provision for sufficient space to store AFC equipment on temporary basis before installation. The Civil Contractor shall provide access to the AFC Contractor for the equipment installation. Special care shall be taken for the transportation path to allow the safe handling of AFC equipment from the outside delivery point to the final transportation equipment location (e.g., avoid stairs for heavy equipment or provide appropriate equipment). Removal of the equipment through the same path must be possible for any heavy maintenance and/or replacement, when in revenue service.

7.12 Testing, Commissioning and Verification

7.12.1 General Requirements

7.12.1.1 This section indicates the requirements for tests to be performed by the contractor on AFC equipment.

7.12.1.2 The Contractor shall ensure that the AFC system is in a state ready for testing and commissioning before commencing the tests to be witnessed. The Contractor shall conduct his own pre-tests, where the Engineer may request for review prior to the tests being witnessed.

7.12.1.3 The Contractor shall provide all necessary test instruments, special tools, simulators, and test software to carry out the tests.

7.12.1.4 The Contractor shall provide simulation for testing, should the interfacing equipment be not available for testing.

7.12.1.5 The Contractor shall extend full support and provide all necessary facilities to enable convenient inspection of materials, work, and testing.

7.12.1.6 The Contractor shall investigate and provide corrective actions for all faults detected during the tests. The tests shall be resumed only after all faults have been cleared. The Contractor shall submit fault reports to describe the symptom and causes of the faults and the corrective actions taken.

7.12.1.7 The Contractor shall implement all tests in accordance with the Test Plan and Test Procedures.

7.12.1.8 The Contractor shall be responsible for providing temporary electricity supply, all instruments, gauges, test equipment, tools, accessories, personnel, services, and necessary facilities required for the execution of all tests and inspection. Wherever necessary, the Contractor shall provide two or more sets of testing equipment, tools, and others to expedite testing. All test equipment shall be accompanied with the appropriate calibration certificate by a testing authority of the equipment.

7.12.2 Cost of Tests

7.12.2.1 The Contractor must bear the cost of all necessary tests.

7.12.2.2 As for the cost of the test which is carried out outside Philippines, the Contractor must bear the expenses relating the witnessing and the verification by the Employer and the Engineer.

7.12.3 Test Plan and Procedures

7.12.3.1 All the test plans and procedures with the exact time and date shall be submitted for the approval of the Employer at least 60 days prior to any test's conduction. The procedure needs to be Approved 14 days prior to the actual test.

7.12.3.2 The contractor shall conduct at least, but not limited to, following tests.

a) Independently witnessed tests: Demonstrate that each unit is completely functioning
b) Prototype tests: Review that equipment is compliant to approved drawings and design documents.
c) First Article Inspection (FAI): Evaluate for each type whether the product manufactured first meets specifications and quality
d) Factory Acceptance Tests (FAT): Demonstrate that each product / system functions according to specifications and quality of equipment before delivery
e) Post Installation Tests (PIT): Demonstrate that all equipment has been installed in accordance with approved Installation Design. All cables are properly and accurately connected and terminated. All installation works are of acceptable workmanship.
f) Partial Acceptance Tests (PAT): Verify that the individual subsystem shall operate normally and properly according to approved design documents after site installation
g) System Acceptance Tests (SAT): Test the AFC system where all individual sub-systems are connected together, can operate in all respects in accordance to approved design documents.
h) System Integration Test (SIT): Demonstrate full compliance and compatibility with other interfacing party (Civil, Merchant Bank, CCHS etc.) and ability to operate in Normal Operation, without any major issues.
i) Performance Demonstration Test

7.12.4 Test Verification

7.12.4.1 The Contractor shall submit a certified report of the results of these Tests to the Engineer within 14 days from the date when the Engineer confirmed that the Contractor has passed each of the Tests.

7.12.5 Trial Operation

7.12.5.1 Trial operation is defined as the period immediately following the completion of a section of railway under construction, but prior to opening, when the O&M concessionaire will be operating the rolling stock and all other systems and generally using the railway as though a scheduled service was operating, except for the absence of fare-paying passengers.

7.12.5.2 The Contractor shall complete all training prior to commencement of Trial Operations and provide all necessary support and attendance during the Trial Operations period. Draft Operations and Maintenance Manual shall be submitted and approved six (6) months prior to commencement of Trial Operations.

7.13 Installation

7.13.1 General Requirements

7.13.1.1 The Contractor shall perform all works related to the installation of equipment, cables, and anything else required to make the system functional for the AFC system.

7.13.1.2 The construction boundaries at each station shall be as follows:

a) The Contractor shall provide all necessary mounting brackets and accessories for ceiling mounted, wall-mounted, pillar-mounted, or pole-mounted equipment around the station area.

b) All mounting brackets and accessories shall be corrosion resistant, aesthetically designed to match with all architectural finishes of the station and of sufficient strength to mount the equipment securely.

c) For power supply and ground or earth, the Contractor shall connect the station main power to the AFC UPS in the AFC UPS room to AFC equipment; the ground is from the common ground point; and

d) For communication, the Contractor shall connect the Station AFC LAN to the connection port(s) of the Communications System's Backbone Transmission System. The contractor shall provide data link to external agencies such as banks, CCHS, etc., not connected through Communication system back bone.

7.13.1.3 The construction boundaries in the OCC building shall be as follows:

a) For power supply and ground or earth, the Contractor shall access the OCC AFC main power from the Communication System's UPS; the ground is from the common ground point; and

b) For communication, the Contractor shall connect the AFC CCS LAN to the connection port(s) of the Communications System's Backbone Transmission System. The works involve connection from the common earth point in the OCC building.

7.13.1.4 The Contractor shall interface and coordinate with all parties involved to ensure that all information inclusive of equipment specifications, are provided where necessary. This will subject to Approval by the Engineer.

7.13.1.5 For grounding or earth, the Works shall involve connection from the common earth point to the AFC room in the stations and depot.

7.13.1.6 The design, supply and installation of all works related to the installation, test and commissioning of the electrical and grounding system for all AFC equipment in the stations and Depot shall comply with the latest edition of the Philippine Electrical Code (PEC 2017 Edition) and . A methodology for all AFC equipment installations shall be submitted and Approved by the Engineer prior to any installation.

7.13.1.7 The Contractor shall perform insulation tests, continuity tests and polarity tests on all cables (power, control, data, and earth) that are to be installed in the AFC System. These tests shall be carried out in full accordance with the latest edition of the PEC and shall be Approved by the Engineer.

7.13.1.8 Sample materials for all installations shall be submitted by the Contractor for the Engineer's Approval. All samples shall be submitted during the final design stage by the Contractor.

7.13.2 Installation of AFC equipment

7.13.2.1 The contractor shall set up the AFC equipment at a specified place. AGs and TVMs must be installed avoiding direct sunlight, raindrops, and splashes.

7.13.2.2 Equipment shall be fixed, by the means of bolts or other Approved mountings, to the floor of the station so as not to fall over or move due to earthquake, vandalism etc., allowing sufficient space for operation and maintenance.

7.13.2.3 For equipment that shall be installed on raised floor, the Contractor shall make the necessary study and analysis to ensure that the floor loading can cater to the weight of equipment installed. The Contractor shall provide equipment plinths and foundation requirements if floor loading is insufficient.

7.13.2.4 The contractor shall provide the schedule of dimension and weight of the equipment and any specific carrying method if needed. The Contractor shall provide details of the AFC equipment with specific requirements for installation (e.g. floor fixing for safe use/maintenance, etc.)

7.13.3 Installation Duct and Cables

7.13.3.1 Requirements for cable are as follows:

a) The cable shall meet the Philippines Electrical Code and Philippines Electronic Code or any other national or international standards appropriate to data processing and data transmission required.

b) The contractor shall propose cable labeling with labeling format to differentiate between other system cables. This shall be subject to the Engineer's approval.

c) The cable shall be manufactured from fire retardant, low smoke, halogen free materials (LSZH) compliant to BS EN 61034 and BS EN 60754.

d) Unless otherwise specified, all cables shall be at least fire-retardant conforming to IEC 60332-1 and IEC 60332-3.

e) The cable shall be sufficiently shielded to minimize its susceptibility to external noise and compliant to relevant EMC standards.

f) The cable shall be anti-termite, rodent and pest resistant. If chemicals are used, those shall conform to the requirements of related Philippines regulations.

7.13.3.2 Installation of the cable shall be carried out in accordance with requirements of Philippines laws, regulations, and standard. The Contractor shall pay special attention to, but not limited to, the cable installation through fire protection wall.

7.13.3.3 The Contractor shall be responsible for the specifications, sizing, procurement, installation, wiring, termination, testing and commissioning of all power and communication cables for AFC system.

7.13.3.4 The Contractor shall supply and install all cable fixings, brackets, equipment racks and accessories necessary.

7.13.3.5 All cables and wiring shall not have cable joints between main termination or distribution points which are between devices and between equipment.

7.13.3.6 All cables shall be neatly dressed into the cable containment to the satisfaction of the Engineer.

7.13.3.7 Cables shall be installed in location that is safe to each environment. Also, there shall be no danger to passengers and station staff.

7.13.3.8 The Contractor shall ensure suitable separation between power, digital signal and analogue cables along the cable route.

7.13.3.9 The communication cable shall be installed so that the influence of noise/EMC from the power cable is minimized as much as possible.

7.13.3.10 There should be 25% spare space in the cable containment for future expansion.

7.13.3.11 The Contractor shall provide fiber optic cable between network equipment with cable length of more than 80m. Single mode and multi-mode optical fiber cables shall confirm to the performance requirements in ISO/IEC 11801.

7.13.4 Installation of Automatic Gate

7.13.4.1 The Contractor shall supply and install all necessary equipment, accessories, fittings, cable, etc., for the complete installation all various types of AGs to form the new gate barriers in accordance with the AFC base-plan lay-out drawings, requiring interface with the civil works Contractor.

7.13.4.2 In each gate barrier, the Contractor shall provide space for additional gates, fitted and ready for future installation, including the provision of power and data cable access and trunking. The localization of this future installation space for the automatic gates shall be coordinated and interfaced with the civil works Contractor and shall be approved by the Engineer.

7.13.4.3 Each automatic gate type shall be referred to as a gate aisle, i.e., the Contractor shall supply and install all the gate stanchions/units, sub-assemblies and electronic links that are required to satisfy the performance and functionality of each distinct automatic gate aisle. The gates are to be installed so as to configure an array of gates, whereas two (2) Gate stanchions/units being necessary to form an aisle.

7.13.4.4 The design and final position of each gate aisle and array shall be coordinated and interfaced with the civil works Contractor, prior to installation of the automatic gates.

7.13.5 Installation of Ticket Vending Machine

7.13.5.1 The Contractor shall supply and install all necessary equipment, accessories, fittings, cables, etc., for the complete installation of all TVMs in accordance with the AFC base plan lay-out drawings, requiring interface with the Civil Works Contractor.

7.13.5.2 All components shall be easily accessible and shall be mounted on withdrawable sliders where necessary to achieve this.

7.13.5.3 All removable components including cash boxes, fare ticket containers and changer hoppers shall be sized, positioned and provided with lifting handles such that they can be removed and inserted without requiring more than the average strength or dexterity of a normal able-bodied person.

7.13.6 Installation of Point of Sales

7.13.6.1 The Contractor shall supply all necessary equipment, accessories, fittings, cables, etc., for the complete installation of all the POS.

7.13.7 Identification

7.13.7.1 Descriptive labels shall be provided for all cabinets, enclosures, panels, assemblies, and sub-assemblies.

7.13.7.2 Labels shall be of engraved type, with durable markings and shall have a character size not less than 6mm high.

7.13.7.3 Details of the labels, including the material and size of the characters and samples of the labels, shall be submitted for the approval of the Engineer

7.13.7.4 Labels and notices on equipment shall be fixed with roundhead brass screws or self-tapping screws.

7.13.7.5 All enclosures containing terminals or exposed live parts, where the voltage exceeds 50 volts, shall have a label with lettering indicating the maximum voltage present in the enclosure.

7.13.7.6 Warning signs shall be provided with graphical symbols for hazardous electrical or optical LASER equipment

7.14 Training

7.14.1 General Requirements

7.14.1.1 The Contractor shall provide all materials, documentation, locations, and other facilities for training.

7.14.1.2 The training instructors provided by the Contractor shall be qualified, competent, with sufficient years of practical experience in the relevant fields and possesses good communication skills.

7.14.1.3 The Contractor shall give the necessary training to the number of station staff and maintenance staff who are necessary at the commencement of the revenue service. The training shall be extended to the Employer as well.

7.14.1.4 The contractor shall conduct maintenance training and operation training for the related staff of the O&M Concessionaire.

7.14.1.5 The training program shall enable staff to operate, service, enhance, maintain, and interact with AFC facilities.

7.14.1.6 The contractor shall provide a training plan under the assumption that the O&M Concessionaire's staff have no knowledge or experience concerning related systems.

7.14.1.7 The contractor shall provide competent instructors, training manuals, training facilities, all necessary aids, and materials in support of all training courses.

7.14.1.8 The training after the commencement of the normal operation should be conducted so as not to affect actual revenue data.

7.14.1.9 The training courses shall include the following.

a) Operations Training Courses

b) System Administration and Maintenance Training Courses

7.14.1.10 The Contractor shall submit a training report for approval by the Engineer, within 14 days after completion of each course.

7.14.1.11 The Contractor shall submit the course evaluation criteria for approval by the Engineer, which shall identify the criteria for course success, course failure leading to re-designing the course, and the trainee failure score for re-attending the course.

7.14.1.12 The Contractor shall provide an AFC Training System, located at the Training Center in depot. The AFC Training System shall include, but shall not be limited to, a SAC, a TVM, an Automatic Gate array with two reversible aisles (one standard, one wide), a POS, a HT with charger and an AFC-CC simulator. It shall be possible to use the AFC Training System to make a simulated, single or return journey between two stations.

7.15 Maintenance

7.15.1 General Requirements

7.15.1.1 The contractor shall provide a Maintenance Plan and shall submit necessary number of maintenance manuals before the commencement of the maintenance training. These manuals shall be approved by the Engineer with coordination with the O&M concessionaire.

7.15.1.2 The updated manuals shall be provided in the case that operation and maintenance method had been changed due to modification of the equipment, etc.

7.15.1.3 When it has been commissioned, the AFC system shall require the minimum maintenance and if scheduled preventive maintenance is performed, shall have no negative impact on passenger operations or train services.

7.15.1.4 The AFC equipment shall be designed that maintenance can be conducted basically by one person.

7.15.1.5 The AFC equipment shall be provided with a diagnostics menu for use in conjunction with the Maintenance manuals, to enable rapid fault diagnosis, repair and verification. For each type of equipment, the diagnostics menu shall be a sub-set of a master diagnostics menu, covering every AFC equipment.

7.15.1.6 Each equipment cabinet shall be equipped with a service light and have at least two spare Type A 220V 60Hz power sockets on the lower part of the front panel, for maintenance purposes.

7.15.1.7 Machines shall be designed to allow repair or restore works at site shall be within 30 minutes after the arrival of maintenance staff. This repair or restore works do not include resuming from damages caused by vandalism, theft, fire or nature disaster.

7.15.1.8 The Contractor shall provide an AFC Maintenance System, located at the AFC Maintenance Workshop in depot. The AFC Maintenance System shall include, but shall not be limited to, a SAC, a TVM, an Automatic Gate array with two reversible aisles (one standard, one wide), a POS, a HT with charger and an AFC-CC simulator. It shall be possible to use the AFC Maintenance System to make a simulated, single or return journey between two stations.

7.15.1.9 In the AFC Maintenance Workshop, a maintenance assistance terminal and a printer shall be provided to inform the equipment operation status and equipment alarm information, of all the stations, and print out the maintenance report.

7.15.1.10 Maintenance data shall be able to be checked by the O&M concessionaire whenever required.

7.15.1.11 The software support is also included in maintenance system.

7.16 Measuring and Special Tools

7.16.1 General Requirements

7.16.1.1 The contractor shall provide the following tools but not limited to:

a) Ticket and Cash handling
   i. The encoder/decoder for the cards and tickets necessary for tests and maintenance
   ii. SJT and SVC encoded for tests and maintenance
   iii. Bank notes and coins for tests and maintenance

b) PC and software
   i. Probe PC for the components of the terminal equipment
   ii. Server performance analysis tool
   iii. Network performance analysis tool
   iv. Terminal management tool
   v. Database management tool

c) Measuring instrument
   i. Voltmeter
   ii. Clamp Meter
   iii. Multimeter
   iv. Stopwatch

End of Section

8 DEPOT FACILITIES

8.1 Scope of Works

8.1.1 Introduction

8.1.1.1. The Technical Specifications establish minimum requirements for the design, procurement, manufacture, installation, testing, commissioning and integration of the Depot/Workshop Equipment in both MCRP-North Depot at Mabalacat and NSRP-South Depot at Banlic.

8.1.1.2. These specifications shall be reviewed by the Contractor and supplemented, changed or adapted as required to ensure that the Depot/Workshop Equipment is fit for purpose to maintain the Rolling Stock Equipment (Train sets) and the Electromechanical Systems as defined in the Contract.

8.1.1.3. The Depot/Workshop Equipment is specified in Appendix 8-1 of the Technical Specification.

8.1.1.4. The scope of supply shall include:

a. design, manufacture, testing, commissioning, integration and spare parts of the Depot/Workshop Equipment;

b. ergonomic and workflow studies to support the layout design HSE standards compliance;

c. operation and maintenance manuals;

d. training of the maintenance staff; technical support during the initial two (2) years after receiving the Taking Over Certificate; and

e. all cable containment and support for the Depot and Workshop Equipment.

8.1.2 General

8.1.2.1 The Depot/Workshop Equipment shall be designed and manufactured for efficient operation, ease of maintenance, and maximum availability, and shall provide trouble-free operation in the climate and environment of the Philippines.

8.1.2.2 The Contractor shall supply and install the full complement of equipment, to be fully operational as specified, corresponding to the required timeline plus produce operation and maintenance (O&M) manuals and maintenance plan(s), clearly showing all required maintenance interventions and periodicities, including time required for each activity.

8.1.2.3 The Contractor shall review the Depot/Workshop Equipment as specified and recommend alternatives where deemed more appropriate for the maintenance of Rolling Stock.

8.1.2.4 The Contractor shall describe and detail any deviations from the Depot/Workshop Equipment specified in Appendix 8-1.

8.1.2.5 The equipment shall be fit for the purpose and shall be available for operation with no or minimal maintenance. Where maintenance is needed, it shall be accomplished with the least equipment downtime.

8.1.2.6 The Contractor shall provide, within 180 days from the Commencement Date, the details of name and nationality of the proposed supplier for each depot/workshop facility or machinery.

8.1.2.7 The Contractor shall also provide adequate information about the proposed suppliers to enable the Engineer to assess the capability and suitability of the proposed suppliers.

8.1.2.8 The supplier for the depot/workshop facilities and machinery shall, for the last ten years, have the experience of design, fabrication, supply, installation, testing and commissioning satisfactorily for similar type and capacity of facility/machinery to those being supplied under the Contract.

8.1.2.9 The Contractor shall submit the evidence demonstrating that the supplier and proposed materials have met with the Contractor supplier evaluation process, this will be subject to obtaining a Notice of No Objection.

8.1.2.10 The Contractor shall maintain configuration control records of the Depot/Workshop Equipment.

8.1.2.11 Where cable containment is not provided by others then cable containment shall be supplied by the Contractor which shall have 25% spare capacity for expansion works. All cable containment material, fixing methods, and routing shall be given a Notice of No Objection by the Engineer.

8.1.3 Requirements

8.1.3.1 The depot/workshop shall have enough capacity and performance to ensure the operation and maintenance for the numbers of rolling stock estimated by 2040.

8.1.3.2 The depot/workshop shall reflect modern, state-of-the-art design and it shall be particularly oriented towards operating proficiency and operational safety.

8.1.3.3 Major equipment of the depot/workshop shall comply with reliability as Mean – Time – Between – Failures (MTBF) target of 2000 hours plus availability target of 95% at least, under conditions below:

8.1.3.4 MTBF shall be evaluated to consider the following failures:

a. due to disturbance in light maintenance work more than one hour;

b. due to disturbance in heavy maintenance and/or repair works more than one day;

8.1.3.5 Availability shall be evaluated to exclude time below:

a. scheduled maintenance for the equipment and/or machine itself;

b. unavoidable time generated by delivery of parts or equipment and/or machines itself, by the time for decision making in NSCR, by suspending of authority and by natural hazard, etc.

8.1.3.6 Regarding the Depot/Workshop Equipment the Contractor shall implement the following:

8.1.3.7 Design and supply the equipment and systems including installation and testing/integrated testing/commissioning to an acceptable quality and timeline;

a. Presentations, reviews and offer audit support as specified, but not limited to, this ERT and ERG;

b. Interface management as specified, but not limited to, this ERT and ERG;

c. Identification of locations, design and installation for concrete foundations, to accommodate piping and wiring etc.;

d. Systems operation and maintenance support services;

e. Training for Operation and Maintenance (O&M) Staff (including train the trainer) and engineering staff as specified, but not limited to, this ERT and ERG Clause 14;

f. At the appropriate time, decommissioning, removal and/or disposal of temporary works, in accordance with, but not limited to the ERG requirements;

g. Defects Notification Period support after commissioning and receiving the Taking Over Certificate, as stipulated in the Contract; and

h. Management of the requirements for individual equipment/systems plus overall system integration(s) through the Requirements Management Database utilizing verification and validation (V&V) procedures to ensure that the requirements are fully satisfied according to the requirements.

8.1.4 System Overview

8.1.4.1. Workshop facilities for Heavy repairs and maintenance of Rolling stock is being provided in MCRP-North Depot cum workshop while light repairs and other maintenance facilities for Rolling stock are being provided in both MCRP-North and the NSRP-South Depot.

8.1.4.2. The depot/workshop shall include, but is not limited to, the followings facilities:

a. Workshop for rolling stock maintenance in North Depot (including train inspections, repairs, painting, overhaul and refurbishment);

b. Automatic car body washer;

c. Weekly/monthly inspection and manual cleaning facility for the Light Repair Shop;

d. Un-scheduled repair and maintenance facility for the Unscheduled Repair Shop;

e. Underfloor wheel re-profiling facility for the Wheel Re-profiling Shop;

f. Final adjustment facility for the Final Adjustment Track in the Workshop in North Depot.

g. Underfloor cleaning facility for the Underfloor Cleaning Shop in North Depot.

h. Weatherproof testing facility for the Weatherproof Test Shop in North Depot.

i. Automobile maintenance facility for the Automobile Maintenance Shop;

j. Shunting Locomotives

k. Test track in North Depot across road, fitted with flashing lights and klaxon to notify all personnel that testing is being undertaken; and

l. Provision of a fixed special type convenience outlet with 100 VDC output from 230 VAC/100 VDC converter and four (4) sets of portable power supply with 100 VDC output in the following areas in the depot /workshop:

  i. Light Repair Shop.

  ii. Electric Parts Shop in North Depot.

  iii. Spring, Air Spring, Brake Parts and Iron works in North Depot.

  iv. Air Brake Valve Shop in North Depot.

  v. Final Adjustment Shop in North Depot

8.1.4.3. Notwithstanding the availability of the above facilities, the following facilities are also expected to be located in the depot/workshop. The requirements for these facilities are described in other Sections or in other Contract Packages.

a. Power supply and substation;

b. Communication facility;

c. Water supply facility;

d. Water treatment facility;

e. Hazardous materials store;

f. Waste material pick-up shelter; and

g. Guard house.

8.1.4.4. The Depot/Workshop Equipment specified in Appendix 8-1 shall be provided by the Contractor, catering for the maintenance requirements, as defined.

8.1.4.5. For ease of understanding., the equipment is categorized as follows:

a. Shop Number (N01, N02, S01, S02 etc., with some numbers not used). Shop No. starting with N denotes Depot equipment for MCRP-North Depot while those starting with S denotes equipment for NSRP-South Depot.

b. Equipment Group Number (sequential numbering of all equipment per shop like N01-01, N01-02 etc); and

c. Description.

Table 8.1 Shop/Equipment Group No.

Shop/Equipment Group Number	Shop/Room/Track/Equipment Name
North Depot	
N01	Light Repair Shop
N02	Unscheduled Repair Shop
N03	Under Floor Wheel Profiling Shop
N04	Car body Washer Track
N11	Underfloor cleaning Track
N12	Bogie Removal/Installation Shop
N13	Car body Shop
N14	Sewage Tank Shop
N15	Paint Shop
N16	Traction Motor Shop
N17	Bogie Shop
N18	Air Conditioner Shop
N19	Electric Parts Shop
N20	Wheelset Shop
N21	Bearing Shop
N22	Spring, Air Spring, Brake Parts & Iron shop
N23	Tight Lock Coupler and Draft Gear Shop
N24	Seat Shop
N25	Air Brake Valve Shop
N26	Mechanical Shop
N27	Warehouse
N28	Compressor Room

Shop/Equipment Group Number	Shop/Room/Track/Equipment Name
N29	(Not Used)
N30	Weatherproof Test Shop
N31	Final Adjustment Shop
N41	Shunting Locomotive
N51	(Not Used)
N61	Common use
N71	Tools
South Depot	
S01	Light Repair Shop
S02	Unscheduled Repair Shop
S03	Wheel Re-profiling Shop
S04	Car body Washer Track
S41	Shunting Locomotive
S51	(NOT USED)
S61	Common use
S71	Tools

8.1.4.6. Apart from above facilities (Specified in Appendix 8.1), the following facilities, are also expected to be located in the depot/workshop.

a. Track

b. Building

c. Signal System

d. Telecommunications

e. Power Supply System (except the test electric power supply, N19-04 and N31-03)

f. Power Distribution System

g. Overhead Contact line System

h. Operation Control Center

i. Water supply facility

j. Water treatment facility

k. Maintenance Facilities for Track, Signal System, Telecommunications, Overhead Contact line System

l. Fire Fighting Facilities

m. Security Facilities

n. Training Facilities (Mabalacat Depot only)

The requirements for these facilities are described in other Sections or in another Contract Package.

8.2 Definitions and Abbreviations

8.2.1 Definitions

Definitions in the context of this document are applied as follows:

'Maintenance'	means rolling stock maintenance that includes Departure inspection, Light repair, Heavy repair, Other maintenance, and Train preparation.
'Light repair'	means Weekly inspection and Monthly inspection.
'Heavy repair'	means Semi overhaul and Overhaul
'Other maintenance'	means Unscheduled repair and Wheel re-profiling
'Train preparation'	means Turn-back Cleaning, Discharge Sewage, Daily cleaning, and Monthly cleaning.
'Consumables'	means parts and materials that are spent during their use and cannot be renewed.
'North Depot'	means Depot on MCRP line at Mabalacat.
'South Depot'	means Depot on NSRP -South line at Banlic.
'Depot'	means Depot on NSCR line.

8.2.2 Abbreviations

ATP	Automatic Train Protection
CIF	Cost, Insurance and Freight
COMMS	Communications
CMMS	Computerized Maintenance Management System
EN	European Norm (Standard)
ERG	General Requirements
ERT	Technical Requirements
FCP	Fire Code of Philippines
HIPOT	High Potential Tester
1C4M	1 Car 4 Motors
IEC	International Electro-Technical Commission
IGBT	Insulated Gate Bipolar Transistor
ISO	International Organization for Standardization
JEM	Japanese Electric Machine Industry Association Standard
LCD	Liquid Crystal Display
MTBF	Mean Time Between Failure(s)
NBCP	National Building Code of the Philippines
OCC	Operations Control Center
PEC	Philippine Electrical Code
PSME	Philippine Society of Mechanical Engineers
RS	Rolling Stock
SIG	Signaling
SIV	Static Inverter
SOW	Scope of Work
TD/WN	Cardan Shaft (TD/WN Type)
TMS	Train Management System
QA	Quality Assurance
QC	Quality Control
UIC	International Union of Railways
VVVF	Variable Voltage Variable Frequency

8.3 Design Criteria, Applicable Standards and Codes

8.3.1 Service-Proven

8.3.1.1. Railway maintenance equipment supplied shall be modern and service-proven in a similar railway application. The Contractor shall provide evidence that railway maintenance equipment proposed is service-proven.

8.3.1.2. Maintenance equipment offered shall be robust, durable, and adequate in function and performance for at least thirty (30) years without needing a major overhaul before the first fifteen (15) years.

8.3.1.3. All the Depot/Workshop Equipment shall be made by manufacturers with a proven supply record to the railway industry, all replaceable piece parts used to make up any major parts will be demonstrated to have previous use within the industry. The Contractor shall provide documentary evidence for the Engineer's review and granting of a Notice of No Objection.

8.3.1.4. The Depot/Workshop Equipment offered shall be designed and manufactured with the view of minimizing the use of consumables as much as possible.

8.3.1.5. The Contractor shall search locally in the Philippines, for consumables and maximize their usage e.g., hardware, lubricants etc. without compromising the availability, reliability and efficiency of operations of the equipment.

8.3.2 Workshop/Depot utility Services

8.3.2.1. Workshop/Depot utility services available for the operation of maintenance equipment at the Depot/Workshop includes but not limited to:

a. 230 V AC, 1 Phase, 60 Hz;

b. 400 V AC, 3 Phase, 60 Hz;

c. Compressed air at 1 MPa;

d. Equipment operating on 230 VAC shall be equipped with three (3) m heavy-duty power cord connected to a circuit breaker or an IP66 rated socket.

e. Equipment operating on 400 VAC shall be equipped with five (5) m power cables.

8.3.2.2. The contractor shall confirm the Workshop services to the interface contractor to resolve the interface problems as specified in this Technical Requirements and Section 19 of ERG.

8.3.3 Standards and Codes

8.3.3.1. Engineering, design, manufacture, and operation shall meet applicable Philippines standards equivalent to appropriate Japanese standards or alternative international standards approved by the Engineer.

8.3.3.2. Applicable Standard and Code for reference;

a. Relevant Philippines standards;

b. Railway Operation Act (Ministry of Land, Infrastructure, Transport and Tourism of Japan);

c. Public Notice to stipulate the items for Regular Inspection of Facilities and Rolling Stock (Ministry of Land, Infrastructure, Transport and Tourism of Japan);

d. Industrial Safety and Health Act (Ministry of Health, Labor and Welfare of Japan);

e. Ordinance on Safety of Boilers and Pressure Vessels (Ministry of Health, Labor and Welfare of Japan);

f. Safety Ordinance for Cranes (Ministry of Health, Labor and Welfare of Japan);

g. Ordinance on Prevention of Organic Solvent Poisoning (Ministry of Health, Labor and Welfare of Japan);

h. Public Notice: Constructional Requirements for Electrical Equipment for Explosive Atmospheres (Ministry of Health, Labor and Welfare of Japan);

i. Relevant standards from Japanese Industrial Standard (JIS);

j. Relevant standards from Japanese Electric Machine Industry Association Standard (JEM)

k. Relevant standards from International Organization for Standardization (ISO)

l. Relevant standards from International Electro-technical Commission (IEC)

m. Relevant standards from European Standards (EN)

n. Relevant standards from International Union of Railways (UIC)

8.3.4 Earthing and Bonding

8.3.4.1. Earthing and bonding of the Depot/Workshop Equipment shall be carried out by the Contractor in accordance with Philippines standards, relevant Japanese standards and relevant international codes or approved equivalent.

8.3.4.2. The purpose of the earthing and bonding system is:

a. Protection from electric shock for operating personnel and the general public; and

b. Damage limitation, subsequent to plant, equipment or system failure.

8.3.5 Others:

8.3.5.1. All the Depot/Workshop Equipment's sound/noise levels shall meet applicable Philippines standards equivalent to appropriate Japanese standards or alternative international standards given a Notice of No Objection by the Engineer.

8.3.5.2. All the Depot/Workshop Equipment shall be capable to work at ambient temperature 50°C without any side effect.

8.3.5.3. The Contractor shall reasonably standardize items, where practical, this shall particularly apply to various small tools and certain equipment, subject to the Engineer's review.

8.4 Engineering Conditions

8.4.1 Local Conditions

8.4.1.1. The Contractor shall duly note and take into consideration the local climate for the equipment supplied.

8.4.1.2. Elevations in the depot will be referenced to the "Top-of-rail" (TOR) level = 0.00 m, which is also the nominal ground floor level in buildings.

8.4.2 New Equipment and Tools

All the Depot/Workshop Equipment and tools supplied shall be new to a standard recognized within the industry, as approved by the Engineer.

8.4.3 Safety

The Contractor shall address in the design those features considered relevant that pertain to operational and personal safety, and areas requiring attention when operating and maintaining the Depot/Workshop Equipment. Reference shall be made to Section 4 of the ERG.

8.5 Design Parameters:

8.5.1. Depot/workshop design parameters for layout, design, and sizing of its facilities include:

8.5.2. Rolling stock gauge for 10-car trains – approximately 202 m long (over coupler faces). Contractor shall refer and follow Rolling stock and construction gauge drawing MCRP-DWG-GEN-TK-0020 Rev 6 or latest

8.5.3. The depot/workshop shall be designed for the ultimate transport capacity.

8.6 Performance and Technical Requirements:

8.6.1. The Contractor shall describe the Depot/Workshop Equipment in sufficient detail to permit adequate review of the submissions by Engineer.

8.6.2. Submission shall include but not limited to:

8.6.2.1. Technical and operational description and features of equipment;

8.6.2.2. Data sheets, drawings and brochures, as may be relevant.

8.6.2.3. Past Performance reports from similar operating and working conditions.

8.6.3. Service Life of Major Equipment.

8.6.3.1. The service life of major maintenance equipment shall be minimum thirty (30) years.

8.6.3.2. It shall operate satisfactorily during this period with the understanding that equipment will be used as intended, and maintenance performed as prescribed.

8.6.3.3. The equipment shall operate satisfactorily for the initial fifteen (15) years before a substantial overhaul may be required.

8.6.3.4. Equipment design and fabrication shall be monitored accordingly with appropriate QA and QC programs.

8.6.3.5. This service life requirement shall apply to major equipment indicated but not limited to Table 8.2 below:

Table 8.2 Major Equipment

Equipment Group No. / Equipment Code No.		Equipment
N02	01	10 / 3t Overhead traveling crane
	02	Bogie replacing equipment
N03		Under Floor Wheel Profile Lathe
N12	01	10 / 3t Overhead traveling crane
	02	Car body lifting jack
	04	Temporary Bogies
	09	Bogie transport unit
N13	01	3t Overhead traveling crane
N15	07	Traverser
N16	01	3t Overhead traveling crane
N17	01	10 / 3t Overhead traveling crane
	02	5t overhead traveling crane
N18	01	3t overhead traveling crane
N20	01	3t overhead traveling crane
	08	Surface Wheel lathe
	10	Axle lathe
	11	Wheel boring machine
	12	Wheel fitting press
N22	01	3t overhead traveling crane
N23	01	3t overhead traveling crane
N24	01	3t overhead traveling crane
N26	01	3t overhead traveling crane
N41	01	Shunting Locomotive (Battery type)

Equipment Group No. / Equipment Code No.		Equipment
	02	Shunting Locomotive (Diesel Type) with Flat car
S02	01	10 / 3t Overhead traveling crane
	02	Bogie replacing equipment
S03	01	Underfloor Wheel re-profiling lathe
S41	01	Shunting Locomotive (Battery type)

8.6.4. Equipment Standardization

8.6.4.1. The Contractor shall, where reasonably practicable, standardize items.

8.6.4.2. This shall particularly apply to various small tools and certain equipment.

8.6.4.3. This will be subject to the Engineer's review, prior to acceptance.

8.7 Maintenance Management

8.7.1 Balanced Maintenance

8.7.1.1. A balanced maintenance program for rolling stock maintenance as well as progressive renewal of equipment to new-like condition

8.7.1.2. It will be developed with the aim to pool maintenance actions over the long terms, typically, one year, divide them into "balanced" portions of work that can fit into periods when trains are not in service.

8.7.1.3. This will maximize service availability of trains, minimize the need for spare trains, and reduce peak workloads in order to achieve leveled workloads over time, as much as is possible.

8.7.1.4. This will be granted Notice of No Objection by the Engineer.

8.7.2 Work Scheduling

8.7.2.1. Annual working days and working hours based on present condition in the Philippines (as shown in Table 8.3) shall be used to compile the maintenance schedules/periodicities.

8.7.2.2. This shall be based around the supplied vehicles and their current maintenance plan.

8.7.2.3. The Contractor shall present the completed maintenance plan and present this to the Engineer/O&M for review.

Table 8.3 Annual Working days and Working hours

Maintenance Category		Annual Working days & Working hours
Light Repair	Weekly Inspection	363 days/year, 24 hours/day (3 shifts)
	Monthly Inspection	241 days/year, 8 hours/day (daytime)
Heavy Repair	Semi overhaul	241 days/year, 8 hours/day (daytime)
	Overhaul	241 days/year, 8 hours/day (daytime)
Other Maintenance	Unscheduled Repair	241 days/year, 8 hours/day (daytime)
	Wheel re-profiling	241 days/year, 8 hours/day (daytime)
Train Preparation	Discharge Sewage	363 days/year, 24 hours/day (3 shifts)
	Daily cleaning	363 days/year, 24 hours/day (3 shifts)
	Monthly cleaning	241 days/year, 8 hours/day (daytime)

8.7.3 Skill Development

8.7.3.1. Three skill levels are assumed for rolling stock maintenance work:

8.7.3.2. Expert - high degree of knowledge of equipment and maintenance process - can provide advice and directions to junior staff.

8.7.3.3. Maintainer – skilled in the performance of maintenance - can work with minimum supervision.

8.7.3.4. Assistant - semi-skilled position, aiding Maintainers and Experts - could be entry level or apprentice position.

8.7.3.5. Multi-skill training will be promoted. Personnel will be trained to become proficient in the maintenance of more than one system or discipline.

8.7.3.6. This will be beneficial for the maintenance organization as a whole since it will permit assignments of personnel to be made more flexible and should minimize overall staffing.

8.8 Depot/Workshop Capacity

The capacity of the depot/workshop for the rolling stock maintenance is made under the following assumptions and calculations for reference.

8.8.1 Objective Cars

8.8.1.1. The objective cars are given in Table 8.4.

8.8.1.2. Though initial train configuration planned is of 8 cars per train but Depot infrastructure and capacity is to be created for taking care of future maintenance requirement of 10 cars per train configuration.

8.8.1.3. Commuter Train will be used commonly for Commuter services on MCRP, NSCR and NSRP-South.

8.8.1.4. The Specifications of the Commuter Train fleets vary.

Table 8.4 Objective Cars

Rolling Stock Type	Number of Train	Car Number of Train	Total Number
NSCR Commuter Train (CP-03)	13 trains	8 cars / train	104 cars
New Limited express Train (CP NS-03)	12 trains	8 cars / train	96 cars
New Commuter Train (CP NS-02)	50 trains	8 cars / train	400 cars

8.8.2 Train Operation (the ultimate transport capacity)

8.8.2.1. The Train operation plan is assumed as shown in Table 8.5.

Table 8.5 Kilometric performance of each train

Type	Total Kilometric performance	Number of Train set for operation	Average of Kilometric performance for operation
Limited Express (8 cars)	9,125 km / day	11	1,304 km / day / train-set
Commuter (8 cars)	34,137 km / day	54	794 km / day / train-set

8.8.2.2. Moreover, the Stabling plan is assumed based on the train operation plan as shown in Table 8.6.

Table 8.6 Stabling plan at each Depot

Type / Location	North Depot	Malanday Depot	South Depot	Total
Limited Express train	7 trains	5 trains	0* trains	12 trains
Commuter train	26 trains	9 trains	28 trains	63 trains
Total	33 trains	14 trains	28 trains	75 trains

8.8.2.3. The numbers in Table 8.5 and Table 8.6 are estimated under the condition of the ultimate transport capacity planned by the year 2040.

8.8.2.4. Assumptions:

a. MCRP line is connected to NSRP South line via NSCR line, and each train can run on these 3 lines.

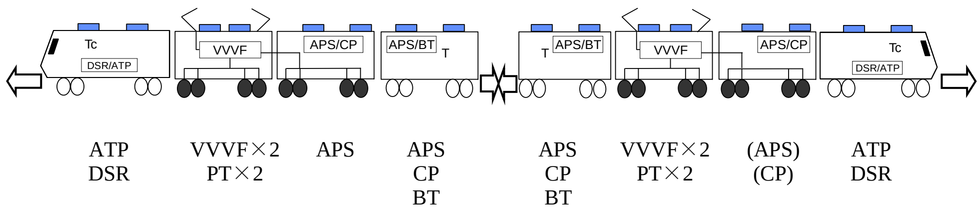
b. MMSP commuter trains will also be operated via NSRP South line and would be stabled and maintained (Turn back cleaning and train preparation) in the South Depot.

c. *Limited Express trainsets may also be required to be stabled (Turn back cleaning and train preparation) in South Depot in case operational plan demands the same.

8.8.3 Major Specification of Rolling Stock

Rolling stock specifications are being given here only for reference, and these trains have 8 cars for one train-set and future additional plan: 10 cars for one train-set.

Table 8.7 Major specification of Commuter Train (CP NS-02)

No	Item	Specification, Performance
1	Basic	Commuter Train DC 1,500V Tc: Trailer Car with driver's cab M: Motor car T: Trailer car
2	Basic Configuration	In case of 4M4T (Tc+M+M+T+T+M+M+Tc) (Empty weight 270t) following is for reference ←South(Malolos) (Clark)North→  Legend ●:Motor Axle ○:Trailer Axle ⇦:Tight lock coupler ATP: Automatic Train Protection, DSR: Digital Space Radio, VVVF: VVVF inverter, CP: Compressor, APS: Auxiliary power Supply, PT: Pantograph, BT: Battery, : Air Conditioner
3	Performance	Acceleration (Design):3.3km/h/s Deceleration (Design):4.2km/h/s (Max service brake, Instantaneous deceleration) 4.7 km/h/s (Emergency brake, Instantaneous deceleration) Design operation Max speed:120km/h

No	Item	Specification, Performance
4	Gauge	1,435mm (standard gauge)
5	Electric system	DC1,500V overhead catenary
6	Capacity	Leading car: 266(45), Intermediate car : 285(54) (Total estimated 2242 passengers per 8-car trainset). Capacity calculated by 7 person/m^2 (Standee)
7	Body	Material: Light weight stainless steel or Aluminum Max.: 19,500mm (Length)×2,950 mm (Width)×3,655 mm (T/TC-Height), Max. MC Height 4,150 mm with pantograph folded. Height of Coach floor: 1,130 mm～1,150 mm TOR. Straight structure without hem aperture Driver unit: right side The length of leading cars may be longer than above
8	Bogie	Bolster less type, Max axle weight:16t Distance between bogie centers: 13,800 mm Wheel base: 2100 mm
9	Coupler	Driver's cab side of leading-car, and between 4th intermediate-car and 5th intermediate-car: tight lock coupler Others: semi-permanent coupler Connectable with NSCR train without adapter
10	Current Collection	Single arm type 4 pantographs/1 train-set (With high voltage train line)
11	Traction Motor	3-phased totally enclosed high efficiency induction motor 4 units / M car Non- disassembly bearing exchange type
12	Driving device	Parallel cardan
13	Propulsion system	VVVF inverter (Self cooling) 1C4M×4sets/train-set The device for VVVF inverter will be applied Hybrid-SiC due to more energy saving. Maximum current of train-set: Approx.3,200A (Powering) , Approx.5,000A (Regenerating)
14	Brake system	Electric command linked to ATP, combined type of electric and pneumatic, Security brake. Regenerative priority (Entire control, Rainy mode control)

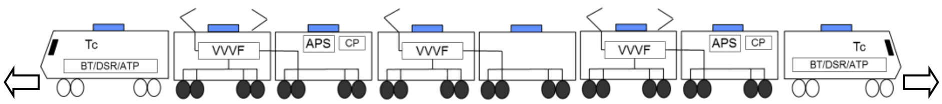
No	Item	Specification, Performance
		Parking brake (leading car), Slide control (Trailer car)
15	Compressor	With air drier 2 or 3 units/train-set Main power: 3-phase 440V・60Hz
16	Auxiliary Power Supply	SIV: 3-phase inverter with IGBT or Hybrid-SiC (self-cooling) 4 units/train-set DC1500V→3-phase 440V・60Hz, single-phase AC220V・60Hz, DC100V Maximum current of train-set: Approx.500A
17	Battery	Sintered alkaline storage battery: DC100V 2 units/train-set
18	Door system	Electric (With adjacent door control backup function) or Pneumatic (With weakened function)
19	Lighting system	Crew cab, Saloon, Headlight, Tail light, Door・Emergency car side light: LED type
20	Fan	Line flow fan
21	Air conditioner	ON/OFF type 3-phase 440V・60Hz Distribution mounting of 2 units /a car
22	Heater	Not mounted
23	PA system	Passenger broadcast: automatic volume control function with a variance amplification, automatic broadcast and outside speaker Broadcast simultaneously by the crew operating unit (Inside and outside) Intercom between crew cab, Interactive emergency communication equipment (with conversation function with the OCC and a broadcast function from the OCC)
24	Space Radio	Digital space radio
25	ATP	ETCS Level 2
26	Destination Display	Collective setting by TMS monitor, front and side display (with collar LED)
27	CCTV	Saloon security camera (4 units /a car) Aggregated each car HUB, displayed in TMS monitor and stored in memory in the cab via Ethernet
28	Saloon Display	LCD type (17-inch-wide) 8 units/car various guidance display
29	Train Management System	Control transmission for powering and service brake command, Monitor transmission for destination, guidance and air conditioner command etc. Trouble monitoring and memory with support guidance, inspection function on the

No	Item	Specification, Performance
	(TMS)	train, On-board driving information system (24hour each device condition memorized) Display function for pressure gauge, ammeter, powering and braking conditions etc. Ethernet type・Control transmission: duplex and loop system or duplex and ladder system with redundancy, Information of CCTV and Monitor transmission for guidance etc.: single system
30	Universal Design	Identification band (cleat) on the floor just before the door Indicator light and chime (inside and outside) at opening and closing doors Wheelchair (free) space
31	Others	Provision for WiFi etc.

Assumption:

The Specifications of the Commuter Train fleets vary.

Table 8.8 Major specification of Limited Express Train (CP NS-03)

No	Item	Specification, Performance
1	Basic	Limited Express Train DC 1,500V Tc: Trailer Car with driver's cab M: Motor car
2	Basic Configuration	6M2T (Tc+M+M+M+M+M+M+Tc) (Empty weight 315t) following is for reference ←South(Malolos) (Clark)North→  38.0t ATP DSR BT / 40.0t 2VVVF 2PT / 40.0t APS CP / 40.0t 2VVVF 1PT / 39.0t / 40.0t 2VVVF 2PT / 40.0t APS CP / 38.0t ATP DSR BT Legend ●:Motor Axle ○:Trailer Axle ⇦:Tight lock coupler ATP: Automatic Train Protection, DSR: Digital Space Radio, VVVF: VVVF inverter, CP: Compressor, APS: Auxiliary power Supply, PT: Pantograph, BT: Battery, ▭: Air Conditioner

No	Item	Specification, Performance
3	Performance	Acceleration (Design, starting):3.0km/h/s Deceleration (Design):4.2km/h/s (Max service brake, Instantaneous deceleration) 4.7 km/h/s (Emergency brake, Instantaneous deceleration) Design operation Max speed:160km/h
4	Gauge	1,435mm (standard gauge)
5	Electric system	DC1,500V overhead catenary
6	Capacity	About 400(seats)
7	Body	Material: Aluminum MAX:19,500 mm (Length)×2,950 mm (Width)×3,655 mm (Height) Reading car length may be longer. MAX Height 4,150mm, when pantograph is folded, 1,130～1,150 mm (Height of floor)
8	Bogie	Bolster less type, Max axle weight:16t
9	Coupler	Driver's cab side of leading car: tight lock coupler Intermediate car, and the other side of leading car : semi-permanent coupler Connectable with each train without adapter
10	Current Collection	Single arm type 5 pantographs/1 train-set (With high voltage train line)
11	Traction Motor	3-phased totally enclosed high efficiency induction motor 4 units / M car Non- disassembly bearing exchange type
12	Driving device	Parallel cardan
13	Propulsion system	VVVF inverter (Self cooling) 1C4M×6sets/train-set The device for VVVF inverter will be applied Hybrid-SiC due to more energy saving. Maximum current of train-set: Approx.4,000A (Powering), Approx.5,350A (Regenerating)

No	Item	Specification, Performance
14	Brake system	Electric command linked to ATP, combined type of electric and pneumatic, Security brake. Regenerative priority (Entire control, Rainy mode control) Parking brake (leading car), Slide control (all cars)
15	Compressor	With air drier 2 or 3 units/train-set Main power: 3-phase 440V・60Hz
16	Auxiliary Power Supply	SIV: 3-phase inverter with IGBT or Hybrid-SiC (self-cooling) 2 units/train-set DC1,500V→3-phase 440V・60Hz, single-phase AC220V・60Hz, DC100V Maximum current of train-set: Approx.300A
17	Battery	Sintered alkaline storage battery: DC100V 2 units/train-set
18	Door system	Electric or Pneumatic (With weakened function)
19	Lighting system	Crew cab, Saloon, Headlight, Tail light, Door Emergency car side light: LED type
20	Fan	Line flow fan
21	Air conditioner	ON/OFF type 3-phase 440V・60Hz Under consideration (including ventilation function)
22	Heater	Not mounted
23	PA system	Passenger broadcast: automatic volume control function with a variance amplification, automatic broadcast and outside speaker Broadcast simultaneously by the crew operating unit (Inside and outside) Intercom between crew cab, Interactive emergency communication equipment (with conversation function with the OCC and a broadcast function from the OCC)
24	Space Radio	Digital space radio
25	ATP	ETCS Level 2
26	Destination Display	Collective setting by TMS monitor, with collar LED

No	Item	Specification, Performance
27	CCTV	Saloon security camera Aggregated each car HUB, displayed in TMS monitor and stored in memory in the cab via Ethernet
28	Saloon Display	Under consideration
29	Train Management System (TMS)	Control transmission for powering and service brake command, Monitor transmission for destination, guidance and air conditioner demand etc. Trouble monitoring and memory with support guidance, inspection function on the train, On-board driving information system (24hour each device condition memorized) Display function for pressure gauge, ammeter, powering and braking conditions etc. Ethernet type・Control transmission: duplex and loop system or duplex and ladder system with redundancy, Information of CCTV and Monitor transmission for guidance etc.: single system
30	Universal Design	Identification band (cleat) on the floor just before the door Indicator light and chime (inside and outside) at opening and closing doors Wheelchair space
31	Toilet	2, One of them is a wheelchair accessible type Under consideration
32	Others	Under consideration about Wi-Fi, power supply and USB, etc.

8.8.4 Maintenance Categories and Period:

Rolling stock maintenance categories and period are being given here only for reference.

Table 8.9 Maintenance Categories and Period of Commuter Train (CP NS-02)

Category		Period	Maintenance Content
Departure Inspection		Before departure	Check in-service monitoring, visual check of major parts of cars.
Light Repair	Weekly Inspection	Within 6 days	Check status of bogies, wheels, pantograph, doors and other items while cars are connected. Replace consumables for brakes, pantographs and other items.

Category		Period	Maintenance Content
	Monthly Inspection	Within 3 months (90 days)	Confirm the status of cars and their functions while cars are connected. Replace consumables, measure voltage of auxiliary circuits, control circuit and other circuits, inspect functioning of main circuit, etc.
Heavy Repair	Semi overhaul	Within 4 years or Within 600,000 km	Remove bogies, wheels, wheel axles, brakes, main motors and other major parts, perform detailed inspection and replace parts
	Overhaul	Within 8 years or Within 1,200,000 km	Disassemble almost all parts, perform detailed inspection of devices. Paint car body if required.
Other Maintenance	Unscheduled Repair	Whenever necessary	Replace broken-down parts. (Bogies, pantograph, air conditioner, etc.).
	Wheel re-profiling	100,000-150,000 km or whenever necessary	Use wheel profiler to correct wheel shape and maintain ride comfort level and safe operation.
Train Preparation	Turn back cleaning	Every shop-in and turn back	Pick up trash.
	Daily cleaning	Within 3 days	Interior cleaning (floor and window) Exterior cleaning (front and rear windshield) Car-body side, rear and front panel cleaning by automatic car-body washer Train Disinfection
	Monthly cleaning	Within 1 month (30 days)	Interior cleaning (floor waxing and all interior parts cleaning) Exterior cleaning (car-body side panels, front and rear panels) on automatic car washer.

Assumption:

Each Commuter Train will have same Maintenance Categories and Period (Table 8.9).

Table 8.10 Maintenance Categories and Period of Limited Express Train (CP NS-03)

Category		Period	Maintenance Content
Departure Inspection		Before departure	Check in-service monitoring, visual check of major parts of cars.
Light Repair	Weekly Inspection	Within 6 days	Check status of bogies, wheels, pantograph, doors and other items while cars are connected. Replace consumables for brakes, pantographs and other items.
	Monthly Inspection	Within 3 months (90 days)	Confirm the status of cars and their functions while cars are connected. Replace consumables, measure voltage of auxiliary circuits, control circuit and other circuits, inspect functioning of main circuit, etc.
Heavy Repair	Semi overhaul	Within 4 years or Within 600,000 km	Remove bogies, wheels, wheel axles, brakes, main motors and other major parts, perform detailed inspection and replace parts.
	Overhaul	Within 8 years or Within 1,200,000 km	Disassemble almost all parts, perform detailed inspection of devices. Paint car body.
Other	Unscheduled Repair	Whenever necessary	Replace broken-down parts. (Bogies, pantograph, air conditioner, etc.).
	Wheel re-profiling	100,000km or whenever necessary	Use wheel profiler to correct wheel shape and maintain ride comfort level and safe operation.
Train Preparation	Turn back Cleaning	Every shop-in and turn back	Pick up trash.
	Discharge Sewage	Within 2 days	Discharge sewage from tank on the train.
	Daily cleaning	Within 3 days	Interior cleaning (floor and window) Exterior cleaning (front and rear windshield) Car-body side, rear and front panel cleaning by automatic car-body washer Train disinfection.
	Monthly cleaning	Within 1 month (30 days)	Interior cleaning (floor waxing and all interior parts cleaning) Exterior cleaning (car-body, front and rear windshield) on automatic car-body washer

8.8.5 Depot/Workshop Function:

Depot/Workshop Function is being given here only for reference.

Table 8.11 Depot and Workshop Function Plan

Place / Function	North Depot			Malanday Depot			South Depot		
	NSCR Com.	**New Exp. NS-03**	**New Com. NS-02**	**NSCR Com.**	**New Exp. NS-03**	**New Com. NS-02**	**NSCR Com.**	**MMSP Com./ New Exp. NS-03**	**New Com. NS-02**
Stabling Rolling Stock	Done	Done	Done	Done	Done	Done	Done	Done	Done
Weekly Inspection	Done	Done	Done	Done	Done	Done	Done		Done
Monthly Inspection		Done	Done	Done					Done
Wheel re-profiling		Done	Done	Done					Done
Unscheduled Repair		Done	Done	Done					Done
Train Preparation	Done	Done	Done	Done	Done	Done	Done	Done	Done
Heavy Repair		Done	Done	Done					

Note Com.: Commuter train, Exp.: Limited Express train

8.8.6 Required Time for maintenance:

This required time is being given here only for reference.

Table 8.12 Required times for maintenance.

Category		Required Time
Light Repair	Weekly Inspection	2 hours / train
	Monthly Inspection	1 day (8 hours) / train

Heavy Repair	Semi overhaul	(Commuter) 17 days / train (Limited Express) 19 days / train
	Overhaul	(Commuter) 20 days / train (Limited Express) 22 days / train
Other Maintenance	Unscheduled Repair	(depends on failure content) (Assumption: 10 days)
	Wheel re-profiling	2 hours / car
Train Preparation	Discharge Sewage	2 hours / train
	Daily cleaning	2 hours /train
	Monthly cleaning	1 day (8 hours) / train

8.9 Depot/Workshop Maintenance Facilities

8.9.1 Depot Facilities in North and South Depots.

8.9.1.1. Light Repair Shop.

a. The light repair shop is to conduct Light Repair and Train Preparation basically.

b. The light repair shop is large enough for trains being maintained in operation condition.

c. The light repair shop has three floor levels (including pit structure); Floors for under-floor inspections, working deck for exterior and interior of car-body cleaning and interior inspections, and roof working deck for the works on the roof.

d. It is possible for NSCR staff to get on and off to the vehicle easily in the light repair shop.

e. The light repair shop should have three tracks for maintaining three train-sets at the same time.

8.9.1.2. Unscheduled Repair Shop.

a. The unscheduled repair shop is to repair and replace the broken-down parts.

b. The unscheduled repair shop is equipped with the facilities for dismantling/reassembling of bogies, under-floor equipment, and rooftop equipment from/to rolling stock.

c. The unscheduled repair shop is equipped with a track in the front and the back of the shop, which is enough long for the train-sets, so as not to affect the train moving on other lines during maintenance.

d. The train can move itself between the unscheduled repair track and other tracks.

8.9.1.3. Car body Washer.

a. The car washing track is to clean the exterior of the rolling stock including front and rear panels.

b. The car washing track is equipped with an automatic car body washer (N04-01 and S04-01).

c. The car washing track has appropriate length track of straight sections in front and back of the automatic car body washer (N04-01 and S04-01).

8.9.1.4. Wheel Re-Profiling Shop.

The concept of locating the wheel re-profiling shop is as follows:

a. The wheel re-profiling shop should be located in a place where trains can move from the stabling facility easily;

b. The wheel re-profiling shop should be long enough for Rolling Stock to be re-profiled while they are assembled in a train-set;

c. The wheel re-profiling shop should be equipped with a track in the front and the back of the shop, which is long enough for train-sets, so as not to affect the shunting of another line during re-profiling; and.

d. Trains are stabled for a long time while they are assembled in a train-set during re-profiling and the wheel re-profiling shop should be designed so as not to affect the aisles inside the shop.

8.9.1.5. Storage Tracks.

a. The storage track is to stable the train in operation conditions.

b. The length of the storage track is sufficient to stable 10 car train set.

c. The number of the storage track meets the conditions of operation and spare trains.

8.9.1.6. Lead tracks.

Lead tracks are to be used for train moving from its track to another track or maintenance shop.

8.9.1.7. Passage tracks.

a. Passage track is to be used for train moving from/to the access tracks even if there are no storage tracks at the west side of the South Depot.

b. Passage track is to be used for train moving from its track to another track or maintenance shops (S01, S02, and S03) in South Depot.

8.9.1.8. Other facilities

a. Parts repair shop.

The parts repair shop is to repair the parts mechanically.

b. Parts cleaning shop.

The parts cleaning shop is to clean the parts for Light Repair, Unscheduled Repair and Train preparation by if necessary, for rolling stock maintenance.

c. Battery shop.

The battery shop is to be used for maintenance on the battery of the rolling stock for Light Repair and Unscheduled Repair.

d. Electric shop.

The parts repair shop is to repair the parts electrically for Light Repair and Unscheduled Repair.

e. Warehouse.

The warehouse is to store the materials, the tools, the consumables, and some spare parts for Light repair and Unscheduled Repair.

f. Compressor room.

The compressor room is to supply the high-pressure air in the Light Repair Shop.

g. Office.

The office is for the MCRP workers concerning with the works of Light Repair, Other Maintenance and Train preparation.

h. Garbage shed for Light Repair Shop

The garbage shed for Light Repair Shop is the collect point of the garbage those are generated by conducting Light Repair, Other Maintenance and Train Preparation.

i. Oil storage for Light Repair Shop

The oil storage for Light Repair shop is to store the lubricant oil, machine oil, etc. for Light Repair and Other Maintenance.

8.9.2 Workshop Facilities in North Depot

8.9.2.1. The methods of Heavy repair are as follows.

a. The train is uncoupled to one by one at the final adjustment shop (N31) to conduct Heavy repair.

b. The rolling stock after maintenance work in the Workshop building is coupled to the train at the final adjustment shop (N31).

c. The rolling stock for Heavy repair is/are moved by the shunting locomotive (N41-02) between the final adjustment tracks (N31) and the lead track, between the bogie removal/installation shop (N12) and the outside of the Workshop building, and between the under-cleaning track (N40) and the lead track.

d. The rolling stock is moved by temporary bogies (N12-04) in the Workshop building.

e. The train can move itself on the track from the lead track to the final adjustment shop (N31).

f. The heavy repair method is that there are not spare parts for heavy repair (bogies and parts/equipment) basically but spare parts for failures/accidents on the train.

  i. The parts for heavy repair are dismantled from the car body.

  ii. The parts are inspected and repaired in the Workshop building basically.

  iii. The parts after inspection and repair are reassembled to the same car body as before dismantling.

8.9.2.2. Under above methods, the basic concept of workshop facilities is as follows.

a. Shop-in Check Facilities (N11 and N31)

  i. There are the shop-in check facilities at the underfloor cleaning track (N11) and the final adjustment shop (N31).

  ii. The underfloor cleaning track is to clean the underfloor equipment/parts of rolling stock.

  iii. The underfloor cleaning track is to clean the underfloor equipment on the train before maintenance works in the workshop building.

  iv. The final adjustment shop is to conduct shop-in check before maintenance works in the Workshop building.

  v. The final adjustment shop is to uncouple the train to one car.

  vi. The final adjustment shop has three tracks for shop-in check and final adjustment to conduct works at the same time.

b. Bogie Removal/Installation Facilities (N12)

  i. There are the bogie removal/installation facilities at the bogie removal/installation shop.

  ii. The bogie removal/installation shop is to divide the rolling stock into the bogies and the car body and to re-install the bogies to the car body after inspections and repairs of the bogies.

  iii. The bogies are installed to/removed from the car body by the car body lifting jack.

  iv. The temporary bogies (N12-04) are installed to/removed from the car body by the car body lifting jack (N12-02).

v. The bogies are moved from/to the bogie shop manually by Bogie Transport Unit (N12.09).

vi. The car body is moved from/to the car body shop by the temporary bogies (N12-04).

vii. The bogie removal/installation shop has three spots for dismantling/reassembling bogies to conduct works at the same time.

c. Bogie inspection and repair facilities (N16, N17, N20, N21, N22, N25, and N26)

There are the bogie inspection and repair facilities at following places.

i. Traction motor shop (N16)

aa. The traction motor shop is to dismantle, wash, repair, inspect, and reassemble the traction motor.

ab. Traction motors are moved by a carrier, and in the shop are moved by an overhead traveling crane.

ii. Bogie shop (N17)

aa. The bogie shop is to dismantle, wash, repair, inspect, and reassemble the bogie.

ab. The traction motor is dismantled from/re-installed to the bogie using the bogie disassembling/assembling equipment (N17-05).

ac. The bogies are moved manually, and bogie frames are moved by an overhead traveling crane.

ad. The bogie frames with equipment/parts are moved by an overhead traveling crane to be disassembled, repaired, inspected, and reassembled.

ae. The bogie frame with equipment/parts is put on the bogie frame stand (N17-07) for maintenance works.

af. Wheel sets with axle bearings are moved from/to the wheelset shop (N20).

iii. Wheelset shop (N20)

aa. The wheel set shop is to dismantle, wash, repair, inspect, overhaul and reassemble the wheel set.

ab. Wheel sets are moved manually.

ac. There are the facilities to exchange the wheels.

ad. The bearings are moved from/to the bearing shop (N21).

iv. Bearing shop (N21)

The bearing shop is to disassemble, repair and reassemble the axle bearing.

v. Spring, Air Spring, Brake parts & Iron shop (N22)

The spring, air spring, brake parts & iron shop is to repair and inspect the bogie parts.

vi. Air brake valve shop (N25)

The air brake valve shop is to dismantle, wash, repair, inspect, and reassemble the parts concerning with the air brake valves of bogie.

vii. Mechanical shop (N26)

The mechanical shop is to repair the parts mechanically.

viii. Parts Disassembly and Assembly facilities (N13)

aa. There are the parts disassembly and assembly facilities at the car body shop.

ab. The car body shop is to disassemble the parts from and assemble the parts to the car body. The car body is moved by the temporary bogies (N12-04). The car body height is adjusted to the working height by raising or lowering the height of the temporary bogies (N12-04).

ac. Equipment/Parts on the roof are removed and re-installed by the overhead traveling cranes.

ad. The car body shop has thirty spots for disassembling & assembling, and inspections & repairs to conduct works at the same time.

d. Car body repair facilities (N13)

i. There are the car body repair facilities at the car body shop.

ii. The car body shop is to inspect and repair the car body.

iii. The car body is moved by the temporary bogies (N12-04).

iv. The car body height is adjusted to the working height by raising or lowering the height of the temporary bogies (N12-04).

v. The car body shop has thirty spots for disassembling & assembling, and inspections & repairs to conduct works at the same time.

e. Car body painting facilities (N15)

i. There are the car body painting facilities at the paint shop.

ii. The paint shop is to paint the car body after inspection and repairs.

iii. The traverser is used for the car body moving from its workspace to another space.

f. Parts inspection and repair facilities (N14, N18, N19, N23, N24, N25, and N26)

There are Parts inspection and repair facilities at following places.

i. Sewage tank shop (N14)

The sewage tank shop is to wash and repair the toilet facilities on the rolling stock.

ii. Air conditioner shop (N18)

The air conditioner shop is to disassemble, wash, repair, reassemble and inspection the air conditioner.

iii. Electric parts shop (N19)

The electric parts shop is to disassemble, clean, repair, inspect, and reassemble electric parts on the rolling stock. Sophisticated Electronic equipment will be maintained and repaired in the clean Electronic Room near the Electric Part shop.

iv. Tight lock coupler and draft gear shop (N23)

The tight lock coupler and draft gear shop is to disassemble, clean, repair, inspect, and reassemble the tight lock and the draft gear.

v. Seat shop (N24)

The seat shop is to clean and repair the seat on the rolling stock.

vi. Air brake valve shop (N25)

The air brake valve shop is to disassemble, wash, repair, inspect, and reassemble the parts concerning with the air brake valves on the car body.

vii. Mechanical shop (N26)

The mechanical shop is to repair the parts mechanically and to make the parts for the repairs.

g. Final adjustment facilities (N30 and N31)

i. There are the final adjustment facilities at the weatherproof test shop (N30) and the final adjustment shop (N31).

ii. The weatherproof test is to conduct water leakage test after maintenance works in the Workshop building.

iii. The final adjustment shop is to conduct functional tests without running after maintenance works in the Workshop building.

iv. The functional tests are conducted in conditions of a single car or a train-set in the final adjustment shop.

v. The final adjustment shop is to couple the cars to the train-set.

vi. The final adjustment shop has three tracks for shop-in check and final adjustment to conduct works at the same time.

h. Test track

i. The test track is to conduct functional tests with running after the works at final adjustment shop.

ii. The test track is long enough for the performance test after rolling stock maintenance considering maximum train length.

i. Other facilities

i. Warehouse (N27)

The warehouse is to store materials, the tools, the parts used for Heavy Repair, and spare parts.

ii. Compressor Room (N28)

The compressor room is to supply high pressure air to each shop in the workshop building and the underfloor cleaning shop (N11).

iii. Office

The office is for the MCRP workers concerning with the works of Heavy Repair.

iv. Garbage shed for Workshop.

The garbage shed for Workshop is the collect point of the garbage those are generated by conducting Heavy Repair.

v. Oil storage for Workshop

The oil storage for Light Repair shop is to store the lubricant oil, machine oil, etc. for Heavy Repair.

vi. Hazardous Store

The hazardous store is to store the coating materials.

8.9.3 Common facilities

8.9.3.1. Shunting Locomotive:

a. The shunting locomotives are to move rolling stock for maintenance when the rolling stock cannot move itself/themselves.

b. Shunting locomotive is to be used at the unscheduled and heavy repairs shop.

8.9.3.2. One of the shunting locomotives (N41-02) in North Depot is to be used for Heavy repair and mainline rescue operations.

8.9.3.3. Contractor shall supply diesel locomotive (1 units) along with one flat car suitable for mainline operations having maximum 2.95m wide, to recover failed train, 270t, on 3.5% downgrade.

8.9.3.4. Locomotives shall be fully equipped for emergency responses.

8.9.3.5. Contractor shall supply adaptors for tight lock couplers to couple to work trains.

8.9.3.6. Flat car: Contractor shall supply flat car with side boards to carry tools, re-railing equipment and emergency response equipment, 15m length, 2.95m wide, with platform 1.10m above T.O.R.

8.9.3.7. Contractor shall supply and install tight lock couplers on both ends flat car (free issue).

8.9.3.8. It is assumed that the fuel supply equipment (N41-03) is used for the shunting Diesel locomotive (N41-02).

8.9.3.9. Common use (N61 and S61):

These facilities are used commonly in/outside of the depot/workshop area for the works concerned with rolling stock maintenance and accidents.

8.9.3.10. Tools:

a. These equipment/facilities are used commonly for the works concerned with rolling stock maintenance and accidents.

b. These tools can be provided by general commercial tool suppliers.

c. The contractor shall confirm to the interface contractor to resolve the interface problems as specified in Technical Requirement and Section 19 of ERG.

8.9.3.11. Other tools/equipment/facilities for rolling stock maintenance that is assumed not to procure at general commercial markets are treated as special tools and test equipment of the railway system and rolling stock.

8.9.3.12. These Special tools and test equipment are to be planned and supplied in close consultation and interfacing with Rolling Stock supplier at appropriate time with approval of Engineer. Special tools and test equipment of the rolling stock shown in Table 8.13 are indicative only. Actual requirement and specifications shall be reviewed and finalized as per the maintenance requirement of the Rolling stock supplier.

Table 8.13 Special Equipment and Tools of the railway system and the rolling stock

Equipment Group No.	Shop Name	Special Equipment and Tools
North Depot		
N01	Light Repair Shop	Signal system tester
		Telecommunications tester (if necessary)
		TMS log reader
		Rewriting device for internal display system
		Rewriting device for external display system
		Rewriting device for public address system
		VVVF log reader
		APS log reader
		Break control unit log reader
		Brake-pad replacing tool
		PSD device log reader
		PSD device tester
		Handheld thermal imaging cameras.
		Shock pulse and Vibration analysers for machines
		Real time wheel geometry measurement system.
N12	Bogie Removal/ Installation Shop	Radius arm gauge
N13	Car Body Shop	Special tools for removal and installations of coach doors
N16	Traction Motor Shop	Motor disassembling/reassembling tools
		WN coupling extractor
		Non-disassembling bearing exchange special tool
N17	Bogie Shop	Bogie disassemble/reassemble special tools
		Lock bolt for axle spring
N18	Air conditioner Shop	Special tools for air conditioner overhaul
		Refrigerant extractor
		Refrigerant filler

Equipment Group No.	Shop Name	Special Equipment and Tools
North Depot		
		Gas leakage tester
		Cleaner for special parts
N19	Electric Parts Shop including Electronic Room	HB tester
		High voltage device tester
		Contactor tester
		Solenoid valve tester
		Electronic relay tester
		Door operating device tester
		Signal System tester
		TMS data reader and analyzer
		Failure data reading device
		Telecommunication tester
		Speed sensor tester
		VVVF inverter module tester
		Auxiliary Inverter module tester
		VVVF log reader
		Master Controller Tester
		Electronic Worktables 10 No. (with ESD protection)
		Soldering and dessoldering stations 10 No.
		Multipurpose Power Supplies 10 No.
		Digital Storage Oscilloscopes 10 No.
N21	Bearing Shop	Cleaners for special parts
N22	Spring, Air Spring & Iron workshop	Special tools for air-spring overhaul
		Special tools for damper overhaul
N23	Tight Lock Coupler and Draft Gear Shop	Special tool for draft gear
N25	Air Brake Valve	Brake valve test equipment

Equipment Group No.	Shop Name	Special Equipment and Tools
North Depot		
	Shop	Break control unit log reader
		Special tools for air valve overhaul
		Special tools for compressor overhaul
N31	Final Adjustment Shop	Signal system tester
		Telecommunications tester (if necessary)
		TMS log reader
		Functional tester for a single car (if necessary)
		PSD device log reader
		PSD device tester
-	Test track	Facilities to check the train speed for Signal System

Equipment Group No.	Shop Name	Special Equipment and Tools
South Depot		
S01	Light Repair Shop	Signal system tester
		Telecommunications tester (if necessary)
		TMS log reader
		Rewriting device for internal display system
		Rewriting device for external display system
		Rewriting device for public address system
		VVVF log reader
		APS log reader
		Break control unit log reader

Equipment Group No.	Shop Name	Special Equipment and Tools
South Depot		
		Brake-pad replacing tool
		PSD device log reader
		PSD device tester
		Handheld thermal imaging cameras.
		Shock pulse and Vibration analysers for machines
		Real time wheel geometry measurement system.

8.10 Depot/Workshop Layout

The layout of the depot/workshop for the Rolling Stock maintenance is based on the following assumptions for reference.

8.10.1 North Depot Layout

The basic concepts of Depot Layout are followings.

8.10.1.1. Light Repair Shop (N01)

The light repair shop is located in a place where trains can move from/to the storage track easily.

8.10.1.2. Unscheduled Repair Shop (N02)

a. The unscheduled repair shop is located in a place where trains can move from the storage track easily.

b. The unscheduled repair shop is located for transport the parts from/to workshop.

8.10.1.3. Car body Washer (N04)

The location is in a place where car bodies can be washed during moving between storage tracks and Light Repair Shop, and between storage tracks and a lead track.

8.10.1.4. Storage Track

a. The location is in a place where trains can move to storage tracks directly and smoothly from/to the access tracks not to affect the train operation, shunting works, maintenance works and training for MCRP staff.

b. The location is in a place where trains can move from storage tracks to the light repair shop (N01) and the unscheduled repair shop (N02) not to use a lead track.

8.10.1.5. Test track

The test track is located not to affect the train operation, shunting works, maintenance works.

8.10.1.6. Lead track

a. One of the lead tracks is located for the train to move for changing the storage track and washing the car body not to affect maintenance works at the light repair shop (N01).

b. One of the lead tracks is located for maintenance works of Heavy Repair and train moving from/to the test track.

c. One of the lead tracks is located for train moving from/to the unscheduled repair track and the wheel re-profiling track.

8.10.1.7. Other facilities

a. Parts repair shop

The parts repair shop is in the light repair shop.

b. Parts cleaning shop

The parts cleaning shop is in the light repair shop.

c. Battery shop

The battery shop is in the light repair shop.

d. Electric shop

The electric shop is in the light repair shop.

e. Warehouse

The warehouse is in the light repair shop.

f. Compressor room

The compressor room is in the light repair shop.

g. Office

The office is in the light repair shop.

h. Garbage shed for Light Repair Shop

The garbage shed for Light Repair Shop is located near the light repair shop.

i. Oil storage for Light Repair Shop

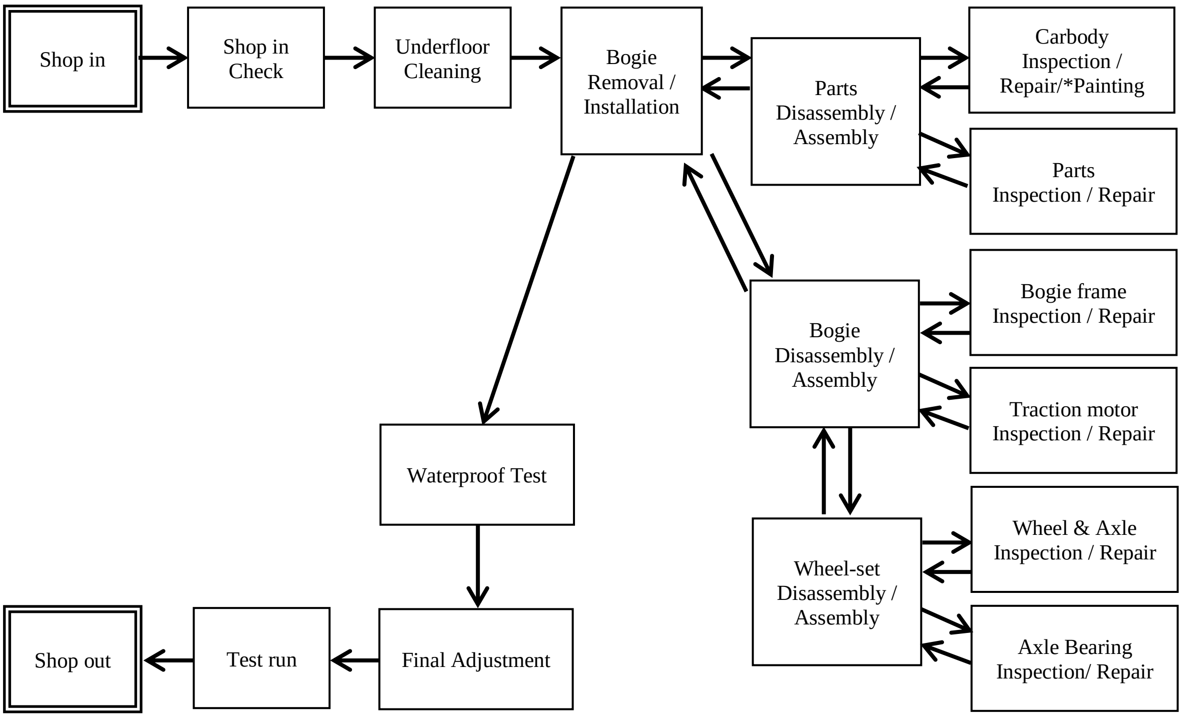
The oil storage for Light Repair shop is located near the light repair shop.

8.10.2 North Depot Workshop Layout

The basic concepts of the workshop layout are as follows.

8.10.2.1. The workshop building is located not to affect the train operation, shunting works except for Heavy Repair, maintenance works except for Heavy Repair and training for MCRP staff.

8.10.2.2. Facilities for Heavy Repair (Section 8.9.2 of this specification) are located considering the workflow of Heavy Repair (Figure 8.1).



Note*: only for Limited Express Train (NS-03)

Figure 8.1 Maintenance Work Flow of Heavy Repair

8.10.2.3. The test track is located near the Workshop building for train to move easily.

8.10.2.4. The car shunting shop is located near the Workshop building for coupling/uncoupling with rolling stock and shunting.

8.10.2.5. The office is in the workshop building.

8.10.2.6. The garbage shed for Workshop is near the workshop building.

8.10.2.7. The oil storage for Workshop is near the workshop building

8.10.2.8. The hazardous store is near the paint shop in the workshop building.

8.10.3 South Depot Layout

The layout of the depot for the Rolling Stock maintenance is based on the following assumptions for reference. The basic concepts of Depot Layout are followings.

8.10.3.1. Light Repair Shop (S01)

The light repair shop is located in a place where trains can move from/to the storage track easily.

8.10.3.2. Unscheduled Repair Shop (S02)

a. The unscheduled repair shop is located in a place where trains can move from the storage track easily.

b. The unscheduled repair shop is located for transport the parts from/to workshop.

8.10.3.3. Wheel Re-profiling Shop (S03)

a. The wheel re-profiling shop is located in a place where trains can move from the storage track easily.

b. The wheel re-profiling shop is located considering long time stabling across the road.

8.10.3.4. Car body Washer (S04)

The location is in a place where car bodies can be washed during moving between storage tracks and Light Repair Shop, and between storage tracks and a lead track.

8.10.3.5. Storage Track

a. The location is in a place where trains can move to storage tracks directly and smoothly from/to the access tracks not to affect the train operation, shunting works, maintenance works and training for NSRP-South staff.

b. The location is in a place where trains can move from storage tracks to the light repair shop (S01), the unscheduled repair shop (S02) and the wheel re-profiling shop (S03) not to use a lead track or a passage track as possible.

8.10.3.6. Lead track

The lead track is located for the train moving from/to the light repair shop (S01), the unscheduled repair shop (S02) and the wheel re-profiling shop (S03).

8.10.3.7. Passage track

a. The passage track is located for the train moving between the access tracks and other tracks that are the storage track, the light repair shop (S01), the unscheduled repair shop (S02), and, the wheel re-profiling shop (S03).

b. The passage track is located for the train moving between the east storage tracks and the maintenance shops (S01, S02, and S03).

8.10.3.8. Other facilities

a. Parts repair shop
b. The parts repair shop is in the light repair shop.
c. Parts cleaning shop
d. The parts cleaning shop is in the light repair shop.
e. Battery shop
f. The battery shop is in the light repair shop.
g. Electric shop
h. The electric shop is in the light repair shop.
i. Warehouse
j. The warehouse is in the light repair shop.
k. Compressor room
l. The compressor room is in the light repair shop.
m. Office
n. The office is in the light repair shop.
o. Garbage shed for Light Repair Shop
p. The garbage shed for Light Repair Shop is located near the light repair shop.
q. Oil storage for Light Repair Shop
r. The oil storage for Light Repair shop is located near the light repair shop.

8.11 Interface Coordination

8.11.1 Interface Coordination during Project

8.11.1.1. The Contractor shall coordinate with all railway system suppliers, and Depot contractor (the contractor of CP N-05 and CP S-07) and

8.11.1.2. Rolling stock supplier (the Contractor of CP-03, NS-02 and NS-03) to ensure that Depot/ Workshop Equipment offered satisfactorily complies with maintenance requirements.

8.11.1.3. The attention of the Contractor is specifically drawn to railway systems and subsystems for which equipment shall be supplied comprising special tools and test equipment for diagnostics and testing in-situ, inspection, repairs, maintenance and overhaul.

8.11.1.4. The Contractor shall note that coordination with Interface Contractors and other parties shall be of utmost importance during the Project.

8.11.1.5. Aspects of coordination shall include, but not be limited to, the following:

a. Interface management - The Contractor shall document interfaces requirements, define and resolve interfaces with all parties concerned, update interface requirements and definitions as may be necessary, throughout the Project including construction, integration and service commencement; and

b. Timing - Coordination shall be carried out in a timely manner to ensure that no Project delays occur.

c. The Contractor shall describe the above issues in the Interface Management Plan which is specified in Clause 4.3 of the ERG.

8.11.2 Equipment Integration

8.11.2.1. The Contractor shall provide with the preliminary interfaces for the integration of major equipment, as may be applicable, including but not limited to the following:

a. Specifics pertaining to transport on site and installation in the depot/workshop;

b. Equipment size and weight;

c. Foundation concepts and layouts, pits and other features shall be included. Civil works or architectural works will be provided by others except the foundation works of the car body washer and fuel tanks.

d. Floor loading, equipment loading and structural support requirements and anchorage;

e. Connected electrical load, power consumption;

f. Lighting levels;

g. Compressed air pressure and consumption;

h. Potable water pressure and consumption;

i. Process water pressure and consumption;

j. Drainage; and

k. Other services.

8.12 Testing, Commissioning and Verification

8.12.1 Outline

The contractor shall explain in a comprehensive outline the processes of QA, QC, testing and commissioning at manufacturers' sites and at the Depot/Workshop site to verify the performance of the equipment as a part of the Works Program.

8.12.2 Documentation

Testing, commissioning and performance verification process shall be a formal process and so documented, complete with QA, QC and test records. Items not conforming to QA, QC and test requirements shall be identified, recorded and promptly remedied.

8.12.3 Formal Plan

As a part of the Testing and Commissioning Management Plan as is described in Section 4 of the ERG, the Contractor shall submit to the Engineer for review a detailed testing, commissioning and performance verification plan, including QA and QC processes, factory acceptance tests, acceptance tests and certification of installations by local authorities where required.

8.12.4 Acceptance Test

The Contractor shall perform all testing and commissioning activities to satisfactorily demonstrate the performance of the Works within the same condition as actual use. For the acceptance test, the Contractor shall coordinate with the Employer and the Engineer to test all the equipment by actually carrying out the maintenance on the train procured in CP NS-02 and CP NS-03. If, however, the Contractor can demonstrate the performance by using any substitutes instead of the train with the approval by the Engineer, the Contractor may use the substitutes for the acceptance test.

8.13 Training

8.13.1 General

a. The Contractor shall refer to the Section 14 of the ERG for training.

b. The Contractor shall provide training of the NSCR staff for the safe and efficient operation and maintenance of the Depot/Workshop Equipment. An outline of the training plan with durations and timing proposed for the various types of equipment shall be submitted as a part of the Works Program.

8.13.2 Theoretical Training

a. The Contractor shall provide the theoretical training twice; namely at NSCR Head Office and at North and South Depots.

b. The language shall be in English at NSCR Head Office and be in Philippines language at the Depots. If needed, the Contractor shall prepare translators at his cost.

8.13.3 Practical Training

a. The Contractor shall provide the practical training at the Depots.

b. The practical training shall include the detail instruction regarding the operation and maintenance for all the equipment and facilities individually to be installed in the Project.

c. The operation training shall be undertaken by using the new train to be purchased in the Project. The Contractor might precede the practical training while he undertakes the acceptance test.

d. The maintenance training shall include the method of periodical maintenance as well as trouble shooting.

e. The language in the practical training shall be Philippines language. If needed, the Contractor shall prepare translators at his cost.

f. Training shall take place in Philippines at the Depot/Workshop site, after successful testing, commissioning and acceptance.

8.14 Drawings

Drawings are included for general reference only. Dimensions and machine location are assumptions only for reference. Contractor must interface with other package contractors to obtain relevant up to date information, plans and drawings wherever applicable.

a. General Layout (MCRP-DWG-DEP-DEF-0002)

b. Light Repair Shop Machine Layout (MCRP-DWG-DEP-DEF-0003)

c. Unscheduled Shop Machine Layout (MCRP-DWG-DEP-DEF-0004)

d. Wheel Reprofiling Shop Machine Layout (MCRP-DWG-DEP-DEF-0005)

e. Workshop Machine layout (1/2) (MCRP-DWG-DEP-DEF-0006)

f. Drawings List (NSRP-DWG-DEP-DEF-0001)

g. General Layout (NSRP-DWG-DEP-DEF-0002)

h. Light Repair Shop Machine Layout (NSRP-DWG-DEP-DEF-0003)

i. Unscheduled Shop Machine Layout (NSRP-DWG-DEP-DEF-0004)

j. Wheel Reprofiling Shop Machine Layout (NSRP-DWG-DEP-DEF-0005)

Part A of Appendix 8.1: North Depot

N01 LIGHT REPAIR SHOP

N01.01 Cleaning Set

1. Quantity: Three (3) sets

2. Functional Requirements.

2.1. The cleaning set shall be provided for manual cleaning of the rolling stock exterior and interior in the N01 Light Repair shop.

2.2. The cleaning set shall have the follows:

- i. 8 pcs - Step ladder, 1.5 m height, made of aluminum,
- ii. 8 sets - Handcart with sweeping and dusting gear, dust bag,
- iii. 8 sets – Handcart with mopping gears (bucket, mop, deck brush and water hose (20 m) reel,
- iv. 8 sets – Handcart with electric vacuum cleaner, wet and dry type,
- v. 8 sets – Handcart with electric rotary floor washer and polisher.
- vi. 1 set – Air-conditioner heat exchanger cleaning equipment to re-establish new-like surface condition without abrasion.

3. Design

The cleaning set shall be composed of off-the-shelf gears.

4. Interface Requirement

No additional requirement

5. Eligible Supplier

There is no preference.

N01.02 Air Blow Booth with Dust Collector

1. Quantity: One (1) set

2. Functional Requirements.

2.1. The air blow booth with dust collector shall be provided for cleaning the small component removed from car.
2.2. The cleaning is performed manually with a compressed air gun in the booth.
2.3. The dust collector for ventilation, exhausting and dust collecting shall be provided for the booth.
2.4. Exhaust duct shall lead to the outside of the building.
2.5. The floor area for the air blow booth with dust collector shall be less than 5.0 m (L), 5.0 m (W) without floor pit except embedded floor rail for the turntable cart.

3. Design

3.1. The air blow booth with dust collector shall be composed of, but not limited to:

i. Air blow booth,
ii. Compressed air gun, flexible hose and air piping with quick coupler,
iii. Dust collecting and exhaust/ventilation system with filter, dust box, exhaust fan(s), exhaust duct,
iv. Control panel,
v. Personal safety gears.

3.2. The booth shall be a pre-fabricated or custom made of steel plate, and equipped with inlet/outlet curtain, windows, sufficient interior lighting, ventilating louver, etc.
3.3. Dust collection, exhaust and ventilation systems shall satisfy environmental regulations.
3.4. Arrangement of the air blow booth with dust collector shall be referred to the drawing MCRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.

4. Interface Requirement

Interface shall be taken with the Building Contractor regarding the following issues, but not limited to:

i. Booth foundation, anchor bolts, if any,
ii. Exhaust ducting, finishing of duct hole on the building,
iii. Utility arrangement such as electric cabling, compressed air piping, etc.
iv. Exhaust duct shall be included in the scope of the equipment.

5. Eligible Supplier

There is no preference.

N01.03 Insulation Resistance Tester (incl. HIPOTT)

1. Quantity: One (1) set

2. Functional Requirements.

2.1. The insulation resistance tester shall be provided for measuring insulation resistance test and the withstand voltage test (HIPOTT) of electric cables onboard and electric components.

2.2. The insulation resistance Tester shall be a portable type with casters.

2.3. The insulation resistance tester shall be a general purpose and manufacture standard, off-the-shelf type covering the followings, but not limited to:

- i. Type: 4 range tester, auto range, portable type,
- ii. Test voltage: DC; 125 V, 250 V, 500 V, 1,000 V,
- iii. Measuring range: 0.1～1,000 Mega ohm at 1,000 V,
- iv. Additional function: Standard value comparison, Automatic discharge,
- v. Other measurement: Voltage; 20～600 V, Resistance; 0～400 ohm,
- vi. Power: Dry battery.

2.4. The withstand voltage tester shall be a general purpose and manufacture standard, off-the-shelf type covering followings, but not limited to:

- i. Type: portable type,
- ii. Test voltage for insulation resistance test: 500 – 1,000 V DC,
- iii. Test voltage for withstand voltage test: max. 5 kV AC,
- iv. Testing time: 0 – 5 min. with time

3. Design

3.1. The Insulation Resistance Tester shall be composed of, but not limited to:

- i. Measuring cables with remote control switch,
- ii. Testing rod,
- iii. Safety alligator clip,
- iv. Shoulder belt,
- v. Cable case,
- vi. Dry battery,
- vii. Other necessary accessories.

3.2. The withstand voltage tester shall be composed of, but not limited to:

- i. The withstand voltage tester with caster,
- ii. Flush light for operation caution (red or orange),
- iii. Electric cable: Supply: 20 m, Measuring: 10 m,
- iv. Cable container cart, if necessary

4. Interface Requirement

Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N01.04 Battery Charger

1. Quantity: One (1) set

2. Functional Requirements.

2.1. The battery charger shall be provided for checking and renewing of batteries after removed from the car in the N01 Light Repair Shop.

2.2. The battery charger shall have function of electric discharge and charge of the battery with constant current.

2.3. Required batteries of rolling stock are as follows; the Contractor shall confirm to the Rolling Stock Contractor:

Voltage	Capacity	Purpose
100 V	120 Ah	Operation Control

2.4. Major functions of battery charger are as follows:

i. Type: Floor-fixed type,
ii. Measurement item 1: Charging voltage,
iii. Measurement item 2: Charging current,
iv. Measurement item3: Battery temperature.

2.5. Battery charger shall have capacity enable to charge for 2 blocks of batteries simultaneously.

3. Design

3.1. Electric discharging and charging shall be performed automatically.

3.2. The battery charger shall be installed on the flat floor without pit.

3.3. The battery charger shall be equipped with battery temperature checking feature.

3.4. Arrangement of the battery charger shall be referred to the drawing MCRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.

3.5. The following accessories shall be included, but not limited to:

i. Cables,
ii. Fuse,
iii. Standard accessories.

4. Interface Requirement

4.1. Interface shall be taken with the Rolling Stock Contractor regarding technical particulars of the battery.

4.2. Interface shall be taken at the appropriate timing within the Building Contractor regarding, but not limited to:

i. Floor anchor work, installation work,
ii. Electric power source, distribution box, cabling, etc.

5. Eligible Supplier

There is no preference.

N01.05 Filter Washing Machine

1. Quantity: One (1) set.

2. Functional Requirement

2.1. The Filter Washing Machine shall be provided for washing of the roll filter of the air conditioner in the N01 Light Repair Shop.

2.2. Major particulars of the roll filter are as follows; the Contractor shall confirm to the rolling stock Contractor:

   i. Type: flame resistance polyester fabric rolled on collar roller,
   ii. Filter size: approx.925 (W) x 10,000 (L) mm,
   iii. Filter weight: approx. 7 kg including roller.

2.3. The Filter Washing Machine shall cover the following functions, but not limited to:

   i. Washing: Automatic washing applied, detergent washing and rising,
   ii. Filter feeding: Feeding by electric motor,
   iii. Setting filter: Manual setting by the operator,
   iv. Tank: two tanks for washing and rinsing
   v. Washing basin: brushing on the punching metal of stainless steel, with washing fluid spray tube, circulation pump, filter, filter feeder,
   vi. Rinsing basin: same structure as washing basin, and air blow device at the last stage,

2.4. The washing capacity shall be as follows; the Contractor shall confirm to the Rolling Stock Contractor:

   i. Number of filter on rolling stock: 4 pcs/rolling stock, 32 pcs/train (Future, 40pcs/train),
   ii. Filter number per day: max. approx.120 pcs during maintenance

3. Design

3.1. The washing machine shall be installed on the floor without floor pit.

3.2. The total area for the washing machine in the N01 Light Repair Shop shall be less than 3,000 (W) x 2,000 (D) mm.

3.3. The basin and major structure shall be made of stainless steel for corrosion protection.

3.4. Arrangement of the Filter Washing Machine shall be referred to the drawing MCRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.

4. Interface Requirement

4.1. Interface shall be taken with the Rolling Stock the appropriate timing.

4.2. Interface shall be taken with the Building Contractor regarding follows, but not limited to:

   i. Drilling anchor bolts, if any,
   ii. Utility arrangement such as electric cabling, water piping, drainage, etc.

5. Eligible Supplier

   There is no preference.

N01.06 Double Head Grinder

1. Quantity: One (1) set

2. Functional Requirements

   The double head grinder shall be a general purpose and manufacture's standard type covering the following major performance:

   i. Floor Installation type without floor pit,
   ii. Grinding wheel: approx. 350 mm dia.

3. Design

3.1. The double head grinder shall be composed of a grinding wheel at the both ends of the motor; safety covers for the wheel and a dust attraction device.
3.2. Arrangement of the double head grinder shall be referred to the drawing MCRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.
3.3. The following accessories shall be included, but not limited to:

   i. Grinding wheels,
   ii. Dust filter.

4. Interface Requirement

   The Contractor shall take interface with the Building Contractor at the appropriate timing regarding the following items, but not limited to:

   i. Installation, anchor bolt holes, if any,
   ii. Electric power supply, cable route, etc.

5. Eligible Supplier

   There is no preference.

N01.07 Upright Drilling Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The upright drilling machine shall be provided for drilling, screw cutting and spot facing in the N01 Light Repair Shop.

2.2. The upright drilling machine shall be a general purpose and manufacture's standard type covering the following major performance:

   i. Type: Vertical drilling, installed on the workshop floor,

   ii. Swing: more than 500 mm,

   iii. Max. Drilling capacity: 50 mm dia,

   iv. Max. Screw cutting capacity: M27.

3. Design

3.1. The following accessories shall be included, but not limited to:

   i. Straight drill set,

   ii. Drill holder arbor,

   iii. Drill socket,

   iv. Drill holder,

   v. Tool kit.

3.2. Arrangement of the upright drilling machines shall be referred to the drawing MCRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.

4. Interface Requirement

   Interface shall be taken at the appropriate timing within the Building Contractor regarding, but not limited to:

   i. Floor anchor bolts, installation work,

   ii. Electric power source, distribution box, cabling, etc.

5. Eligible Supplier

   There is no preference.

N01.08 Disc Cutter

1. Quantity: One (1) set

2. Functional Requirements

2.1. The disc cutter shall be used for cutting metal bar or section steel with abrasive wheel cutter in the N01 Light Repair Shop.

2.2. The disc cutter shall be a general purpose and manufacture's standard type covering the following major performance:

   i. Type: Installed on the workshop floor, movable,

   ii. Abrasive wheel diameter: approx. 400 mm dia,

   iii. Max. cutting capacity: up to 115 mm dia. steel bar.

3. Design

3.1. The disc cutter shall be operated manually and equipped with a work holder, cutting device with a safety guard cover.

3.2. The following accessory shall be included, but not limited to:

   i. Abrasive wheel.

4. Interface Requirement

   No additional requirement

5. Eligible Supplier

   There is no preference.

N01.09 Welding Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. General purpose and manufacture's standard AC arc welders with variable current control shall be supplied.

2.2. The welding machine shall be applicable to a welding electrode up to 5 or 6mm diameter.

2.3. The welding machine shall be provided with an electric shockproof device.

3. Design

3.1. Rate current approx. AC 70 - 300 A,

3.2. Input electric power: AC400V, 60 Hz, three-phase.

3.3. The following accessories shall be included, but not limited to:

   i. Portable cart for moving of welder,

   ii. Primary cable, welding lead with electrode holder, and return lead with clamp,

   iii. Weld shield (full face type) and hand shield,

   iv. Gloves, chipping hammer, wire brush,

   v. Fume extractor, portable, with electrostatic filter.

4. Interface Requirement

   No additional requirement

5. Eligible Supplier

   There is no preference.

N01.10 Oxygen Acetylene Gas Welder

1. Quantity: One (1) set

2. Functional Requirements

   The oxygen acetylene gas welder of general-purpose type shall be supplied.

3. Design

3.1. Oxygen-acetylene sets shall be self-contained, complete with accessories and 2-wheel cart for 2 gas cylinders.

3.2. Gas welding capability up to 8 mm thick steel.

3.3. Cutting up to 50 mm thick steel plates.

3.4. The following accessories shall be included, but not limited to:

   i. Gas regulators,
   ii. welding torch,
   iii. cutting attachment,
   iv. welding nozzle,
   v. cutting nozzle,
   vi. nozzle cleaning set,
   vii. goggles,
   viii. gas hoses,
   ix. spark lighter,
   x. wire brush and protective clothing.

4. Interface Requirement

   No additional requirement

5. Eligible Supplier

   There is no preference.

N01.11 Air Compressor (Include Air tank)

1. Quantity: Two (2) sets

2. Functional Requirements

2.1. The air compressors (Include Air tank) shall be provided for general purpose air supply system in N01 Light Repair Shop and installed in the Compressor Room.

2.2. The air compressor shall be a general purpose and manufacture's standard type covering the following major performance:

2.3. Type: Electric driven package type screw compressor, air cooled oil free type, with integrated air dryer, on-floor installation type,

2.4. Minimum Compressor capacity: 2.0 m3/min. 0.69 MPa.

2.5. The air compressor shall be composed of, but not limited to:

   i. Air compressor: two (2) sets,

   ii. Air reservoir: one (1), approx.2.9 m3,

   iii. Exhaust ducts.

3. Design

3.1. The supply system shall be connected to the distribution piping provided by the Building Contractor at the outlet of the pressure regulating valve after the air reservoir.

3.2. The following accessories shall be included, but not limited to:

   i. Drain collecting device for two compressors and the air reservoir,

   ii. Necessary air piping system with valves,

   iii. Pressure regulating valve unit,

   iv. Exhaust duct for each compressor,

   v. Maintenance tool kit.

4. Interface Requirement

Interface shall be taken at the appropriate timing with the Building Contractor regarding, electric source, distribution box, cable connection, ducting, etc. particularly regarding the following issues, but not limited to:

   i. Floor drilled anchor bolt, if any,

   ii. Exhaust duct route, duct supports and penetration of building wall, finishing of penetration hole, etc.,

   iii. Drainage,

   iv. Equipment weight,

   v. Floor loading (t/m2) in floor contact areas.

   vi. Distribution air pipes to the Light Repair Shop after the outlet valve on the air tank will be provided by the Building Contractor.

5. Eligible Supplier

There is no preference.

N01.12 Forklift Truck 2t

1. Quantity: One (1) set

2. Functional Requirements

2.1. Two (2) tons forklift truck shall be provided for general transportation purpose in the N01 Light Repair Shop.

2.2. The major particulars of the forklift truck shall cover the followings, but the manufacture standard type shall be provided:

   i. Type: Four-wheeler of self-sealing rubber tires, with guarded driving seat, battery driven,

   ii. Capacity: 2,000 kg,

   iii. Battery: Enclosed maintenance free type,

   iv. Speed: approx. 14 km/h in loaded condition.

3. Design

   The following accessories shall be supplied, but not limited to:

   i. Charging device and cable,

   ii. Standard accessories and tools.

4. Interface Requirement

   No additional requirement

5. Eligible Supplier

   There is no preference.

N01.13 Worktable

1. Quantity: Five (5) pcs
2. Functional Requirements

2.1. The worktable shall be provided for general use in the shop.

2.2. The worktable shall be of welded steel structure and plain table as follows:

- i. Table surface: plywood with stainless steel plate,
- ii. Table size: approx. 1,800 (L) x 900 (W) x 740 (H) mm.

3. Design

No special requirement

4. Interface Requirement

No special requirement

5. Eligible Supplier

There is no preference.

N01.14 Tool Cabinet

1. Quantity: Four (4) pcs

2. Functional Requirements

2.1. The tool cabinet shall be provided for general storage of tools, consumables, spare parts, etc. in the shop.

2.2. The cabinet shall be made of steel with appropriate painting, lockable with a key having swing doors and 6 adjustable shelves inside.

2.3. Dimensions of the cabinet shall be as follows:

Overall size: approx. 800 mm width x 1,300 mm height x 600 mm depth

3. Design

The cabinet shall be commercial goods.

4. Interface Requirement

No special requirement

5. Eligible Supplier

There is no preference.

N01.15 Rack System

1. Quantity: Forty-four (44) sets

2. Functional Requirements

2.1. The rack system shall be provided for storage material, tools, spare parts and consumables in the Material Shop of the N01 Light Repair Shop.

3. Design

3.1. The racks shall be designed and manufactured with following features described hereto, but the manufacture standard racks covering requirements shall be provided.

3.2. The racks shall be pallet rack of steel truss structure and heavy-duty type with high quality painting having long life work.

3.3. Rack system for general goods including traction motor shall be:

i. Bay length: approx. 1,500 mm,

ii. Bay depth: approx. 900 mm,

iii. Bay height: approx. 1,800 mm,

iv. Bay load: 2,000 kg,

v. Shelf: 3 shelves/rack for 4 storing decks.

3.4. A vertical ladder shall be provided at the end of row.

3.5. Each rack shall be securely fastened together.

3.6. The racks shall be fixed on the floor by drilled anchor bolts.

3.7. Arrangement of the rack system shall be referred to the drawing MCRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.

4. Interface Requirement

Interface shall be taken at the appropriate timing within the Building Contractor regarding, but not limited to:

i. Floor anchor bolts, installation work,

ii. Electric power source, distribution box, cabling, etc.

5. Eligible Supplier

There is no preference.

N01.16 High Pressure Water Cleaner

1. Quantity: Eight (8) sets

2. Functional Requirement

2.1. High pressure water cleaner of off-the-shelf and general-purpose washer with high pressured hot water shall be provided for Air Conditioner Parts cleaning.

2.2. High pressure water cleaners shall be, but not limited to:

   i. Type: Portable type high pressure hot water cleaner with kerosene boiler,
   ii. Discharge pressure: max. approx. 9 MPa, variable,
   iii. Discharge capacity: max. approx. 750 liter/h,
   iv. Water temperature: max. 80 deg.C, variable,
   v. Detergent washing applicable,
   vi. Automatic ignition.

2.3. The pressurized pump shall be an electrical driven type.

2.4. The hot water generator of kerosene burning is applicable.

2.5. The machine can be operated manually by one operator.

3. Design

3.1. The High-pressure water cleaner shall be of heavy-duty design and proven in the railway maintenance field.

3.2. A set of easy connectors of male and female shall be provided and shall be installed on the water pipe by the Contractor.

3.3. The following accessories shall be included, but not limited to:

   i. Washing trigger gun with nozzle,
   ii. High pressure hose: 10 m
   iii. Kerosene boiler, oil tank, if applied,
   iv. Water supply hose,
   v. Safety device: manufacture standard including motor overload protection, overheat protection, earth leakage breaker, flame failure detection, safety valve, etc.

4. Interface Requirement

The Contractor shall take interface with the Building Contractor at the appropriate timing regarding following item, but not limited to:

   a. Water supply hose connection

5. Eligible Supplier

There is no preference.

N01.17 Sewage Discharge Pipe

1. Quantity: Six (6) sets

2. Functional Requirements

2.1. The sewage discharge pipe shall be provided for discharge from the sewage tank on each car and transfer to sewage drainage hole in the N01 Light Repair Shop.

2.2. The sewage discharge pipe shall be composed of, but not limited to:

- i. Telescopic arm, which shall be composed of steel pipe, rotary joint, flexible hose, coupling to the outlet port of rolling stock, etc.,
- ii. Cover of sewage drainage hole with pipe mounting flange,
- iii. Pipe (underground portion).
- iv. Water Hose (Rubber, Braided type),
- v. Reducer for supplying water if necessary.

2.3. Major function of the sewage discharge pipe shall be as follows:

- i. Type: gravity-driven type, without using any suction mechanism,
- ii. No. of the telescopic arm for each cover: two (2),
- iii. Length of telescopic arm: to reach the outlet port of rolling stock (which depend on the rolling stock's design).
- iv. Water Hose is connected between the tank on the Rolling Stock and the water valve (ground side).

3. Design

3.1. The sewage discharge pipe shall be of anticorrosion materials or paints.

3.2. The flexible hose shall be of transparent material.

3.3. The coupling shall be prepared to match the rolling stock's specification.

3.4. The cap of coupling and supporting jig shall be prepared for when not in use.

3.5. Arrangement of the sewage discharge pipe shall be referred to the drawing MCRP-DWG-DEP-DEF-0003, N01 Light Repair Shop Layout.

3.6. Standard accessories shall be included.

4. Interface Requirement

4.1. Interface shall be taken with the Rolling Stock Contractor regarding the position and technical particulars of the sewage tank and the water tank.

4.2. Interface shall be taken at the appropriate timing within other related contractors such as for the Building Contractor regarding, but not limited to:

- i. Floor pit structure and size, etc.,
- ii. The position, size and depth of the sewage drainage holes,
- iii. The anchor bolts for fixing the cover of sewage drainage hole, etc.,
- iv. Water piping, route, connection, etc.

5. Eligible Supplier

There is no preference.

N01.18 Front Car Maintenance Platform

1. Quantity: Two (2) sets

2. Functional Requirements

2.1. The Front Car Maintenance Platform is used during maintenance of windshield or wipers of the Limited Express rolling stock cars.

2.2. The Front Car Maintenance Platform shall be installed on the service deck of both the sides of rolling stock car.

2.3. The Front Car Maintenance Platform shall be possible to move it to the front of the Front Car of Express rolling stock set for maintenance of the windshield.

2.4. The Front Car Maintenance Platform shall be move to up and down and rotate of the deck.

2.5. The Front Car Maintenance Platform shall be possible for the operator to adjust the height and the longitudinal position of the deck.

2.6. Major function of the Front Car Maintenance Platform shall be as follows:

- i. Loading capacity: 200 kg (min. 2 persons with hand tools),
- ii. Deck size: approx. W900×L3,500mm,
- iii. Longitudinal moving range; approx. 2,000mm,
- iv. Lifting height: approx. 600 mm to 1900 mm from rail level on the service deck,
- v. Weight: approx.1,000 kg / one side

3. Design

3.1. The Front Car Maintenance Platform shall be possible to control the operation from the Control and/or Operating panel and the Pendant switch.

3.2. The handrail of steel pipes having min. height of 900 mm shall be provided all around of the platform for safety. However, there shall be some place(s) where workers can work on the front of the car body from the platform. At this place(s), the handrail shall be removable, or door, wire rope or chain for worker's safety is acceptable.

3.3. The floor of the platform shall be of non-slip type.

3.4. Standard accessories shall be included.

4. Interface Requirement

4.1. Interface shall be taken with the Rolling Stock Contractor regarding the technical particulars of the Front form and size.

4.2. Interface shall be taken at the appropriate timing within other related contractors such as for the Building Contractor.

5. Eligible Supplier

There is no preference.

N02 UNSCHEDULED REPAIR SHOP

N02.01 10/3t Overhead Travelling Crane

1. Quantity: One (1) set of crane

2. Functional Requirements

2.1. The crane shall be used for transferring parts/equipment on the train, bogie and bogie components.

2.2. The crane shall be provided in the N02 Un-scheduled Repair Shop.

2.3. Crane performance shall be as follows:

- i. Lifting capacity: Two hoists, 10 tons and 3 tons,
- ii. Travelling distance: approx. 70 m,
- iii. Traverse distance (between center of crane rails): approx. 14 m,
- iv. Lifting height: approx. 8.5 m,
- v. Lift speed: maker's standard (reference, 5 & 0.5 m/min.),
- vi. Traverse speed: maker's standard (reference, 2.5～12.5 m/min.),
- vii. Travel speed: maker's standard (reference, 5～25 m/min.).

3. Design

3.1. The crane shall be of single or double girder type with catwalk on it.

3.2. Operation and control on a pendant shall be applied, on which an emergency stop button shall be provided.

3.3. Jogging function for lifting shall be provided.

3.4. Motor insulation class F, Dust/Water Protection: IP 55

3.5. Flashing light (orange color) shall be provided for work safety.

3.6. Safety devices shall be integrated for overload, highest/lowest limit switch, etc.

3.7. Magnetic disc brake shall be provided.

3.8. The crane shall be equipped with anti-collision device.

3.9. The following lifting tools shall be provided:

- i. 2 sets of lifting gear for lifting bogie (approx. 3.0 m x 2.7 m, < 10 tons)
- ii. 2 sets of lifting ropes, shackles and slings (for 1 ton – 3 tons, <3 tons)

4. Interface Requirement

4.1. The Contractor shall provide and install the crane in the workshops, with appropriate interface coordination with the between Building and OCS Contractors, regarding material supply, power conductor rail layout, capacity, control and interlocking arrangements and installation work.

4.2. Crane rails shall be included in crane supply scope and shall be supplied to the Building Contractor who will install it on the building beams.

4.3. Power conductor rails will be installed by the crane supplier.

5. Eligible Supplier

There is no preference.

N02.02 Bogie Replacing Equipment

1. Quantity: One (1) set

2. Functional Requirements

2.1. The bogie replacing equipment of 'Drop-Pit type' shall be used for replacing one bogie, or underfloor large equipment of the train in-situ condition (10 cars coupled) without uncoupling.

2.2. The major components of the equipment shall be, but not limited to:

i. Bogie replacing traverser with a lifting table,

ii. Car body supporting device.

2.3. The train can run on the bogie replacing equipment itself or can be moved by a shunting car.

2.4. After positioning the train, in case of bogie replaced, car body shall be supported by the car body supporting devices and the bogie shall be taken down to the underfloor pit by the bogie replacing traverser.

2.5. The traverser shall transport the bogie in the underfloor pit to the side of the track, then, lift and release the bogie on the floor rails. New installation of spare equipment shall be made in the reverse process.

2.6. The traverser shall be composed of an electric driven traversing cart, a lifting table on the traverser with rails for train running, running rails in the pit for the traverser, and a locking devices and hydraulic units.

2.7. The car body supporting device shall be composed of two columns at the both side of the track, which is movable when the train is on the bogie replacing equipment. One support block shall be provided on each column, which can be adjusted to the support position of the car body manually.

2.8. Control and operation of the bogie replacing equipment shall be performed on the pendant switch of each device.

2.9. Bogie replacing traverser, lifting table on the traverser and car body supporting device shall be equipped with a mechanical interlocking device for each to prevent unexpected falling down due to the power failure, hydraulic pressure loss, etc.

2.10. Time of bogie replacement shall be within 2 hours after train positioned.

3. Design

3.1. Rolling stock and its components data for design of the equipment, given below, is for reference only. The Contractor shall take interface with the Rolling Stock Contractor for actual data and dimensions at appropriate stage of the project.

i. Track gauge: 1,435 mm,

ii. Rolling stock weight (Motor car): approx. 45 tons,

iii. Car body size and weight: 2,950 (W) x 19,500 (L) mm, approx. 40 tons,

iv. Bogie size and weight: approx. 3,000 (L) x 2,700 (W) x 1,000 (H) mm, approx. 8 ton,

v. Axle distance: 2,100 mm,

vi. Wheelset weight: max. 2,500 kg,

vii. Max. underfloor equipment: 4,300 (L) x 900 (W) mm, approx. 2 tons.

3.2. Arrangement of the equipment shall be referred to the drawing MCRP-DWG-DEP-DEF-0004, Un-scheduled Repair Shop Layout.

3.3. The following underfloor pit is planned. The Contractor shall take interface regarding details, but not limited to, with the Building Contractor.

i. Width: approx. 10,000 mm (7,700 mm from track centre to traverse side),

ii. Length: approx. 4500 mm,

iii. Depth: approx. 2,000 mm from floor.

3.4. Safety measures shall be provided for operator, train and equipment including flashing light (orange color).

3.5. The pit cover or floor grating, if required, shall be provided and installed with the equipment.

4. Interface Requirement

Interface shall be taken at the appropriate timing with the Rolling Stock Contractor and the Building Contractor.

5. Eligible Supplier

There is no preference.

N02.03 Underfloor Equipment Exchange Device 2t

1. Quantity: One (1) set

2. Functional Requirements

2.1. The underfloor equipment Exchange Device 2t shall be provided to dismantling or installing underfloor large equipment.

2.2. Major performance shall be as follows, but not limited to:

   i. Lifting capacity: 2 tons,

   ii. Lifting height: more than 500 mm,

   iii. Underfloor equipment size: approx. 3,000 x 1,500 mm,

   iv. Power: Battery driven DC motored hydraulic unit,

3. Design

3.1. The lowest height of the lifter shall be minimized as much as possible.

3.2. Battery charger shall be provided and built on the Exchange Device, if possible.

3.3. Battery of 24 V DC is preferable and shall be of maintenance-free type.

3.4. The Exchange Device shall have ahead and astern running modes.

4. Interface Requirement

   Interface shall be taken at the appropriate timing with the Rolling Stock Contractor.

5. Eligible Supplier

   There is no preference.

N02.04 Movable Lifting Platform

1. Quantity: One (1) set

2. Functional Requirements

2.1. The movable lifting platform of scissor type shall be provided for high place work in the N02 Un-scheduled Repair Shop.

2.2. Major performance shall be as follows:

   i. Loading capacity: 200 kg (min. 2 persons with hand tools),

   ii. Top height: approx. 5,000 mm above the floor,

   iii. Platform size: approx. 3,000mm x 1,200 mm,

   iv. Power: Battery driven DC motored hydraulic unit,

   v. Mobile mechanism: Casters driven by motor.

3. Design

3.1. The lowest height of the platform shall be minimized as much as possible.

3.2. Sufficient outriggers shall be provided for safety.

3.3. Battery charger shall be provided and built on the lifter, if possible.

3.4. Battery of 24 VDC is preferable and shall be of maintenance-free type.

3.5. Lifting operation shall be performed on the platform.

3.6. The lifter shall have manual manoeuvring handle (lever) on one caster. The caster shall be of heavy load type.

3.7. The lifter shall have ahead and astern running modes. The running motor shall be interlocked with the scissor lifter lowest position.

3.8. The handrail of steel pipes having min. height of 900 mm shall be provided all around of the platform for safety.

3.9. However, there shall be some place(s) where workers can go up to the roof or can work on the side of the car body from the lifting platform. At this place(s), the handrail shall be removable, or door, wire rope or chain for worker's safety is acceptable.

3.10. The floor of the platform shall be of non-slip type.

4. Interface Requirement

Interface shall be taken with other related contractors, if required.

5. Eligible Supplier

There is no preference.

N02.05 Boarding Step

1. Quantity: Two (2) sets

2. Functional Requirements

2.1. The boarding step made of aluminum shall be provided to access rolling stock interior or car body side exterior in the N02 Un-scheduled Repair Shop.

2.2. Major dimension shall be as follows; the Contractor shall confirm to the Rolling Stock Contractor:

   i. Platform size: approx. 1,000 mm x 1,000 mm,

   ii. Height: 1,100 mm.

3. Design

3.1. The boarding step shall be easily moved by hand with strong and lockable casters.

3.2. The steps and the platform shall be of non-slip type.

4. Interface Requirement

   Interface shall be taken at the appropriate timing with the Rolling Stock Contractor

5. Eligible Supplier

   There is no preference.

N02.06 Welding Machine

The same requirements as of N01.10 shall be applied except follows:

1. Quantity: One (1) set

N02.07 Oxygen Acetylene Gas Welder

The same requirements as of N01.11 shall be applied except follows:

1. Quantity: One (1) set

N02.08 Worktable

The same requirements as of N01.14 shall be applied except follows:

1. Quantity: One (1) pc

N02.09 Tool Cabinet

The same requirements as of N01.15 shall be applied except follows:

1. Quantity: One (1) pc

N02.10 Front Car Working Deck

1. Quantity: One (1) set

2. Functional Requirements

2.1. The Front Car Working Deck made of aluminum shall be provided repair of the windshield or wiper in the N02 Un-scheduled Repair Shop.

2.2. Major dimension shall be as follows:

i. Deck size: approx. H2,000 mm x W3,000 mm×L2.000mmm,

ii. Loading capacity: 200 kg (min. 2 persons with hand tools)

iii. Deck Weight: approx.500 kg.

3. Design

3.1. The Front Car Working Deck shall be easily moved by hand with strong and lockable casters.

3.2. The Front Car Working Deck shall be of non-slip type.

3.3. The Front Car Working Deck shall be suitable for Front Car body

3.4. The Front Car Working Deck shall be installed all around safety fence

3.5. The Front Car Working Deck shall be installed boarding step for the working deck

4. Interface Requirement

Interface shall be taken at the appropriate timing with the Rolling Stock Contractor.

5. Eligible Supplier

There is no preference.

N03 Wheel Re-Profiling Shop

N03.01 Underfloor Wheel Re-profiling Lathe

1. Quantity: One (1) set.

2. Functional Requirements

2.2. The underfloor wheel re-profiling lathe shall perform precise machining of wheel tread, wheel flange, wheel front and back faces on a single wheelset.

2.3. Re-profiling of wheels on bogies removed from trains and re-profiling of wheels on individual wheelsets removed from bogies can be performed when the wheel lathe (N20.08) is under maintenance or out of order.

2.4. The wheels shall be re-profiled in-situ without removing bogies and wheelsets from the train.

2.5. Train movement and shunting will be carried out by a shunting locomotive.

2.6. All machining process shall be performed automatically by a CNC system equipped for process control, measurement data, records and sorting and managing wheelset data.

2.7. The machine shall be installed in a dedicated pit of the N03 Wheel Re-profiling Shop.

2.8. Measuring system shall include, but not limited to:

i. Diameter and profile wear of wheels,

ii. Position of wheels.

iii. Wheel distance between inner faces and active faces of wheels on same axle

iv. Automatic measurement of wheel warping and wheel out of roundness measuring on several points of the wheels.

2.9. Wheelset data of EMU is described below; the Contractor shall confirm to the Rolling Stock Contractor:

i. Track gauge: 1,435 mm,

ii. Wheel diameter range: 760 – 860 mm,

iii. Brake disc diameter: range: 300 – 700 mm,

iv. Axle length range: 1,850 - 2,200 mm,

v. Tread profile: EMU standard,

vi. Axle load of a wheelset: max. 15 tons,

vii. Diameter allowance within 2 wheels: within 0.5 mm,

viii. Diameter allowance within a bogie: within 3 mm,

ix. Diameter allowance within a car: within 6 mm.

x. The data shall be able to be uploaded by USB at any time.

xi. The chip conveyer shall be integrated. Two (2) chip bins shall be provided with the machine.

2.10. The machine shall be able to support maintenance for rolling stock from NSCR N-1 CP 03, CP NS-02 and CP NS-03.

3. Design

3.1. Arrangement of the lathe shall be referred to the drawing MCRP-DWG-DEP-DEF-0005, Wheel, Re-profiling Shop Layout.

3.2. The automatic control and monitoring system shall be equipped for the throughout the machining process including:

i. Clamping the wheelset,

ii. Measurement before, during and after machining,

iii. Determining machining parameters,

iv. Proposing machining cycle, which can be manually modified and approved,

v. Slip detection,

vi. Control of machining cycle.

3.3. The control and monitoring display (s) shall be equipped, on which the operator can receive necessary data and information for the wheelset and machining and can be guided for operation.

3.4. The data system shall have, but not limited to:

i. Train ID, Bogie ID, wheel ID,

ii. Profile evaluation (wear status), machining parameters,

iii. Production data recording, ordering management,

iv. Operator ID, date,

3.5. Machine diagnosis and logging.

3.6. Data input shall be at the machine by operator on touch screen or keyboard, or via USB.

3.7. Automatic storing of all wheel dimensions after machining associated with wheel location within train and individual wheel serial number shall be provided for data export by USB data transmission.

3.8. A printer for outputting data and results of machining shall be provided.

3.9. Chip crushing facility, with chip collection and transfer by conveyor(s) to container on workshop floor (next to machine pit) for removal by forklift truck.

3.10. Safety and alarm system shall be provided for operator, overload in cutting process, cutting tool retraction in case of tool damage or power failure and protect machine and tool, and after recovery, the machining can be resumed at the suspended position.

3.11. The electrical cabinets shall comply with IP 55 as standard.

3.12. The following adjustment tools shall be provided:

1 set of Wheelset

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing within other related contractors such as for Building regarding floor pit, electric source, distribution box, cable connection, etc. particularly regarding the following issue, but not limited to:

i. Floor pit and anchor bolt hole, if any,

ii. Tolerance of floor levelness,

iii. Equipment weight,

iv. Electric power supply, cable route, etc.,

v. Floor loading (t/m2) in floor contact areas.

4.2. The pit cover, floor grating or stairs to the pit, if required, shall be provided and installed with the machine.

4.3. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N03.02 Jib Crane 1t

1. Quantity: Two (2) sets.

2. Functional Requirements

2.1. The jib cranes shall be provided for the N03 Wheel Re-profiling Shop.

2.2. Major performance shall be as follows:

   i. Type: Cantilever-pillar, self standing type,

   ii. Lifting capacity: 1 ton,

   iii. Swing: 180deg. motorized,

   iv. Reach: approx. 4 m,

   v. Lifting height: approx. 4 m from the floor,

   vi. Lifting speed: maker's standard (reference, 7 m/min.), with jogging,

   vii. Hoist travel speed: maker's standard (reference, 20 m/min.),

   viii. Swing speed: maker's standard.

3. Design

3.1. Operation and control on a pendant shall be applied, on which an emergency stop button shall be provided.

3.2. Safety devices shall be integrated for overload, highest/lowest limit switch, etc.

3.3. Arrangement of the equipment shall be referred to the drawing MCRP-DWG-DEP-DEF-0005, Wheel Re-profiling Shop Layout.

4. Interface Requirement

The Contractor shall provide and install the crane in the workshops, with appropriate interface coordination with the Building Contractor, regarding layout, anchor holes, anchor bolts, power supply, electric distribution box, installation work.

5. Eligible Supplier

There is no preference.

N03.03 Worktable

The same requirements as of N01.14 shall be applied except follows:

Quantity: One (1) pc

N03.04 Tool Cabinet

The same requirements as of N01.15 shall be applied except follows:

Quantity: One (1) pc

N03.05 Baby Compressor

1. Quantity: One (1) set

2. Functional Requirements

2.1. The Baby compressors shall be provided for general purpose air supply system in N03 Wheel Re-profiling Shop.

2.2. The air compressor shall be a general purpose and manufacture's standard type covering the following major performance:

2.3. Type: Electric driven package type, air cooled oil free type, with integrated air dryer, on-floor installation type,

2.4. Compressor capacity: approx. 1.3 m3/min. 0.85 MPa.

2.5. The air compressor shall be composed of, but not limited to:

i. Air compressor: one (1) sets,

ii. Air reservoir: one (1), approx.1.3 m3,

iii. Exhaust ducts.

3. Design

3.1. The supply system shall be connected to the distribution piping provided by the Building Contractor at the outlet of the pressure regulating valve after the air reservoir.

3.2. The following accessories shall be included, but not limited to:

i. Air filter

ii. Necessary air piping system with valves,

iii. Pressure regulating valve unit,

iv. Air hose (10m) and Air Gun

v. Maintenance tool kit.

4. Interface Requirement

Interface shall be taken at the appropriate timing with the Building Contractor regarding, electric source, distribution box, cable connection, ducting, etc. particularly regarding the following issues, but not limited to:

i. Floor drilled anchor bolt, if any,

ii. Exhaust duct route, duct supports and penetration of building wall, finishing of penetration hole, etc.,

iii. Drainage,

iv. Equipment weight,

v. Floor loading (t/m2) in floor contact areas.

vi. Distribution air pipes to the Unscheduled Shop and the Wheel Reprofiling Shop after the outlet valve on the air tank will be provided by the Building Contractor.

5. Eligible Supplier: There is no preference.

N04 CARBODY WASHER

N04.01 AUTOMATIC CAR BODY WASHER

1. Quantity: One (1) set
2. Functional Requirements

2.1. The system shall be custom designed for washing trains for MCRP and NSCR.

2.2. The automatic car body washer shall be provided for the external washing of rolling stock entering from the stabling yard.

2.3. One directional, automatic washing process shall be applied, where when the train is passing the washing machine, water washing, and brushing shall be performed in.

i. Wash System - Automatic: Sequential starting and stopping of the vehicle washer and interfacing controls shall be completely automatic, not requiring services of an attendant other than for routine servicing, inspection, and maintenance.

ii. Manual Controls: A manual capability shall be provided to override automatic controls in the event of malfunctions or failure of system, or permit passage of train through the wash lane without being washed

2.4. Entry shall be through a pre-rinse high pressure arch for cooling or heating the surface and the proceeding through an alkaline application cycle, progressing through a brush washing cycle which shall effectively scrub surfaces of eaves and sides of rail vehicles including windows using a minimum of four (4) rotary brushes, each equipped with detergent spray applicators.

2.5. When the train comes into the front wash section, the signal light blinks red and the train stops. The front is washed with front brushes which shall effectively scrub all body surfaces of front and sides of rail vehicles including curved front and rear windshield, windows, using a minimum of four (4) rotary brushes, each equipped with detergent spray applicators

2.6. When the rear of the train enters the rear wash station, the driver is signaled to STOP by a red light (traffic light). The brushes shall then move into the back of the train, cleaning with the split horizontal top brush.

2.7. The number of passes shall be programmable as per the operator's requirement. The light signal then indicates forward, and the train continues to drive through the wash bay.

2.8. Final rinse of the front, sides and rear, shall be by high efficiency water saving rinse system.

2.9. Finally, a high-speed blower/dryer system to strip excess water from the vehicle. The system can include a complete water treatment system with a fresh water reducing system.

2.10. The machine shall be provided with recycling water system and wastewater treatment system.

i. Wash water shall be recycled to the maximum extent.

ii. For final rinse fresh water shall be used.

iii. Wash water shall be of biodegradable type.

iv. Detergents and related ingredients for the wash process shall be available locally in the Philippines.

v. Wastewater shall be treated to meet Philippine Environmental Standards.

2.11. The machine shall be designed to meet the washing rate of max. 40 trains of eight-cars per day.

2.12. Rolling stock side shell, front and rear panels shall be washed by the rotating brush technology in this machine.

2.13. The washing process shall be activated by the train driver through the cabin window with a start button at once stop in front of the machine. The automatic start washing program by the sensor shall be also applied.

2.14. Automatic car body wash shall be designed to prevent damage to any part of the train. For instance, windscreen wiper.

2.15. The washing process and detergents proposed to be used shall not reduce the life of the car body structure and car finishing.

2.16. The machine shall be able to use recycled water.

2.17. The pit cover and floor grating shall be provided and installed with the machine.

3. Design

3.1. The rolling stock parameters for the machine are as follows:

i. Track gauge : 1,435 mm,

ii. Shape : to be confirmed to the Rolling Stock Contractor,

iii. Car body size : 2,950 (W) x 20,000 (L) x 3,600 (H) mm,

iv. Car body material : to be confirmed to the Rolling Stock Contractor,

v. Train speed : max. 5km/h (Configurable from 1-5 kmph) for washing, others 25 km/h,

vi. Train length : 160 m (8 cars). Design of car body washing machine be able to accommodate the potential change of train configuration to 10-cars length (200 m) in future.

3.2. The equipment shall be arranged at a proper position in the allocated space of the Depot.

3.3. Fresh water supply system shall be provided by the Building Contractor.

3.4. The machine shall be controlled and monitored from an industrial PC interface with all functions for proper operation indicated in real-time and warnings provided in visual and audible with a flashlight (red color) for the depot personnel.

3.5. Track works and Civil works comprising track rails, concrete foundation for installation of the plant, drainage of wash water, shall be constructed by the Building Contractor and the Track Contractor.

3.6. Planned size of the foundation and drainage slab for this machine is around 7.0 m width (excl. operation room and mechanical room) and maximum 50 m length for drainage slab.

3.7. The System shall be composed of followings, but not limited to:

i. Program/Wash Selector
ii. Pre-rinse Arch
iii. Booster pump for Pre-rinse Arch
iv. Detergent arch
v. Automatic detergent mixing with pump
vi. Four (4) side brushes (Wash section)
vii. Four (4) brush gantry system, (front/side and rear wash system)
viii. Automatic rinse distribution system
ix. Final Rinse Arch
x. Booster pump for rinse water

xi. Buffer tank for Fresh water
xii. High Speed Dryer/Blower System
xiii. Water Recycling
xiv. Buffer tank for Reclaim water
xv. Wash Water Pump (Reclaim water)
xvi. Motor Control Center
xvii. Traffic lights (2 no.)

3.8. Finish: All fabricated sections of washer frame, brush yokes and arms, spray arch frames, and miscellaneous structures shall be hot-dipped galvanized after fabrication.

i. Metallic surfaces not suitable for galvanizing shall be coated with 95% zinc primer and covered with durable machine enamel.

ii. All erection bolts shall be plated.

iii. Miscellaneous components including automatic air system with control panel, brush yokes, columns, base plates, anchor bolts, etc. shall be included.

iv. The washing brushes and spray nozzles shall be installed in the casing made of stainless-steel plates.

3.9. The casing shall be equipped with an inspection deck and a ladder at the convenient height for inspection and adjustment.

3.10. Rolling stock and Structure gauge drawing MCRP-DWG-GEN-TK- 0020 Rev 6 or latest shall be referred.

4. Interface Requirement

4.1. The Contractor shall take sufficient interface with the Building Contractor regarding size, structure, performance for; but not limited to:

i. Drain trench and sump pit, connection with civil scope including, measures for strong squall water, etc.

ii. Utilities Required:

a. Electrical: 400 VAC, 3 phase and 230 VAC, 1 phase

b. Water: 2" at 3-4 BAR minimum feed with backflow protection to mutually agreed service areas such as the pump room and wash bay. (5L/second)

c. Compressed Air: 1/2", 200L/min feed (compressed dry air) to mutually agreed service areas such as the pump room and wash bay.

d. Drain: 160mm floor drain, minimum.

e. Ground tanks

4.2. Interface shall be taken with the Rolling Stock Contractor regarding the technical particulars of the Rolling stock.

4.3. The washing shall cover NS-02 rolling stock, NS-03 rolling stock and NSCR CP-03 rolling stock.

5. Eligible Supplier

There is no preference.

N11 Underfloor cleaning Shop

N11.01 Underfloor Air Blow Machine with Dust Collector

1. Quantity: One (1) set

2. Functional Requirements

2.1. The Underfloor air blow machine with dust collector shall be provided for cleaning of the underfloor equipment of car and collecting dust in the N11 Underfloor cleaning shop

2.2. The cleaning is performed automatically with a compressed air gun running the car through the machine by the shunter, car speed less than 5km/h

2.3. The dust collector for ventilation, exhausting and dust collecting shall be provided for the machine.

2.4. Exhaust duct shall lead to the outside of the building.

2.5. The floor area for the air blow machine with dust collector shall be less than shop size 20.0 m (L), 10.0 m (W).

3. Design

3.1. The Underfloor Air Blow Machine with Dust Collector shall be composed of, but not limited to:

- i. Air blow gun type: swing drive type,
- ii. Number of air blow gun: Underfloor side 3 sets×2, pit 2 sets,
- iii. Air blow wind velocity: 40～50m/s
- iv. Dust collecting and exhaust/ventilation system with filter, dust box, exhaust fan(s), exhaust duct,
- v. Control panel,
- vi. Personal safety gears

3.2. Dust collection, exhaust and ventilation systems shall satisfy environmental regulations.

3.3. Arrangement of the underfloor air blow machine with dust collector shall be referred to the Workshop Layout drawings.

4. Interface Requirement

4.1. Interface shall be taken with the Building Contractor regarding the following issues, but not limited to:

- i. Floor pit and anchor bolts, if any,
- ii. Exhaust ducting, finishing of duct hole on the building,
- iii. Utility arrangement such as electric cabling, compressed air piping, etc.

4.2. Exhaust duct shall be included in the scope of the equipment

4.3. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N12 Bogie Removal / installation shop

N12.01 10/3 t Overhead Traveling Crane

The same requirements as those of N02.01 shall be applied except follows:

1. Quantity: One (1) set of crane, One (1) lots of lifting gear (described hereunder)
2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including battery for temporary bogie (as max. load), which is used at the N12 Bogie removal/installation Shop.

2.2. Crane performance is as follows:

- i. Lifting capacity: Two hoists, 10 / 3 tons,
- ii. Travelling distance: approx. 290 m,
- iii. Traverse distance (between center of crane rails): approx. 30 m,
- iv. Lifting height: approx. 9.0 m.

3. Design

The following lifting tools shall be provided:

- i. 2 sets of lifting gear for lifting bogie (approx. 3.0 m x 2.7 m, < 10 tons),
- ii. 2 sets of lifting slings. (for 1 ton – 3 tons, <10 tons)

4. Interface Requirement

Same as those specified for N02.01

5. Eligible Supplier

There is no preference.

N12.02 Car Body Lifting Jack

1. Quantity: Twenty-Five (25) sets

2. Functional Requirements

Quantity of Lifting Jacks:	4 Nos per Set
Lifting capacity per Jack	10t Min.
Lifting capacity per set	04 x 10t =40t Min.
Lowest position of cantilever (claw) above T.O.R.	400mm
Highest position of cantilever (claw) above T.O.R.	2.500mm
Vertical stroke	2.115mm
Regulating range of the cantilever	475mm in horizontal direction
Lifting/lowering speed	approx. 300mm/min
Operating voltage	400V±10% / 50Hz±5%/ 3 phases
Control voltage	230V±10%/ 50Hz±5%/ 24V DC
Protection of electrical equipment	IP55
Isolation class	F
Synchronization tolerance	±5mm
Noise level	Max 75 dB(A) in a distance of 1m
Floor flatness	Max ±5mm in a distance of 2m

2.1. One car body lifting jack set shall consist of four (4) on-floor type mobile jacks of electric motor driven screw type having self-locking features when the power fails, and a control system for lifting of single car provided in the N12 Bogie Removal/Installation Shop.

2.2. Four jacks shall be synchronized during the lifting process after confirming enough contact with jacking pads on the car within a tolerance of +/- 5 mm..

2.3. Each Lifting Jack will be overload tested Dynamically with 115% of the SWL and Statically with 150% of the SWL.

2.4. The equipment will be executed in metric system.

2.5. All the basic components in the system will be interchangeable

3. Design:

3.1. Major particulars of car will be as follows; the Contractor shall confirm to the Rolling Stock Contractor:

i. Track: 1,435 mm gauge,

ii. Cary weight: less than 40 tons except bogies,

iii. Car width: 2,950 mm (1,435 mm gauge).

3.2. Arrangement of lifting positions shall be referred to the Workshop Layout drawings.

3.3. The jacking operation shall be carried out and controlled on the central control panel, and remote-control box shall be provided for single jack operation.

3.4. In-floor socket boxes including plugs shall be provided.

3.5. Safety measure shall be provided for the train opposite side where the staff cannot watch from the central control panel.

3.6. Flashing lights and audible warning device shall be provided for operation safety.

3.7. Emergency stop button (mushroom type) shall be provided on each control position.

3.8. Contact condition between a jack and the car body at starting and during lifting process shall be confirmed securely by the sensor technology.

3.9. Lifting jacks shall be stopped when exceeding the synchronization tolerance and correction of deviation and resuming synchronized operation shall be performed.

3.10. Operating and failure status shall be indicated on the central control panel.

3.11. PC/PLC for controlling jacks shall have back-up battery for power-source failure.

3.12. Power and control cables for jacks set shall be provided with multipin connectors and sufficient length covering each jack's position.

3.13. All integral wirings to the control panel and individual jack shall be factory-wired. Other wirings shall be completed on site during installation. All equipment shall be suitably earthed.

3.14. Movement of jacks to the lifting position shall be available manually on the floor, assisted by hydraulically raised wheels. Wheels shall be retracted for lifting.

3.15. Each jack shall be equipped with lifting eye-plates and/or hungers for transport with crane or forklift truck within the Depot/Workshop.

4. Interface Requirement

4.1. Interface shall be taken with other related contractors such as for the Building Contractor regarding electric source, distribution box, cable connection, etc. especially the following issues, but not limited to:

- i. Tolerance of floor levelness in jacking areas,
- ii. Equipment weight,
- iii. Floor loading (t/m2) in floor contact areas,
- iv. Power and control cable pipe, route, location and dimension.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N12.03 Not used

N12.04 Temporary Bogie

1. Quantity: Twenty-four (24) sets

   (A power-driven bogie and a trailer bogie)

2. Functional Requirements

2.1. One set is composed of two temporary bogies: a power-driven bogie and a trailer bogie.

2.2. The temporary bogie shall have a function to be driven with power and to move a car body in the Lifting direction.

2.3. The temporary bogie is to be used at the N12 Bogie removal/ installation shop, the N13 Car body Shop and N15 Paint Shop.

2.4. Power-driven bogies shall have functions to drive and lift a car body.

2.5. A trailer bogie shall have both functions to move by manual and to lift a car body.

2.6. The two bogies shall be manually operated by pendant switch manipulation to drive and/or lift a car body.

2.7. The two bogies shall have a function to stop by pressing the emergency pushbutton switch.

3. Design

3.1. The temporary bogie shall be composed of the following components:

3.2. Wheels, a frame, running motors, hydraulic pumps, ascending/descending cylinders, a pendant, an emergency stop button for safety and a warning lamp.

3.3. The major particulars of the temporary bogie shall be as follows, but not limited to:

   i. Type: Approximate dimensions: width approx. 2.6 m, length approx. 2.5 m, height approx.1.0m and wheelbase approx.1.4 m,
   ii. Total weight: Approx. 5.0 tons or less,
   iii. Operating method: Wired remote-control pendant,
   iv. Approximate car body lifting stroke: Maximum 0.6 m, with a stopper provided to suspend the car body midway at the intermediate height,
   v. The unit shall be designed to lift a car body with hydraulic pumps and cylinders,
   vi. Approximate maximum car body weight: 40 tons,
   vii. Approximate running speed: 20 m/min (low-speed mode) and 40 m/min (high-speed mode),
   viii. Maximum gradient climbing performance: Gradient approx. 7° (when loaded with a weight of 40 tons),
   ix. Maximum running distance: 1,500 m or over (with batteries fully charged),
   x. Maximum heart resistance: 80 deg.
   xi. Power source: batteries for running and external power cable for lifting.
   xii. The following accessories shall be supplied, but not limited to:
   Battery charging device and cable and accessories and tools.

4. Interface Requirement

   Interface shall be taken with the Rolling Stock Contractor appropriate timing.

5. Eligible Supplier

   There is no preference.

N12.05 Welding Machine

The same requirements as of N01.10 shall be applied except follows:

Quantity: One (1) set

N12.06 Oxygen Acetylene Gas Welder

The same requirements as of N01.11 shall be applied except follows:

Particle Quantity: One (1) set

N12.07 Worktable

The same requirements as of N01.14 shall be applied except follows:

Quantity: Two (2) pcs

N12.08 Tool Cabinet

The same requirements as of N01.15 shall be applied except follows:

Quantity: two (2) pcs

N12.09 Bogie Transport Unit

1. Quantity: six (6) pcs

2. Functional Requirements

2.1. Battery-operated Bogie Transport Unit for removal and installation of bogies on lifted rolling stock, hi-rail type, manually and remotely guided operation.

2.2. Operations

i. Vehicle with load carrying platform shall be placed under respective bogie of lifted car or train.
ii. After the detachment the bogie shall be lowered, and the Bogie Transport Unit shall maneuver laterally from under the car then transport the bogie to the overhaul area in the workshop where the bogie will be hoisted by crane on to a disassembly stand or placed on the workshop floor.
iii. After the overhaul bogies will be loaded on the Bogie Transport Unit and brought to designated locations for installation under the car or train.
iv. The Bogie Transport Unit shall be equipped with four steerable wheels and resilient tires in order to move in any direction as needed.
v. For lateral positioning the Bogie Transport Unit shall engage with the embedded rails in the floor.
vi. This process shall be suitable for bogie replacement on individual cars and trains.
vii. The Bogie Transport Unit shall be provided with full safety features for protection of equipment operators

2.3. Control

i. The Bogie Transport Unit shall be approximately the size bogies.
ii. The remote control shall be detachable to permit the operator to walk alongside the Bogie Transport Unit. All operating commands shall be performed from the console.
iii. The raising and lowering of the loading platform may be powered by on-board batteries or from a nearby 400 V ac 60 Hz source in the workshop.
iv. The bogie platform shall be adjustable +/-50 mm in the fore and aft direction for bogie installation.

3. Design

i. The Bogie Transport Unit shall be approximately the size of bogies.
ii. The bogie platform lifting height shall be 1.6 to 1.8 m from workshop floor.
iii. The loading and transport capacity shall be 8 t.
iv. Travelling speed shall be in the range of 0.5 to 4.0 km/h.
v. Battery operation of Bogie Transport Unit shall be eight (8) hours. Duration for charging batteries shall be within eight (8) hours.

4. Interface Requirement

Interface shall be taken with the Rolling Stock Contractor appropriate clearance.

5. Eligible Supplier

There is no preference.

N13 CARBODY SHOP

N13.01 3t Overhead Traveling Crane

The same requirements as of N12.01 shall be applied except follows:

1. Quantity: Three (3) sets of cranes

   Three (3) lots of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including air conditioner for rolling stock (as max. load), which is used at the N13 Car Body Shop.

2.2. Crane performance is as follows:

   i. Lifting capacity: One hoist, 3 tons,

   ii. Traverse distance (between center of crane rails): approx. 30 m,

   iii. Lifting height: approx. 9.0 m.

3. Design

   The following lifting tools shall be provided:

   i. 2 sets of lifting gear for general use (< 3 tons),

   ii. 2 sets of lifting slings,

   iii. 2 sets of lifting slings for air conditioner.

N13.02 Not Used

N13.03 Underfloor Equipment Lifter 2t

1. Quantity: Three (3) sets,

2. Functional Requirements

2.1. The underfloor equipment lifter 2t of scissor type shall be provided to dismantling or installing underfloor large equipment.

2.2. Major performance shall be as follows:

   i. Lifting capacity: 2 tons,

   ii. Lifting height: more than 500 mm,

   iii. Table size: 2,500 x 1,000 mm, slide table type,

   iv. Power: Battery driven DC motored hydraulic unit,

3. Design

3.1. The lowest height of the table shall be minimized as much as possible.

3.2. The table turning device shall have a locking mechanism.

3.3. Battery charger shall be provided and built on the lifter, if possible.

3.4. Battery of 24 V DC is preferable and shall be of maintenance-free type.

3.5. The lifter shall have manual manoeuvring handle (lever) on one caster. The caster shall be of heavy load type.

3.6. The lifter shall have ahead and astern running modes.

4. Interface Requirement

   Interface shall be taken with other related contractors, if required

5. Eligible Supplier

   There is no preference

N13.04 Movable Lifting Platform

The same requirements as N02.04 shall be provided except flows:

1. Quantity: Sixteen (16) sets

2. Functional Requirements

   The movable lifting platform of scissor type shall be provided for high place work of the N13 Car Body Shop.

N13.05 Boarding Step

The same requirements as N02.05 shall be provided except flows:

1. Quantity: Twenty-four (24) Sets

2. Functional Requirements

2.1. The boarding step made of aluminum shall be provided to access rolling stock interior or car body side exterior in the N13 Car Body Shop.

2.2. Two kinds of the boarding steps shall be provided, but not limited to:

   i. 1,100 mm height: Twenty-four (24) pcs,

   ii. 2,000 mm height: Twenty-four (24) pcs.

2.3. Major dimension shall be as follows:

Platform size: approx. 1,000 mm x 1,000 mm.

3. Design

The boarding step shall be easily moved by hand with strong and lockable casters.

The steps and the platform shall be of non-slip type.

4. Interface Requirement

Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N13.06 Tight lock Coupler Carrier

1. Quantity: Three (3) pc

2. Functional Requirements

2.1. The tight lock coupler carrier shall be provided for the installation and removal of the tight lock coupler and the draft gear to/from the car body in the N13 Car Body Shop and shall be provided for the transportation between N13 Car Body Shop and the N23 Tight Lock Coupler & Draft Gear Shop.

2.2. The tight lock coupler carrier shall be composed of the forklift truck and the tight lock coupler & draft gear supporting section.

2.3. This means the coupler head and the draft gear support device attached on the back rest of the forklift truck.

2.4. Major functions of the tight lock coupler carrier shall be as follows:

i. The set of the tight lock coupler &draft gear dimension (max.): approx. 1,500 (L) x 500 (W) x 600 (H) mm,

ii. The set of the tight lock coupler &the draft gear weight (max.): approx. 500 kg,

iii. Type of mast, back rest and supporting section operation:

a. Lift up/down of back rest and supporting section:
Max. height of the coupler center: approx. 2,000 mm from the floor.
b. Tilt for/back-word of the mast,
Tilt angle: approx. (For-word) 6°, (Back-word) 12°,
c. Shift the coupler head potion in the lateral direction,
Distance of shift: approx. 100mm shift for both left and right,
d. Reach out and retract the draft gear support device,
Distance of reach-out: approx. 600mm,
e. Rotation of the coupler head around longitudinal axis,
Rotation angle: approx. 90° both CW and CCW.

2.5. The major particulars of the forklift truck:

i. Type: four wheelers of self-sealing rubber tires, with guarded driving seat, battery driven,
ii. Battery: enclosed maintenance free type,
iii. Speed: approx. 13.5 (14) km/h in loaded (unloaded) condition.

3. Design

3.1. The tight lock coupler carrier shall be operated by hydraulic power device.
3.2. Source of hydraulic power shall be supplied by electric-motor-powered hydraulic pump.
3.3. The tight lock coupler & draft gear shall not be fallen down rapidly by gravity when the hydraulic power generator is shut down due to any reason.
3.4. The tight lock coupler & draft gear supporting section shall be made of steel structure and shall be light as much as possible.
3.5. The coupler head shall enable to rotate manually around its linkage hole center.
3.6. Necessary protective material (for example; non-slip rubber material) shall be used to avoid the damage of the tight lock coupler & drafting gear.
3.7. The following accessories shall be supplied, but not limited to:

i. Coupler head jig for the couplers that rolling stock has,
ii. Battery charging device and cable,
iii. Standard accessories and tools.

4. Interface Requirement
   Interface shall be taken with the Rolling Stock Contractor regarding technical particulars (especially, dimension and weight) about the tight lock coupler & draft gear.

5. Eligible Supplier
   There is no preference.

N13.07 Double Head Grinder

The same requirements as those of N01.07 shall be applied except follows:

Quantity: Four (4) sets

N13.08 Upright Drilling Machine

The same requirements as those of N01.08 shall be applied except follows:

Quantity: Two (2) sets

N13.09 Disc Cutter

The same requirements as those of N01.09 shall be applied except follows:

Quantity: Two (2) sets

N13.10 Welding Machine

The same requirements as those of N01.10 shall be applied except follows:

Quantity: Four (4) sets

N13.11 Oxygen Acetylene Gas Welder

The same requirements as those of N01.11 shall be applied except follows:

Particle Quantity: Four (4) sets

N13.12 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: Eight (8) pcs

N13.13 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: Eight (8) pcs

N14 SEWAGE TANK SHOP

N14.01 3t Overhead Traveling Crane

The same requirements as of N12.01 shall be applied except follows:

1. Quantity: One (1) set of crane

   One (1) lot of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including Sewage tank for rolling stock (as max. load), which is used at the N14 Sewage tank Shop.

2.2. Crane performance is as follows:

   i. Lifting capacity: One hoist, 3 tons,
   ii. Traverse distance (between center of crane rails): approx. 20 m,
   iii. Lifting height: approx. 9.0 m.

3. Design

   The following lifting tools shall be provided:

   i. 2 sets of lifting gear for general use (< 3 tons),
   ii. 2 sets of lifting slings,
   iii. 2 sets of lifting slings for air conditioner.

N14.02 High Pressure Water Cleaner

The same requirements as those of N01.17 shall be applied except follows:

Quantity: One (1) set

N14.03 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: One (1) pc

N14.04 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: One (1) pc

N15 PAINT SHOP

N15.01 Work Lift Platform

1. Quantity: Eight (8) sets

2. Functional Requirements

2.1. One set is composed of two lifting platforms.

2.2. The work lift platform of scissor type shall be provided for painting work deck in the painting booth and on the Pit of the N15 Paint Shop.

2.3. Two lifting platforms shall be installed on the floor along the sides of the car body in each booth.

2.4. Major performance shall be as follows:
i. Loading capacity: 200 kg (min. 2 persons with hand tools),
ii. Top height: approx. 4,200 mm above the floor,
iii. Platform size: approx. L 21,000 x W 900 mm,
iv. Power: AC 400V, 3 phase,
v. Lifting mechanism: scissors lifting device with hydraulic cylinder,
vi. Accessories: foot plates for car end painting work.

3. Design

3.1. The lowest height of the table shall be minimized as much as possible.

3.2. Lifting operation shall be performed on the platform. Operating switch shall be of explosion-proof type.

3.3. In order to keep safety for lifting platform, lifting platform shall have 900 mm height handrail at 3 sides except the car body side. The door on the platform shall be provided at both ends.

3.4. The floor of the platform shall be of non-slip type such as checkered steel plate or grating.

3.5. The floor of the platform shall be equipped with utility connections such as water supply and compressed air with quick couplers.

3.6. Arrangement of the lift platform shall be referred to the drawing Workshop Layout drawings.

4. Interface Requirement

Interface shall be taken at the appropriate timing with the Building Contractor regarding, but not limited to:

i. Lifting platform size, installation, anchor bolts, etc.,
ii. Electric power source, distribution box, cabling, etc.,
iii. Water and air piping, route, etc.

5. Eligible Supplier

There is no preference.

N15.02 Car Body Washing Booth

1. Quantity: One (1) set

2. Functional Requirements

2.1. The car body washing booth shall be provided for the prevention of spray scattering by car body washing in the N15 Paint Shop.

2.2. The car body washing booth shall be composed of, but not limited to:

i. Booth,
ii. Ventilation device of push-pull in the booth,
iii. Air washing and dust collecting device.

2.3. The booth shall be equipped with the following facilities at minimum:

i. Fresh air discharge outlet in the ceiling,
ii. Air outlet at the floor,
iii. Underfloor water pool,
iv. Air duct with exhaust fan,
v. Traveling rails for the work lift platforms,
vi. Car body transfer device.

2.4. Air mean velocity shall be about 0.2 m/sec. at 1.5 m above the floor.

2.5. Floor embedded rail for car body moving will be provided through the booth by the Building Contractor.

2.6. Car body data of EMU is described below; the Contractor shall confirm to the Rolling Stock Contractor:

i. Track gauge: 1,435 mm,
ii. Size: L 19,500 mm x W 2,950 mm x H 3,800 mm,
iii. Net weight: max. 40 ton.

3. Design

3.1. The booth size shall be within approx. L 30,000 x W 6,000 x H 7,000 mm.

3.2. Working lift platforms (N15.01) for painting work shall be integrated in the booth.

3.3. The pit cover (floor grating) shall be provided and installed.

3.4. Arrangement of the Car body washing booth shall be referred to the Workshop Layout drawings.

4. Interface Requirement

Interface shall be taken at the appropriate timing with the Building Contractor regarding, but not limited to:

i. Floor pit structure and size,
ii. Booth size, installation, anchor bolts, floor finishing work,
iii. Electric power source, distribution box, cabling, etc.
iv. Water piping, route, supply piping, drainage, etc.
v. Duct, size, support, route, wall penetration, opening finishing, etc.

5. Eligible Supplier

There is no preference.

N15.03 Car Body Painting Booth

1. Quantity: One (1) set

2. Functional Requirements

2.1. The car body painting booth shall be provided for painting of the car body in the N15 Paint Shop.

2.2. The car body painting booth shall be composed of, but not limited to:

- i. Booth,
- ii. Ventilation device of push-pull in the booth,
- iii. Air washing and dust collecting device.

2.3. The booth shall be equipped with the following facilities at minimum:

- i. Fresh air discharge outlet in the ceiling,
- ii. Air outlet at the floor,
- iii. Underfloor water pool,
- iv. Air duct with exhaust fan collecting paint mist by water,
- v. Traveling rails for the work lift platforms,
- vi. Car body transfer device.

2.4. Air mean velocity shall be about 0.2 m/sec. at 1.5 m above the floor.

2.5. Floor embedded rail for car body moving will be provided through the booth by the Building Contractor.

2.6. Car body data of EMU are described below; the Contractor shall confirm to the Rolling Stock Contractor:

- i. Track gauge: 1,435 mm,
- ii. Size: L 19,500 mm x W 2,950 mm x H 3,800 mm,
- iii. Net weight: max. 50 ton.

3. Design

3.1. The booth size shall be within L 30,000 x W 6,000 x H 7,000 mm.

3.2. Working lift platforms (N15.01) for painting work and painting machine (N15.05) shall be integrated in the booth.

3.3. The pit cover (floor grating) shall be provided and installed.

3.4. Arrangement of the car body painting booth shall be referred to Workshop Layout drawings.

4. Interface Requirement

Interface shall be taken at the appropriate timing with the Building Contractor regarding, but not limited to:

- i. Floor pit structure and size,
- ii. Booth size, installation, anchor bolts, floor finishing work,
- iii. Electric power source, distribution box, cabling, etc.,
- iv. Water piping, route, supply piping, drainage, etc.,
- v. Duct, size, support, route, wall penetration, opening finishing, etc.

5. Eligible Supplier

There is no preference.

N15.04 Car Body Drying Booth (Include Fuel Tank)

1. Quantity: Two (2) sets

2. Functional Requirements

2.1. The car body drying booth including its fuel tank shall be provided for drying paint and ventilation of harmful gas in the N15 Paint Shop.

2.2. The car body drying booth shall have the function to hold the inside of the booth up to 80 deg. (usually 60 deg.).

2.3. The car body drying booth shall be composed of, but not limited to:

i. Booth built with thermal insulation wall,

ii. Circulation fan of heated air,

iii. Light oil burner or gas burner,

iv. Temperature control device,

v. Booth lighting and emergency lighting,

vi. Regular and emergency door (with interlock),

vii. Shutter (for entrance and exit),

viii. Car body transfer device,

ix. Fuel Pump (Light oil burner),

x. Fuel tank: Underground type (Light oil burner) 3m3.

2.4. The civil works for fuel tank's foundation and pit shall be included to the Contractor's scope of works as specified in section 8.1 of this ERT. The Contractor shall take the interface with the Building Contractor.

2.5. Floor embedded rail for car body moving will be provided through the booth by the Building Contractor.

2.6. Car body data of EMU are described below; the Contractor shall confirm to the Rolling Stock Contractor:

i. Track gauge: 1,435 mm,

ii. Size: L 19,500 mm x W 2,950 mm x H 3,800 mm,

iii. Net weight: max. 50 ton.

3. Design

3.1. The booth size shall be within approx. L 30,000 x W 6,000 x H 7,000 mm.

3.2. The design of Car Body Drying Booth shall include of underground fuel tank and the civil works for its foundation and pit.

3.3. Fuel receiving pipe with delivery hose screw connection at ground level. The delivery hose connection shall be protected within a connection box set into the ground and having lockable cover plate,

3.4. Arrangement of the car body drying booth shall be referred to the workshop layout drawings.

4. Interface Requirement

Interface shall be taken at the appropriate timing with the Building Contractor regarding, but not limited to:

i. Booth size, installation, anchor bolts, floor finishing work,

ii. Electric power source, distribution box, cabling, etc.,

iii. Duct, size, support, route, wall penetration, opening finishing, etc.

5. Eligible Supplier

There is no preference.

N15.05 Airless Spray-painting Machine

1. Quantity: Two (2) sets

2. Functional Requirements

2.1. The airless spray-painting machine shall be provided for painting the car body.

2.2. The airless spray-painting machine shall be used in the N15.03 car body painting booth installed in the N15 Paint Shop.

2.3. The airless spray-painting machine shall consist of the pump, the airless gun, the pump rack, the paint hose and the mixing machine, etc.

2.4. The airless spray-painting machine shall be a general purpose and manufacturer standard type.

3. Design

3.1. Major functions of the airless spray-painting machine shall be as follows:

  i. Type: Portable,

  ii. Maximum discharge rate: approx. 6 litre/min.

3.2. The length of the hose of the airless spray-painting machine shall be set to 10 m and more.

3.3. The airless spray-painting machine shall have the function in which a paint tank can be attached easily.

3.4. A mixing machine of air motor driven type shall be provided.

3.5. The following accessories shall be included, but not limited to:

  i. Nozzle chip set,

  ii. Manufacturer standard accessories.

4. Interface Requirement

The equipment shall be installed for effective work and in fit-of-purpose with the N15.03 car body painting booth.

5. Eligible Supplier

The same supplier as N15.03 car body painting booth is eligible for effective integration of the system.

N15.06 Parts Painting Booth

1. Quantity: One (1) set

2. Functional Requirement

2.1. The Parts Painting Booth shall be provided for general painting use by manual painting in the N15 Paint Shop.

2.2. A manual painting with airless gun and a painting machine shall be performed.

2.3. The Parts Painting Booth shall be a complete painting system for:

   i. Manual painting including painting equipment,

   ii. Dust collecting, water eliminator and exhausting out of the workshop,

   iii. Personal safety gears for painting work.

2.4. Exhaust duct shall lead to outside of the building.

2.5. The floor area for the Parts Painting Booth except exhaust duct shall be less than approx. 2.0 m (W), 2.5 m (D) without floor pit.

3. Design

3.1. The Parts Painting Booth shall be integrated equipment with a painting compartment, water pool, eliminator, exhaust fan and switch box in the one compact steel casing.

3.2. The Parts Painting Booth shall be composed of, but not limited to:

   i. Casing and painting compartment with light,

   ii. Water eliminator device,

   iii. Exhaust fan, exhaust duct,

   iv. Paint spraying equipment including paint gun, hose, etc.

   v. Paint mixer, portable paint pump, preparation can, caster cart,

   vi. Personal safety gears.

3.3. The booth shall be a pre-fabricated steel plate structure.

3.4. The electric equipment such as light, motor, switch, etc. shall be explosion-proof type.

3.5. Dust eliminator and exhaust systems shall satisfy environmental regulations.

3.6. Exhaust duct shall be included in the scope of the Booth.

3.7. Arrangement of the Parts Painting Booth shall be referred to the work shop layout drawings.

4. Interface Requirement

   Interface shall be taken with the Building Contractor regarding the following issue, but not limited to:

   i. Booth foundation, anchor bolts, if any,

   ii. Exhaust ducting, finishing of duct hole on the building,

   iii. Utility arrangement such as electric cabling, water supply and discharge piping, etc.

5. Eligible Supplier

   There is no preference.

N15.07 Traverser

1. Quantity: One (1) set

2. Functional Requirements

2.1. The traverser shall be provided for traversing the car body between tracks of the N15 Paint Shop and N13 Car body shop.

2.2. The traverser shall be installed between N15 Paint Shop and N13 Car body shop.

2.3. Functions of the traverser shall be as follows, but not limited to:

i. Type: plane track with shallow pit type, two traversing rails, electric motor driven,

ii. Track on traverser: 1,435mm gauge,

iii. Track level: same level as embedded track for shifting,

iv. Load on traverser: max. car body weight: 50 tons,

v. Size of car body: max. W 2,950 mm x L 19,500 mm,

vi. Stop points: the side of the N15 Painting Shop and the N13 Car body shop; 14 points,

vii. Traveling distance: max. approx. 110 m,

viii. Traveling speed: max. approx.25m/min,

ix. Operation: manual control,

x. Electric power supply: insulation cable trolley duct supply.

3. Design

3.1. The traverser shall be of side box-girders structure on which there is the track.

3.2. The Car body with temporary bogies can be put on the traverser.

3.3. Each wheel load of the traverser shall be uniform as much as possible.

3.4. The traverser shall allow a forklift of 5 tons to be able to pass on the traverser floor.

3.5. Locking device shall be provided to avoid moving when the car is moving. The locking device shall be operated from the traverser operation panel.

3.6. The traverser shall be equipped with operation safety device such as operation flush lights, permission of traversing operation device, etc.

3.7. The traverser shall have a driving cab on the traverser.

3.8. The Contractor shall provide, but not limited to:

i. Traverser,

ii. Electric cable trolley from the distribution box provided by the Building Contractor,

iii. Embedded rails in the floor, fastenings, and its installation work,

iv. Standard tools for maintenance,

v. Standard spare parts and consumables.

4. Interface Requirement

4.1. The Contractor shall provide and install the traverser in the workshops, with sufficient interface coordination with the Building Contractor and the Track Contractor at the appropriate timing for, but not limited to:

i. Weight and size of the traverser for civil design confirmation,

ii. Power requirement for power distribution box design,

iii. Power cable route and trough provided by Building Contractor,

iv. Pit size and profile, rail position, rail foundation, installation,

v. Stopping position mechanism, requirement to the pit structure,

vi. Installation work of the traverser.

4.2. Traversing rails and installation work shall be included in the scope, where mortar plastering, and floor finishing work will be carried out by the Building Contractor.

5. Eligible Supplier

There is no preference.

N16 TRACTION MOTOR SHOP

N16.01 3t Overhead Traveling Crane

The same requirements as those of N12.01 shall be applied except follows:

1. Quantity: One (1) set of crane

   One (1) lot of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including rotor (as max. load), which is used at the N16 Traction Motor Shop.

2.2. Crane performance is as follows:

   i. Lifting capacity: One hoist, 3 tons,

   ii. Traverse distance (between center of crane rails): approx. 20 m,

   iii. Lifting height: approx. 9.0 m.

3. Design

   The following lifting tools shall be provided:

   i. 2 sets of lifting gear for general use (< 3 ton),

   ii. 2 sets of lifting slings.

4. Eligible Supplier

   There is no preference.

N16.02 Air Blow Booth with Dust Collector

1. Quantity: One (1) set

2. Functional Requirements

2.1. The air blow booth with dust collector shall be provided for cleaning the traction motor and collecting dust in the N16 Traction Motor Shop.

2.2. The motor is put on the turntable cart by using the overhead crane, and then, the turntable cart is pushed into the booth by the operator.

2.3. The cleaning is performed manually with a compressed air gun with turning the turntable in the booth.

2.4. The dust collector for ventilation, exhausting and dust collecting shall be provided for the booth.

2.5. Exhaust duct shall lead to the outside of the building.

2.6. The floor area for the air blow booth with dust collector shall be less than 5.0 m (L), 5.0 m (W) without floor pit except embedded floor rail for the turntable cart.

3. Design

3.1. The traction motor data for design of the system are as follows, but not limited to:

   i. Motor size: approx. 700 (L) x 800 (W) x 750 (H) mm,

   ii. Motor weight: approx. 600 kg.

3.2. The air blow booth with dust collector shall be composed of, but not limited to:

   i. Air blow booth,
   ii. Turntable cart and embedded rails,
   iii. Compressed air gun, flexible hose and air piping with quick coupler,
   iv. Dust collecting and exhaust/ventilation system with filter, dust box, exhaust fan(s), exhaust duct,
   v. Control panel,
   vi. Personal safety gears.

3.3. The booth shall be a pre-fabricated or custom made of steel plate, and equipped with inlet/outlet curtain, windows, sufficient interior lighting, ventilating louver, etc.

3.4. Dust collection, exhaust and ventilation systems shall satisfy environmental regulations.

3.5. Arrangement of the air blow booth with dust collector shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken with the Building Contractor regarding the following issues, but not limited to:

   i. Booth foundation, anchor bolts, if any,
   ii. Exhaust ducting, finishing of duct hole on the building,
   iii. Utility arrangement such as electric cabling, compressed air piping, etc.,
   iv. Exhaust duct shall be included in the scope of the equipment.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N16.03 Insulation Resistance Tester (incl. HIPOTT)

The same requirements shall be applied as those of N01.03 except the following:

Quantity: One (1) set

N16.04 Grease Supply Equipment

1. Quantity: One (1) set

2. Functional Requirements

2.1. The grease supply equipment shall be provided for easy supply of grease to the motor bearing in the N16 Traction Motor Shop.

2.2. The grease supply equipment shall be an integrated grease supply device with the following major performance:

   i. Quantitative grease supply: 3 -10 cc adjustable with the constant flow valve,

   ii. Air driven grease pumping,

   iii. High pressure grease gun with hose of 10 m,

   iv. Movable with casters.

3. Design

The grease supply equipment shall be composed of the followings, but not limited to:

   i. Frame stand with a pail can table and casters,

   ii. Air driven grease pump,

   iii. Constant flow valve,

   iv. Grease gun with hose,

   v. Control panel with a foot switch,

   vi. Air hose reel of self-winding type,

   vii. Electric cable reel of self-winding type.

   viii. Air hose connector shall be a quick coupler.

   ix. Grease pump shall be driven with the factory compressed air, 0.49 MPa at the service point.

4. Interface Requirement

Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N16.05 Induction Heater for flexible coupling

1. Quantity: One (1) set

2. Functional Requirements

2.1. The induction heater for flexible coupling shall be provided for assembling flexible coupling of the motor shaft in the N16 Traction Motor Shop.

2.2. The induction heater for flexible coupling of a general purpose and off-the-shelf type shall have the following performance:

   i. Temperature range: max. 250 deg. C, controlled by thermocouple,

   ii. Heating time: 0 – 99 min., timer control

2.3. Flexible coupling is as follows:

   i. Taper hub with key,

   ii. Inner diameter: approx. 50 - 70 mm,

   iii. Outer diameter of hub: approx. 110 – 125 mm,

   iv. Hub length: approx. 65 mm,

   v. Max. diameter: approx. 330 mm.

3. Design

   The manufacture standard accessories shall be provided including:

   i. I type core,

   ii. I core guide,

   iii. Temperature sensor.

4. Interface Requirement

4.1. Interface shall be taken the building works in the design stage regarding position of this equipment.

4.2. Interface shall be taken with the Rolling Stock Contractor regarding flexible coupling data.

5. Eligible Supplier

   There is no preference.

N16.06 Motor No-load Test Equipment

1. Quantity: One (1) set

2. Function Requirement

2.1. The motor no-load test equipment shall be provided for automatic unload rotation test of the traction motors which have been removed from bogie, and which is performed on two motors simultaneously in accordance with the fixed pattern.

2.2. The motor no-load test equipment shall be provided for test while the traction motor is fixed to the pallet.

2.3. The motor unload test equipment shall be composed of, but not limited to:

i. Power supply and control board,

ii. Rotation speed sensor, ammeter, vibration meter,

iii. Thermocouple (Temperature sensor of bearing),

iv. Safety fence,

v. Worktable.

2.4. The major functions of the motor no-load test equipment are as follows:

i. Number of motors which can be tested simultaneously: two

ii. Input device: touch screen

iii. Output device: printer

iv. Test item: rotation speed, no-load current, bearing temperature, output waveform of the speed detector, operation in the forward and reverse,

v. Testing time: approx. 40 min.

2.5. The following accessories shall be included, but not limited to:

i. Manufacturer's standard spares,

ii. Thermocouple,

iii. Cover of the speed detector.

3. Design

3.1. The motor no-load test equipment shall be installed on the floor without pit and fixed with drilled anchor bolts.

3.2. Arrangement of the motor unload test equipment shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken within the Building Contractor regarding the following issues, but not limited to:

i. Drilling anchor bolts, if any,

ii. Utility arrangement such as electric cabling, etc.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N16.07 Rack System

1. Quantity: Eight (8) sets

2. Functional Requirements

2.1. The rack system shall be provided for storage material, tools, spare parts and consumables in the Material Shop of the N16 Traction Motor Shop.

2.2. The racks shall be designed and manufactured with following features described hereto, but the manufacture standard racks covering requirements shall be provided.

2.3. The racks shall be pallet rack of steel truss structure and heavy-duty type with high quality painting, and thus bear long life work.

2.4. Rack system for general goods including traction motor shall be:

i. Bay length : approx. 1,800 mm,
ii. Bay depth : approx. 1,200 mm,
iii. Bay height : approx. 2,400 mm,
iv. Bay load : 2,000 kg,
v. Shelf : 3 shelves/rack for 4 storing decks.

2.5. A vertical ladder shall be provided at the end row.

2.6. Each rack shall be securely fastened together.

2.7. The racks shall be fixed on the floor by drilled anchor bolts.

2.8. Arrangement of the rack system shall be referred to the workshop layout drawings.

3. Eligible Supplier

There is no preference.

N16.08 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: Five (5) pcs

N16.09 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: Two (2) pcs

N17 BOGIE SHOP

N17.01 10 /3t Overhead Traveling Crane

The same requirements as those of N12.01 shall be applied except follows:

1. Quantity: One (1) set of crane

   One (1) lot of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including Bogie (as max. load), which is used at the N17 Bogie Shop.

2.2. Crane performance is as follows:

- i. Lifting capacity: One hoist, 10 / 3 tons,
- ii. Travelling distance: approx. 290 m,
- iii. Traverse distance (between center of crane rails): approx. 20 m,
- iv. Lifting height: approx. 9.0 m.

3. Design

   The same requirements for N12.01 shall be applied.

   The following lifting tools shall be provided:

- i. 2 sets of lifting gear for lifting bogie (approx. 3.0 m x 2.7 m, < 10 tons),
- ii. 2 sets of lifting slings. (for 1 ton – 3 tons)

N17.02 5t Overhead Traveling Crane

The same requirements as those of N12.01 shall be applied except follows:

1. Quantity: One (1) sets of crane

   One (1) lots of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including Bogie frame (as max. load), which is used at the N17 Bogie Shop.

2.2. Crane performance is as follows:

   i. Lifting capacity: One hoist, 5 tons,

   ii. Travelling distance: approx. 290 m,

   iii. Traverse distance (between center of crane rails): approx. 20 m,

   iv. Lifting height: approx. 9.0 m.

3. Design

   The following lifting tools shall be provided:

   i. 2 sets of lifting gear for lifting bogie frame (approx. 3.0 m x 2.7 m, < 5 tons),

   ii. 2 lot of lifting ropes, shackles and slings (for 1 ton – 5 tons).

N17.03 Bogie Turntable

1. Quantity: Two (2) sets

2. Functional requirement:

2.1. The turntable is manually operated and capable of rotating a bogie 360° in either direction and conforms to requirements for the turntable pit.
2.2. The turntables will be mounted flush to the floor with rails recessed and set such that the gap between the shop rails and the turntable rails will not exceed 10 mm.
2.3. The rails used are suitable for the design loads and configured so as to provide smooth movement between the shop rails and the turntable.
2.4. Automatic locking shall be provided to lock and align the turntable rails with the shop rails at each 90° position.
2.5. Release of the automatic lock shall be carried out via the retractable push handle prior to rotating the turn table.
2.6. The handle retracts flush with the top of the turn table when not in use.

3. Design

Sr. No.	**Parameter**	**Dimensions**
1	Turntable diameter	3800 mm
2	Track gauge	1435 mm
3	Turning capacity	10 t
4	Rollover capacity	20 t
5	Max. gap between shop rails and turntable rails	10 mm
6	Rail on the turntable	Track crossing
7	Max. gap between turntable surface/pit ring and floor	10 mm
8	Max. variation in plane of table between any two points on surface under specified loads	max. 6 mm
9	Vertical and horizontal misalignment between the workshop rail and turntable rail with the turntable fully loaded and locked	max. 5 mm

4. Interface requirement

Interface shall be taken within the Building Contractor regarding the following issues, but not limited to:

i. Foundations and all Concrete Works
ii. Mortise and masonry work
iii. Conduits
iv. Main Current supply to MCC
v. Grouting of Equipment

Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N17.04 Wheelset Turntable

1. Quantity: Two (2) sets

2. Functional Requirements

2.1. The wheelset turntables shall be provided and installed in the N17 Bogie shop.

2.2. The wheelset data of rolling stock is; but the Contractor shall provide manufacturer's standard type as follows:

- i. Track gauge: 1,435 mm,
- ii. Wheel diameter range: 780 – 860 mm,
- iii. Axle length range: 1,850 – 2,200 mm,
- iv. Wheelset weight: max. 2,500 kg.
- v. Major function of the wheelset turntable shall be as follows:
- vi. Turntable diameter: approx. 2,200 mm (estimated),
- vii. Load capacity: 3 ton,
- viii. Turning: manual,
- ix. Turning angle: 180 degree.

3. Design

3.1. The wheelset turntables shall be equipped with ant-friction bearings for rotation and support for ease of operation. Load bearing elements shall be supported by wheels/rollers running on a suitable surface.

3.2. Manual locking device shall be provided at 90-degree increments, aligned with embedded running rails in workshop.

3.3. Surface of turntables shall be anti-slip type and flush with workshop floor

3.4. Turntables shall be suitably robust for forklift traffic (3 t forklift).

3.5. Arrangement of the wheel turn table shall be referred to the workshop layout drawings.

3.6. The following accessories shall be included, but not limited to:

3.7. Manufacture's standard accessories.

4. Interface Requirement

The Contractor shall take interface with the Building Contractor at the appropriate timing regarding the following items, but not limited to:

- i. Floor pit size, installation,
- ii. Arrangement of dual track for wheels and gearboxes of rolling stock.
- iii. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N17.05 Bogie Disassembling/Assembling Equipment

1. Quantity: Four (4) unit

2. Functional Requirements

2.1. The bogie disassembling/assembling equipment shall be installed on the N17 Bogie Shop.

2.2. The bogie disassembling/assembling equipment shall be provided for disassembling mainly traction motors and electric components from the bogie in the N17 Bogie Shop. The equipment shall be used for assembling traction motors after completion of bogie maintenance.

2.3. The bogie disassembling/assembling equipment shall have the following performance, but not limited to:

   i. Max. lifting height: approx. 1,600 mm from the floor,

   ii. Stopper for bogie rolling.

   iii. Checkered plate shall be installed as a part of this lifter.

3. Design

3.1. Bogie data and preliminary floor pit condition for design of the bogie disassembling/assembling equipment are as follows:

   i. Track gauge: 1,435 mm,

   ii. Bogie size: approx. 3.000 (L) x 2,700 (W) x 1,000 (H) mm (with air springs or coil springs),

   iii. Bogie weight: max. approx. 8 ton,

   iv. Axle distance: 2,100 mm.

3.2. The positioning of the bogie is performed manually.

3.3. Safety measures shall be provided against power failure specially to avoid falling down.

3.4. A control panel shall be provided with an emergency stop button.

3.5. Pit opening shall be covered with floor checkered plates of anti-slip type, and when lifted, the floor shall be covered with additional gratings for working safety.

3.6. Arrangement of the bogie disassembling/assembling equipment shall be referred to the workshop layout drawings.

4. Interface Requirement

Interface shall be taken with the building works regarding the following issues, but not limited to:

   i. Floor pit dimension,

   ii. Equipment weight,

   iii. Floor loading (t/m2) in floor contact areas,

   iv. Utility arrangement such as electric cabling route, compressed air piping, etc.

The Contractor shall take interface with the Rolling Stock Contractor, regarding bogie dimensions.

5. Eligible Supplier

There is no preference.

N17.06 Bogie Washing Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The bogie washing machine shall automatically wash bogies from which motors have been dismantled and rolling stock parts.

2.2. The bogie washing machine shall be installed at the N17 Bogie shop.

2.3. The bogie washing machine shall have a function to move the bogie into the machine automatically.

2.4. The bogie shall be moved to/from the booth by the driving chain conveyer.

2.5. The bogie washing machine shall have a function to spray high-pressure water and chemical fluid for washing.

2.6. The bogie shall be sprayed first with a heated chemical fluid.

2.7. The bogie shall be sprayed with hot water after chemical fluid spraying.

2.8. The bogie washing machine shall have a function to blow air for dewatering.

2.9. The chemical fluid and washing water shall be separately stored in different tanks and reused to reduce consumption.

2.10. The bogie washing machine shall have the following:

- i. The dewatering shall be placed in the exit side,
- ii. The storage tank shall be structured to separate the sludge, dirt and oil, which shall be disposed to the outside,
- iii. Personal safety gears and guard for washing work.

2.11. The size of the washing booth shall be less than 7.0 m (L), 5.5 m (W), 4.0 m (H) and total projected area less than 13.0 m (L), 7.5 m (W) including floor pit for dust collection.

3. Design

3.1. Bogie data and preliminary floor pit condition for design of the washing booth are as follows.

- i. Track gauge: 1,435 mm,
- ii. Bogie size: approx. 3.000 (L) x 2,700 (W) x 1,000 (H) mm (with air springs or coil springs),
- iii. Bogie weight: max. approx. 8 ton,
- iv. Floor pit dimension (planning): Depth 1,000 – 2,500 mm within booth projected area mentioned above.

3.2. The bogie washing machine shall be equipped with, but not limited to:

- i. Washing booth,
- ii. Chemical fluid spraying, washing water spraying and dewatering,
- iii. Heating media: electric heater and steam heating,
- iv. Sludge collecting and exhaust/ventilation system including water pool, eliminator duct, exhaust fan(s), exhaust duct to the outside of the building,
- v. Compressed air piping with air filter,

vi. Personal safety gears,

vii. Standard accessories and tools.

3.3. The booth shall be a pre-fabricated or custom made of steel plate, and equipped with inlet/outlet manual doors, windows, sufficient interior lighting, ventilating louver, grating floor, etc.

3.4. The electric equipment such as light, motor, switch, etc. shall be water-proof type.

3.5. Pit opening shall be covered with floor grating plates of anti-slip type.

3.6. Dust collection, exhaust and ventilation systems shall satisfy environmental regulations.

3.7. Arrangement of the bogie washing booth shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken within the Building Contractor regarding the following issue, but not limited to:

i. Floor pit dimension,

ii. Booth foundation, mortar plastering,

iii. Exhaust ducting, finishing of duct hole on the building,

iv. Utility arrangement such as electric cabling, compressed air piping, etc.

4.2. Grating plate and exhaust duct shall be included in the scope of the equipment.

4.3. The Contractor shall take interface with the Rolling Stock Contractor, regarding bogie dimensions.

5. Eligible Supplier

There is no preference.

N17.07 Bogie Frame Stand Set

1. Quantity: Twenty-four (24) sets

2. Functional Requirements

2.1. The bogie frame stand set shall be provided to support bogie frame for inspection of the frame and for dismantling/mounting auxiliaries on the frame in the N15 Bogie Shop.

2.2. The bogie frame stand set shall be of a fabricated steel structure and consist of eight (8) stands per set, which height can be adjustable manually at 850 mm, 1,050 and 1,300 mm above the floor.

3. Design

3.1. Bogie data for design of the bogie frame stand set are as follows. The Contractor shall take interface, if any, with the Rolling Stock Contractor.

   i. Track gauge: 1,435 mm,
   ii. Bogie size: approx. 3.000 (L) x 2,700 (W) x 1,000 (H) mm (with air springs or coil springs)
   iii. Bogie frame weight: max. approx. 3.0 ton (with accessories on the frame)

3.2. Arrangement of the bogie frame stand set shall be referred to the workshop layout drawings.

4. Interface Requirement

   The Contractor shall take interface with the Rolling Stock Contractor, regarding bogie frame dimensions and weight.

5. Eligible Supplier

   There is no preference.

N17.08 Magnetic Flaw Detector (Movable)

1. Quantity: One (1) set

2. Functional Requirements

2.1. The magnetic flaw detector (MPI) shall be used for detecting flaw of the bogie frame by the magnetic particle flaw detecting technology in the N17 Bogie Shop.

2.2. The MPI equipment shall be of portable type with a caster cart and composed of a magnetizing power device with the Hand-Magna, a demagnetizing device, a black light, a gauss meter to check residual magnetism, a portable blackout curtain kit, necessary cables and accessories.

2.3. MPI process shall be performed manually by the operator.

2.4. Reference performance of magnetic flaw detector's magnetize power device are as follows:

i. Power input: AC 230 V single phase, 60Hz, approx.300A,

ii. Output of electric current: AC 7,000A / DC 7,000A,

iii. Exciting time: 0～2 sec. adjustable timer,

iv. Pause time: 0.5sec. exciting, 5 sec. pause,

v. Dimension: approx. W 800mm×D1,000mm×H1,200mm.

2.5. Reference performance of portable Magnetic flaw detector's auxiliary equipment are as follows:

i. Power input: AC 230 V, single phase, 60Hz, approx.90A,

ii. Output of electric current: AC 3,000A / DC 3,000A,

iii. Demagnetizing time: 6 sec. attenuation, instant return,

iv. Exciting time: 0～2 sec. adjustable timer,

v. Pause time: 0.5 sec. exciting, 5 sec. pause,

vi. Size: approx. W450mm×D590mm×H440mm.

2.6. Reference performance of AC yoke magnet are as follows:

i. Distance between magnetic poles: 140mm,

ii. Area of magnetic pole: 25mm×30mm.

2.7. Main function of gauss meter shall be as follows:

i. Type ：Portable type,

ii. Measure magnetic field: DC, AC,

iii. Measuring area: 0.01 mT～1.000T,

iv. Source of electricity：Battery.

3. Design

3.1. Arrangement of the magnetic flaw detector shall be referred to the workshop layout drawings.

3.2. The cable connections shall be of quick coupling type as much as possible.

3.3. Magnetic flaw detector shall be general purpose type in the market.

3.4. The following accessories shall be included, but not limited to:

i. Light magnetic particles,

ii. Magnetic dispersant materials,

iii. Standard accessories.

4. Interface Requirement

Interface shall be taken within other related contractors, if required.

5. Eligible Supplier

Same supplier as N22.03 is eligible for operational convenience on common parts and consumables among other MPI.

N17.09 Bogie Painting/Drying Booth, Painting Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The bogie painting/drying booth, painting machine shall be provided for manual painting of the assembled bogie in the N17 Bogie Shop.

2.2. The bogie shall be moved to/from the booth by the driving chain conveyer.

2.3. The bogie painting/drying booth shall be designed to have two spaces for painting and drying.

2.4. At the painting work section in the painting booth, workers shall perform manual painting by airless guns.

2.5. The drying section in the drying booth shall have a function to dry painted bogies naturally.

2.6. The bogie painting booth shall be a complete painting system for:

i. Manual painting including painting equipment,

ii. Light cleaning such as air blowing,

iii. Dust collecting and exhausting to out of the workshop,

iv. Personal safety gears for painting work.

2.7. The bogie drying booth shall have a function to blow from the ceiling to under the floor for painting mist collecting.

2.8. The size of the painting booth shall be less than 6.5 m (L), 5.5 m (W), 3.0 m (H) and total projected area less than 6.5 m (L), 8.5 m (W) including underfloor pit for dust collection.

3. Design

3.1. Bogie data and preliminary floor pit condition for design of the painting booth are as follows:

i. Track gauge: 1,435 mms,

ii. Bogie size: approx. 3,000 (L) x 2,700 (W) x 1,000 (H) mm (with air springs)

iii. Bogie weight: max. approx. 8 ton

iv. Floor pit dimension (planning): Depth 1,000 – 2,500 mm within booth projected area mentioned above

3.2. The bogie painting booth shall be equipped with, but not limited to:

i. Painting booth,

ii. Dust collecting and exhaust/ventilation system including water pool, eliminator duct, exhaust fan(s), exhaust duct,

iii. Paint spraying equipment including paint gun, hose, etc.

iv. Compressed air piping with air filter,

v. Paint mixer, portable paint pump, preparation can, caster cart,

vi. Personal safety gears

3.3. The booth shall be a prefabricated or custom made of steel plate, and equipped with inlet/outlet manual doors, windows, sufficient interior lighting, ventilating louver, grating floor, etc.

3.4. The electric equipment such as light, motor, switch, etc. shall be explosion-proof type.

3.5. Pit opening shall be covered with floor grating plates of anti-slip type.

3.6. Dust collection, exhaust and ventilation systems shall satisfy environmental regulations.

3.7. Arrangement of the bogie painting booth shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken with the Building Contractor regarding the following issue, but not limited to:

i. Floor pit dimension,

ii. Booth foundation, mortar plastering,

iii. Exhaust ducting, finishing of duct hole on the building,

iv. Utility arrangement such as electric cabling, compressed air piping, etc.

4.2. Grating plate and exhaust duct shall be included in the scope of the equipment.

4.3. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N17.10 Double Head Grinder

The same requirements as those of N01.07 shall be applied except follows:

Quantity: One (1) set

N17.11 Upright Drilling Machine

The same requirements as those of N01.08 shall be applied except follows:

Quantity: One (1) set

N17.12 Welding Machine

The same requirements as those of N01.10 shall be applied except follows:

Quantity: One (1) set

N17.13 Oxygen Acetylene Gas Welder

The same requirements as those of N01.11 shall be applied except follows:

Particle Quantity: One (1) set

N17.14 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: Two (2) pcs

N17.15 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: Eight (8) pcs

N17.16 3t Overhead Traveling Crane

The same requirements as those of N16.01 shall be applied except follows:

1. Quantity: One (1) set of crane

   One (1) lot of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including Bogie parts (as max. load), which is used at the N17 Bogie Shop.

2.2. Crane performance is as follows:

   i. Lifting capacity: one hoist, 3 tons,
   ii. Traverse distance (between center of crane rails): approx. 20 m,
   iii. Lifting height: approx. 9.0 m.

3. Design

   The following lifting tools shall be provided:

   i. 2 sets of lifting gear for general use (< 3 tons),
   ii. 2 sets of lifting slings,
   iii. 2 sets of lifting slings for air conditioner.

N17.17 Bogie Test Stand

1. Quantity: One (1) set

2. Functional Requirements

2.1. The bogie test stand shall be provided for the Bogie Shop for the testing and adjustment of the wheel loads and bogie geometry.

2.2. The bogie test stand shall provide the test features for the items listed below but not limited to:

i. Wheel load measurement on each wheel
ii. Wheel load comparison between wheel and axles.
iii. Height of Bogie frame from TOR
iv. Height of secondary suspension from TOR.
v. Calculation of shim plates for primary suspension
vi. Calculation of shim plates for secondary suspension.
vii. Wheel Diameter measurement
viii. Wheel back to back / shoulder distance/Axle parallelism
ix. Axle angle
x. Wheel run out measurement
xi. Air suspension leakage test

3. Design

3.1. The bogie test stand shall be designed to test for 2 axle bogie type.

3.2. All functions of the machine and the measuring processes shall be controlled by a PC and a PLC according to IEC 61131-3.

3.3. The conditions in a workshop are to be considered and only high-quality industrial components are to be used.

3.4. After the main switch and the PC are switched on, the machine is to be controlled exclusively via the PC.

3.5. The accuracy of the measurement reading shall be ± 200N.

3.6. Bogie data and preliminary floor pit condition for design of the bogie test stand are as follows:

i. Track gauge: 1,435 mms,
ii. Bogie size: approx. 3,000 (L) x 2,700 (W) x 1,000 (H) mm (with air springs)
iii. Bogie weight: max. approx. 8 ton

4. Interface Requirement

4.1. Interface shall be taken with the Building Contractor regarding the utility arrangement such as electric cabling, compressed air piping, foundation and grouting etc.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N18 AIR CONDITIONER SHOP

N18.01 3t Overhead Traveling Crane

The same requirements as those of N16.01 shall be applied except follows:

1. Quantity: One (1) set of crane

   One (1) lot of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including air conditioner for rolling stock (as max. load), which is used at the N18 Air Conditioner Shop.

2.2. Crane performance is as follows:

   i. Lifting capacity: one hoist, 3 tons,
   ii. Traverse distance (between center of crane rails): approx. 20 m,
   iii. Lifting height: approx. 9.0 m.

3. Design

   The following lifting tools shall be provided:

   i. 2 sets of lifting gear for general use (< 3 tons),
   ii. 2 sets of lifting slings,
   iii. 2 sets of lifting slings for air conditioner.

N18.02 High Pressure Water Cleaner

The same requirements as those of N01.17 shall be applied except follows:

Quantity: One (1) set

N18.03 Air Conditioner Parts Washing Bath

1. Quantity: One (1) set

2. Functional Requirements

2.1. The air conditioner parts washing bath shall be provided for washing parts and components of the air conditioner in the N18 Air Conditioner Shop.

2.2. Manual washing with hot water shall be applied to the air conditioner parts washing bath.

2.3. Heating media shall be steam supplied by the workshop.

2.4. Major functions of the air conditioner parts washing bath shall be as follows, but not limited to:

- i. Bath size: approx. L 3,000 x W 2,000 x H650mm,
- ii. Height of bath: 850 mm on the floor,
- iii. Material: stainless steel (JIS SUS 304 or equivalent).

3. Design

3.1. The air conditioner parts washing bath shall be equipped with a working stand at the both left and right sides of the washing bath.

3.2. Drain valve with pipe to the sump pit on the floor and water supply pipe from water distribution piping to the bath shall be provided.

3.3. Arrangement of the air conditioner parts washing bath shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with the Building Contractor regarding, but not limited to:

- i. Installation of the bath,
- ii. Piping of water, steam, compressed air, drainage, etc.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N18.04 Air Conditioner Testing System

1. Quantity: One (1) set

2. Functional Requirements

2.1. The air conditioner testing system shall be provided for testing the performance of the air conditioner removed from the train car.

2.2. Performance test shall be performed in cooling mode and heating mode.

2.3. For the cooling test, the enclosed test room shall be heated up to 40 deg.

2.4. Air conditioner performance shall be checked by measuring the following items, but not limited to:

i. Compressor current (A),
ii. Ventilator current (A),
iii. Ambient air temperature (deg.),
iv. Discharge air temperature (deg.),
v. Temperature difference between intake and discharge (deg.),
vi. Discharge air velocity (m/sec.),
vii. Heater current (A).

2.5. Measured data and calculated result shall be recorded in the control panel and can be downloaded to USB.

3. Design

3.1. The air conditioner testing system shall be composed of, but not limited to:

i. Control panel,
ii. Measuring instruments, sensors,
iii. Test room of bellows type,
iv. Hot air generator,
v. Air conditioner bench.

3.2. Arrangement of the air conditioner testing system shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken with the Rolling Stock Contractor regarding the technical particulars of the air conditioner.

4.2. Interface shall be taken at the appropriate timing with the Building Contractor regarding, but not limited to:

i. Floor anchor work, installation work,
ii. Electric power source, distribution box, cabling, etc.

5. Eligible Supplier

There is no preference.

N18.05 Copper Pipe Cutting and Welding Equipment

1. Quantity: One (1) set

2. Functional Requirements

2.1. The copper pipe cutting and welding equipment shall be provided for the repair of copper pipes in the air conditioner.

2.2. The copper pipe cutting and welding equipment shall be composed of, but not limited to:

 i. Pipe cutting kit,

 ii. Pipe bending kit,

 iii. Pipe flaring kit,

 iv. Pipe welding kit.

2.3. Major performance of the equipment shall be as follows:

 i. Pipe cutting kit: pipe dia.: approx. φ 3～28 mm, hand work,

 ii. Pipe bending kit: pipe dia.: approx. φ 10～28 mm, hand work,

 iii. Pipe flaring kit: pipe dia.: approx. φ 4～16 mm, hand work,

 iv. Pipe welding kit: acetylene gas, hard brazing, dia. ～φ 2 1/8".

3. Design

3.1. Each kit shall be stored in each toolbox for work convenience and efficiency.

3.2. Pipe welding shall be available even without oxygen cylinder.

3.3. Standard accessories shall be included.

4. Interface Requirement

 No additional requirement

5. Eligible Supplier

 There is no preference.

N18.06 Cooler Carrier

1. Quantity: Twenty-four (24) sets

2. Functional Requirements

2.1. Two coolers shall be carried on one cooler carrier of movable type with casters. Grid type cooler pallet shall be used to store cooler on the carrier.

2.2. Cooler size and weight will be as follows:

   i. Size: approx. 4,100 mm x 2,140 mm x 400 mm height,

   ii. Weight: approx. 700 kg.

2.3. The following carriers and pallets shall be provided:

   i. Type : double - decker pallet

   ii. Carrier: 24 sets,

   iii. Pallet: 48 pcs.

3. Design

3.1. Carrier shall be made of steel structure and shall be light as much as possible.

3.2. Cooler shall be put on a pallet, which is designed to fit the cooler dimension.

3.3. Upper storage rack and the pallet shall be removable from the carrier.

3.4. The pallet shall have lifting hooks on side to carry a cooler on the pallet.

3.5. Necessary protective material shall be used to avoid cooler damage.

4. Interface Requirement

   Interface with Rolling Stock Contractor shall be taken at appropriate timing to confirm cooler dimension, etc.

5. Eligible Supplier

   There is no preference.

N18.07 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: One (1) pc

N18.08 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: One (1) pc

N18.09 Pump Down Equipment with recovery tank

1. Quantity: One (1) set

2. Functional Requirements

   The equipment shall be used to extract refrigerant from the train air conditioners unit before overhaul.

3. Interface Requirement

   Interface with Rolling Stock Contractor shall be taken at appropriate timing to confirm the interface requirement.

4. Eligible Supplier

   There is no preference.

N18.10 Refrigerant Charging Equipment

1. Quantity: One (1) set

2. Functional Requirements

   The equipment shall be used to resupply the air conditioner refrigerant to the train air conditioners unit after overhaul.

3. Interface Requirement

   Interface with Rolling Stock Contractor shall be taken at appropriate timing to confirm the interface requirement.

4. Eligible Supplier

   There is no preference.

N18.11 Gas Leak Detector

1. Quantity: One (1) set
2. Functional Requirements

   The equipment shall be used to detect the gas leak at the pipe connection.
3. Interface Requirement

   Interface with Rolling Stock Contractor shall be taken at appropriate timing to confirm the requirement.
4. Eligible Supplier

   There is no preference.

N19 ELECTRIC PARTS SHOP

N19.01 Air Blow Booth with Dust Collector

The same requirements as those of N01.02 shall be applied except follows:

Quantity: One (1) set

N19.02 Parts Washer

1. Quantity: One (1) set

2. Functional Requirements

2.1. The parts washer of a general-purpose type shall be provided for general cleaning for small parts in the N19 Electric parts Shop.

2.2. The parts washer shall have the following functions, but not limited to:

i.	Type	: integrated in a casing, on floor installation type,
ii.	Hot water	: max. 80 deg., electric heater and/or steam heating
iii.	Washing table	: approx. 800 mm dia., total works 120 kg,
iv.	Washing method	: rotating nozzle, or rotating table,
v.	Washing time	: 5 – 30 min. Adjustable with timer.

3. Design

3.1. The washer shall be installed on the floor without floor pit.

3.2. The parts washer shall be equipped with, but not limited to:

i. Earth leakage breaker,
ii. Overload thermal trip relay,
iii. Thermostat control,
iv. Safety breaker,
v. Standard accessories.

3.3. Arrangement of the parts washer shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken with the Building Contractor regarding the following issues, but not limited to:

i. Drilling anchor bolts, if any,
ii. Utility arrangement such as electric cabling, water piping, drainage, etc.

5. Eligible Supplier

There is no preference.

N19.03 Insulation Resistance Tester

The same requirements shall be applied as those of N01.03 except the following:

Quantity: One (1) set

N19.04 Test electric Power Supply

1. Quantity: One (1) set

2. Functional Requirements

2.1. The test electric power supply shall be provided for the DC power source of the test of rolling stock electrical parts in the N19 Electric Parts Shop.

2.2. Major functions of the electric power supply device for test shall be as follows, but not limited to:

i. Input power: AC 400V, 60 Hz, 3 phase,

ii. Output power: DC 100 V, 3φAC440V,

iii. Electric power: 15 kW.

3. Design

3.1. Electric power supply device for the test shall be composed of the converter, the control panel and power cables.

3.2. Electric power supply device for the test shall be received electric power from the distribution box.

3.3. Electric power supply device for the test shall be controlled by switching on/off from the control panel.

3.4. Electric power supply device for test shall display the supplying condition of output power.

3.5. Arrangement of the electric power supply device for test shall be referred to the workshop layout drawings.

3.6. The following accessories shall be included, but not limited to:

Manufacture's standard accessories.

4. Interface Requirement

4.1. The Contractor shall take interface with the Building Contractor at the appropriate timing regarding electric power source, distribution box.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N19.05 Induction Heater

1. Quantity: One (1) set

2. Functional Requirements

2.1. The induction heater shall be provided for fitting the inner ring of the cylindrical roller bearing onto the shaft of the motor and for removing the inner ring from the shaft.

2.2. Major functions of the bearing induction heater shall be as follows:

  i. Type: Induction heating coil supported in the movable frame,

  ii. Coil inner diameter: approx. 200 mm dia,

  iii. Heating temperature: approx. 120 deg.,

  iv. Cable: approx. 20 m.

2.3. The induction heater shall be composed of, but not limited to:

  i. Heating device with heating coil, coil positioning device, movable caster cart,

  ii. Control panel for power source,

  iii. Inner ring draw-out tool.

3. Design

3.1. The induction heater shall be equipped with temperature setting device with a temperature sensor, which can be attached on the inner ring.

3.2. The inner ring draw-out tool shall be a simple manual tool having inner ring supporting cage to avoid falling down.

3.3. The induction heater shall have demagnetizing function.

4. Interface Requirement

   The Contractor shall take interface with related contractors, if any.

5. Eligible Supplier

   There is no preference.

N19.06 Air Compressor Testing Equipment

1. Quantity: One (1) set

2. Functional Requirements

2.1. The air compressor testing equipment shall be provided for checking performance of the air compressor of the rolling stock in the N19 Electric Parts Shop.

2.2. The air compressor testing equipment shall have the following functions:

- i. No load operation check with rotation speed, motor current and voltage measuring, etc.
- ii. Temperature rise test: air-high-temp. stop, lubricating oil temp,
- iii. Capacity check by measuring time to fill up the test reservoir,
- iv. Air leakage test by measuring pressure drop of the test reservoir,
- v. Frequent start/stop test to check unloader valve, etc.,
- vi. Insulation resistance measurement.

2.3. Major particulars of the air compressor are as follows; the Contractor shall confirm to the Rolling Stock Contractor:

- i. Type : Electric screw compressor,
- ii. Discharge air : max. 980 kPa, approx. 1,600 liter/min,
- iii. Motor : 14.5 kW, 1,750 rpm, AC3φ440V motor,
- iv. Size : approx. 1,500 x 800 x 700 (H) mm,
- v. Weight : approx. 500 kg including motor.

2.4. Simple operation for the test processes shall be provided with the support by the computer.

2.5. The compressor shall be placed during the test in such a way that workers can test it easily.

3. Design

3.1. The air compressor testing equipment shall be installed on the floor without pit and fixed with drilled anchor bolts.

3.2. The air compressor testing equipment shall be composed of, but not limited to:

- i. Control panel with computer,
- ii. Electric panel,
- iii. Test bench,
- iv. Tank unit with piping.

3.3. Arrangement of the air compressor testing equipment shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken with the Rolling Stock Contractor and the Building Contractor regarding the following issues, but not limited to:

- i. Confirmation of air compressor,
- ii. Drilling anchor bolts, if any,
- iii. Utility arrangement such as electric cabling, etc.,

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

Discussion with the Rolling Stock Contractor is needed.

N19.07 Pantograph Testing Equipment

1. Quantity: One (1) set

2. Functional Requirement

2.1. The Pantograph Testing Equipment shall be provided for static test of the pantograph in the N19 Electric Parts Shop.

2.2. The Pantograph Testing Equipment shall be an integrated testing device for the following tests; the Contractor shall confirm to the Rolling Stock Contractor:

   i. Push up force measurement: 0 – 500 N,

   ii. Free height measurement: approx. 2,080 mm stroke,

   iii. Rising time measurement,

   iv. Lock releasing test,

   v. Air leakage test by soap water.

   vi. The test shall be operated sequentially.

3. Design

3.1. Pantograph data is; the Contractor shall confirm to the Rolling Stock Contractor:

   i. Pantograph size: approx. 2,000 x 1,900 x 400 (H) mm,

   ii. Pantograph height: approx. 400 – 2050 mm

   iii. Pantograph weight: approx. 130 kg

3.2. The Pantograph Testing Equipment shall be composed of the following, but not limited to:

   i. Measurement arm with servomotor, encoder, rising arm, sensors,

   ii. Equipment frame and pantograph bench,

   iii. Air control panel, self-standing type

   iv. Control panel with touch panel, printer, X-Y recorder.

   v. The rising arm shall follow the pantograph movement without pushing force.

   vi. Air hose connector shall be a quick coupler.

3.3. Workshop compressed air, 0.49 MPa at the service point will be supplied.

3.4. If high pressure air is required for the equipment, a high-pressure air generator or an independent compressor shall be provided.

3.5. Planned installation area is approx. 2.5 m x 2.0 m except control panel on the floor without floor pit.

3.6. Arrangement of the Pantograph Testing Equipment shall be referred to the workshop layout drawings.

4. Interface Requirement

   Interface shall be taken with Rolling Stock Contractor at the appropriate timing,

5. Eligible Supplier

   Japanese supplier is eligible due to successful interface.

N19.08 Battery Charger

The same requirements shall be applied as those of N01.04 except the following:

Quantity: One (1) set

N19.09 Soft Blast Equipment

1. Quantity: One (1) set

2. Functional Requirements

2.1. The soft blast equipment for the surface cleaning of parts shall be provided in the N19 Electric Parts Shop.

2.2. The soft blast equipment shall be a general purpose and manufacture’s standard type covering the following major performance:

- i. Type: front operation, manual handling through window, integrated structure with all components,
- ii. Driven by: factory compressed air or integrated blower,
- iii. Workshop compressed air: 0.49 MPa,
- iv. Shot material: oxidation aluminum shot material,
- v. Work: max. 30 kg,
- vi. Automatic dust separation and shot recycling.

3. Design

3.1. The following accessories shall be included, but not limited to:

- i. Lighting in cabinet,
- ii. Shot blast nozzle,
- iii. Built-in rubber gloves,
- iv. Foot operation switch,
- v. Shot circulation device,
- vi. Bag filter,
- vii. Tool kit.

3.2. Arrangement of the machine shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. The Contractor shall take interface with the Building Contractor at the appropriate timing regarding the following items, but not limited to:

- i. Installation, anchor bolt holes, if any,
- ii. Electric power supply, cable route, compressed air piping, etc.

5. Eligible Supplier

There is no preference.

N19.10 Double Head Grinder

The same requirements as those of N01.07 shall be applied except follows:

Quantity: One (1) set

N19.11 Upright Drilling Machine

The same requirements as those of N01.08 shall be applied except follows:

Quantity: One (1) set

N19.12 Work Table

The same requirements as those of N01.14 shall be applied except follows:

Quantity: Nine (9) pcs

N19.13 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: Two (2) pcs

N19.14 3t Overhead Traveling Crane

The same requirements as those of N16.01 shall be applied except follows:

1. Quantity: One (1) set of crane

   One (1) lot of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including Electric Parts for rolling stock (as max. load), which is used at the N19 Electric Parts Shop.

2.2. Crane performance is as follows:

   i. Lifting capacity: one hoist, 3 tons,
   ii. Traverse distance (between center of crane rails): approx. 20 m,
   iii. Lifting height: approx. 9.0 m.

3. Design

3.1. The following lifting tools shall be provided:

   i. 2 sets of lifting gear for general use (< 3 tons),
   ii. 2 sets of lifting slings,
   iii. 2 sets of lifting slings for air conditioner.

N20 WHEELSET SHOP

N20.01 3t Overhead Traveling Crane

The same requirements as those of N16.01 shall be applied except follows:

1. Quantity: Two (2) sets of crane

   Two (2) lots of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including wheelset with traction parts (as max. load), which is used at the N20 Wheelset Shop.

2.2. Crane performance is as follows:

- i. Lifting capacity: One hoist, 3 tons,
- ii. Traverse distance (between center of crane rails): approx. 20 m,
- iii. Lifting height: approx. 9.0 m.

3. Design

3.1. The following lifting tools shall be provided:

- i. 2 sets of lifting gear for general use (< 1 ton)
- ii. 2 sets of lifting gear for lifting wheel
- iii. 2 sets of lifting slings for lifting wheelset

4. Eligible Supplier

   There is no preference.

N20.02 Wheelset Turntable

The same requirements as those of N17.04 shall be applied except follows:

Quantity: Five (5) sets

N20.03 Axle Bearing Pulling/Fitting Press (Movable)

1. Quantity: Two (2) set

2. Functional Requirements

2.1. The axle bearing pulling/fitting press shall be supplied for the removal/fitting of axle bearings.

2.2. The press shall be of movable type with casters. Setting to the bearing shall be performed manually.

3. Design

3.1. The axle bearing pulling/fitting press shall be of universal type of journal bearing pulling/fitting for railway wheelset. The device shall be applicable for removal/fitting of the bearing as well.

3.2. Wheelset and bearing data as follows;

3.3. The Contractor shall confirm to the Rolling Stock Contractor:

i. Track gauge: 1,435 mm,

ii. Wheelset size: approx. 860 mm dia. x max. 2,200 mm (L),

iii. Wheelset weight: max. 2,500 kg,

iv. Bearing type: sealed double-row tapered roller bearing,

v. Inner diameter of bearing: approx. 120 mm,

vi. Bearing fitting force: approx. 200 - 300 kN.

3.4. The press shall be equipped with manually operated hydraulic pump for bearing removal and fitting.

3.5. Bearing sizes and interface requirement for handling the removal and fitting process shall be coordinated with the Rolling Stock Contractor.

3.6. All necessary tools and attachment shall be included.

3.7. Arrangement of the press shall be referred to the workshop layout drawings.

4. Interface Requirement

Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N20.04 Wheelset Washing Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The wheelset washing machine shall be provided for automatic cleaning of the wheelset after bearings and axle boxes are removed from the wheelset.

2.2. The wheelset washing machine shall be of portal type of water jet washing technology, in which the wheelset can go through from front to rear.

2.3. A wheelset shall be placed manually on the receiving device of the wheelset washing machine. The machine shall pull the wheelset in the machine and wash automatically. After the checking by the operator, the machine shall pull the wheelset out to the rear side.

2.4. The wheelset washing machine shall be installed on the floor with floor pit that is on the wheelset repair flow line in the N20 Wheelset Shop.

2.5. Wheelset data of rolling stock is as follows; the Contractor shall confirm to the Rolling Stock Contractor:

i. Track gauge: 1,435 mm,
ii. Wheel diameter range: 780 – 860 mm,
iii. Axle length range: 1,850 – 2,200 mm,
iv. Wheelset weight: max. 2,500 kg.

2.6. Total machining time from receiving to releasing of one wheelset shall be less than planned tact time of the flow line; 20 min.

3. Design

3.1. The wheelset washing machine is composed of, but not limited to:

i. Washing machine,
ii. Wheelset rotating device during washing,
iii. Wheelset transfer device,
iv. Cleaning booth,
v. Washing tank with discharge pump.

3.2. Arrangement of the wheelset washing machine shall be referred to the workshop layout drawings.

3.3. Wheel washing machine shall have two operation mode; automatic operation and independent operation.

3.4. The independent operation shall permit to operate each step independently.

3.5. Waste and dust of washing shall be discharged in the dust box on the floor.

3.6. Water make-up in the washing tank shall be performed automatically.

3.7. Water level gauge shall be provided on the washing tank, which can be checked at the working floor.

3.8. The Wheel washing machine shall be equipped with two heating features; steam heating and electric heating, which can be changed on the control panel.

3.9. Fouled washing water shall be discharged by the discharge pump to the sump pit under the floor.

3.10. Estimated size of the washing booth is as follows:

i. Booth size: approx. L 2,000 x W 4,000 x H 1,800 mm,

ii. Entrance and exit gates: approx. W 3,000 x H 1,350 mm,
iii. Entrance and exit door: Air cylinder driven, lift-up type.

3.11. Estimated washing water tank is as follows:

i. Size of washing water tank: approx. 3,000 litres,
ii. Temperature of water: 70 - 85 deg., automatic temperature control,
iii. Water heating method: (Main)steam heating, (sub) electric heating,
iv. Accessories: Filtering device and sludge conveyor.

3.12. The following accessories shall be included, but not limited to:

i. Signal light: includes spares of the same numbers,
ii. Spray nozzle: includes 50% of spares,
iii. Working tool kit.

3.13. The pit cover (floor grating) shall be provided and installed.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with other related contractors such as the Building Contractor regarding, but not limited to:

i. Floor pit size,
ii. Electric source, distribution box, cable connection, etc.,
iii. Piping of water, steam, compressed air, etc.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N20.05 Axle Grinding Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The axle grinding machine shall be provided for automatic grinding of the axle surface to detect flaw by the magnetic flaw detector.

2.2. The axle grinding machine shall be a portal type, in which the wheelset can go through from front to rear.

2.3. A wheelset shall be placed manually on the receiving device of the axle grinding machine. The machine shall pull the wheelset in the machine and grind automatically. After the checking by the operator, the machine shall pull out the wheelset to the rear side.

2.4. The axle grinding machine shall be installed on the floor with floor pit that is on the wheelset repair flow line in the N20 Wheelset Shop.

2.5. Wheel set data of EMU is as follows; the Contractor shall confirm to the Rolling Stock Contractor:

- i. Track gauge: 1,435 mm,
- ii. Wheel diameter range: 780 – 860 mm,
- iii. Axle length range: max. 2,200 mm,
- iv. Wheel set weight: max. 2,500 kg.

2.6. Total machining time from receiving to releasing of one-wheel set shall be less than planned tact time of the flow line: 20 min.

3. Design

3.1. The axle grinding machine shall be composed of, but not limited to:

- i. Sander grinding device,
- ii. Wheelset rotating device,
- iii. Dust collector.

3.2. Arrangement of the axle grinding machine shall be referred to the workshop layout drawings.

3.3. The axle grinding machine shall have two operation mode; automatic operation and independent operation.

3.4. The independent operation shall permit to operate each step independently, which includes independent operation of each disc sander or wire brush polisher.

3.5. Contact force of disc sander or polisher can be adjusted manually.

3.6. Estimated sander grinding device is as follows:

- i. Disc Sander inside wheels: 2 pcs,
- ii. Disc Sander outside wheels: 2 pcs,
- iii. Disc Sander axle ends: 2 pcs,
- iv. Wire Polisher: 2 pcs.

3.7. The following accessories shall be included, but not limited to:

- i. Disc sander and wire polisher,

ii. Work tool kit.

3.8. The pit cover (floor grating) shall be provided and installed.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with other related contractors such as the Building Contractor regarding, but not limited to:

i. Floor pit size,

ii. Electric source, distribution box, cable connection, etc.,

iii. Piping of compressed air, etc.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N20.06 Axle Magnetic Flaw Detector

1. Quantity: One (1) set

2. Functional Requirements

2.1. The axle magnetic flaw detector shall be provided for inspecting flaw of a wheelset continuously with Magnetic Particle Inspection (MPI) technology on the flow line system in the N20 Wheelset Shop.

2.2. The axle magnetic flaw detector shall be of portal type, in which the wheelset can go through from front to rear.

2.3. A wheelset shall be placed manually on the receiving device of the axle magnetic flaw detector.

2.4. The machine shall pull the wheelset in the equipment, magnetized and spray particles automatically.

2.5. At the darkroom, the operator checks visually and after that, the machine shall demagnetize and pull out the wheelset to the rear side.

2.6. The axle magnetic flaw detector shall be composed of, but not limited to:

i. Wheelset transfer device,
ii. Magnetizing device,
iii. Particle spraying device with pump and wheel rotating device,
iv. Darkroom for inspection with a black light,
v. Demagnetizing (degaussing) device.

2.7. MPI process shall be performed automatically except inspection with a black light by the operator.

2.8. Wheelset data of rolling stock is as follows; the Contractor shall confirm to the Rolling Stock Contractor:

i. Track gauge: 1,435 mm,
ii. Wheel diameter range: 780 – 860 mm,
iii. Axle length range: 1,850 – 2,200 mm,
iv. Wheelset weight: max. 2,500 kg.

2.9. Total machining time from receiving to releasing of one wheel set shall be less than planned tact time of the flow line: 20 min.

2.10. Major functions of the magnetic flaw detector shall be as follows:

i. Power input: AC 400V 3 phase, 60 Hz,
ii. Output current: mean DC 400 A, AC 4,000 A,
iii. Magnetizing: 3-phase full-wave rectification method,
iv. Demagnetizing: DC auto-continuous pole-change attenuation method,

3. Design

3.1. The axle magnetic flaw detector shall be controlled on the control panel installed in the dark room.

3.2. Operation of the axle magnetic flaw detector shall be performed automatically except checking flaw with the black light in the dark room.

3.3. The axle magnetic flaw detector shall have two operation modes; automatic operation and independent operation.

3.4. The independent operation shall permit to operate each step independently, which includes independent operation of each process.

3.5. The axle magnetic flaw detector shall be installed on the floor with pit in the N20 Wheelset Shop.

3.6. The darkroom of the axle magnetic flaw detector is estimated as follows:

i. Room size: L 2,800 x W 4,500 x H 2,200 mm,
ii. Size of entrance and outlet: W 3,000 x H1,800mm,
iii. Entrance and outlet closing: automatic curtain,
iv. Accessories: room light, ventilating fan.

3.7. The following accessories shall be included, but not limited to:

i. Black light,
ii. Portable gauss meter,
iii. Tool kit,
iv. Anchor bolt (no anchor hole preferable),
v. Pit cover,
vi. Standard spare parts.

3.8. The pit cover (floor grating) shall be provided and installed.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with other related contractors such as the Building Contractor regarding, but not limited to:

i. Floor pit size,
ii. Electric source, distribution box, cable connection, etc.
iii. Piping of compressed air, etc.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

The same supplier as N22.03 is eligible for operational convenience on common parts and consumables among other MPI.

N20.07 Axle Ultrasonic Flaw Detector

1. Quantity: One (1) set

2. Functional Requirements

2.1. The axle ultrasonic flaw detector shall be supplied for detecting material defect by the ultrasonic technology on the surface of the wheel axle.

2.2. The detector shall be installed on the flow-repair-track in the wheelset shop, shall position a wheelset, and shall measure flaws in the axle.

2.3. The measurement process from positioning to releasing the axle shall be performed automatically.

2.4. The measurement result shall be indicated on the display of the computer for the checking by the operator.

2.5. When an excessive flaw that is deeper than the pre-set depth of flaw or abnormal result is detected, an information device of the detector shall inform the operator by audible alarm and/or flushing light.

2.6. Total process time from receiving to releasing of one wheelset shall be less than planned tact time of the flow line: 20 min.

3. Design

3.1. The system shall be proven integrated system in the railway maintenance field.

3.2. The measurement shall be carried out at/from the axle end.

3.3. Wheelset data and floor pit condition for the design of the axle ultrasonic flaw detector are as follows:

   i. Track gauge: 1,435 mm,
   ii. Wheel diameter range: 780 – 860 mm,
   iii. Axle length range: 1,850 – 2,200 mm,
   iv. Wheelset weight: max. 2,500 kg,
   v. Axle size: approx. 100 -200 mm dia,
   vi. Kind of wheelset: Motor wheelset with gearbox, Trailer wheelset with brake disc(s), without bearing normally,
   vii. Floor pit (now planning): approx. 1,400 (L) x 5,700 (W) x 950 (D) mm.

3.4. The measuring parts shall be as follows, but not limited to:

   i. Axle general surface,
   ii. Journal parts,
   iii. Wheel-boss parts,
   iv. Gear-boss parts.

3.5. The system shall consist of, but not limited to:

   i. Flow detecting unit,
   ii. Wheelset positioning/releasing device,
   iii. Ultrasonic generation and control device,
   iv. Operation panel, Control panel,
   v. Computer,
   vi. Color printer,
   vii. UPS,
   viii. Model axle with artificial flaws.

3.6. The software shall be, but not limited to:

i. Flaw measurement software with axle list and measurement operation,
ii. Record, setting and maintenance software for recorded data management, axle management, detector management, and document and form management.
iii. Output of data shall be able to be printed out or USB downloading.

3.7. The following adjustment tools shall be provided:

i. 1 set of Wheelset.
ii. All necessary tools and attachment shall be included.

3.8. Arrangement of the ultrasonic flaw detector shall be referred to the workshop layout drawings.

4. Interface Requirement

Interface shall be taken with Rolling Stock Contractor and the Building Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N20.08 Surface Wheel Lathe

1. Quantity: One (1) set

2. Functional Requirements

2.1. The wheel lathe of one-way wheelset run-through type shall perform precise machining of wheel tread, wheel flange, wheel front and back faces and axle-mounted brake discs on a wheelset.

2.2. All machining process shall be performed automatically by a CNC system equipped for process control, measurement data, records and sorting and managing wheelset data.

2.3. The lathe shall be installed on the floor-tracks that is on the wheelset repair flow line, and wheelset receiving from upstream and releasing to downstream shall be carried out sequentially.

2.4. Measuring system shall include, but not limited to:

i. Diameter and profile wear of wheels and axle-mounted brake disc,
ii. Position of wheels and axle-mounted brake disc on axle.

2.5. The data shall be able to be uploaded by USB at any time.

2.6. The chip conveyer shall be integrated. Two (2) chip bins shall be provided with the lathe.

2.7. Total machining time from receiving to releasing of one wheelset shall be less than planned tact time of the flow line: 40 min.

3. Design

3.1. Wheelset data of rolling stock is described below; the Contractor shall confirm to the Rolling Stock Contractor:

i. Track gauge: 1,435 mm,
ii. Wheel diameter range: 760 – 1,000 mm,
iii. Brake disc diameter: range: 300 – 700 mm,
iv. Axle length range: max. 2,200 mm,
v. Wheelset weight: max. 2,500 kg,
vi. Diameter allowance within 2 wheels: within 0.5 mm.

3.2. A wheelset is to be manually placed on the receiving position of the lathe, after that automatic sequentially machining process is to be performed.

3.3. The re-profiled wheelset is to be released to the discharging position automatically.

3.4. Rolling flow of the wheelset through the lathe is to be one direction.

3.5. Arrangement of the lathe shall be referred to the workshop layout drawings.

3.6. The automatic control and monitoring system shall be equipped throughout the machining process including:

i. Automatic receiving and clamping the wheelset,
ii. Preliminary measurement,
iii. Determining machining parameters,
iv. Proposing machining cycle, which can be modified manually and approved,
v. Control of machining cycle,
vi. Remeasurement, which can be checked and approved,
vii. Automatic releasing the wheelset from the lathe.

3.7. The control and monitoring display (s) shall be equipped, on which the operator can receive necessary data and information for the wheelset and machining, and can be guided for operation.

3.8. The data system shall have, but not limited to:

i. Wheelset data grasp and management,
ii. Profile evaluation (wear status),
iii. Production data recording, ordering management,
iv. Machine diagnosis and logging.

v. When overload is detected in cutting process, the wheel lathe shall stop immediately with alarm for the safety of the operator as well as for the protection of the machine. After recovery, the machining can be resumed at the suspended position.

3.9. The pit cover (floor grating) shall be provided and installed with the lathe.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with other related contractors such as the Building Contractor regarding floor pit, electric source, distribution box, cable connection, etc. particularly regarding the following issues, but not limited to:

i. Floor pit and anchor bolt hole, if any,
ii. Tolerance of floor levelness,
iii. Equipment weight,
iv. Floor loading (t/m2) in floor contact areas.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N20.09 Oil Flushing Equipment

1. Quantity: One (1) set

2. Functional Requirements

2.1. The oil flushing equipment shall be supplied for flushing traction gear and case and filling new oil into the gear case of the motor axle.

2.2. The wheelset will be placed manually on the equipment, then, lifted up and the used oil will be discharged in the drain tank located under the wheelset. After the discharge, the flushing oil hoses will be connected to the gear case, and flushing process will be performed by oil circulation. Finally, new oil shall be filled up to the filling level.

2.3. Flushing oil shall be the same oil as new oil.

2.4. In the flushing process, the wheelset shall be rotated by the equipment.

2.5. Every process shall be controlled on the control panel manually, and flushing process shall be continued by the timer control and its completion shall be informed with sound and light to the operator.

2.6. Total process time from receiving to releasing of one wheelset shall be less than planned tact time of the flow line: 40 min.

3. Design

3.1. Wheelset data and floor pit condition for design of the oil flushing equipment are as follows; the Contractor shall confirm the wheelset data and the gearbox data to the Rolling Stock Contractor:

i. Track gauge: 1,435 mm,
ii. Wheel diameter range: 780 – 860 mm,
iii. Axle length range: 1,850 – 2,200 mm,
iv. Wheelset weight: max. 2,500 kg,
v. New oil filling volume: approx. 2 Litre,
vi. Floor pit (now planning): approx. 2,500 (L) x 3,100 (W) x 900 (D) mm.

3.2. The tank/pump unit shall be installed beside the pit.

3.3. Discharged oil from the gearbox shall not be used even as the flushing oil, which shall be collected into the drum can by the drain pump.

3.4. The equipment shall consist of, but not limited to:

i. Wheelset lift-up device with rotating device and rails,
ii. Flushing oil system: tank, pump(s), filter/strainer, hoses, etc.,
iii. Drain system: tank (min. 100 L), pump, strainer, hoses, etc.,
iv. New oil filling system; manual filling procedure shall be applied with oil jug from the drum can or pail can. An air pump shall be provided,
v. Control panel.
vi. The pit shall be of non-slip type such as grating plate.
vii. All necessary tools and attachment shall be included.

3.5. Arrangement of the oil flushing equipment shall be referred to the drawing MCRP-DWG-DEP-DEF-0006, Workshop Layout.

4. Interface Requirement

Interface shall be taken with Rolling Stock Contractor and the Building Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N20.10 Axle Lathe

1. Quantity: One (1) set

2. Functional Requirements

2.1. The axle lathe shall perform precision machining of axle wheel seat and bearing journal surface.

2.2. The axle lathe shall accommodate axle assemblies with and without wheels, gear boxes and/or other wheel set components installed.

2.3. All machining process shall be performed with a CNC system equipped for process control.

2.4. The wheel axle lathe is installed in the N20 Wheelset Shop.

2.5. The axle or wheelset will be carried to the axle lathe by using the overhead travelling crane.

3. Design

3.1. Axle and wheel set data of EMU is described below; the Contractor shall confirm to the Rolling Stock Contractor:

- i. Track gauge: 1,435 mm,
- ii. Axle diameter: approx. 130 – 250 mm,
- iii. Axle length: max. 2,300 mm,
- iv. Axle weight: max. approx. 1,000 kg except gear,
- v. Wheel diameter range: 780 – 1,000mm,
- vi. Wheelset weight: max. 2,500 kg.

3.2. Planned floor area of approx. 6 m x 2 m is being prepared for the lathe.

3.3. The axle lathe shall be equipped with overload protection and an emergency stop button.

3.4. Arrangement of the axle lathe shall be referred to the workshop layout drawings.

3.5. The following accessories shall be provided, but not limited to:

- i. Tool kit for maintenance,
- ii. Installation bolts & jigs (foundation bolts, foundation plates, levelling blocks, jack-bolt),
- iii. Lighting,
- iv. Measuring tool (dial gauges, micro-meter), if needed for machining.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with the Building Contractor regarding floor anchor bolt holes, electric source, distribution box, cable connection, etc. particularly regarding the following issues, but not limited to:

- i. Floor anchor bolt hole arrangement, dimension and mortar plastering,
- ii. Equipment weight,
- iii. Floor loading (t/m2) in floor contact areas.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N20.11 Wheel Boring Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The wheel boring machine shall be provided for precise finishing of the wheel boss bore for cold press-fitting of the wheel to the axle and additionally machining of oil groove on the bore and high pressure injection hole on the hub with screw cutting shall be available.

2.2. All machining process for wheel hub bore with its facing and oil groove shall be performed automatically by a CNC system.

2.3. The wheel boring machine is installed in the N20 Wheelset Shop.

2.4. The wheel is carried to the wheel boring machine by using the overhead travelling crane.

2.5. The wheel boring machine shall be equipped with, but not limited to:

i. Honing machining device,

ii. Work measuring and automatic adjustment,

iii. Cutter offset automatic adjustment,

iv. Automatic tool changer,

v. Chip discharging device such as chip conveyor, chip box, etc.

2.6. The data shall be able to be printed out or uploaded by USB.

3. Design

3.1. Wheel data is; but the Contractor shall provide manufacturer's standard type covering follows:

i. Wheel type: solid rolled wheel,

ii. Wheel tread diameter: 780 – 860 mm for EMU,

iii. Bore inner diameter: 130 – 250 mm,

iv. Wheel weight: approx. 500 kg.

3.2. The control and monitoring display (s) shall be equipped, on which the operator can receive necessary data and information for the wheel and machining, and can be guided for operation.

3.3. When overload is detected in cutting process, the wheel boring machine shall stop immediately with alarm for the safety of the operator as well as for the protection of the machine. After recovery, the machining can be resumed at the suspended position.

3.4. Arrangement of the wheel boring machine shall be referred to the workshop layout drawings.

3.5. The following accessories shall be provided, but not limited to:

i. Tool kit for maintenance,

ii. Installation bolts & jigs (foundation bolts, foundation plates, levelling blocks, jack-bolt),

iii. Lighting,

iv. Air blowing device,

v. Wheel lifting jig,

vi. Measuring tool (dial gauges, micro-meter for inner dia.).

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with the Building Contractor regarding floor foundation bolt holes, electric source, distribution box, cable connection, air piping, etc., particularly regarding the following issues, but not limited to:

i. Floor anchor bolt hole arrangement, dimension and mortar plastering,

ii. Equipment weight,

iii. Floor loading (t/m2) in floor contact areas.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N20.12 Wheel Fitting Press

1. Quantity: One (1) set

2. Functional Requirements

2.1. The wheel fitting press shall be supplied for replacing EMU wheel, which shall be used for replacing traction gear of EMU.

2.2. The wheels and the axle or wheelset will be carried to the press by using the overhead travelling crane.

2.3. The wheel has oil grooves on the inside surface of its boss, and for removing wheel by pressing, high pressure oil injection procedure will be applied for smooth, steady and safe operation. The wheel fitting press shall be equipped with sufficient hydraulic oil injection equipment.

2.4. A centering device shall be provided for accurate wheel positioning and assurance that wheels are perfectly square with the axle at the beginning and during pressing.

2.5. Computerized control system shall be provided for operator interface via touch screen or keyboard to control machine and to enter relevant information.

2.6. The wheel pressing process in the form of force/travel diagrams shall be recorded for each wheel individually and managed in the equipment.

2.7. Maximum pressing load shall be 3,000 kN for cold pressing.

3. Design

3.1. The equipment shall be a proven integrated system of the wheel press in the railway maintenance field. Wheelset and axle data and floor pit condition for design of the equipment are as follows; the Contractor shall confirm wheelset data to the Rolling Stock Contractor:

   i. Track gauge: 1,435 mm,
   ii. Wheel diameter range: 780 – 860 mm,
   iii. Wheel weight: 300 kg/wheel,
   iv. Wheel boss inner diameter: approx. 180 – 200 mm,
   v. Axle length range: 1,850 - 2,200 mm,
   vi. Axle weight: max. approx. 1,000 kg except gear, brake discs,
   vii. Wheelset weight: max. 2,500 kg,

3.2. Floor pit (now planning): Main pit: approx. 2,500 (L) x 7,000 (W) x 750 (D) mm, Sub. Pit in front of main pit: 1,500 (L) x 3,000 (W) x 300 (D) for preparation work.

3.3. The machine frame shall be sufficiently sturdy and robust for pressing.

3.4. The equipment shall be designed to perform pressing sequence safely for the operator and machine, and therefore, especially, in the process from receiving wheel and axle to completing pressing, devices to prevent wheels, axle or wheels from falling down shall be taken into the design.

3.5. The wheel press shall be equipped with a single acting hydraulic cylinder for pressing.

3.6. The pressing data shall include wheel serial number, wheelset ID, Train ID, date, pressing parameters, lubrication type, machine operator identification, etc.

3.7. Pressing data and diagrams shall be able to be printed out or downloaded via USB.

3.8. The pit shall be non-slip type such as checkered plate.

3.9. All necessary tools and attachment shall be included.

3.10. Arrangement of the wheel fitting press shall be referred to the workshop layout drawings.

4. Interface Requirement

Interface shall be taken with Rolling Stock Contractor and the Building Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N20.13 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: Two (2) pc

N20.14 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: Two (2) pcs

N21 BEARING SHOP

N21.01 Bearing Washer

1. Quantity: One (1) set

2. Functional Requirements

2.1. The bearing washer of a general-purpose type shall be provided for axle bearing cleaning in the N21 Bearing Shop.

2.2. The cleaning shall be performed by hot and high-pressure water jet with detergent washing and rinsing.

2.3. The bearing washer shall have the following functions, but not limited to:

i.	Type	: Integrated in a casing, on floor installation type,
ii.	Hot water	: max. 80 deg., electric heater and steam heating,
iii.	Washing table	: approx. 1,000 mm dia., total works 400 kg,
iv.	Washing method	: rotating nozzle, or rotating table,
v.	Washing time	: 5 – 30 min. Adjustable with timer.

2.4. Major particulars of the bearing are as follows; the Contractor shall confirm to the Rolling Stock Contractor:

i.	Type	: sealed duplex taper roller bearing,
ii.	Overall size	: 220 mm dia. x 155 mm (L) assembled size,
iii.	Weight total	: approx. 30 kg.

2.5. The components of the bearing will be put in the washer after disassembling.

3. Design

3.1. The washer shall be installed on the floor without floor pit.

3.2. The bearing washer shall be equipped with, but not limited to:

i. Earth leakage breaker,
ii. Overload thermal trip relay,
iii. Thermostat control,
iv. Safety breaker,
v. Standard accessories.

3.3. Arrangement of the bearing washer shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken with the Rolling Stock Contractor and the Building Contractor regarding the following issues, but not limited to:

i. Confirmation of bearing,
ii. Drilling anchor bolts, if any,
iii. Utility arrangement such as electric cabling, water piping, drainage, etc.

5. Eligible Supplier

There is no preference.

N21.02 Oil seal draw-out equipment

1. Quantity: One (1) unit

2. Functional Requirement

2.1. The oil seal draw-out equipment shall be provided for drawing out of the oil seal on the axle bearing in the N21 Bearing Shop.

2.2. The drawing-out of the oil seal shall be performed by using hydraulic cylinder according to the drawing procedure of the bearing supplier.

2.3. The bearing with oil seal shall be set on the drawing device manually by the operator, and the device shall support the operator to perform drawing out work step by step.

2.4. Major particulars of the bearing are as follows; the Contractor shall confirm to the Rolling Stock Contractor:

i. Type : Sealed duplex taper roller bearing,
ii. Overall size : 220 mm dia. x 155 mm (L) assembled size,
iii. Weight total : approx. 30 kg,
iv. Draw-out force : approx. 80 – 100 kN

2.5. The oil seal draw-out equipment shall be composed of the following devices, but not limited to:

i. Draw-out device with hydraulic cylinder and hydraulic unit,
ii. Bearing storage conveyor: V-type free roller conveyor, storing capacity: 4-bearings,
iii. Bearing turn table with conveyor: manual turning.

3. Design

3.1. All devices shall be integrated on the common bed, and installed on the floor without pit, in which the hydraulic unit can be installed independently.

3.2. The oil seal draw-out equipment shall be equipped with, but not limited to:

i. Control panel, and foot switch for draw-out device control,
ii. Overload protection of hydraulic unit,
iii. Standard accessories.

3.3. The oil seal draw-out equipment shall be arranged at proper position in the Bearing Shop.

4. Interface Requirement

4.1. Interface shall be taken with the building works regarding the following issue, but not limited to:

i. Confirmation of bearing and disassembling procedure,
ii. Drilling anchor bolts, if any,
iii. Utility arrangement such as electric cabling, etc.

4.2. Interface shall be taken with the Rolling Stock Contractor regarding particulars of the bearing.

5. Eligible Supplier

There is no preference.

N21.03 Oil seal fit & grease supply equipment

1. Quantity: One (1) unit

2. Functional Requirement

2.1. The oil seal fit & grease supply equipment shall be provided for greasing and oil seal fitting of the axle bearing in the N21 Bearing Shop.

2.2. The axle bearing after cleaning and visual check will be assembled manually, and then, grease filling and oil seal fitting will be performed.

2.3. The assembled bearing shall be put on the equipment manually, measured dry weight, filled with grease, measured wet weight and then, fitted with the oil seals.

2.4. Major particulars of the bearing are as follows; the Contractor shall confirm to the Rolling Stock Contractor:

i.	Type	: Sealed duplex taper roller bearing,
ii.	Overall size	: 220 mm dia. x 155 mm (L) assembled size,
iii.	Weight total	: approx. 30 kg,
iv.	Grease quantity	: approx. 260 – 300 g,
v.	Seal fitting force	: 30 – 50 kN.

2.5. The oil seal fit & grease supply equipment shall be composed of the following devices, but not limited to:

i. Grease supply device with grease pump of air driven or electric driven,
ii. Weighing equipment (dry weight),
iii. Grease quantity feeder: 100 – 600 g
iv. Weighing equipment (wet weight),
v. Oil seal fitting device with hydraulic unit, cylinder, fitting jigs, etc.,
vi. Bearing rolling way: manual rolling.

2.6. Supplied grease quantity (weight) shall be checked automatically, indicated and printed out.

3. Design

3.1. All devices shall be integrated on the common bed, and installed on the floor without pit, in which the grease pump unit can be installed independently.

3.2. The oil seal fit & grease supply equipment shall be equipped with, but not limited to:

i. Control panel for weighing equipment,
ii. Control panel for oil seal fitting device,
iii. Oil seal fitting jigs,
iv. Overload protection of hydraulic unit,
v. Standard accessories.

3.3. The oil seal fit & grease supply equipment shall be arranged at proper position in the Bearing Shop.

4. Interface Requirement

4.1. Interface shall be taken with the building works regarding the following issue, but not limited to:

i. Confirmation of bearing and assembling procedure,
ii. Drilling anchor bolts, if any,
iii. Utility arrangement such as electric cabling, compressed air piping, etc.

4.2. Interface shall be taken with the Rolling Stock Contractor regarding particulars of the bearing.

5. Eligible Supplier

There is no preference.

N21.04 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: One (1) pc

N21.05 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: One (1) pc

N22 SPRING, AIR SPRING, BRAKE PARTS & IRON WORKSHOP

N22.01 3t Overhead Traveling Crane

The same requirements as those ofN16.01 shall be applied except follows:

1. Quantity: One (1) set of crane

   One (1) lot of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including air spring for bogie (as max. load), which is used at the N22 Spring, Air spring, Brake Parts & Iron Shop.

2.2. Crane performance is as follows:

   i. Lifting capacity: One hoist, 3 tons,
   ii. Traverse distance (between center of crane rails): approx. 20 m,
   iii. Lifting height: approx. 9.0 m.

3. Design

3.1. The following lifting tools shall be provided:

   i. 2 sets of lifting ropes,
   ii. shackles and
   iii. slings (for 1 ton – 3 tons).

N22.02 Shot Blast Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The shot blast machine for surface preparation of metal works shall be provided in the N22 Spring, Air Spring, Brake Parts & Iron Workshop.

2.2. The shot blast machine shall be a general purpose and manufacture's standard type covering the following major performance:

   i. Type: Front operation, manual handling through window, integrated structure with all components,
   ii. Driven by: Factory compressed air or integrated blower,
   iii. Workshop compressed air: 0.49 MPa,
   iv. Shot material: Metal shot material,
   v. Work: max. 30 kg,
   vi. Automatic dust separation and shot recycling.

3. Design

3.1. The following accessories shall be included, but not limited to:

   i. Lighting in cabinet,
   ii. Shot blast nozzle,
   iii. Built-in rubber gloves,
   iv. Foot operation switch,
   v. Shot circulation device,
   vi. Bag filter,
   vii. Tool kit.

3.2. Arrangement of the machine shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. The Contractor shall take interface within the Building Contractor at the appropriate timing regarding the following items, but not limited to:

   i. Installation,
   ii. anchor bolt holes, if any,
   iii. Electric power supply,
   iv. cable route,
   v. compressed air piping, etc.

5. Eligible Supplier

   There is no preference.

N22.03 Magnetic Flaw Detector

1. Quantity: One (1) set

2. Functional Requirements

2.1. The magnetic flaw detector (MPI) shall be used for detecting flaw of the spring, air spring & brake parts by the magnetic particle flaw detecting technology, which can be used for bogie components such as radius arms (axle box), monolink bar, coil springs, etc.

2.2. The MPI equipment shall be of fixed on-floor type in the N22 Spring, Air Spring, Brake Parts & Iron Workshop, and composed of work conveyors, a magnetizing device, particle spraying device, a darkroom for inspection with a black light, demagnetizing (degaussing) device.

2.3. MPI process shall be performed automatically except the inspection with a black light by the operator.

2.4. Inspection objects of magnetic flaw detector are as follows;

i. Size: max approx. 1,300 mm length,
ii. Weight: max approx. 300 kg,
iii. Material properties: magnetisable material,
iv. Surface condition: completely cleaned surface.

2.5. Flaw detected by the magnetic flaw detector shall be follows:

i. Type: metal fatigue cracks,
ii. Direction: all directions,
iii. Parts: whole surface,
iv. Detection method: visual inspection with black light.

2.6. Major functions of the magnetic flaw detector shall be as follows:

i. Power input: AC 400V 3 phase, 60Hz, approx. 200A,
ii. Output of electric current: AC 1,000～1,200A,
iii. Demagnetize capacity: under 1.0 mT (10 gauss),
iv. Dimension: approx. L 5,600 x W 3,200 x H 2,200mm,
v. Size of dark room: approx. L 2,000 x W 2,200 x H 2,200mm.

3. Design

3.1. Magnetic flaw detector shall be controlled on the control panel installed in the dark room.

3.2. Operation of the magnetic flaw detector shall be performed automatically except checking flaw with the black light in the dark room.

3.3. Arrangement of the equipment shall be referred to the workshop layout drawings.

3.4. The following accessories shall be included, but not limited to:

i. Black light,
ii. Portable gauss meter,
iii. Tool kit,
iv. Anchor bolt (no anchor holes the preferable),
v. Standard spare parts.

4. Interface Requirement

Interface shall be taken with Rolling Stock Contractor and the Building Contractor at the appropriate timing.

5. Eligible Supplier

The same supplier as N23.03 is eligible for operational convenience on common parts and consumables among other MPI.

N22.04 Coil Spring Tester

1. Quantity: One (1) set

2. Functional Requirements

2.1. The coil spring tester shall be provided to check performance of coil springs of the axle box removed from the bogie.

2.2. The tester shall have the following functions for the coil spring:

i. Hydraulic cylinder-load cell type installed on the floor without pit,

ii. Free height measurement,

iii. Loaded height measurement,

iv. Axial and lateral stiffness

v. Calculation of shim thickness for each spring to get uniform height among coil in a bogie.

2.3. The coil spring is put on the tester by hand or using the overhead crane.

2.4. Major characteristics of the coil spring are as follows;

i. Free height,

ii. Min. height,

iii. Outer diameter.

2.5. The tester shall have enough capacity and strength for the pressing force.

3. Design

3.1. The tester shall be composed of the following devices, but not limited to:

i.	Loading	: Hydraulic cylinder,
ii.	Load measuring	: Load cell, min. 100 kN, 0.1% accuracy,
iii.	Displacement	: min. stroke 300 mm, 1/100 mm accuracy,
iv.	Coil table	: having eight coil positions,
v.	Control panel	: with touch panel or computer.

3.2. The pressing condition/position shall be same as when the coil spring is installed onboard.

3.3. Bogie ID, date and operator ID shall be able to be input on the check sheet for one bogie's coil springs on the control panel by the operator, and the results of test including calculated shim thickness, etc. shall be shown on the screen.

3.4. The test data shall be uploaded by USB.

3.5. Arrangement of the tester shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with the Building Contractor regarding, electric source, distribution box, cable connection, etc.

4.2. The Contractor shall take interface with the Rolling Stock Contractor, regarding coil spring dimensions and weight.

5. Eligible Supplier

There is no preference.

N22.05 Hydraulic Press 30t

1. Quantity: One (1) set

2. Functional Requirements

2.1. The hydraulic 30t press shall be used for pressing in and drawing out of the component.

2.2. The hydraulic press 30t shall be a general purpose and manufacture's standard type with the following major performance:

   i. Type: C type hydraulic press, floor Installation without floor pit,
   ii. Press load: max. 300 kN, variable,
   iii. Press stroke: 250 mm,
   iv. Daylight: approx. 400 mm,
   v. Slide: approx. 300 mm,
   vi. Bolster: approx. 600 (W) x 400 (D) mm,
   vii. Stopping at: Top dead point, Bottom dead point,
   viii. One cycle action of up and down.

3. Design

3.1. The hydraulic press 30t shall be equipped with one cycle action from up to down, variable stroke.

3.2. The hydraulic press 30t shall be equipped with a safety device to prevent operator from injury.

3.3. The following accessories shall be included, but not limited to:

   i. Packing,

   ii. Tool kit.

4. Interface Requirement

4.1. The Contractor shall take interface with the Building Contractor at the appropriate timing regarding the following items, but not limited to:

   i. Installation, anchor bolt holes, if any,

   ii. Electric power supply, cable route, etc.

5. Eligible Supplier

   There is no preference.

N22.06 Air Spring Leakage Tester

1. Quantity: One (1) set

2. Functional Requirements

2.1. The air spring leak tester is used to test for leakage of the air spring units dismounted from bogies.

2.2. The air spring leak tester is composed of a testing device and an air spring test stand.

2.3. The major functions of the air spring tester are as follows:

i. Type: The tester, except the movable test stand, is fixed to the floor,
ii. Testing air pressure: 0.7 MPa or over,
iii. Testing time: 10 min,
iv. Acceptable when the pressure drop is 10 kPa or less,
v. No. of air springs that can be tested simultaneously: 2 sets.

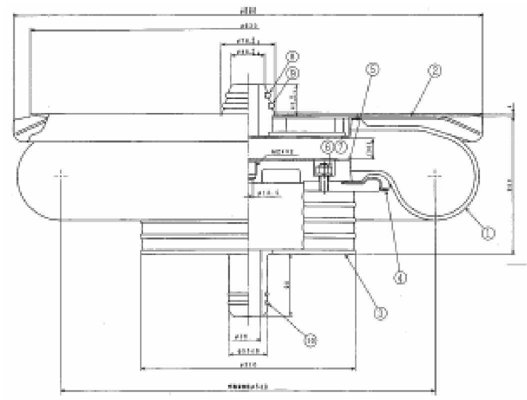
2.4. Major particulars of the air spring for reference are as follow; the Contractor shall confirm to the Rolling Stock Contractor.

i. Bellows

ii. Top plate

iii. Stopper

iv. Bottom plate



2.5. The following accessories shall be included, but not limited to:

Manufacturer's standard spares.

3. Design

3.1. The test stand of the air spring leakage tester has a function to fix an air spring thereon and supply air into it from the top.

3.2. The air spring leak tester has a function to test air springs with an air hose connected from the testing device to the test stand.

3.3. The tester shall be arranged at proper position in the N22 Spring, Air Spring, Brake Parts & Iron Workshop.

4. Interface Requirement

The Contractor shall take interface with the Rolling Stock Contractor at the appropriate timing regarding major particulars of the air spring.

5. Eligible Supplier

There is no preference.

N22.07 Oil Damper Tester

1. Quantity: One (1) set

2. Functional Requirements

2.1. The oil damper tester shall be provided for inspection of the damper of the bogie in the N22 Spring, Air Spring, Brake Parts & Iron Workshop.

2.2. The damper after overhaul shall be checked by applying specified displacement with specified velocity, measuring absorbing force and comparing with required performance by the tester.

2.3. The damper tester shall have the following functions:

i. Clamping oil damper,

ii. Excitation with regulated speed and amplitude,

iii. Measurement of damping force,

iv. Display inspection result,

v. Record of result,

vi. Test stroke : 5 – 15 mm,

vii. Max. Stroke : 100 mm,

2.4. Major particulars of the damper are as follows; the Contractor shall confirm to the Rolling Stock Contractor:

i. Type : Horizontal oil damper (Lateral damper, Yaw damper).

ii. Lateral damper : Length: 315 - 415 mm,

iii. Vp max : ±5,0,±15.0×10-2 m/s,

iv. Yaw damper : Length: 540 – 830 mm,

v. Vp max : ±0.5,±5.0×10-2 m/s,

2.5. Displacement and velocity shall be generated by servo actuator technology.

2.6. Lissajous figure shall be displayed on the monitor and stored with check list format.

2.7. Simple operation shall be applied with supporting by the computer, e.g. only selection of damper on the monitor without setting test condition at every moment.

2.8. Damper attitude during the test shall be same as working position onboard.

3. Design

3.1. The damper tester shall be installed on the floor without pit and fixed with drilled anchor bolts.

3.2. The damper tester shall be composed of, but not limited to:

i. Control panel with computer,

ii. Test stand with hydraulic actuator,

iii. Hydraulic unit.

iv. Easy clamping device of the damper shall be provided.

3.3. Arrangement of the damper tester shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken within the Building Contractor regarding the following issues, but not limited to:

i. Drilling anchor bolts, if any,

ii. Utility arrangement such as electric cabling, etc.

4.2. The Contractor shall take interface with the Rolling Stock Contractor, regarding oil damper dimensions and weight.

5. Eligible Supplier

There is no preference.

N22.08 Double Head Grinder

The same requirements as those of N01.07 shall be applied except follows:

Quantity: One (1) set

N22.09 Upright Drilling Machine

The same requirements as those of N01.08 shall be applied except follows:

Quantity: One (1) set

N22.10 Welding Machine

The same requirements as those of N01.10 shall be applied except follows:

Quantity: One (1) sets

N22.11 Oxygen Acetylene Gas Welder

The same requirements as those of N01.11 shall be applied except follows:

Quantity: One (1) set

N22.12 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: One (1) pcs

N22.13 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: One (1) pcs

N23 TIGHT LOCK COUPLER AND DRAFT GEAR SHOP

N23.01 3t Overhead Traveling Crane

The same requirements as those of N16.01 shall be applied except follows:

1. Quantity: One (1) set of crane

   One (1) lot of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including tight lock coupler set for rolling stock (as max. load), which is used at the N23 Tight Lock Coupler and Draft Gear Shop.

2.2. Crane performance is as follows:

   i. Lifting capacity: One hoist, 3 tons,

   ii. Traverse distance (between center of crane rails): approx. 20 m,

   iii. Lifting height: approx. 9.0 m.

3. Design

3.1. The following lifting tools shall be provided:

   i. 2 sets of lifting gear for general use (< 3 tons),

   ii. 2 sets of lifting slings.

N23.02 Parts Washer

1. Quantity: One (1) set

2. Functional Requirements

2.1. The parts washer shall be provided for washing the tight lock coupler & draft gear parts removed from the car body.

2.2. The parts washer shall be installed on the floor with pit in the N23 Tight Lock Coupler and Draft Gear Shop.

2.3. Parts to be washed shall be put manually in the basket on the entrance conveyor of the parts washing machine. The machine shall transfer, wash and discharge the parts automatically.

2.4. The washing tact time shall be less than 20 min. per two pallets.

3. Design

3.1. The parts washer machine shall be composed of; but not limited to:

i. Transfer conveyor, baskets,
ii. Washing booth,
iii. Detergent washing device in a booth,
iv. Hot water washing device in a booth,
v. Air blowing device in a booth,
vi. Oil separator,
vii. Sludge discharging device,
viii. Ventilating device with duct.

3.2. Arrangement of the parts washer shall be referred to the workshop layout drawings.

3.3. The parts washer shall have two operation modes; automatic operation and independent operation.

3.4. The independent operation shall permit to operate each process independently.

3.5. Estimated washing booth is as follows:

Booth size: approx. L 3,400 x W 1,900 x H 1,890 mm.

3.6. Estimated detergent washing device is as follows:

Detergent tank: approx.2,400 litter.

3.7. Estimated hot water washing device is as follows:

i. Temperature of water: 70 – 85 deg., automatic temperature control,
ii. Heating media: electric heater and steam heating
iii. Hot water tank: approx. 1,200 litter.

3.8. Estimated ventilating device capacity will be approx. 50 m^3/min.

3.9. The following accessories shall be included, but not limited to:

i. Nozzle; includes spares of the same working numbers,
ii. Signal light; includes spares of the same working numbers,
iii. Work tool kit.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with other related contractors such as the Building Contractor regarding, but not limited to:

i. Floor pit size,

ii. Electric source, distribution box, cable connection, etc.,
iii. Piping of water, steam, compressed air, etc.,
iv. Exhaust duct, size, location, support, penetration, finishing of opening.

4.2. The pit cover (floor grating) shall be provided and installed by the Contractor.

4.3. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N23.03 Magnetic Flaw Detector

1. Quantity: One (1) set

2. Functional Requirements

2.1. The magnetic flaw detector (MPI) shall be used for the flaw detecting of the tight lock coupler & draft gear parts by the magnetic particle flaw detecting technology.

2.2. The MPI equipment shall be of fixed on-floor type in the N23 Tight Lock Coupler and Draft Gear Shop, and composed of work conveyors, a magnetizing device, particle spraying device, a darkroom for inspection with a black light, demagnetizing (degaussing) device.

2.3. MPI process shall be performed automatically except the inspection with a black light by the operator.

2.4. The feature for minimizing dead zone in the work shall be provided in the AC magnetizing technology.

2.5. Major particulars of the coupler are as follows; the Contractor shall confirm to the Rolling Stock Contractor:

i. Type of coupler : auto tight lock couplers and bar couplers of steel,
ii. Major dimensions : approx. 1,000 mm x 350 mm x 400 mm,
iii. Weight : max. 450 kg.

2.6. Flaw detected by the Magnetic flaw detector shall be follows:

i. Type: Metal fatigue cracks,
ii. Direction: All directions,
iii. Parts: Whole surface,
iv. Detection method: Visual inspection with Black light.

2.7. Major functions of the magnetic flaw detector shall be as follows

i. Power input: 400V AC 3 phase, 50Hz, approx. 200A
ii. Output of electric current: AC 1,000～1,200A
iii. Demagnetize capacity: under 1.0 mT (10 gauss)
iv. Dimension: approx. L 5,700 x W 1,300 x H 2,200mm
v. Size of dark room: approx. L 2,000 x W 2,200 x H 2,200 mm

3. Design

3.1. The tight lock coupler or works to be inspected will be put on the entrance conveyor of the MPI equipment by using the crane or by hand.

3.2. Arrangement of the MPI equipment shall be referred to the workshop layout drawings.

3.3. The MPI equipment shall be equipped with automatic operation and individual operation.

3.4. The following accessories shall be included, but not limited to:

i. Portable gauss meter,
ii. Tool kit,
iii. Anchor bolt (no anchor hole preferable).

4. Interface Requirement

4.1. Interface shall be taken with Rolling Stock Contractor and the Building Contractor at the appropriate timing,

5. Eligible Supplier

There is no preference.

N23.04 Hydraulic Press 50t

1. Quantity: One (1) set

2. Functional Requirements

2.1. The hydraulic press shall be used for pressing in and drawing out of the component.

2.2. The hydraulic press shall be a general purpose and manufacture's standard type covering the following major performance:

   i. Type: C type hydraulic press, floor Installation without floor pit,

   ii. Press load: max. 500 kN, variable,

   iii. Press stroke: 300 mm,

   iv. Daylight: approx. 400 mm,

   v. Slide: approx. 300 mm,

   vi. Bolster: approx. 600 (W) x 400 (D) mm,

   vii. Stopping at: top dead point, bottom dead point,

   viii. One cycle action of up and down,

   ix. Worktable.

3. Design

3.1. The hydraulic press shall be equipped with one cycle action from up to down, variable stroke.

3.2. The hydraulic press shall be equipped with a safety device to prevent operator from injury.

3.3. The following accessories shall be included, but not limited to:

   i. Packing,

   ii. Tool kit.

4. Interface Requirement

4.1. The Contractor shall take interface with the Building Contractor at the appropriate timing regarding the following items, but not limited to:

   i. Installation, anchor bolt holes, if any,

   ii. Electric power supply, cable route, etc.

5. Eligible Supplier

   There is no preference.

N23.05 Draft Gear Setter

1. Quantity: One (1) set

2. Functional Requirements

2.1. The draft gear setter shall be provided for disassembling and assembling the draft gear of the coupler in the N23 Tight Lock Coupler and Draft Gear Shop.

2.2. The draft gear setter shall be composed of, but not limited to:

i. Compression cylinder for buffer springs,

ii. Pulling cylinder for inserting buffer springs into the draft gear frame,

iii. Control box,

iv. Hydraulic unit.

2.3. Parts handling will be carried out by manual work or by using the crane.

2.4. Major functions of the draft gear setter shall be as follows:

i. Type: on-floor installation hydraulic equipment,

ii. Compression cylinder: 300 kN, 200 mm stroke,

iii. Pulling cylinder: 200 kN, 700 mm stroke.

3. Design

3.1. The draft gear setter shall be so designed as to be fit-for-purpose of the disassembling and assembling the draft gear.

3.2. The draft gear setter shall be able to operate both on the control panel and by a pendent box.

3.3. Operation of the draft gear setter shall be carried out step by step by the operator's control.

3.4. The draft gear setter shall have inching operation.

3.5. Arrangement of the draft gear setter shall be referred to the workshop layout drawings.

3.6. The following accessories shall be included, but not limited to:

i. Standard accessories,

ii. Working toolkit.

4. Interface Requirement

4.1. Interface shall be taken with Rolling Stock Contractor.

4.2. Interface shall be taken at the appropriate timing with the Building Contractor regarding, but not limited to:

i. Floor anchor work, installation work,

ii. Electric source, distribution box, cable connection, etc.

5. Eligible Supplier

There is no preference.

N23.06 Double Head Grinder

The same requirements as those of N01.07 shall be applied except follows:

Quantity: One (1) set

N23.07 Upright Drilling Machine

The same requirements as those of N01.08 shall be applied except follows:

Quantity: One (1) set

N23.08 Welding Machine

The same requirements as those of N01.10 shall be applied except follows:

Quantity: One (1) set

N23.09 Oxygen Acetylene Gas Welder

The same requirements as those of N01.11 shall be applied except follows:

Quantity: One (1) set

N23.10 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: Two (2) pc

N23.11 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: Two (2) pc

N24 SEAT SHOP

N24.01 3t Overhead Traveling Crane

The same requirements as those of N16.01 shall be applied except follows:

1. Quantity: One (1) set of crane

   One (1) lot of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including seat pallet for DEMU (as max. load), which is used at the N24 Seat Shop.

2.2. Crane performance is as follows:

   i. Lifting capacity: One hoist, 3 tons,

   ii. Traverse distance (between center of crane rails): approx. 20 m,

   iii. Lifting height: approx. 9.0 m.

3. Design

3.1. The following lifting tools shall be provided:

   i. 2 sets of lifting gear for general use (< 3 tons),

   ii. 2 sets of lifting slings.

N24.02 Seat Cleaning Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The seat cleaning machine shall be provided for the air blow cleaning of the seat cushion and back removed from rolling stock in the N24 Seat Shop.

2.2. The seat cleaning machine shall be composed of, but not limited to:

   i. Automatic air blow device,

   ii. Seat transfer conveyor,

   iii. Dust collector, exhaust duct,

   iv. Air compressor, air tank, filter, drain separator.

2.3. Seat to be cleaned: W 390 – 530 x L 3,000 x H 80 – 160 mm,

2.4. Major performance of seat cleaning machine shall be as follows:

   i. Type: automatic flow line cleaning system,

   ii. Air blow: rotating impulse blast air,

   iii. Conveyor speed: max. 5 m/min,

   iv. Number of air nozzle: approx. 30 pcs,

   v. Outlet pressure: max. 0.69 MPa,

   vi. Air-compressor: 6 m3/min,

   vii. Air tank: 600 litres.

3. Design

3.1. The seat cleaning machine shall be installed on the flat floor without pit.

3.2. The seat cleaning machine shall have two operation modes; automatic and individual operation.

3.3. Conveyor speed shall be adjustable.

3.4. Dust collector shall be of cartridge type.

3.5. Arrangement of the seat cleaning machine shall be referred to the drawing MCRP-DWG-DEF-DEP-0005, Workshop Layout.

4. Interface Requirement

4.1. Interface shall be taken with Rolling Stock Contractor.

4.2. Interface shall be taken at the appropriate timing with the Building Contractor regarding, but not limited to:

   i. Floor anchor bolts, installation work,

   ii. Electric power source, distribution box, cabling, etc.,

   iii. Duct support and route, wall penetration, opening finishing, etc.

5. Eligible Supplier

   There is no preference.

N24.03 Vacuum Cleaner

1. Quantity: One (1) set

2. Functional Requirements

2.1. The vacuum cleaner shall be provided for seat cleaning in the N24 Seat Shop.

2.2. The vacuum cleaner shall be a general purpose and manufacture's standard, off-the-shelf, heavy duty and wet and dry type.

2.3. The capacity of the cleaner shall be min. 60 litters.

3. Design

3.1. The manufacture's standard accessories shall be included.

4. Interface Requirement

4.1. No additional requirement

5. Eligible Supplier

There is no preference.

N24.04 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: One (1) pc

N24.05 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: One (1) pc

N25 AIR BRAKE VALVE SHOP

N25.01 Parts Washer

1. Quantity: One (1) set

2. Functional Requirements

2.1. The parts washer of a general-purpose type shall be provided for general cleaning for small parts in the N25 Air Brake Valve Shop.

2.2. The parts washer shall have the following functions, but not limited to:

i.	Type	: integrated in a casing, on floor installation type,
ii.	Hot water	: max. 80 deg., electric heater and/or steam heating,
iii.	Washing table	: approx. 800 mm dia., total works 120 kg,
iv.	Washing method	: rotating nozzle, or rotating table,
v.	Washing time	: 5 – 30 min. Adjustable with timer.

3. Design

3.1. The washer shall be installed on the floor without floor pit.

3.2. The parts washer shall be equipped with, but not limited to:

i. Earth leakage breaker,

ii. Overload thermal trip relay,

iii. Thermostat control,

iv. Safety breaker,

v. Standard accessories.

3.3. Arrangement of the parts washer shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken with the Building Contractor regarding the following issues, but not limited to:

i. Drilling anchor bolts, if any,

ii. Utility arrangement such as electric cabling, water piping, drainage, etc.

5. Eligible Supplier

There is no preference.

N25.02 Ultrasonic Parts Cleaner

1. Quantity: One (1) set

2. Functional Requirements

2.1. The ultrasonic parts cleaner of a general purpose and off-the-shelf type shall be provided for general cleaning for small parts by ultrasonic wave in the N23 Air Brake Valve Shop.

2.2. The ultrasonic parts cleaner shall cover the following functions, but not limited to:

i. Type : Integrated, off-the-shelf, on table installation type,

ii. Wash basin size : approx. 350 x 400 x 400 (D) mm.

3. Design

3.1. The ultrasonic cleaner shall be equipped with, but not limited to:

i. Dry washing protection,

ii. Overload detector,

iii. Overheat detector,

iv. Installation table of steel fabricated.

3.2. Arrangement of the ultrasonic parts cleaner shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken with the Building Contractor regarding the following issues, but not limited to:

i. Drilling anchor bolts, if any,

ii. Utility arrangement such as electric cabling, water piping, drainage, etc.

5. Eligible Supplier

There is no preference.

N25.03 Air Blow Booth with Dust Collector

1. Quantity: Two (2) sets

2. Functional Requirements

2.1. The air blow booth shall be provided for the air blow cleaning of small components removed from rolling stock.

2.2. The air blow cleaning work shall be performed by air blowing to the components on the roller conveyer with air nozzle manually.

2.3. Dust exhaust device consisted of exhaust fan, dust collection filter and exhaust ducts.

2.4. The air blow booth shall be composed of, but not limited to:

i. Booth,

ii. Roller conveyer,

iii. Dust collector,

iv. Exhaust fan,

v. Air blow nozzle.

2.5. Major performance of the air blow booth shall be as follows:

i. Workspace in the booth: approx. W 0.7 x D 0.5 x H 0.5m,

ii. Mean air velocity in booth: approx.2.0m/sec,

iii. Exhaust fan: approx. 55 m3/min,

iv. Roller conveyer size: W570 mm x L 500 mm φ38,

v. Cleaning work: manual cleaning.

3. Design

3.1. The dust collector shall be equipped with dry filter such as roll filter or bag filter.

3.2. The booth shall be equipped with room lamps for work.

3.3. Duct and duct installation shall be included in the scope of the Contractor.

3.4. Arrangement of the air blow booth shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with the Building Contractor regarding, but not limited to:

i. Installation of the booth, anchor bolts (drilled anchor preferable), finishing work of the booth foundation,

ii. Piping of compressed air,

iii. Exhaust duct; route, support, penetration, finishing of opening, etc.

5. Eligible Supplier

There is no preference.

N25.04 Pressure Gauge Tester

1. Quantity: One (1) set

2. Functional Requirements

2.1. The pressure gauge tester shall be provided for calibration of the pneumatic pressure gauge in the N25 Air Brake Valve Shop.

2.2. The pressure gauge tester shall be a general purpose and manufacture's standard type, covering the following major performance:

   i. Weight type table mounted,

   ii. Pressure range : 0.05 – 1.0 MPa,

   iii. Min. Pressure : 0.01 MPa,

   iv. Accuracy : 0.2 % of operating pressure.

3. Design

3.1. The equipment and weight shall be sufficiently painted, and metal plated against site weather circumstances.

3.2. The following accessories shall be included, but not limited to:

   i. Main equipment,

   ii. Weights,

   iii. Weight box,

   iv. Equipment storage container.

4. Interface Requirement

   Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

   There is no preference.

N25.05 Hydraulic Press 30t

The same requirement shall be applied as those of N22.05 except the following:

Quantity: One (1) set

N25.06 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: Nine (9) pcs

N25.07 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: One (1) pc

N26 MECHANICAL SHOP

N26.01 3t Overhead Traveling Crane

The same requirements as those of N16.01 shall be applied except follows:

1. Quantity: One (1) set of crane

   One (1) lot of lifting gear (described hereunder)

2. Functional Requirements

2.1. An overhead travelling crane shall be provided for lifting and transporting materials including cylinder block (as max. load), which is used at the N26 Mechanical Shop.

2.2. Crane performance is as follows:

- i. Lifting capacity: one hoist, 3 tons,
- ii. Traverse distance (between center of crane rails): approx. 20 m,
- iii. Lifting height: approx. 9.0 m.

3. Design

3.1. The following lifting tools shall be provided:

- i. 2 sets of lifting gear for general use (< 3 tons),
- ii. 2 sets of lifting slings.

N26.02 Lathe

1. Quantity: One (1) set

2. Functional Requirements

2.1. The lathe shall be a general purpose and manufacture's standard type covering the following major performance:

   i. Floor Installation type without floor pit,
   ii. Vertical swing on bed: approx. 660 mm,
   iii. Horizontal swing cross bed: approx. 400 mm,
   iv. Center distance: approx. 1,500 mm.

3. Design

3.1. The lathe shall be able to perform screw cutting of both metric and inch screw without changing components.

3.2. The lathe shall be able to set the cutting depth easily.

3.3. The safeguard to prevent chip spattering shall be provided.

3.4. Arrangement of the lathe shall be referred to the workshop layout drawings.

3.5. The following accessories shall be included, but not limited to:

   i. Three-jaw chucks (self-centering),
   ii. Four-jaw chucks (independent chucking),
   iii. Face plate,
   iv. Rotating center,
   v. Manufacture standard accessories,
   vi. Tool kit,
   vii. Foundation bolt, levelling block, jack bolts.

4. Interface Requirement

4.1. The Contractor shall take interface with the Building Contractor at the appropriate timing regarding the following items, but not limited to:

   i. Installation, anchor bolt holes, if any,
   ii. Electric power supply, cable route, etc.

5. Eligible Supplier

   There is no preference.

N26.03 Pipe Threading Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The pipe threading machine shall be of portable type with electric driven chaser.

2.2. The pipe threading machine shall be a general purpose and manufacture's standard type covering the following major performance:

   i. Thread cutting capacity: 15 mm to 80 mm dia. steel pipe.

3. Design

3.1. The machine shall be automatically stopped when the completion of threading.

3.2. The machine shall be equipped with overload protection.

3.3. Arrangement of the machine shall be referred to the workshop layout drawings.

3.4. The following accessories shall be included, but not limited to:

   i. Die head,
   ii. Chaser.

4. Interface Requirement

   No additional requirement

5. Eligible Supplier

   There is no preference.

N26.04 Universal Milling Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The Universal milling machine shall be a general purpose and manufacture's standard type covering the following major performance:

i. Floor Installation type without floor pit,

ii. Table size: approx. 1,100 mm x 280 mm,

iii. Table moving distance: right & left: 700 mm, back & forth: 300 mm, up & down: 400 mm.

3. Design

3.1. The Universal milling machine shall be composed of a universal cutter axle, a vertically and horizontally moving table with operating handles.

3.2. The machine shall be equipped with an automatic lubrication device for sliding parts, X and Y axles digital scales with displays, and a local light, but not limited to.

3.3. Arrangement of the Universal milling machine shall be referred to the workshop layout drawings.

3.4. The following accessory shall be included, but not limited to:

i. Tool kit.

4. Interface Requirement

4.1. The Contractor shall take interface with the Building Contractor at the appropriate timing regarding the following items, but not limited to:

i. Installation, anchor bolt holes, if any,

ii. Electric power supply, cable route, etc.

5. Eligible Supplier

There is no preference.

N26.05 Double Head Grinder

The same requirements as those of N01.07 shall be applied except follows:

Quantity: One (1) set

N26.06 Upright Drilling Machine

The same requirements as those of N01.08 shall be applied except follows:

Quantity: One (1) set

N26.07 Radial Drilling Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The radial drilling machine shall be used for drilling, counter boring, spot facing, lapping, screwing, reaming, tapping and boring.

2.2. The radial drilling machine shall be a general purpose and manufacture's standard type covering the following major performance:

i. Type: vertical drilling, installed on the workshop floor,

ii. Max. drilling capacity: 75 mm dia,

iii. Max. distance from the column to the spindle center: approx. 1,600 mm,

iv. Max. distance from the table to the spindle end: approx. 1,500 mm,

v. Max. screw cutting capacity: M60.

3. Design

3.1. The radial drilling machine shall be composed of a column, a rotatable radial arm around the column, a cutting device on the arm and a working table.

3.2. Arrangement of the radial drilling machine shall be referred to the workshop layout drawings.

3.3. The following accessories shall be included, but not limited to:

i. Straight drill set,

ii. Drill holder arbor,

iii. Drill socket,

iv. Drill holder,

v. Tool kit.

4. Interface Requirement

4.1. The Contractor shall take interface with the Building Contractor at the appropriate timing regarding the following items, but not limited to:

i. Installation, anchor bolt holes,

ii. Electric power supply, cable route, etc.

5. Eligible Supplier

There is no preference.

N26.08 Metal Cutting Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The metal cutting machine shall be used for cutting metal bar by straight saw blade in the N26 Mechanical Shop.

2.2. The metal cutting machine shall be a general purpose and manufacture's standard type covering the following major performance:

   i. Type: vertical drilling, installed on the workshop floor,

   ii. Cutting capacity: 190 mm square steel bar, 210 mm dia. steel bar.

3. Design

3.1. The following accessories shall be included, but not limited to:

   i. Saw blade,

   ii. Tool kit.

4. Interface Requirement

   No additional requirement

5. Eligible Supplier

   There is no preference.

N26.09 Worktable

The same requirements as those of N01.14 shall be applied except follows:

Quantity: One (1) pc

N26.10 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: One (1) pc

N27 WAREHOUSE

N27.01 Rack System

The same requirements as those of N01.16 shall be applied except follows:

Quantity: One hundred eighty-six (186) sets

N27.02 Wheelset Storage System

1. Quantity: One (1) sets

2. Functional Requirements

2.1. The Wheelset storage system shall be provided for storage Wheelset in the N27 Warehouse Shop.

2.2. The Wheelset storage system manages inventory of Wheelset automatically.

2.3. The major components of the equipment shall be, but not limited to:

i. Wheelset storage machine,
ii. Stack Crane
iii. Inventory Management system.
iv. Wheelset shall be on the pallet in the Wheelset storage machine.
v. One pallet shall be able to carry 1 Wheelset.
vi. Stacker Crane shall be carried in and out from each shelf Wheelset storage machine.

3. Design

3.1. Wheelset storage Machine shall be following major performance:

i. Number of Racks : 2 banks x 5 bays x 5 Levels,
ii. Storage capacity : 49 Wheelsets,
iii. Wheelset size : approx. W2200 mm x L1200mm x H1100mm,
iv. Pallet size : W2400 mm x L1200mm x H180mm
v. Load capacity : max. 2,500kg / pallet

3.2. Stack Crane shall be following major performance:

i. Running speed : approx. 65m/min with load,
ii. Elevating speed : approx. 10m/min with loads,
iii. Fork Speed : approx. 20m/min with load,
iv. Carrying capacity : max. 2,500kg / pallet

3.3. Inventory Management system shall be installed, and managed by storage date, Wheelset number, Wheelset information (such as outer / inner diameter of wheel)

3.4. Wheelset slip stopper shall be installed on pallet.

3.5. Height of storing / taking base shall be 0 m from floor level, approx.

3.6. The floor area for the Wheelset storage system shall be less than 15.0 m (L), 10.0 m (W).

3.7. Arrangement of the Wheelset storage system shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken with other related contractors such as for the Building Contractor regarding electric source, distribution box, cable connection, etc. especially the following issues, but not limited to:

i. Equipment weight,
ii. Floor loading (t/m2) in floor contact areas,

5. Eligible Supplier

There is no preference.

N27.03 Traction Motor storage System

1. Quantity: One (1) sets

2. Functional Requirements

2.1. The Traction Motor storage system shall be provided for storage Traction Motor in the N27 Warehouse Shop.
2.2. The Traction Motor storage system manages inventory of Traction Motor automatically.
2.3. The major components of the equipment shall be, but not limited to:

   i. Traction Motor storage machine,
   ii. Stack Crane
   iii. Inventory Management system.

2.4. Traction Motor shall be on the pallet in the Wheelset storage machine.
2.5. One pallet shall be able to carry 2 Traction Motors.
2.6. Stacker Crane shall be carried in and out from each shelf Traction Motor storage machine.

3. Design

3.1. Traction Motor storage Machine shall be following major performance:

   i. Number of Racks : 2 banks x 7 bays x 3 Levels,
   ii. Storage capacity :39 pallets,
   iii. Traction Motor size : approx. W1000 mm x L1000mm x H850mm,
   iv. Pallet size : W2100 mm x L1200mm x H180mm
   v. Load capacity : max. 2000kg / pallet

3.2. Stack Crane shall be following major performance:

   i. Running speed : approx.65m/min with load,
   ii. Elevating speed : approx.15m/min with loads,
   iii. Fork Speed :approx. 20m/min with load,
   iv. Carrying capacity : max. 2000kg / pallet

3.3. Inventory Management system shall be installed, and managed by storage date, Traction Motor number, Traction Motor information (such as outer / inner diameter of wheel)
3.4. Traction Motor slip stopper shall be installed on pallet.
3.5. Height of storing / taking base shall be 0 m from floor level, approx.
3.6. The floor area for the Traction Motor storage system shall be less than 15.0 m (L), 10.0 m (W).
3.7. Arrangement of the Wheelset storage system shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken with other related contractors such as for the Building Contractor regarding electric source, distribution box, cable connection, etc. especially the following issues, but not limited to:

   i. Equipment weight,
   ii. Floor loading (t/m2) in floor contact areas,

5. Eligible Supplier

   There is no preference.

N28 COMPRESSOR ROOM

N28.01 Air Compressor (Include Air Tank)

1. Quantity: Two (2) sets

2. Functional Requirements

2.1. The air compressors shall be provided for general purpose air supply system in the N28 Compressor Room.

2.2. The air compressor shall be a general purpose and manufacture's standard type covering the following major performance:

   i. Type: electric driven package type screw compressor, air cooled oil free type, with integrated air dryer, on-floor installation type,

   ii. Compressor capacity: 5.0 m3/min. 0.7 MPa.

   iii. The air compressor shall be composed of, but not limited to:

   iv. Air compressor: two (2) sets,

   v. Air reservoir: one (1), approx. 6.0 m3,

   vi. Exhaust ducts.

3. Design

3.1. The supply system shall be connected to the distribution piping provided by the Building Contractor at the outlet of the pressure regulating valve after the air reservoir.

3.2. The following accessories shall be included, but not limited to:

   i. Drain collecting device for two compressors and the air reservoir,

   ii. Necessary air piping system with valves,

   iii. Pressure regulating valve unit,

   iv. Exhaust duct for each compressor,

   v. Maintenance tool kit.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with the Building Contractor regarding, electric source, distribution box, cable connection, ducting, etc., particularly regarding the following issues, but not limited to:

   i. Floor drilled anchor bolt, if any,

   ii. Exhaust duct route, duct supports and penetration of building wall, finishing of penetration hole, etc.,

   iii. Drainage,

   iv. Equipment weight,

   v. Floor loading (t/m2) in floor contact areas.

4.2. Distribution air pipes to the workshop after the outlet valve on the air tank will be provided by the Building Contractor.

5. Eligible Supplier

   There is no preference.

N29 NOT USED

N30 WEATHERPROOF TEST SHOP

N30.01 Weatherproof Testing Equipment

1. Quantity: One (1) set

2. Functional Requirements

2.1. The weatherproof testing equipment shall be provided for the leakage testing of car body in the N30 Weatherproof Test Shop.

2.2. The weatherproof testing equipment shall be a water spraying system to the car body to the car-roof and the side-body of the rolling stock on the track, which is constructed with water nozzles covering car body.

2.3. Major functions of the weatherproof testing equipment shall be as follows:

- i. Position of nozzles: less than 1.5 m from the car body,
- ii. Nozzles above car-roof: 2 nozzles on 24 pipes (total 48 nozzles),
- iii. Nozzles to side-body: 2 nozzles on 24 pipes x 2 side (total 96 nozzles),
- iv. Nozzle spraying angle: 45°,
- v. Spraying capacity: approx. 2 litre/min./nozzle,
- vi. Spraying pressure: 100 – 200 kPa.

3. Design

3.1. The weatherproof testing equipment shall include the water pump with a pump room and if required, water tank.

3.2. Arrangement of the weatherproof testing equipment shall be referred to the workshop layout drawings.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with the Building Contractor regarding, but not limited to:

- i. Equipment: foundation, installation, anchor bolts, etc.,
- ii. Water tank,
- iii. Water piping, route, trough, connection, drainage, etc.

4.2. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N31 FINAL ADJUSTMENT SHOP

N31.01 Insulation Resistance Tester

The same requirement shall be applied as those of N01.03 except the following:

Quantity: One (1) set

N31.02 Wheel Load Measuring System

1. Quantity: One (1) unit.

2. Functional Requirements

2.1. The wheel load measuring system shall measure each wheel load of one rolling stock (8 wheels/car) at the same time to confirm that wheel load distribution and deviation required on E rolling stock maintenance manual are to be within acceptable range.

2.2. Result of measurement shall be recorded and indicated on the control panel with alarm when load deviation exceeds the range.

2.3. The measurement result of each car shall be consolidated into one data file for one train and stored in the system until the next measurement of the train at least.

2.4. The data shall be able to be uploaded to USB at any time.

3. Design

3.1. The system shall be installed in the entrance rails of the N31 Final Adjustment Shop. The design shall take consideration of self propulsive condition of rolling stock such as the effect of return current.

3.2. The system shall be designed for bogie distance of 13,800 mm, wheelbase 2,100 mm and axle load max. approx. 16 tons.

3.3. The measurement shall be capable on stopping condition. Stopping accuracy shall be within +\- 500 mm.

3.4. The measurement of one axle shall be possible.

4. Interface Requirement

4.1. Interface shall be taken with the Rolling Stock Contractor for the design and performance condition to be confirmed to with the Rolling Stock Contractor in the design stage.

4.2. The Contractor shall take interface with the Building Contractor at the appropriate timing regarding electric power source, distribution box.

5. Eligible Supplier

There is no preference

N31.03 Testing Electric Power Supply

1. Quantity: One (1) set

2. Functional Requirements

2.1. The testing electric power supply shall be provided for the DC power source of the test of rolling stock electrical parts in the N31 Final Adjustment Shop.

2.2. Major functions of the electric power supply device for test shall be as follows:

i. Input power: AC 400V, 60 Hz, 3 phase,

ii. Output power: DC100 V,

iii. Electric power: 15 kW.

3. Design

3.1. Electric power supply device for the test shall be composed of the converter, the control panel and power cables.

3.2. Electric power supply device for the test shall be received electric power from the distribution box.

3.3. Electric power supply device for the test shall be controlled by switching on/off from the control panel.

3.4. Electric power supply device for test shall display the supplying condition of output power.

3.5. Arrangement of the electric power supply device for test shall be referred to the workshop layout drawings.

3.6. The following accessories shall be included, but not limited to:

i. Manufacture's standard accessories.

4. Interface Requirement

4.1. Interface shall be taken with the Rolling Stock Contractor for the design and performance condition to be confirmed with the Rolling Stock Contractor in the design stage.

4.2. The Contractor shall take interface with the Building Contractor at the appropriate timing regarding electric power source, distribution box.

5. Eligible Supplier

There is no preference.

N31.04 Tool Cabinet

The same requirements as those of N01.15 shall be applied except follows:

Quantity: One (1) pc

N41 SHUNTING CAR SHOP

N41.01 Shunting Locomotive (Both Rail and Road Drive Type)

1. Quantity: One (1) set
2. Functional Requirements

2.1. The shunting locomotive (both rail and road drive type) shall be provided for the shunting of the car body in the Depot and Workshop.

2.2. The shunting locomotive (both rail and road drive type) shall be the structure which can be remotely operated and manned operation.

2.3. Major performance of the shunting locomotive shall be as follows; the Contractor shall confirm the type of coupler to the Rolling Stock Contractor:

- i. Type: Battery locomotive, both rail and road drive,
- ii. Track gauge: 1,435 mm,
- iii. Coupler: the couplers of rolling stock,
- iv. Driver cab: single cab for both direction operation, with the room light and the cooling fan,
- v. Traction force: max. for rolling stock with Ten (10)-car set,
- vi. Speed: max speed single car 5km/h (at horizontal level) with creep speed of 0.5 km/h on the rail operation.
- vii. The speed on road operation shall be min 8 km/h.

3. Design

3.1. The shunting locomotive (both rail and road drive type) shall be able to operate by single driver or remote operation.

3.2. The shunting locomotive (both rail and road drive type) shall be equipped with the following features, but not limited to:

- i. Windows shall be wide and clear view from the cab for safe operation,
- ii. Visually checking of the coupling status in the cab,
- iii. Remote releasing of coupling,
- iv. Parking brake,
- v. Melody horn and flashlight operated when in operation,
- vi. Emergency stop buttons both on the vehicle and the remote control pendant.

3.3. The following accessories shall be included, but not limited to:

3.4. Standard accessories,

- i. Maintenance tool kit.

4. Interface Requirement

Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

N41.02 Shunting Locomotive (Engine Type)

1. Quantity: One (1) set

2. Functional Requirements

2.1. The shunting locomotive (engine type) shall be provided for the shunting of the rolling stock in the Depot/Workshop and during rescue operation of a failed Trainset on mainline.

2.2. Contractor shall supply diesel locomotive (1 units) along with one flat car suitable for mainline operations having maximum 2.95m wide, to recover failed train, 270t, on 3.5% downgrade.

2.3. Locomotives shall be fully equipped for emergency responses.

2.4. Contractor shall supply adaptors for tight lock couplers to couple to work trains.

2.5. Space for Onboard Signaling and Telecom equipment shall be provided by doing proper interfacing with Signaling and Telecom contractor for equipment installation details.

2.6. All onboard Signaling and Telecom Equipment along with cables and wire harness will be provided by Signaling and Telecom sub-contractors.

2.7. Installation will be done by Locomotive manufacture by doing necessary interface. Commissioning will be done jointly with Signaling and Telecom contractosr.

2.8. The shunting locomotive shall be stored in the shunting locomotive shed supplied by the Building Contractor.

2.9. Major performance of the shunting locomotive shall be as follows; the Contractor shall confirm the type of coupler to the Rolling Stock Contractor:

i. Type: diesel locomotive,
ii. Track gauge: 1,435 mm,
iii. Coupler: the couplers of rolling stock at both ends,(to be supplied by Rolling stock contractor CP NS-02)
iv. The locomotive envelope to follow rolling stock and structure gauge drawing MCRP-DWG-GEN-TK- 0020 Rev 6 or latest.
v. Driver cab: air conditioned, with assistant driver's seat,
vi. Traction force: max. for rolling stock with Ten (10)-car set,
vii. Maximum speed: 80km/h
viii. Onboard signaling and telecom equipment

3. Design

3.1. The shunting locomotive can be operated by single driver. The shunting locomotive shall be equipped with the following features, but not limited to:

i. Wide windows for wide and clear view from the cab for safe operation,
ii. Bi-directional operation
iii. Visually checking of the coupling status in the cab,
iv. Decks and handrails at both end for marshalling staff,
v. Remote releasing of coupling.

3.2. The following accessories shall be included, but not limited to:

i. Standard accessories,
ii. Maintenance tool kit.

4. Interface Requirement

Interface shall be taken with Rolling Stock, Signaling, Telecom and building contractors at the appropriate timing.

5. Eligible Supplier

There is no preference.

N41.03 Fuel Supply Equipment (Include Fuel Tank)

1. Quantity: One (1) set

2. Functional Requirements

2.1. The fuel supply equipment including its fuel tank shall be provided for diesel oil supply to Shunting Locomotive.

2.2. The fuel supply equipment shall be equipped with, but not limited to:

- i. Fuel supply stand,
- ii. Fuel tank,
- iii. Fuel supply pump

2.3. The fuel supply stand shall be composed of, but not limited to:

- i. Supply stand with control board,
- ii. Flow meter,
- iii. Fuel supply nozzle, hose, hose stand, hose reel,
- iv. Locking System.

2.4. Major function of the fuel supply stand shall be as follows:

- i. Type: on-floor self standing type,
- ii. Supply capacity: max. 150 litre/min,
- iii. Fuel indicator: digital display,
- iv. Number of nozzles: 1 nozzle,
- v. Supply setting: pre-setting function, automatic stopping function,
- vi. Length of fuel supply hose: 20 m×1

2.5. The fuel tank shall be composed of, but not limited to:

- i. Type: Underground tank,
- ii. Fuel receiving pipe with delivery hose screw connection at ground level. The delivery hose connection shall be protected within a connection box set into the ground and having lockable cover plate,
- iii. Fuel supply pump,
- iv. Recirculation piping.

2.6. Major performance of the fuel tank shall be as follows:

- i. Type: Horizontal cylindrical tank, commercially standard tank,
- ii. Tank capacity: 3 m3 x 1 tank,
- iii. Tank accessories: manhole, measuring hole, vent pipe, water drainage apparatus, level gauge, etc.

2.7. The civil works for fuel tank's foundation and pit shall be included to the Contractor's scope of works as specified in section 8.1 of this ERT. And, the Contractor shall take the interface with the Building Contractor.

2.8. Fuel supply pump shall be operated automatically when the fuel supply stand is operated.

3. Design

3.1. The fuel supply equipment shall comply with the local regulation.

3.2. The fuel supply equipment shall be of non-spark materials.

3.3. The fuel supply stand shall be equipped with easy storage devices of the hose and the nozzle.

3.4. The fuel supply stand shall be connected to the fuel supply pump of underground fuel tank.

3.5. The design of fuel supply equipment shall include of underground fuel tank and the civil works for its foundation and pit.

3.6. Arrangement of the fuel supply stand shall be referred to the drawing MCRP-DWG-DEF-DEP-0002, General Layout.

3.7. Standard accessories shall be included.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing within the Building Contractor regarding, but not limited to:

i. Fuel supply stand installation, anchor bolts, etc.,

ii. Underground tank pit, etc.

iii. Electric power source, distribution box, cabling, etc.

iv. Fuel piping, route, gutter, etc.

5. Eligible Supplier

There is no preference.

N51 NOT USED

N61 COMMON USE

N61.01 5-ton Forklift Truck

1. Quantity: One (1) set

2. Functional Requirements

2.1. Five (5) tons forklift truck shall be provided for general transportation purpose in the Depot/Workshop.

2.2. The major particulars of the forklift truck shall cover the followings:

   i. Type: four wheelers of self-sealing rubber tire, with guarded driving seat, battery driven,

   ii. Capacity: 5,000 kg,

   iii. Battery: enclosed maintenance free type,

   iv. Speed: approx. 14 km/h in loaded condition.

3. Design

3.1. The following accessories shall be supplied, but not limited to:

3.2. Battery charging device and cable,

3.3. Standard accessories and tools.

4. Interface Requirement

   No additional requirement

5. Eligible Supplier

   There is no preference.

N61.02 3-ton Forklift Truck

1. Quantity: Three (3) sets

2. Functional Requirements

2.1. Three (3) tons forklift truck shall be provided for general transportation purpose in the Depot/Workshop.

2.2. The major particulars of the forklift truck shall cover the followings:

   i. Type: four wheelers of self-sealing rubber tire, with guarded driving seat, battery driven,

   ii. Capacity: 3,000 kg,

   iii. Battery: enclosed maintenance free type,

   iv. Speed: approx. 14 km/h in loaded condition.

3. Design

   The following accessories shall be supplied, but not limited to:

   i. Battery charging device and cable,

   ii. Standard accessories and tools.

4. Interface Requirement

   No additional requirement

5. Eligible Supplier

   There is no preference.

N61.03 5-ton Cargo Truck

1. Quantity: One (1) set

2. Functional Requirements

2.1. Five (5) tons cargo truck shall be provided for general transportation purpose in the Depot/Workshop.

2.2. The major particulars of the cargo truck shall cover the followings:

   i. Type: Commercial road cargo truck with rear loading space, pneumatic rubber tires, with driving cab, diesel engine driven,

   ii. Capacity: 5,000 kg,

   iii. Loading space: min. 5,000 (L) x 2,000 (W) mm, with gate boards (hinged type for sides and rear boards).

3. Design

3.1. The following accessories shall be supplied, but not limited to:

   i. Cab air conditioning,

   ii. Standard accessories and tools.

4. Interface Requirement

   No additional requirement

5. Eligible Supplier

   There is no preference.

N61.04 Rescue device

1. Quantity: One (1) set

2. Functional Requirement

2.1. The rescue device shall be supplied to restore a train derailed in the main line where a mobile crane cannot approach. (incl. Equipment for rescue of passengers and crew from damaged trains shall be supplied)

2.2. The 'Rescue Device' comprising the items specified comprising re-railing equipment, damaged bogie rescue device, and rescue equipment shall be accommodated in two (2) transport type containers.

2.3. The containers shall be designated 'Rerailing' and 'Rescue' and shall be kept at the depot in a location that will readily permit the containers to be loaded with a crane onto vehicles, i.e., flat cars or truck.

2.4. Containers shall be based on shipping container type structures and shall be sized approximately 4.0 m long, 2.0 m wide, and 2.5 m high.

2.5. Rerailing and rescue devices shall be stored in containers on shelves, containers, etc. and shall be readily accessible via roll-up shutters on the 4 m sides and doors on the 2 m sides.

2.6. Containers shall be provided with forklift 'pockets' and attachments for lifting with cranes.

3. Design

3.1. All components of the rescue device shall be portable and shall be designed and manufactured with following features, but not limited to:

3.2. De-railed car rescue equipment

   i. This equipment shall work by hydraulic power for lifting and traversing the derailed car and setting it down on the rail.

   ii. Track gauge: 1435mm

   iii. Axle load: 16t

   iv. Lateral shifting function

   v. Accessory: Hydraulic unit and jack, Roller carriage, Guide rail, Engine generator and lighting, etc.

3.3. Re-railing Guide Equipment

   i. This equipment shall be used to restore a train which is slightly derailed. After this guide, set under derail axle, another car pulls the derail train back onto the line.

   ii. Track gauge: 1435mm

   iii. Axle load: 16t

3.4. Temporary rescue truck

   i. This truck shall be used for carrying heavy damaged wheelset after being restored from the derailment.

   ii. It shall consist of several components which can be lifted and handled by no more than two persons per item and assembled into truck on site.

   iii. Track gauge: 1435mm

   iv. Axle load: 16t

3.5. Passenger rescue equipment

i. This equipment shall be used to rescue of passengers and crew from damaged trains.

ii. Set of equipment and devices for rescue operations to remove and free persons from damaged trains.

iii. Equipment to include device(s) capable of cutting car body materials, 'jaws of life' type equipment and spreaders, as well as compressed air cushions for lifting/separating heavy components.

iv. Equipment to include first aid supplies and devices, and stretchers.

4. Interface requirement

Contractor shall interface with Rolling stock package contractors to obtain necessary technical details of the Object cars and Bogies.

5. Eligible Supplier

There is no preference.

N61.05 Vehicle (Van)

1. Quantity: One (1) set

2. Functional Requirements

2.1. Vehicle (Van) shall be provided for general transportation purpose in the Depot/Workshop.

2.2. The major particulars of the cargo truck shall cover the followings:

   i. Type: Commercial road Vehicle Van with rear loading space, pneumatic rubber tires, with driving cab, diesel or gasoline engine driven,
   ii. Capacity : 10 persons,1,000 kg,
   iii. Loading space: Approx. 4,500 (L) x 1,500 (W) mm.

3. Design

3.1. The following accessories shall be supplied, but not limited to:

   i. Cab air conditioning,
   ii. Standard accessories and tools.

4. Interface Requirement

   No additional requirement

5. Eligible Supplier

   There is no preference.

N71 TOOLS

N71.01 Measuring Instruments, Gauges

1. Quantity: One (1) lot

2. Functional Requirements

2.1. The following one (1) lot of measuring Instruments and gauges shall be provided for general measuring purpose, which shall be durable and of high quality:

2.2. Measuring Instruments and gauges shall provide the latest type of the following:

a. 27 sets: micrometer, outside, 0 – 225 mm,
b. 27 sets: micrometer, inside, 6 – 100 mm,
c. 2 pcs: Vernier caliper, 0 – 150 mm,
d. 2 pcs: Vernier caliper, 0 – 200 mm,
e. 27 sets: Vernier caliper, 0 – 300 mm,
f. 27 sets: Vernier caliper, 0 – 400 mm,
g. 2 sets: height gauge,
h. 2 sets: depth gauge,
i. 2 sets: dial indicator with magnetic base and arm,
j. 2 sets: gauge block set,
k. 2 sets: thickness gauge (feeler gauge),
l. 37 sets: steel ruler, 20 cm, 30 cm, 100 cm,
m. 2 sets: surface plate,
n. 1 set: V block set,
o. 35 sets: torque wrench (0 - 50 N-m),
p. 32 sets: torque wrench (0 - 200 N-m),
q. 30 sets: torque wrench (0 - 300 N-m),
r. 28 sets: torque wrench (0 - 1000 N-m),
s. 20 sets: torque screwdriver tools group,
t. 29 sets: convex scale, 5 m,
u. 29 pcs: measuring tape, 20 m,
v. 14 pcs: digital multi mater,
w. 10 pcs: ampere meter, digital, clamp type,
x. 10 sets: insulation tester (megger),
y. 3 pcs: direct current tester, under 1.2 mA,
z. 3 sets: oscilloscope, portable, with LCD screen,
aa. 5 sets: handy tachometer, digital type,
bb. 6 pcs: contactless thermometers, 0 - +400 deg., digital type,
cc. 1 pc: sound level meter, digital type,
dd. 10 sets: Handy Force Gauge, digital type,
ee. 4 sets: Wheel measuring device, portable type. (measurement item: Wheel profile, diameter, clearance,etc.)
ff. 1 set: Wheel load measuring devise, portable type. (Load cell unit, Rail set, Power unit, etc.)
gg. 149Sets: Laptop Computer (Minimum indicative specifications RAM: 4GB, HDD: 320GB, 13.3" Display, OS: MS Windows 10 or latest version, Software: MS Office professional latest version)

3. Eligible Supplier

There is no preference.

N72.02 General Tools

1. Quantity: One (1) lot

2. Functional Requirements

2.1. The following power tools shall be provided for general use, which shall be of AC 230V 60 Hz or AC 400V 3 Phase 60Hz, durable and of high quality:

a. 39 sets: screwdriver, flat type, 10 assorted sizes,
b. 39 sets: screwdriver, Phillips type, 4 assorted sizes and lengths,
c. 39 sets: hexagon wrench (Allen keys), 2 to 14 mm,
d. 39 sets: socket wrench, 9 to 32 mm, ratchet, universal drive,
e. 7 pcs: socket wrench, 19 to 50 mm, ratchet, universal drive,
f. 6 sets: torque multiplier,
g. 39 sets: adjustable wrench, 4 sizes,
h. 39 sets: double open end spanner set, 5.5 to 36 mm,
i. 39 sets: open & close end wrench set, 5.5 to 36 mm,
j. 39 sets: pliers, combination type, insulated handle, 2 sizes,
k. 37 pcs: external snap ring plier (straight), 2 sizes,
l. 37 pcs: internal snap ring plier (straight), 2 sizes,
m. 4 pcs: external snap ring plier (bent), 2 sizes,
n. 4 pcs: internal snap ring plier (bent), 2 sizes,
o. 39 sets. pliers, flat nose, straight, insulated handle, 2 sizes,
p. 39 sets: pliers, needle nose, straight, insulated handle, 2 sizes,
q. 39 sets: cutting plier set,
r. 39 sets: grip plier,
s. 39 sets: bolt cutter, up to 15 mm,
t. 39 sets: hack saw with blades for various materials,
u. 1 pc: cutter (various),
v. 39 sets: tin snip, different sizes,
w. 39 sets: steel hammer, different sizes,
x. 39 sets: mallet, different sizes,
y. 39 pcs: inspection hammer,
z. 39 sets: chisel and punches, assorted set,
aa. 25 pcs: vice,
bb. 12 pcs: file flat tapper bastard and smooth set,
cc. 12 sets: file round tapper set,
dd. 12 sets: file round smooth set,
ee. 39 sets: taps and dies, M6 to M24, taps and dies handles,
ff. 39 sets: wire strippers, insulated handle, 2 sizes,
gg. 39 sets: crimping tools, 1.25, 2, 5.5, 8, 14 mm,
hh. 9 sets: hydraulic crimping tools,
ii. 39 sets: cable cutter, insulated handle, up to 22 mm,
jj. 39 sets: soldering sets,
kk. 35 sets: pipe wrench stillson types, 5 sizes,
ll. 35 pcs: chain pipe wrench 100 mm,
mm. 35 pcs: small type pipe cutter (φ20 mm),
nn. 35 pcs: pipe cutter (φ50 mm),
oo. 39 sets: water pump pliers, 3 sizes,
pp. 39 pcs: toolbox, hand carry type,
qq. 39 pcs: tool trolley, 4 wheels, for use in workshop,
rr. 5 sets: submersible pump, electric, portable type (discharge pip φ50, hose)
ss. 27 sets: hand cordless driver, Philips and Allen, etc.,

tt. 22 sets: hand drill, electric, cordless, up to 5 mm,
uu. 18sets: hand disc grinder, electric, angle type, 125 mm dia.,
vv. 13 pcs: electric nibbler, 1.6 mm,
ww. 35 sets: impact wrench, pneumatic, side handle, up to M10,
xx. 35 sets: impact wrench, pneumatic, side handle, up to M24,
yy. 35 sets: impact wrench, pneumatic, side handle, up to M33,
zz. 7 pcs: pneumatic drill, 6.5 mm,
aaa. 11 pcs: pneumatic chipping hammer, 2,600/min,
bbb. 1 set: pipe bending machine (max. 60 mm dia. Steel pipe, 90 degree).
ccc. 2 sets: mobile refuelling equipment for fueling generator and other machines.

3. Eligible Supplier

There is no preference.

END OF PART A OF APPENDIX 8.1

Part B of Appendix 8.1: South Depot

S01 LIGHT REPAIR SHOP

S01.01 Cleaning Set

1. Quantity: Three (3) sets

2. Functional Requirements.

2.3. The cleaning set shall be provided for manual cleaning of the rolling stock exterior and interior in the N01 Light Repair shop.

2.4. The cleaning set shall have the follows:
   - i. 8 pcs - Step ladder, 1.5 m height, made of aluminum,
   - ii. 8 sets - Handcart with sweeping and dusting gear, dust bag,
   - iii. 8 sets – Handcart with mopping gears (bucket, mop, deck brush and water hose (20 m) reel,
   - iv. 8 sets – Handcart with electric vacuum cleaner, wet and dry type,
   - v. 8 sets – Handcart with electric rotary floor washer and polisher.
   - vi. 1 set – Air-conditioner heat exchanger cleaning equipment to re-establish new-like surface condition without abrasion.

3. Design
   The cleaning set shall be composed of off-the-shelf gears.

4. Interface Requirement
   No additional requirement

5. Eligible Supplier
   There is no preference.

S01.02 Air Blow Booth with Dust Collector

1. Quantity: One (1) set

2. Functional Requirements

2.1. The air blow booth with dust collector shall be provided for cleaning the small component removed from car.

2.2. The cleaning is performed manually with a compressed air gun in the booth.

2.3. The dust collector for ventilation, exhausting and dust collecting shall be provided for the booth.

2.4. Exhaust duct shall be led to the outside of the building.

2.5. The floor area for the air blow booth with dust collector shall be less than 5.0 m (L), 5.0 m (W) without floor pit except embedded floor rail for the turntable cart.

3. Design

3.1. The air blow booth with dust collector shall be composed of, but not limited to:

- i. Air blow booth,
- ii. Compressed air gun, flexible hose and air piping with quick coupler,
- iii. Dust collecting and exhaust/ventilation system with filter, dust box, exhaust fan(s), exhaust duct,
- iv. Control panel,
- v. Personal safety gears.

3.2. The booth shall be a prefabricated or custom made of steel plate, and equipped with inlet/outlet curtain, windows, sufficient interior lighting, ventilating louver, etc.

3.3. Dust collection, exhaust and ventilation systems shall satisfy environmental regulations.

3.4. Arrangement of the air blow booth with dust collector shall be referred to the drawing NSRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.

4. Interface Requirement

4.1. Interface shall be taken with the Building Contractor regarding the following issues, but not limited to:

- i. Booth foundation, anchor bolts, if any,
- ii. Exhaust ducting, finishing of duct hole on the building,
- iii. Utility arrangement such as electric cabling, compressed air piping, etc.

4.2. Exhaust duct shall be included in the scope of the equipment.

5. Eligible Supplier

There is no preference.

S01.03 Insulation Resistance Tester (incl. HIPOTT)

1. Quantity: One (1) set

2. Functional Requirements

2.1. The insulation resistance tester shall be provided for measuring insulation resistance test and the withstand voltage test (HIPOTT) of electric cables onboard and electric components.

2.2. The insulation resistance Tester shall be a portable type with casters.

2.3. The insulation resistance tester shall be a general purpose and manufacture standard, off-the-shelf type covering the followings, but not limited to:

i. Type: 4 range tester, auto range, portable type,
ii. Test voltage: DC; 125 V, 250 V, 500 V, 1,000 V,
iii. Measuring range: 0.1～1,000 Mega ohm at 1,000 V,
iv. Additional function: Standard value comparison, Automatic discharge,
v. Other measurement: Voltage; 20～600 V, Resistance; 0～400 ohm,
vi. Power: Dry battery.

2.4. The withstand voltage tester shall be a general purpose and manufacture standard, off-the-shelf type covering followings, but not limited to:

i. Type: portable type,
ii. Test voltage for insulation resistance test: 500 – 1,000 V DC,
iii. Test voltage for withstand voltage test: max. 5 kV AC,
iv. Testing time: 0 – 5 min. with time

3. Design

3.1. The Insulation Resistance Tester shall be composed of, but not limited to:

i. Measuring cables with remote control switch,
ii. Testing rod,
iii. Safety alligator clip,
iv. Shoulder belt,
v. Cable case,
vi. Dry battery,
vii. Other necessary accessories.

3.2. The withstand voltage tester shall be composed of, but not limited to:

i. The withstand voltage tester with caster,
ii. Flush light for operation caution (red or orange),
iii. Electric cable: Supply: 20 m, Measuring: 10 m,
iv. Cable container cart, if necessary

4. Interface Requirement

Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

S01.04 Battery Charger

1. Quantity: One (1) set

2. Functional Requirements

2.1. The battery charger shall be provided for checking and renewing of batteries after removed from the car in the S01 Light Repair Shop.

2.2. The battery charger shall have function of electric discharge and charge of the battery with constant current.

2.3. Required batteries of rolling stock are as follows; the Contractor shall confirm to the Rolling Stock Contractor:

Voltage	Capacity	Purpose
100 V	120 Ah	Operation Control

2.4. Major functions of battery charger are as follows:

i. Type: Floor-fixed type,

ii. Measurement item 1: Charging voltage,

iii. Measurement item 2: Charging current,

iv. Measurement item 3: Battery temperature.

2.5. Battery charger shall have capacity enable to charge for 2 blocks of batteries simultaneously.

3. Design

3.1. Electric discharging and charging shall be performed automatically.

3.2. The battery charger shall be installed on the flat floor without pit.

3.3. The battery charger shall be equipped with battery temperature checking feature.

3.4. Arrangement of the battery charger shall be referred to the drawing NSRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.

3.5. The following accessories shall be included, but not limited to:

i. Cables,

ii. Fuse,

iii. Standard accessories.

4. Interface Requirement

4.1. Interface shall be taken with the Rolling Stock Contractor regarding technical particulars of the battery.

4.2. Interface shall be taken at the appropriate timing within the Building Contractor regarding, but not limited to:

i. Floor anchor work, installation work,

ii. Electric power source, distribution box, cabling, etc.

5. Eligible Supplier

There is no preference.

S01.05 Filter Washing Machine

1. Quantity: One (1) set

2. Functional Requirement

2.1. The Filter Washing Machine shall be provided for washing of the roll filter of the air conditioner in the S01 Light Repair Shop.

2.2. Major particulars of the roll filter are as follows; the Contractor shall confirm to the rolling stock Contractor:

- i. Type : flame resistance polyester fabric rolled on collar roller,
- ii. Filter size: approx.925 (W) x 10,000 (L) mm,
- iii. Filter weight : approx. 7 kg including roller.

2.3. The Filter Washing Machine shall cover the following functions, but not limited to:

- i. Washing: Automatic washing applied, detergent washing and rising,
- ii. Filter feeding: Feeding by electric motor,
- iii. Setting filter: Manual setting by the operator,
- iv. Tank: two tanks for washing and rinsing
- v. Washing basin: brushing on the punching metal of stainless steel, with washing fluid spray tube, circulation pump, filter, filter feeder,
- vi. Rinsing basin: same structure as washing basin, and air blow device at the last stage,

2.4. The washing capacity shall be as follows; the Contractor shall confirm to the Rolling Stock Contractor:

- i. Number of filter on rolling stock : 4 pcs/ rolling stock, 32 pcs/train (Future, 40pcs/train),
- ii. Filter number per day: max. approx.120 pcs during maintenance

3. Design

3.1. The washing machine shall be installed on the floor without floor pit.

3.2. The total area for the washing machine in the S01 Light Repair Shop shall be less than 3,000 (W) x 2,000 (D) mm.

3.3. The basin and major structure shall be made of stainless steel for corrosion protection.

3.4. Arrangement of the Filter Washing Machine shall be referred to the drawing NSRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.

4. Interface Requirement

4.1. Interface shall be taken with the Rolling Stock the appropriate timing.

4.2. Interface shall be taken with the Building Contractor regarding follows, but not limited to:

- i. Drilling anchor bolts, if any,
- ii. Utility arrangement such as electric cabling, water piping, drainage, etc.

5. Eligible Supplier

There is no preference.

S01.06 Double Head Grinder

1. Quantity: One (1) set

2. Functional Requirements

2.1. The double head grinder shall be a general purpose and manufacture's standard type covering the following major performance:

   i. Floor Installation type without floor pit,

   ii. Grinding wheel: approx. 350 mm dia.

3. Design

3.1. The double head grinder shall be composed of a grinding wheel at the both ends of the motor, safety covers for the wheel and a dust attraction device.

3.2. Arrangement of the double head grinder shall be referred to the drawing NSRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.

3.3. The following accessories shall be included, but not limited to:

   i. Grinding wheels,

   ii. Dust filter.

4. Interface Requirement

4.1. The Contractor shall take interface with the Building Contractor at the appropriate timing regarding the following items, but not limited to:

   i. Installation, anchor bolt holes, if any,

   ii. Electric power supply, cable route, etc.

5. Eligible Supplier

   There is no preference.

S01.07 Upright Drilling Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. The upright drilling machine shall be provided for drilling, screw cutting and spot facing in the S01 Light Repair Shop.

2.2. The upright drilling machine shall be a general purpose and manufacture's standard type covering the following major performance:

- i. Type: Vertical drilling, installed on the workshop floor,
- ii. Swing: more than 500 mm,
- iii. Max. Drilling capacity: 50 mm dia,
- iv. Max. Screw cutting capacity: M27.

3. Design

3.1. The following accessories shall be included, but not limited to:

- i. Straight drill set,
- ii. Drill holder arbor,
- iii. Drill socket,
- iv. Drill holder,
- v. Tool kit.

3.2. Arrangement of the upright drilling machines shall be referred to the drawing NSRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing within the Building Contractor regarding, but not limited to:

- i. Floor anchor bolts, installation work,
- ii. Electric power source, distribution box, cabling, etc.

5. Eligible Supplier

There is no preference.

S01.08 Disc Cutter

1. Quantity: One (1) set

2. Functional Requirements

2.1. The disc cutter shall be used for cutting metal bar or section steel with abrasive wheel cutter in the S01 Light Repair Shop.

2.2. The disc cutter shall be a general purpose and manufacture's standard type covering the following major performance:

i. Type: Installed on the workshop floor, movable,
ii. Abrasive wheel diameter: approx. 400 mm dia,
iii. Max. cutting capacity: up to 115 mm dia. steel bar.

3. Design

3.1. The disc cutter shall be operated manually and equipped with a work holder, cutting device with a safety guard cover.

3.2. The following accessory shall be included, but not limited to:

i. Abrasive wheel.

4. Interface Requirement

No additional requirement

5. Eligible Supplier

There is no preference.

S01.09 Welding Machine

1. Quantity: One (1) set

2. Functional Requirements

2.1. General purpose and manufacture's standard AC arc welders with variable current control shall be supplied.

2.2. The welding machine shall be applicable to a welding electrode up to 5 or 6 mm diameter.

2.3. The welding machine shall be provided with an electric shockproof device.

3. Design

3.1. Rate current approx. AC 70 - 300 A,

3.2. Input electric power: AC 400V, 60 Hz, three-phase.

3.3. The following accessories shall be included, but not limited to:

i. Portable cart for moving of welder,

ii. Primary cable, welding lead with electrode holder, and return lead with clamp,

iii. Weld shield (full face type) and hand shield,

iv. Gloves, chipping hammer, wire brush,

v. Fume extractor, portable, with electrostatic filter.

4. Interface Requirement

No additional requirement

5. Eligible Supplier

There is no preference.

S01.10 Oxygen Acetylene Gas Welder

1. Quantity: One (1) set

2. Functional Requirements

2.1. The oxygen acetylene gas welder of general-purpose type shall be supplied.

3. Design

3.1. Oxygen-acetylene sets shall be self-contained, complete with accessories and 2-wheel cart for 2 gas cylinders.

3.2. Gas welding capability up to 8 mm thick steel.

3.3. Cutting up to 50 mm thick steel plates.

3.4. The following accessories shall be included, but not limited to:

- i. Gas regulators,
- ii. welding torch,
- iii. cutting attachment,
- iv. welding nozzle,
- v. cutting nozzle,
- vi. nozzle cleaning set,
- vii. goggles,
- viii. gas hoses,
- ix. spark lighter,
- x. wire brush and protective clothing.

4. Interface Requirement

No additional requirement

5. Eligible Supplier

There is no preference.

S01.11 Air Compressor (Include Air tank)

1. Quantity: Two (2) sets

2. Functional Requirements

2.1. The air compressors (Include Air tank) shall be provided for general purpose air supply system in S01 Light Repair Shop and installed in the Compressor Room.

2.2. The air compressor shall be a general purpose and manufacture's standard type covering the following major performance:

2.3. Type: Electric driven package type screw compressor, air cooled oil free type, with integrated air dryer, on-floor installation type,

2.4. Compressor capacity: 2.0 m3/min. 0.69 MPa.

2.5. The air compressor shall be composed of, but not limited to:

i. Air compressor: two (2) sets,

ii. Air reservoir: one (1), approx.2.9 m3,

iii. Exhaust ducts.

3. Design

3.1. The supply system shall be connected to the distribution piping provided by the Building Contractor at the outlet of the pressure regulating valve after the air reservoir.

3.2. The following accessories shall be included, but not limited to:

i. Drain collecting device for two compressors and the air reservoir,

ii. Necessary air piping system with valves,

iii. Pressure regulating valve unit,

iv. Exhaust duct for each compressor,

v. Maintenance tool kit.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with the Building Contractor regarding, electric source, distribution box, cable connection, ducting, etc. particularly regarding the following issues, but not limited to:

i. Floor drilled anchor bolt, if any,

ii. Exhaust duct route, duct supports and penetration of building wall, finishing of penetration hole, etc.,

iii. Drainage,

iv. Equipment weight,

v. Floor loading (t/m2) in floor contact areas.

4.2. Distribution air pipes to the Light Repair Shop after the outlet valve on the air tank will be provided by the Building Contractor.

5. Eligible Supplier

There is no preference.

S01.12 Forklift Truck 2t

1. Quantity: One (1) set

2. Functional Requirements

2.1. Two (2) tons forklift truck shall be provided for general transportation purpose in the S01 Light Repair Shop.

2.2. The major particulars of the forklift truck shall cover the followings, but the manufacture standard type shall be provided:

   i. Type : Four-wheeler of self-sealing rubber tires, with guarded driving seat, battery driven,

   ii. Capacity : 2,000 kg,

   iii. Battery : Enclosed maintenance free type,

   iv. Speed : approx. 14 km/h in loaded condition.

3. Design

3.1. The following accessories shall be supplied, but not limited to:

   i. Battery charging device and cable,

   ii. Standard accessories and tools.

4. Interface Requirement

   No additional requirement

5. Eligible Supplier

   There is no preference.

S01.13 Worktable

1. Quantity: Five (5) pcs

2. Functional Requirements

2.1. The worktable shall be provided for general use in the shop.

2.2. The worktable shall be of welded steel structure and plain table as follows:

   i. Table surface: plywood with stainless steel plate,

   ii. Table size: approx. 1,800 (L) x 900 (W) x 740 (H) mm.

3. Design

   No special requirement

4. Interface Requirement

   No special requirement

5. Eligible Supplier

   There is no preference.

S01.14 Tool Cabinet

1. Quantity: Four (4) pcs

2. Functional Requirements

2.1. The tool cabinet shall be provided for general storage of tools, consumables, spare parts, etc. in the shop.

2.2. The cabinet shall be made of steel with appropriate painting, lockable with a key having swing doors and 6 adjustable shelves inside.

2.3. Dimensions of the cabinet shall be as follows:

i. Overall size: approx. 800 mm width x 1,300 mm height x 600 mm depth

3. Design

The cabinet shall be commercial goods.

4. Interface Requirement

No special requirement

5. Eligible Supplier

There is no preference.

S01.15 Rack System

1. Quantity: Forty-four (44) sets

2. Functional Requirements

2.1. The rack system shall be provided for storage material, tools, spare parts and consumables in the Material Shop of the S01 Light Repair Shop.

2.2. The racks shall be designed and manufactured with following features described hereto, but the manufacture standard racks covering requirements shall be provided.

2.3. The racks shall be pallet rack of steel truss structure and heavy-duty type with high quality painting having long life work.

2.4. Rack system for general goods including traction motor shall be:

i. Bay length : approx. 1,500 mm,

ii. Bay depth : approx. 900 mm,

iii. Bay height : approx. 1,800 mm,

iv. Bay load : 2,000 kg,

v. Shelf : 3 shelves/rack for 4 storing decks.

2.5. A vertical ladder shall be provided at the end of row.

2.6. Each rack shall be securely fastened together.

2.7. The racks shall be fixed on the floor by drilled anchor bolts.

2.8. Arrangement of the rack system shall be referred to the drawing NSRP-DWG-DEP-DEF-0003, Light Repair Shop Layout.

3. Eligible Supplier

There is no preference.

S01.16 High Pressure Water Cleaner

1. Quantity: Eight (8) sets

2. Functional Requirement

2.1. High pressure water cleaner of off-the-shelf and general-purpose washer with high pressured hot water shall be provided for Air Conditioner Parts cleaning.

2.2. High pressure water cleaners shall be, but not limited to:

- i. Type: Portable type-high pressure hot water cleaner with kerosene boiler,
- ii. Discharge pressure: max. approx. 9 MPa, variable,
- iii. Discharge capacity: max. approx. 750 liter/h,
- iv. Water temperature: max. 80 deg.C, variable,
- v. Detergent washing applicable,
- vi. Automatic ignition.

2.3. The pressurized pump shall be an electrical driven type.

2.4. The hot water generator of kerosene burning is applicable.

2.5. The machine can be operated manually by one operator.

3. Design

3.1. The High-pressure water cleaner shall be of heavy-duty design and proven in the railway maintenance field.

3.2. A set of easy connectors of male and female shall be provided and shall be installed on the water pipe by the Contractor.

3.3. The following accessories shall be included, but not limited to:

- i. Washing trigger gun with nozzle,
- ii. High pressure hose: 10 m
- iii. Kerosene boiler, oil tank, if applied,
- iv. Water supply hose,
- v. Safety device: manufacture standard including motor overload protection, overheat protection, earth leakage breaker, flame failure detection, safety valve, etc.

4. Interface Requirement

4.1. The Contractor shall take interface with the Building Contractor at the appropriate timing regarding following item, but not limited to:

4.2. Water supply hose connection

5. Eligible Supplier

There is no preference.

S02 UNSCHEDULED REPAIR SHOP

S02.01 10/3t Overhead Travelling Crane

1. Quantity: One (1) set of crane

2. Functional Requirements

2.1. The crane shall be used for transferring parts/equipment on the train, bogie and bogie components.

2.2. The crane shall be provided in the S02 Un-scheduled Repair Shop.

2.3. Crane performance shall be as follows:

   i. Lifting capacity: Two hoists, 10 tons and 3 tons,

   ii. Travelling distance: approx. 70 m,

   iii. Traverse distance (between center of crane rails): approx. 14 m,

   iv. Lifting height: approx. 8.5 m,

   v. Lift speed: maker's standard (reference, 5 & 0.5 m/min.),

   vi. Traverse speed: maker's standard (reference, 2.5～12.5 m/min.),

   vii. Travel speed: maker's standard (reference, 5～25 m/min.).

3. Design

3.1. The crane shall be of single or double girder type with catwalk on it.

3.2. Operation and control on a pendant shall be applied, on which an emergency stop button shall be provided.

3.3. Jogging function for lifting shall be provided.

3.4. Motor insulation class F, Dust/Water Protection: IP 55

3.5. Flashing light (orange color) shall be provided for work safety.

3.6. Safety devices shall be integrated for overload, highest/lowest limit switch, etc.

3.7. Magnetic disc brake shall be provided.

3.8. The crane shall be equipped with anti-collision device.

3.9. The following lifting tools shall be provided:

   i. 2 sets of lifting gear for lifting bogie (approx. 3.0 m x 2.7 m, < 10 tons)

   ii. 2 sets of lifting ropes, shackles and slings (for 1 ton – 3 tons, <3 tons)

4. Interface Requirement

4.1. The Contractor shall provide and install the crane in the workshops, with appropriate interface coordination with the between Building and OCS contractors, regarding material supply, power conductor rail layout, capacity, control and interlocking arrangements and installation work.

4.2. Crane rails shall be included in crane supply scope and shall be supplied to the Building Contractor who will install it on the building beams.

4.3. Power conductor rails will be installed by the crane supplier.

5. Eligible Supplier

   There is no preference.

S02.02 Bogie Replacing Equipment

1. Quantity: One (1) sets

2. Functional Requirements

2.1. The bogie replacing equipment of 'Drop-Pit type' shall be used for replacing one bogie, or underfloor large equipment of the train in-situ condition (10 cars coupled) without uncoupling.

2.2. The major components of the equipment shall be, but not limited to:

i. Bogie replacing traverser with a lifting table,

ii. Car body supporting device.

2.3. The train can run on the bogie replacing equipment itself or can be moved by a shunting car.

2.4. After positioning the train, in case of bogie replaced, car body shall be supported by the car body supporting devices and the bogie shall be taken down to the underfloor pit by the bogie replacing traverser.

2.5. The traverser shall transport the bogie in the underfloor pit to the side of the track, then, lift and release the bogie on the floor rails. New installation of spare equipment shall be made in the reverse process.

2.6. The traverser shall be composed of an electric driven traversing cart, a lifting table on the traverser with rails for train running, running rails in the pit for the traverser, and a locking devices and hydraulic units.

2.7. The car body supporting device shall be composed of two columns at the both side of the track, which is movable when the train is on the bogie replacing equipment. One support block shall be provided on each column, which can be adjusted to the support position of the car body manually.

2.8. Control and operation of the bogie replacing equipment shall be performed on the pendant switch of each device.

2.9. Bogie replacing traverser, lifting table on the traverser and car body supporting device shall be equipped with a mechanical interlocking device for each to prevent unexpected falling down due to the power failure, hydraulic pressure loss, etc.

2.10. Time of bogie replacement shall be within 2 hours after train positioned.

3. Design

3.1. Rolling stock and its components data for design of the equipment are as follows. The Contractor shall take interface, if any, with the Rolling Stock Contractor.

i. Track gauge: 1,435 mm,

ii. Rolling stock weight (Motor car): approx. 45 tons,

iii. Car body size and weight: 2,950 (W) x 19,500 (L) mm, approx. 40 tons,

iv. Bogie size and weight: approx. 3,000 (L) x 2,700 (W) x 1,000 (H) mm, approx. 8 ton,

v. Axle distance: 2,100 mm,

vi. Wheelset weight: max. 2,500 kg,

vii. Max. underfloor equipment: 4,300 (L) x 900 (W) mm, approx. 2 tons.

3.2. Arrangement of the equipment shall be referred to the drawing NSRP-DWG-DEP-DEF-0004, Un-scheduled Repair Shop Layout.

3.3. The following underfloor pit is planned. The Contractor shall take interface regarding details, but not limited to, with the Building Contractor.

i. Width: approx. 10,000 mm (7,700 mm from track centre to traverse side),

ii. Length: approx. 4500 mm,

iii. Depth: approx. 2,000 mm from floor.

3.4. Safety measures shall be provided for operator, train and equipment including flashing light (orange color).

3.5. The pit cover or floor grating, if required, shall be provided and installed with the equipment.

4. Interface Requirement

Interface shall be taken at the appropriate timing with the Rolling Stock Contractor and the Building Contractor.

5. Eligible Supplier

There is no preference.

S02.03 Underfloor Equipment Exchange Device 2t

1. Quantity: One (1) set

2. Functional Requirements

2.1. The underfloor equipment Exchange Device 2t shall be provided to dismantling or installing underfloor large equipment.

2.2. Major performance shall be as follows, but not limited to:

   i. Lifting capacity: 2 tons,

   ii. Lifting height: more than 500 mm,

   iii. Underfloor equipment size: approx. 3,000 x 1,500 mm,

   iv. Power: Battery driven DC motored hydraulic unit,

3. Design

3.1. The lowest height of the lifter shall be minimized as much as possible.

3.2. Battery charger shall be provided and built on the Exchange Device, if possible.

3.3. Battery of 24 V DC is preferable and shall be of maintenance-free type.

3.4. The Exchange Device shall have ahead and astern running modes.

4. Interface Requirement

   Interface shall be taken at the appropriate timing with the Rolling Stock Contractor.

5. Eligible Supplier

   There is no preference.

S02.04 Movable Lifting Platform

1. Quantity: One (1) set

2. Functional Requirements

2.1. The movable lifting platform of scissor type shall be provided for high place work in the S02 Unscheduled Repair Shop.

2.2. Major performance shall be as follows:

   i. Loading capacity: 200 kg (min. 2 persons with hand tools),

   ii. Top height: approx. 5,000 mm above the floor,

   iii. Platform size: approx. 3,000mm x 1,200 mm,

   iv. Power: Battery driven DC motored hydraulic unit,

   v. Mobile mechanism: Casters driven by motor.

3. Design

3.1. The lowest height of the platform shall be minimized as much as possible.

3.2. Sufficient outriggers shall be provided for safety.

3.3. Battery charger shall be provided and built on the lifter, if possible.

3.4. Battery of 24 VDC is preferable and shall be of maintenance-free type.

3.5. Lifting operation shall be performed on the platform.

3.6. The lifter shall have manual manoeuvring handle (lever) on one caster. The caster shall be of heavy load type.

3.7. The lifter shall have ahead and astern running modes. The running motor shall be interlocked with the scissor lifter lowest position.

3.8. The handrail of steel pipes having min. height of 900 mm shall be provided all around of the platform for safety. However, there shall be some place(s) where workers can go up to the roof or can work on the side of the car body from the lifting platform. At this place(s), the handrail shall be removable, or door, wire rope or chain for worker's safety is acceptable.

3.9. The floor of the platform shall be of non-slip type.

4. Interface Requirement

   Interface shall be taken with other related contractors, if required.

5. Eligible Supplier

   There is no preference.

S02.05 Boarding Step

1. Quantity: Two (2) sets

2. Functional Requirements

2.1. The boarding step made of aluminum shall be provided to access E rolling stock interior or car body side exterior in the S02 Un-scheduled Repair Shop.

2.2. Major dimension shall be as follows; the Contractor shall confirm to the Rolling Stock Contractor:

i. Platform size: approx. 1,000 mm x 1,000 mm,

ii. Height: 1,100 mm.

3. Design

3.1. The boarding step shall be easily moved by hand with strong and lockable casters.

3.2. The steps and the platform shall be of non-slip type.

4. Interface Requirement

Interface shall be taken at the appropriate timing with the Rolling Stock Contractor

5. Eligible Supplier

There is no preference.

S02.06 Welding Machine

The same requirements as of S01.10 shall be applied except follows:

Quantity: One (1) set

.

S02.07 Oxygen Acetylene Gas Welder

The same requirements as of S01.11 shall be applied except follows:

Quantity: One (1) set

S02.08 Worktable

The same requirements as of S01.14 shall be applied except follows:

Quantity: One (1) pc

S02.09 Tool Cabinet

The same requirements as of S01.15 shall be applied except follows:

Quantity: One (1) pc

S02.10 Bogie Transport Unit

1. Quantity: Two (2) pcs.

2. Functional Requirements.

2.1. Battery-operated Bogie Transport Unit for removal and installation of bogies on lifted rolling stock, hi-rail type, manually and remotely guided operation.

2.2. Operations.

i. Vehicle with load carrying platform shall be placed under respective bogie of lifted car or train.

ii. After the detachment the bogie shall be lowered, and the Bogie Transport Unit shall manoeuvre laterally from under the car then transport the bogie to the overhaul area in the workshop where the bogie will be hoisted by crane on to a disassembly stand or placed on the workshop floor.

iii. After the overhaul bogies will be loaded on the Bogie Transport Unit and brought to designated locations for installation under the car or train.

iv. The Bogie Transport Unit shall be equipped with four steerable wheels and resilient tires in order to move in any direction as needed.

v. For lateral positioning the Bogie Transport Unit shall engage with the embedded rails in the floor.

vi. This process shall be suitable for bogie replacement on individual cars and trains.

vii. The Bogie Transport Unit shall be provided with full safety features for protection of equipment operators.

2.3. Control.

i. The Bogie Transport Unit shall be approximately the size bogies.

ii. The remote control shall be detachable to permit the operator to walk alongside the Bogie Transport Unit. All operating commands shall be performed from the console.

iii. The raising and lowering of the loading platform may be powered by on-board batteries or from a nearby 400 V ac 60 Hz source in the workshop.

iv. The bogie platform shall be adjustable +/-50 mm in the fore and aft direction for bogie installation.

2.4. Size and Capacity.

i. The Bogie Transport Unit shall be approximately the size of bogies.

ii. The bogie platform lifting height shall be 1.6 to 1.8 m from workshop floor.

iii. The loading and transport capacity shall be 8 t.

iv. Travelling speed shall be in the range of 0.5 to 4.0 km/h.

v. Battery operation of Bogie Transport Unit shall be eight (8) hours.

vi. Duration for charging batteries shall be within eight (8) hours.

3. Interface Requirement.

Interface shall be taken with the Rolling Stock Contractor appropriate clearance.

4. Eligible Supplier.

There is no preference.

S02.11 CAR BODY LIFTING JACK

1. Quantity: Nine (9) sets

2. Functional Requirements

2.1. One car body lifting jack set shall consist of four (4) on-floor type mobile jacks of electric motor driven screw type having self-locking features when the power fails, and a control system for lifting of single car.

2.2. Each jack shall have a capacity of 10 tons (40 tons/set) and lifting stroke min. 1,800 mm.

2.3. Four jacks shall be synchronized during the lifting process after confirming sufficient contact with jacking pads on the car within a tolerance of +/- 5 mm.

3. Design

3.1. Major particulars of car will be as follows; the Contractor shall confirm to the Rolling Stock Contractor:

   i. Track: 1,435 mm gauge,

   ii. Cary weight: less than 40 tons except bogies,

   iii. Car width: 2,950 mm (1,435 mm gauge).

3.2. Arrangement of lifting positions shall be referred to the workshop layout drawings.

3.3. The jacking operation shall be carried out and controlled on the central control panel, and remote-control box shall be provided for single jack operation.

3.4. Safety measure shall be provided for the train opposite side where the staff cannot watch from the central control panel.

3.5. Flashing lights and audible warning device shall be provided for operation safety.

3.6. Emergency stop button (mushroom type) shall be provided on each control position.

3.7. Contact condition between a jack and the car body at starting and during lifting process shall be confirmed securely by the sensor technology.

3.8. Lifting jacks shall be stopped when exceeding the synchronization tolerance and correction of deviation and resuming synchronized operation shall be performed.

3.9. Operating and failure status shall be indicated on the central control panel.

3.10. PC/PLC for controlling jacks shall have back-up battery for power-source failure.

3.11. Power and control cables for jacks set shall be provided with multipin connectors and sufficient length covering each jack's position.

3.12. All integral wirings to the control panel and individual jack shall be factory-wired. Other wirings shall be completed on site during installation.

3.13. All equipment shall be suitably earthed.

3.14. Movement of jacks to the lifting position shall be available manually on the floor, assisted by hydraulically raised wheels. Wheels shall be retracted for lifting.

3.15. Each jack shall be equipped with lifting eye-plates and/or hungers for transport with crane or forklift truck within the Depot/Workshop.

4. Interface Requirement

4.1. Interface shall be taken with other related contractors such as for the Building Contractor regarding electric source, distribution box, cable connection, etc. especially the following issues, but not limited to:

i. Tolerance of floor levelness in jacking areas,

ii. Equipment weight,

iii. Floor loading (t/m2) in floor contact areas,

iv. Power and control cable pipe, route, location and dimension.

4.2. Interface shall be taken with Rolling Stock Contractor and building contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

S03 WHEEL RE-PROFILING SHOP

S03.01 Underfloor Wheel Re-profiling Lathe

1. Quantity: One (1) set

2. Functional Requirements

2.1. The underfloor wheel re-profiling lathe shall perform precise machining of wheel tread, wheel flange, wheel front and back faces on one wheelset.

2.2. Re-profiling of wheels on bogies removed from trains and re-profiling of wheels on individual wheelsets removed from bogies can be performed, if manufacture's standard machine has those functions.

2.3. The machine shall perform the re-profiling for the two wheels on the axle simultaneously.

2.4. The wheels shall be re-profiled in-situ without removing bogies and wheelsets from the train.

2.5. Train movement and shunting will be carried out by a shunting locomotive.

2.6. All machining process shall be performed automatically by a CNC system equipped for process control, measurement data, records and sorting and managing wheelset data.

2.7. The machine shall be installed in a dedicated pit of the S03 Wheel Re-profiling Shop.

2.8. Measuring system shall include, but not limited to:

i. Diameter and profile wear of wheels,

ii. Position of wheels.

2.9. Wheelset data of E rolling stock is described below; the Contractor shall confirm to the Rolling Stock Contractor:

i. Track gauge: 1,435 mm,

ii. Wheel diameter range: 760 – 860 mm,

iii. Brake disc diameter: range: 300 – 700 mm,

iv. Axle length range: 1,850 - 2,200 mm,

v. Tread profile: rolling stock standard,

vi. Axle load of a wheelset: max. 15 tons,

vii. Diameter allowance within 2 wheels: within 0.5 mm,

viii. Diameter allowance within a bogie: within 3 mm,

ix. Diameter allowance within a car: within 6 mm.

x. The data shall be able to be uploaded by USB at any time.

xi. The chip conveyer shall be integrated. Two (2) chip bins shall be provided with the machine.

2.10. The machine shall be able to support maintenance for rolling stock from Metro Manila Subway Project (MMSP), NSCR N-1 CP 03, CP NS-02 and CP NS-03.

3. Design

3.1. Arrangement of the lathe shall be referred to the drawing NSRP-DWG-DEP-DEF-0005, Wheel Re-profiling Shop Layout.

3.2. The automatic control and monitoring system shall be equipped for the throughout the machining process including:

i. Clamping the wheelset,

ii. Measurement before, during and after machining,

iii. Determining machining parameters,

iv. Proposing machining cycle, which can be manually modified and approved,

v. Slip detection,

vi. Control of machining cycle.

3.3. The control and monitoring display (s) shall be equipped, on which the operator can receive necessary data and information for the wheelset, machining and can be guided for operation.

3.4. The data system shall have, but not limited to:

i. Train ID, Bogie ID, wheel ID,

ii. Profile evaluation (wear status), machining parameters,

iii. Production data recording, ordering management,

iv. Operator ID, date,

3.5. Machine diagnosis and logging.

3.6. Data input shall be at the machine by operator on touch screen or keyboard, or via USB.

3.7. Automatic storing of all wheel dimensions after machining associated with wheel location within train and individual wheel serial number shall be provided for data export by USB data transmission.

3.8. A printer for outputting data and results of machining shall be provided.

3.9. Chip crushing facility, with chip collection and transfer by conveyor(s) to container on workshop floor (next to machine pit) for removal by forklift truck.

3.10. Safety and alarm system shall be provided for operator, overload in cutting process, cutting tool retraction in case of tool damage or power failure and protect machine and tool, and after recovery, the machining can be resumed at the suspended position.

3.11. The electrical cabinets shall comply with IP 55 as standard.

3.12. The following adjustment tools shall be provided:

One Set of Wheelset

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing within other related contractors such as for Building regarding floor pit, electric source, distribution box, cable connection, etc. particularly regarding the following issue, but not limited to:

i. Floor pit and anchor bolt hole, if any,

ii. Tolerance of floor levelness,

iii. Equipment weight,

iv. Electric power supply, cable route, etc.,

v. Floor loading (t/m2) in floor contact areas.

4.2. The pit cover, floor grating or stairs to the pit, if required, shall be provided and installed with the machine.

4.3. Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

S03.02 Jib Crane 1t

1. Quantity: Two (2) sets

2. Functional Requirements

2.1. The jib cranes shall be provided for the S03 Wheel Re-profiling Shop.

2.2. Major performance shall be as follows:

   i. Type: Cantilever-pillar, self standing type,

   ii. Lifting capacity: 1 ton,

   iii. Swing: 180deg. motorized,

   iv. Reach: approx. 4 m,

   v. Lifting height: approx. 4 m from the floor,

   vi. Lifting speed: maker's standard (reference, 7 m/min.), with jogging,

   vii. Hoist travel speed: maker's standard (reference, 20 m/min.),

   viii. Swing speed: maker's standard.

3. Design

3.1. Operation and control on a pendant shall be applied, on which an emergency stop button shall be provided.

3.2. Safety devices shall be integrated for overload, highest/lowest limit switch, etc.

3.3. Arrangement of the equipment shall be referred to the drawing NSRP-DWG-DEP-DEF-0005, Wheel Re-profiling Shop Layout.

4. Interface Requirement

The Contractor shall provide and install the crane in the workshops, with appropriate interface coordination with the Building Contractor, regarding layout, anchor holes, anchor bolts, power supply, electric distribution box, installation work.

5. Eligible Supplier

There is no preference.

S03.03 Worktable

The same requirements as of S01.14 shall be applied except follows:

Quantity: One (1) pc

S03.04 Tool Cabinet

The same requirements as of S01.15 shall be applied except follows:

Quantity: One (1) pc

S03.05 Baby Compressor

1. Quantity: One (1) set

2. Functional Requirements

2.1. The Baby compressors shall be provided for general purpose air supply system in S03 Wheel Re-profiling Shop.

2.2. The air compressor shall be a general purpose and manufacture's standard type covering the following major performance:

i. Type: Electric driven package type, air cooled oil free type, with integrated air dryer, on-floor installation type,

ii. Compressor capacity: approx. 1.3 m3/min. 0.85 MPa.

2.3. The air compressor shall be composed of, but not limited to:

i. Air compressor: one (1) sets,

ii. Air reservoir: one (1), approx.1.3 m3,

iii. Exhaust ducts.

3. Design

3.1. The supply system shall be connected to the distribution piping provided by the Building Contractor at the outlet of the pressure regulating valve after the air reservoir.

3.2. The following accessories shall be included, but not limited to:

i. Air filter

ii. Necessary air piping system with valves,

iii. Pressure regulating valve unit,

iv. Air hose (10m) and Air Gun

v. Maintenance tool kit.

4. Interface Requirement

4.1. Interface shall be taken at the appropriate timing with the Building Contractor regarding, electric source, distribution box, cable connection, ducting, etc. particularly regarding the following issues, but not limited to:

i. Floor drilled anchor bolt, if any,

ii. Exhaust duct route, duct supports and penetration of building wall, finishing of penetration hole, etc.,

iii. Drainage,

iv. Equipment weight,

v. Floor loading (t/m2) in floor contact areas.

4.2. Distribution air pipes to the Unscheduled Shop and the Wheel Reprofiling Shop after the outlet valve on the air tank will be provided by the Building Contractor.

5. Eligible Supplier

There is no preference.

S04 CARBODY WASHER

S04.01 AUTOMATIC CAR BODY WASHER

1. Quantity: One (1) set

2. Functional Requirements

2.1. The system shall be custom designed for washing trains for MMSP, MCRP and NSCR.

2.2. The automatic car body washer shall be provided for the external washing of rolling stock entering from the stabling yard.

2.3. One directional, automatic washing process shall be applied, where when the train is passing the washing machine, water washing, and brushing shall be performed in.

2.4. Wash System - Automatic: Sequential starting and stopping of the vehicle washer and interfacing controls shall be completely automatic, not requiring services of an attendant other than for routine servicing, inspection, and maintenance.

2.5. Manual Controls: A manual capability shall be provided to override automatic controls in the event of malfunctions or failure of system, or permit passage of train through the wash lane without being washed

2.6. Entry shall be through a pre-rinse high pressure arch for cooling or heating the surface and the proceeding through an alkaline application cycle, progressing through a brush washing cycle which shall effectively scrub surfaces of eaves and sides of rail vehicles including windows using a minimum of four (4) rotary brushes, each equipped with detergent spray applicators.

2.7. When the train comes into the front wash section, the signal light blinks red and the train stops. The front is washed with front brushes which shall effectively scrub all body surfaces of front and sides of rail vehicles including curved front and rear windshield, windows, using a minimum of four (4) rotary brushes, each equipped with detergent spray applicators

2.8. When the rear of the train enters the rear wash station, the driver is signaled to STOP by a red light (traffic light). The brushes shall then move into the back of the train, cleaning with the split horizontal top brush.

2.9. The number of passes shall be programmable as per the operator's requirement. The light signal then indicates forward and the train continues to drive through the wash bay.

2.10. Final rinse of the front, sides and rear, shall be by high efficiency water saving rinse system.

2.11. Finally, a high-speed blower/dryer system to strip excess water from the vehicle. The system can include a complete water treatment system with a fresh water reducing system.

2.12. The machine shall be provided with recycling water system and wastewater treatment system.

2.13. Wash water shall be recycled to the maximum extent.

2.14. For final rinse fresh water shall be used.

2.15. Wash water shall be of biodegradable type.

2.16. Detergents and related ingredients for the wash process shall be available locally in the Philippines.

2.17. Waste water shall be treated to meet Philippine Environmental Standards.

2.18. The machine shall be designed to meet the washing rate of max. 40 trains of eight-cars per day.

2.19. Rolling stock side shell, front and rear panels shall be washed by the rotating brush technology in this machine.

2.20. The washing process shall be activated by the train driver through the cabin window with a start button at once stop in front of the machine. The automatic start washing program by the sensor shall be also applied.

2.21. Automatic car body wash shall be designed to prevent damage to any part of the train. For instance, windscreen wiper.

2.22. The washing process and detergents proposed to be used shall not reduce the life of the car body structure and car finishing.

2.23. The machine shall be able to use recycled water.

2.24. The pit cover and floor grating shall be provided and installed with the machine.

3. Design

3.1. The rolling stock parameters for the machine are as follows:

i. Track gauge : 1,435 mm,
ii. Shape : to be confirmed to the Rolling Stock Contractor,
iii. Car body size : 2,950 (W) x 20,000 (L) x 3,600 (H) mm,
iv. Car body material: to be confirmed to the Rolling Stock Contractor,
v. Train speed : max. 5km/h (Configurable 0-5 kmph) for washing, others 25 km/h,
vi. Train length :160 m (8 cars). Design of car body washing machine be able to accommodate the potential change of train configuration to 10-cars length (200 m) in future.

3.2. The equipment shall be arranged at a proper position in the allocated space in the Depot.

3.3. Fresh water supply system shall be provided by the Building Contractor.

3.4. The machine shall be controlled and monitored from an industrial PC interface with all functions for proper operation indicated in real-time and warnings provided in visual and audible with a flash light (red color) for the depot personnel.

3.5. Track works and Civil works comprising track rails, concrete foundation for installation of the plant, drainage of wash water, shall be constructed by the Building Contractor and the Track Contractor.

3.6. Planned size of the foundation and drainage slab for this machine is around 7.0 m width (excl. operation room and mechanical room) and maximum 50 m length for drainage slab.

3.7. The System shall be composed of followings, but not limited to:

i. Program/Wash Selector
ii. Pre-rinse Arch
iii. Booster pump for Pre-rinse Arch
iv. Detergent arch
v. Automatic detergent mixing with pump
vi. Four (4) side brushes (Wash section)
vii. Four (4) brush gantry system, (front/side and rear wash system)
viii. Automatic rinse distribution system
ix. Final Rinse Arch
x. Booster pump for rinse water
xi. Buffer tank for Fresh water

xii. High Speed Dryer/Blower System
xiii. Water Recycling
xiv. Buffer tank for Reclaim water
xv. Wash Water Pump (Reclaim water)
xvi. Motor Control Center
xvii. Traffic lights (2 no.)

3.8. Finish: All fabricated sections of washer frame, brush yokes and arms, spray arch frames, and miscellaneous structures shall be hot-dipped galvanized after fabrication.

i. Metallic surfaces not suitable for galvanizing shall be coated with 95% zinc primer and covered with durable machine enamel.
ii. All erection bolts shall be plated.
iii. Miscellaneous components including automatic air system with control panel, brush yokes, columns, base plates, anchor bolts, etc. shall be included.
iv. The washing brushes and spray nozzles shall be installed in the casing made of stainless-steel plates.

3.9. The casing shall be equipped with an inspection deck and a ladder at the convenient height for inspection and adjustment.

3.10. Rolling stock structure envelope shall be kept strictly.

4. Interface Requirement

4.1. The Contractor shall take sufficient interface with the Building Contractor regarding size, structure, performance for; but not limited to:

i. Drain trench and sump pit, connection with civil scope including, measures for strong squall water, etc.
ii. Utilities Required:
a. Electrical: 400 VAC, 3 phase and 230 VAC, 1 phase
b. Water: 2" at 3-4 BAR minimum feed with backflow protection to mutually agreed service areas such as the pump room and wash bay. (5L/second)
c. Compressed Air: 1/2", 200L/min feed (compressed dry air) to mutually agreed.

service areas such as the pump room and wash bay.

d. Drain: 160mm floor drain, minimum.
e. Ground tanks

4.2. Interface shall be taken with the Rolling Stock Contractor regarding the technical particulars of the Rolling stock.

4.3. The washing shall cover NS-02 rolling stock, NS-03 rolling stock, MMSP and NSCR rolling stock.

5. Eligible Supplier

There is no preference.

S41 SHUNTING CAR SHOP

S41.01 Shunting Locomotive (Both Rail and Road Drive Type)

1. Quantity: One (1) set

2. Functional Requirements

2.1. The shunting locomotive (both rail and road drive type) shall be provided for the shunting of the car body in the S03 Wheel Re-Profiling Shop.

2.2. The shunting locomotive (both rail and road drive type) shall be the structure which can be remotely operated and manned operation.

2.3. Major performance of the shunting locomotive shall be as follows; the Contractor shall confirm the type of coupler to the Rolling Stock Contractor:

- i. Type: Battery locomotive, both rail and road drive,
- ii. Track gauge: 1,435 mm,
- iii. Coupler: the couplers of rolling stock,
- iv. Driver cab: single cab for both direction operation, with the room light and the cooling fan,
- v. Traction force: max. for rolling stock with Ten (10)-car set,
- vi. Speed: max speed single car 5km/h (at horizontal level).

3. Design

3.1. The shunting locomotive (both rail and road drive type) shall be able to operate by single driver or remote operation.

3.2. The shunting locomotive (both rail and road drive type) shall be equipped with the following features, but not limited to:

- i. Windows shall be wide and clear view from the cab for safe operation,
- ii. Visually checking of the coupling status in the cab,
- iii. Remote releasing of coupling,
- iv. Parking brake,
- v. Melody horn and flashlight operated when in operation,
- vi. Emergency stop buttons both on the vehicle and the remote control pendant.

3.3. The following accessories shall be included, but not limited to:

- i. Standard accessories,
- ii. Maintenance tool kit.

4. Interface Requirement

Interface shall be taken with Rolling Stock Contractor at the appropriate timing.

5. Eligible Supplier

There is no preference.

S51 NOT USED

S51.01 Not Used

S61 COMMON USE

S61.01 Not Used

S61.02 Not used

S61.03 Not Used

S61.04 5-ton Cargo Truck

1. Quantity: One (1) set

2. Functional Requirements

2.1. Five (5) tons cargo truck shall be provided for general transportation purpose in the Depot/Workshop.

2.2. The major particulars of the cargo truck shall cover the followings:

i. Type : Commercial road cargo truck with rear loading space,

ii. pneumatic rubber tires, with driving cab, diesel engine driven,

iii. Capacity : 5,000 kg,

iv. Loading space : min. 5,000 (L) x 2,000 (W) mm, with gate boards (hinged type for sides and rear boards).

3. Design

3.1. The following accessories shall be supplied, but not limited to:

i. Cab air conditioning,

ii. Standard accessories and tools.

4. Interface Requirement

No additional requirement

5. Eligible Supplier

There is no preference.

S61.05 Rescue Device

1. Quantity: One (1) set

2. Functional Requirement

2.1. The rescue device shall be supplied to restore a train derailed in the main line where a mobile crane cannot approach. (incl. Equipment for rescue of passengers and crew from damaged trains shall be supplied)

2.2. The 'Rescue Device' comprising the items specified comprising re-railing equipment, damaged bogie rescue device, and rescue equipment shall be accommodated in two (2) transport type containers.

2.3. The containers shall be designated 'Rerailing' and 'Rescue' and shall be kept at the depot in a location that will readily permit the containers to be loaded with a crane onto vehicles, i.e., flat cars or truck.

2.4. Containers shall be based on shipping container type structures and shall be sized approximately 4.0 m long, 2.0 m wide, and 2.5 m high.

2.5. Rerailing and rescue devices shall be stored in containers on shelves, containers, etc. and shall be readily accessible via roll-up shutters on the 4 m sides and doors on the 2 m sides.

2.6. Containers shall be provided with forklift 'pockets' and attachments for lifting with cranes.

3. Design

3.1. All components of the rescue device shall be portable and shall be designed and manufactured with following features, but not limited to:

3.2. De-railed car rescue equipment

i. This equipment shall work by hydraulic power for lifting and traversing the derailed car and setting it down on the rail.

ii. Track gauge: 1435mm

iii. Axle load: 16t

iv. Lateral shifting function

v. Accessory: Hydraulic unit and jack, Roller carriage, Guide rail, Engine generator and lighting, etc.

3.3. Re-railing Guide Equipment

i. This equipment shall be used to restore a train which is slightly derailed. After this guide, set under derail axle, another car pulls the derail train back onto the line.

ii. Track gauge: 1435mm

iii. Axle load: 16t

3.4. Temporary rescue truck

i. This truck shall be used for carrying heavy damaged wheelset after being restored from the derailment. It shall consist of several components which can be lifted and handled by no more than two persons per item and assembled into truck on site.

ii. Track gauge: 1435mm

iii. Axle load: 16t

3.5. Passenger rescue equipment

i. This equipment shall be used to rescue of passengers and crew from damaged trains.

ii. Set of equipment and devices for rescue operations to remove and free persons from damaged trains.

iii. Equipment to include device(s) capable of cutting car body materials, 'jaws of life' type equipment and spreaders, as well as compressed air cushions for lifting/separating heavy components.

iv. Equipment to include first aid supplies and devices, and stretchers.

4. Interface requirement:

Contractor shall interface with Rolling stock package contractors to obtain necessary technical details of the Object cars and Bogies.

5. Eligible Supplier

There is no preference.

S61.06 Vehicle (Van)

1. Quantity: One (1) set

2. Functional Requirements

2.1. Vehicle (Van) shall be provided for general transportation purpose in the Depot/Workshop.

2.2. The major particulars of the cargo truck shall cover the followings:

i.	Type:	Commercial road Vehicle Van with rear loading space, pneumatic rubber tires, with driving cab, diesel or gasoline engine driven,
ii.	Capacity:	10 persons,1,000 kg,
iii.	Loading space:	Approx. 4,500 (L) x 1,500 (W) mm.

3. Design

3.1. The following accessories shall be supplied, but not limited to:

i. Cab air conditioning,
ii. Standard accessories and tools.

4. Interface Requirement

No additional requirement

5. Eligible Supplier

There is no preference.

S71 TOOLS

S71.01 Measuring Instruments, Gauges

1. Quantity: One (1) lot
2. Functional Requirements

2.1. The following one (1) lot of measuring Instruments and gauges shall be provided for general measuring purpose, which shall be durable and of high quality:

2.2. Measuring Instruments and gauges shall provide the latest type of the following:

a. 4 sets: micrometer, outside, 0 – 225 mm,
b. 4 sets: micrometer, inside, 6 – 100 mm,
c. 1 pc: vernier caliper, 0 – 150 mm,
d. 1 pc: vernier caliper, 0 – 200 mm,
e. 3 sets: vernier caliper, 0 – 300 mm,
f. 3 sets: vernier caliper, 0 – 400 mm,
g. 1 set: height gauge,
h. 1 set: depth gauge,
i. 1 set: dial indicator with magnetic base and arm,
j. 1 set: thickness gauge (feeler gauge),
k. 4 sets: steel ruler, 20 cm, 30 cm, 100 cm,
l. 1 set: surface plate,
m. 3 sets: torque wrench (0 - 50 N-m),
n. 3 sets: torque wrench (0 - 200 N-m),
o. 2 sets: torque wrench (0 - 300 N-m),
p. 2 sets: torque wrench (0 - 1000 N-m),
q. 2 sets: torque screwdriver tools group
r. 4 sets: convex scale, 5 m,
s. 4 pcs: measuring tape, 20 m,
t. 4 pcs: digital multi mater,
u. 4 pcs: ampere meter, digital, clamp type,
v. 4 sets: insulation tester (megger),
w. 1 pc: direct current tester, under 1.2 mA,
x. 1 set: oscilloscope, portable, with LCD screen,
y. 2 pcs: contactless thermometers, 0 - +400 deg., digital type,
z. 1 pc: sound level meter, digital type,
aa. 4 sets: Handy Force Gauge, digital type,
bb. 2sets: Wheel measuring device, portable type. (measurement item: Wheel profile, diameter, clearance etc.)
cc. 1 set: Wheel load measuring devise, portable type. (Load cell unit, Rail set, Power unit, etc.)
dd. 41 sets: Laptop Computer (Minimum indicative specifications RAM: 4GB, HDD: 320GB, 13.3" Display, OS: MS Windows 10 or latest version, Software: MS Office professional latest version)

3. Eligible Supplier

There is no preference.

S71.02 General Tools

1. Quantity: One (1) lot

2. Functional Requirements

2.1. The following power tools shall be provided for general use, which shall be of AC 230V 60 Hz or AC 400V 3 Phase 60Hz, durable and of high quality:

a. 6 sets: screwdriver, flat type, 10 assorted sizes,
b. 6 sets: screwdriver, Philips type, 4 assorted sizes and lengths,
c. 6 sets: hexagon wrench (Allen keys), 2 to 14 mm,
d. 6 sets: socket wrench, 9 to 32 mm, ratchet, universal drive,
e. 6 sets: adjustable wrench, 4 sizes,
f. 6 sets: double open-end spanner set, 5.5 to 36 mm,
g. 6 sets: open & close end wrench set, 5.5 to 36 mm,
h. 6 sets: pliers, combination type, insulated handle, 2 sizes,
i. 4 pcs: external snap ring plier (straight), 2 sizes,
j. 4 pcs: internal snap ring plier (straight), 2 sizes,
k. 1 pc: external snap ring plier (bent), 2 sizes,
l. 1 pc: internal snap ring plier (bent), 2 sizes,
m. 6 sets. pliers, flat nose, straight, insulated handle, 2 sizes,
n. 6 sets: pliers, needle nose, straight, insulated handle, 2 sizes,
o. 6 sets: cutting plier set,
p. 6 sets: grip plier,
q. 6 sets: bolt cutter, up to 15 mm,
r. 6 sets: hack saw with blades for various materials,
s. 1 pc: cutter (various),
t. 6 sets: tin snip, different sizes,
u. 6 sets: steel hammer, different sizes,
v. 6 sets: mallet, different sizes,
w. 6 pcs: inspection hammer,
x. 6 sets: chisel and punches, assorted set,
y. 3 pcs: vice,
z. 3 pcs: file flat, tapper bastard and smooth set,
aa. 3 sets: file round tapper set,
bb. 3 sets: file round smooth set,
cc. 6 sets: taps and dies, M6 to M24, taps and dies handles,
dd. 6 sets: wire strippers, insulated handle, 2 sizes,
ee. 6 sets: crimping tools, 1.25, 2, 5.5, 8, 14 mm,
ff. 3 sets: hydraulic crimping tools,
gg. 6 sets: cable cutter, insulated handle, up to 22 mm,
hh. 6 sets: soldering sets,
ii. 3 sets: pipe wrench stillson types, 5 sizes,
jj. 3 pcs: chain pipe wrench 100 mm,
kk. 3 pcs: small type pipe cutter (φ20 mm),
ll. 3 pcs: pipe cutter (φ50 mm),
mm. 6 sets: water pump pliers, 3 sizes,
nn. 6 pcs: toolbox, hand carry type,
oo. 6 pcs: tool trolley, 4 wheels, for use in workshop,
pp. 2 sets: submersible pump, electric, portable type (discharge pip φ50, hose)
qq. 6 sets: hand cordless driver, Philips and Allen, etc.,
rr. 5 sets: hand drill, electric, cordless, up to 5 mm,
ss. 2 sets: hand disc grinder, electric, angle type, 125 mm dia.,

tt. 2 pcs: electric nibbler, 1.6 mm,
uu. 3 sets: impact wrench, pneumatic, side handle, up to M10,
vv. 3 sets: impact wrench, pneumatic, side handle, up to M24,
ww. 3 sets: impact wrench, pneumatic, side handle, up to M33,
xx. 2 pcs: pneumatic drill, 6.5 mm,
yy. 2 pcs: pneumatic chipping hammer, 2,600/min,
zz. 1 set: pipe bending machine (max. 60 mm dia. Steel pipe, 90 degree).
aaa. 2 sets: mobile refuelling equipment for fueling generator and other machines

3. Eligible Supplier

There is no preference.

END OF PART B OF APPENDIX 8.1

9 TRAINING FACILITY AT TRAINING CENTER

9.1 General

The Railway Operator's staff shall have sufficient knowledge and skills to maintain the railway operation and to facilitate this the Employer has a plan to establish the governmental railway institute for enacting common railway regulations, training human resources and technology development for railways nationwide where basic training and licensing will be undertaken including that for drivers.

The Railway Operator shall ensure that their train operators are familiar with each line's characteristics and the new equipment. The Railway Operator's staff should be trained to handle emergencies and rolling stock fault repair, signal system faults and track faults, etc. Therefore, the Contractor shall prepare Training facilities in Mabalacat depot to develop the skills and knowledge for the Railway Operator's staff. The Contractor shall supply Train Operation Simulator as well as training equipment for Trackwork, Signal System, Telecommunications, Power Supply System, Overhead Contact line System, AFC, Pantograph and Bogie Assembly.

The contractor shall plan and prepare full operations and maintenance training facilities, documentation and training for the Railway Operator's staff.

It should be noted that training of train operators and maintenance personnel will be needed for a partial operation. For instances when this occurs prior to the completion of the Training Facilities in Mabalacat Depot then temporary facilities shall be provided by the Contractor for the training together with all necessary spares and training equipment.

9.2 Requirements

9.2.1 Train Operation Simulator

The Contractor shall provide two (2) Train Operation Simulators at the Training Center in Mabalacat Depot. One (1) Train Operation Simulator shall be designed for the Commuter Train (CP NS-02) and the other one (1) for Limited Express Train (CP NS-03). The train operation simulators shall be provided in order to establish a high-quality approach for driver training and route familiarization. It is essential to train the required number of train drivers ready prior to the taking-over of NSCR. They may be newly trained and/or be existing drivers from existing lines. Accordingly, these drivers have to be familiar with the new line profile and the newly applied signaling system before the inauguration. In addition, drivers shall be trained in handling emergencies such as rolling stock faults, signaling faults and railway bogie faults, derailment, accidents etc.

The Contractor shall be responsible to their equipment into the driver cab equipment's supplied by the CP NS-02 and CP NS-03 contractors at the Mabalacat Depot Training Center.

9.2.1.1 Required Main Functions and Performance

9.2.1.1.1 Environment Simulation

The simulators shall project the actual driver`s view of the complete alignment covering MCRP, NSCR and NSRP-South under multiple mode of operations including train recovery scenarios. A virtual reality environment shall be provided, such as running sound generation and a body sensitive seat. Wayside visual systems with wide LCD/LED monitors shall be provided. Artificial wayside landscape data (All the alignment from Clark to Calamba Stations and the Depots) shall be provided; after taking-over of the main line, real wayside visual data shall be provided.

a) 4 kinds of weather shall be simulated and be available to be chosen for use: Sunny, Cloudy, Rainy and Misty.
b) 3 kinds of time range shall be simulated and can be chosen: Daytime, Night-time and Twilight.
c) 8 kinds of sound shall be simulated and can be chosen: rail friction sound, rail gap sound, emergency brake sound, inverter sound, turnout passing sound, crash sound, wind/rain/thunder sound and horn sound.
d) 4 kinds of objects shall be simulated as moving objects: trains on railway, passengers on platform, station staff and obstacles.

The simulator shall have the capacity for adding any future phase alignment and station details. The whole MCRP, NSCR and NSRP driver`s view shall be prepared by the Contactor and shared with the NSCR contractor to harmonize the views in the various simulators.

9.2.1.1.2 Driver Console and On-board Equipment Simulator

The driver`s console panel and equipment shall follow the actual driver console panel including the on-board equipment. The reaction of moving the handles shall simulate the same effect using the visual image generator, sound generator, body sensitive seat, signal monitor, meters and lamps compared to the real driving environment. Door opening and closing features and operation shall be simulated to reflect the actual equipment used on the train. Interfaces with Rolling stock contractors of CP NS-02, CP NS-03, CP-03 and CP 107 shall be carried out for train cab equipment details and views.

9.2.1.1.3 Driver Training

The Train Operation Simulator shall allow the drivers to be trained under the simulated situation not only for regular operation but also abnormal situations such as rolling Stock failures, signaling failures and railway bogie failures, etc.

Hereinafter, training scenarios shall mean a combination of route settings, environment settings, and events. Details of the scenarios shall be proposed by the Contractor for review and granting of Notice of No Objection by Engineer.

9.2.1.2 Subsystems of Train Operation Simulator

Subsystems of the train operation simulator shall be typically categorized as seen below and the functions and performance shall be defined and specified on each subsystem.

a) Simulated driver's cab;
b) Display system;
c) Computer unit;
d) Instructor's console; and
e) Platform and simulated Platform Information Display (PID) monitors on the platform.

9.2.1.2.1 Rolling Stock Cab (Driver Console subsystem)

The cab equipment, driver's console desk, layout, and operation-related provision shall be the same as the actual ones as much as possible. Driving Cab Equipment's are to be provided by the CP NS-02 and CP NS-03 Contractors whereas Signaling, Telecom and PID items to be provided by System contractor NS-01. Interfacing with other contractors is required to obtain necessary design details and the materials. In addition, speakers for simulated sounds, body sensitive seat for feeling train motion and cameras to monitor trainees shall be installed. One set of doors shall be installed at the right-side back of the driver's cab which will be controlled with a door switch.

9.2.1.2.2 Visual Image Display subsystem

A visual image display subsystem shall be installed in the front of the driver's console and to show the simulated view of the driver. Monitors shall be furnished on the floor without any shade. The Specification is shown below.

a) Monitors Minimum 3 sets of minimum 70 inches.
b) Resolution more than 1920×1080

9.2.1.2.3 Computer Unit

A computer unit shall be provided which connects each subsystem and generates visual image/sound in accordance with training scenario or driver/instructor's command. The computer unit consists of visual image generators, TMS control unit, amplifier and central processing unit, and UPS. The UPS capacity is only required to cover the shutdown process of the Central Processing Unit.

9.2.1.2.4 Control and Monitoring Subsystem

This subsystem enables the instructor to monitor each subsystem and control sequences such as start/stop, initial condition set, reposition, temporary pause, visual control, malfunction set, and emergency set. This subsystem also has the function of mirroring the TMS monitor and on-board signaling system monitor, communication system (which is wired to the instructor's telephone handset), speaker system generating the same sound as when train is in use, and monitoring cameras installed in the driver's cab.

The instructor's console has a record and playback function. This function records the front image of the driver along with video image of driver's operations and displays it later on the same monitor. Maximum recording time is assumed to be less than 30 min.

9.2.1.2.5 Platform and Displays Simulating Platform Image Subsystem

The platform shall be installed at the right side of the simulator. PID monitors for checking passengers boarding ad alighting (Station CCTV monitor) shall be installed or simulated.

9.2.1.3 Major Equipment of the Simulator

The related parts and equipment shall be identical to that in the actual train cabs. The detailed equipment required shall include but not be limited to that shown in Table 9.1 below.

Table 9-1

System	Description	Qty.	Scope	Remarks
Simulated Driver's Cab	Body	2 sets	NS-01	Approx. Half Car body. Cab Saloon Partition door.
	Cab seat, Cab doors	1 set	NS-02 and NS-03	
	Body sensitive of lower-case seat	1 set	NS-01	
	Coupler items	1 set	NS-02 and NS-03	A Physical coupler is not required. Software simulation is acceptable.
	Doors	1 set	NS-02 and NS-03	Emergency switch and unlock system are included.

System	Description	Qty.	Scope	Remarks
	Passenger side door system	1 set	NS-02 and NS-03	Passenger door manual release mechanism is included.
	Brake release valve	1 set	NS-02 and NS-03	
	Driver's Console	1 set	NS-01, NS-02 and NS-03	Master controller, switch panels, buttons, meters, gauges, TMS unit, signaling monitor, sun visors are included. Wipers can be simulated.
Simulated Driver's Cab	PID Display	1 set	NS-02 and NS-03	
	Passenger emergency call system	1 set	NS-02 and NS-03	
	Handy talks	1 set	NS-01	Connect to instructor console
	Sound System	1 set	NS-01, NS-02 and NS-03	Simulated PA system, Train Radio system, cab and saloon speakers included. Train Radio to be provided by contractor
	On board signaling	1 set	NS-01	To be provided by NS-01 contractor
	Camera	1 set	NS-01	For instructor to monitor
Display System	Minimum 70-inch LCD/LED monitor	Minimum 3 sets	NS-01	
Computer Unit	Visual Image generator	3 sets	NS-01	For display system
	Visual Image generator	4 sets	NS-01	For station CCTV monitor, if necessary
	TMS control unit	1 set	NS-01	
	Central Processing Unit	1 set	NS-01	
	Amplifier	1 set	NS-01	
	Instructor's computer	1 set	NS-01	
	Rack, flame	1 set	NS-01	
	Hub	2 sets	NS-01	
	UPS	1 set	NS-01	
Instructor's Console	Front Image monitor	1 set	NS-01	For monitoring Driver.
	Monitoring camera monitor	1 set	NS-01	Mirroring the driver cabin monitor
	Communication device	1 set	NS-01	Wiring to Handy talks in cabin
	Speaker	1 set	NS-01	
	Signal control system	1 set	NS-01	

System	Description	Qty.	Scope	Remarks
	Control device for instructor	1 set	NS-01	Including monitor, printer and switches
	Instructor's console desk and chair	1 set	NS-01	
Platform	Platform	1 set	NS-01	
Recorder		1 set	NS-01	If necessary
Monitor		4 sets	NS-01	For Station CCTV monitor, if necessary
Others	Transformer		NS-01	Necessary amount
	Cable, server rack		NS-01	Necessary amount
	UPS	2 sets	NS-01	

9.2.1.4 Language

All subsystems and manuals of the Train Operation Simulator shall be produced in English.

9.2.1.5 Software Installation and Upgrade

1st stage: Artificial landscape visual data before taking-over of the Works

2nd stage: Real wayside visual data is preferable after taking-over of the Works

An external re-loadable software (in Hard Disk or USB) shall be supplied by the Contractor should the pre-installed software become corrupted after the Defects Notification Period. There shall be no restrictions (license) to usage.

9.2.1.6 Design Life

The design life is eight (8) years after completion, visual devices and central processing unit shall be replaced to maintain its performance.

15 years after completion, all systems shall be replaced.

The Contractor shall use parts which match the above design life.

9.2.1.7 Period of Defects Notification

The Contractor shall have the Defects Notification Period for 2 years upon issuance of TOC.

9.2.1.8 Installation Requirements

9.2.1.8.1 Locations

The train operation simulators shall be installed in the Training Centre in Mabalacat Depot

9.2.1.8.2 Condition

Train Operation Simulator must be designed for the condition shown below.

a) Temperature 16 – 26 °C (operation)
0 – 40 °C (reservation)

b) Humidity 40- 70%

c) Dust Same level ISO6 in ISO 14644-1d

9.2.1.8.3 Power supply

Two (2) kinds of electricity shall be provided for the train operation simulator in the

OCC building. The first is single phase 230 V ac, and the other is 3 phase 400 V ac. The electric consumption of the train operation simulator is assumed to be less than 33 kW. A transformer shall be provided by the Contractor, if necessary.

9.2.1.9 Test of Train Operation Simulator

The Contractor shall submit a plan for testing and commissioning the Train Operation Simulator, as well as the test specification for the Engineer's review.

Training of operation staff shall be completed two months prior to the commencement of the first train's running test. The number of staff and schedule shall be specified in due course.

Major testing items after installing the equipment and software are as follows:

a) Visual check and safety inspection;
b) Grounding circuit, insulation resistance check, and dielectric test;
c) Visibility and brightness of the screen;
d) Equipment allocation;
e) Power ON, indication, electric meter, gauge check;
f) Equipment operability;
g) Function check;
h) Electro-Magnetic Interference check; and
i) Vibration, sound level check.

9.2.1.10 Staff Training

The Contractor shall supply the train operation simulator. The simulator is a tool for operation staff to study the operation procedures in a virtual reality environment.

After handing over the simulator, the Contractor shall have its commissioning engineers on stand-by during the experimental train running period and to train the Employer's instructors about the way to operate and maintain the simulator as well as how to install and modify the software.

9.2.1.11 Submitting Document

The Contractor shall provide the operation and maintenance manual of the simulator written in English. The simulator maintenance manual shall include the following but not be limited to: schematic/electrical diagram, illustrated parts catalogue, and spare parts (complete with description and part nos.).

9.2.1.12 Shipping and delivery:

9.2.1.12.1 Shipping

At no time shall any item shall be exposed to saltwater or spray when unprotected, loading on deck shall not be allowed.

The Contractor shall prepare a shipping manual to cover the shipping of all items covered under the Contract, including spare parts and simulator. The shipping manual shall detail the method, packaging and other details required to ensure the safe shipment to the delivery point. The shipping manual shall be submitted for review by the Engineer prior to the shipment of any equipment.

The Contractor shall notify the Engineer ten days in advance of any expected shipment date and give further notification of the actual shipment date and routing when established. This shall complement the inspection requirements prior to delivery as specified herein.

The Contractor shall be responsible for the insurance for shipping.

9.2.1.12.2 Delivery

The Contractor shall be responsible for delivery of all items to be supplied under this Contract to the Site, as designated by the Engineer. The Contractor shall be responsible for the loading, transport and unloading of all the items.

9.2.2 Track Work

The Contractor shall lay typical track structures and a turnout in the Training Center as detailed below:

a) Elastic Sleeper Directly Fastened Track

All materials must be the same as those of the main line.

i. Two (2) 8 m length concrete bed track
ii. Two (2) 5 m length concrete bed track
iii. One (1) Expansion Joint with plastic sleeper
iv. One (1) set Glued insulated joint

b) Ballasted Track

All materials must be the same as those of the depot.

i. One (1) set compromise rail for 60kg-50kg
ii. Ten (10) m standard jointed track
iii. One (1) set fishplate joint
iv. One (1) set Insulated joint

c) Turnout Assembly

i. In ballasted track with FFU sleeper
ii. Fix crossing

9.2.3 Signal System

The contractor shall incorporate and include, but not limited to, the following facilities for the Signal System equipment in the training center.

a) Train simulator room
   i. Signal System equipment (single)
   ii. Signal monitor (single)
b) Station office
   i. Training control board
c) Equipment room (TER）
   i. Work-station device (WS）
   ii. Computer Based Interlocking device (CBI)
   iii. Onboard ATP/ATO equipment
   Complete set with power supply and add-on simulator for testing and training

d) On the platform
   i. Emergency button
   ii. Warning light
e) Simulation track for training
   i. Point machine
f) Level crossing road
   i. Level crossing alarm (With speaker warning light, train direction indicator, Emergency button)
   ii. Barrier machine
   iii. Crossing obstructing detector
   iv. Obstruction warning device for level crossing
g) Rail side
   i. ETCS radio sets and antenna

9.2.4 Telecommunications

The contractor shall incorporate and include, but not limited to, the following facilities.

a) Network System (Miniature)

i.	Server	1 set
ii.	Work Station	2 sets
iii.	L3/L2 Switch	1 set (each)
iv.	Media Converter	2 sets
v.	Optical Fiber	1 lot
vi.	UTP	1 lot

b) Radio System

i.	Transmitter	2 sets
ii.	Receiver	2 sets
iii.	Antenna	1 sets

c) PID System

i.	Transmitter	2 sets
ii.	Receiver	2 set
iii.	Antenna	1 sets

d) CCTV System

i.	Controller	1 set
ii.	Display	2 sets
iii.	Recorder	1 set
iv.	Camera	3 sets
v.	UTP	1 lot

e) PA System

i.	Amplifier	1 set
ii.	Microphone	2 sets
iii.	Speaker	2 sets
iv.	PVC Wire	1 lot

9.2.5 Power Supply System

The contractor shall incorporate and include, but not limited to, the following facilities.

a) Control and Monitoring Items of Power Supply System

i. Power supply AC & DC voltage and current.
ii. Status of Switchgears, Rectifiers and major equipment.
iii. Status of all alarm and protection equipment and devices.

b) Event Recorder

Any event shall be recorded caused by faults, malfunctions, warning or alarm information generated automatically by the selected equipment.

i. High Voltage Tester
ii. Insulation Tester

9.2.6 Overhead Contact line System

The contractor shall incorporate and include, but not limited to, the following facilities.

a) Support structure

i. Steel mast
ii. Hinged cantilever.
iii. Guy wire assembly

b) Catenary

i. Feeder and messenger wire assembly
ii. Catenary wire suspension and termination assembly.
iii. Automatic tensioning device.

c) Various equipment

i. Pull Lifts and Tirfor
ii. Height and Stagger gauge (Optical)

d) Tools

i. Insulated ladder.
ii. Contact wire replacement tools
iii. Special tools for section insulator installation
iv. Portal earth and live line tester

9.2.7 Automatic Fare Collection

The Contractor shall prepare and supply the equipment for Training Center as below;

a) Automatic Gate: 1 set
b) Automatic Gate (wide type): 1 set
c) Ticket Vending Machine: 1 set
d) Point of Sales: 1 set (PC, printer, card reader/writer, passenger display)
e) Handheld Terminal: 1 set
f) Station Computer System: 1 set (server, work-station, printer)

The Contractor is responsible for the installation of a, b and c above.

The Contractor shall supply desks for d, e, f and g equipment above.

The Contractor is responsible for the cabling for all the equipment.

9.2.8 Computerized Maintenance Management System

The Contractor shall prepare and supply the equipment for Training Center as below;

a) Bar code scanners; 3 sets
b) Tablets; 3 sets
c) Handheld devices; 3 sets
d) Maintenance laptops 3 sets
e) Workstation and display screen: 1 set

9.2.9 Pantograph and Bogie Assembly

CP NS-02 Contractor and CP NS-03 Contractor will supply the equipment for Training Center as below;

a) Pantograph: 2 set (Limited Express:1set, Commuter:1set)
b) Bogie-assembly for Motor-car including traction motor, gearbox, and coupling: 2 sets. (Limited Express:1set, Commuter:1set)

The supply of this equipment shall be coordinated with the CP NS-03 and CP NS-02 Contractors.

9.2.10 Platform Screen Door

The Contractor shall supply install the HH PSD equipment along the platform for 2 car length in the depot for training purpose as below;

a) Automatic Sliding Door sets: 8 sets for the 2-car length
b) Fixed Screens and emergency escape doors: for the 2 car lengths
c) Local control panel for driver: 1
d) Local control panel for the station staffs: 1 set
e) Power Supply Distribution panel: 1 set
f) Interface Control Panel with Signaling: 1 set
g) Workstation and display screen: 1 set

9.2.11 Train Arcade Simulator and Information Console

The Contractor shall supply ten (10) units Train Arcade Simulator and information Consoles to be delivered prior to the operation of the first section of line. The simulators shall be located at stations as directed by the Engineer.

The Contractor shall be responsible for the design, supply, delivery, testing and commissioning, software licensing for all the simulators.

The simulators shall be equipped with the minimum equipment listed as below:

a) Minimum 40-inch-high resolution display.
b) The driver console shall reflect the train driver console with as a minimum, dead man's handle, horn button, emergency brake button and headlight button.
c) Sound system.

The simulator shall simulate the view of the track alignment as practical as it can be including stations. The contractor shall submit the proposal and specification to the Engineer for review.

The simulator shall have separate touch screens that display information useful to passengers. The Passenger information display function of these units shall cover:

a) Key facts about stations along the NSCR
b) Points of interest
c) Interconnecting transportation links
d) Travel promotions and advertisements
e) Interactive station directory

The Employer must be able to customize and revise the details shown in the display.

The simulator shall be mobile, easily transportable and power by 220 V 60 Hertz.

End of Section

10 PLATFORM SCREEN DOORS

10.1 Scope of Work

10.1.1 General

(1) Platform Screen Doors (PSD) shall be provided for all stations on the MCRP, NSCR and NSPR-South. The PSD's shall prevent people falling onto or gaining unauthorized access to the tracks.

(2) The Contract shall comprise of but shall not be limited to design, manufacturing, factory testing, installation, integration testing with Interfacing Parties, site testing, commissioning, training, defects liability, spare parts, consumables, special tools and jigs for maintenance.

10.1.2 Abbreviations

Abbreviations used in this section shall be shown as Table 10.1.

Table 10.1 Abbreviations

ASD	Automated Sliding Doors
ATO	Automatic Train Operation system
CIP	Center Interface Panel
EED	Emergency Egress Doors
FH PSD	Full-height PSD
FFL	Finished Floor Level
FS	Fixed Screen Panel
HH PSD	Half-height PSD
IEC	International Electrotechnical Commission
ILCP	Individual Local Control Panel
ISO	International Organization for Standardization
JIS	Japanese Industrial Standard
LCPD	Local Control Panel for Driver
LCPS	Local Control Panel for Station staff
MCP	Monitoring and Control Panel
MTBF	Mean Time Between Failure

MTTR	Mean Time To Repair
OCC	Operation Control Center
PSD	Platform Screen Door
UPS	Uninterruptible Power Supply

10.1.3 Employers Requirements

(1) The Contractor shall provide a PSD system that comprises of but not be limited to platform screen doors and associated control equipment. The PSD system shall comply with Employer's Requirements and any applicable Philippine Standards equivalent to appropriate Japanese Standards or alternative International Standards as approved by the the Engineer and shall be designed for safe and efficient operation.

(2) All doors shall have a locking system operable automatically and /or manually.

(3) PSD system shall include all the associated control and operation mechanisms for the safe operation of the platform screen doors.

(4) The Contractor shall be responsible for the integration of PSD system into the overall operations of the project and for the design, manufacture, installation, testing and commissioning of PSD system including all the associated control and interfacing equipment.

(5) The Contractor shall provide spares according the requirements of the General Requirement (ERG).

(6) The Contractor shall prepare a plan that identifies in detail the sequence of evaluation and testing of the prototype equipment at the Contractors factory and on-site testing of final product.

(7) The Contractor shall submit equipment operation training plan and maintenance training plan which describe the content, duration, timing and location of all training activities in accordance with the Employer's Requirements.

(8) The Contractor shall prepare and supply operation and maintenance manuals.

(9) Display text for the monitoring facilities shall be written in English.

(10) Where cable containment is not provided by others then cable containment shall be supplied by the Contractor which shall have 25% spare capacity for expansion works. All cable containment material, fixing methods, and routing shall be given Notice of No Objection by the Engineer.

10.1.4 System Overview

(1) The stations at which PSD system shall be installed are shown in Table 10.2 below.

Table 10.2 Stations to be provided with PSD

No	Line	Station Name	Station Type	PSD Type	Sets	Doors
1	MCRP	CIA	Underground	Full-height	4	128
2	MCRP	Clark	Elevated	Half-height	4	128
3	MCRP	Angeles	Elevated	Half-height	4	128
4	MCRP	San Fernando	Elevated	Half-height	4	128
5	MCRP	Apalit	Elevated	Half-height	2	64
6	MCRP	Calumpit	Elevated	Half-height	4	128
7	NSCR	Malolos	Elevated	Half-height	2	64
8	NSCR	Guiguinto	Elevated	Half-height	2	64
9	NSCR	Balagtas	Elevated	Half-height	2	64
10	NSCR	Bocaue	Elevated	Half-height	2	64
11	NSCR	Marilao	Elevated	Half-height	4	128
12	NSCR	Meycauayan	Elevated	Half-height	2	64
13	NSCR	Valenzuela	Elevated	Half-height	2	64
14	NSCR	Caloocan	Elevated	Half-height	2	64
15	NSCR	Solis	Elevated	Half-height	2	64

No	Line	Station Name	Station Type	PSD Type	Sets	Doors
16	NSRP-South	Tutuban	Elevated	Half-height	2	64
17	NSRP-South	Blumentritt	Elevated	Half-height	4	128
18	NSRP-South	Espana	Elevated	Half-height	2	64
19	NSRP-South	Santa Mesa	Elevated	Half-height	2	64
20	NSRP-South	Paco	Elevated	Half-height	4	128
21	NSRP-South	Buendia	Elevated	Half-height	4	128
22	NSRP-South	EDSA	At Ground	Half-height	2	64
23	NSRP-South	Nichols	At Ground	Half-height	2	64
24	NSRP-South	FTI	At Ground	Half-height	2	64
25	NSRP-South/ MMSP	Bicutan	Elevated	Half-height	4	128
26	NSRP-South	Sucat	Elevated	Half-height	2	64
27	NSRP-South	Alabang	Elevated	Half-height	4	128
28	NSRP-South	Muntinlupa	Elevated	Half-height	2	64
29	NSRP-South	San Pedro	Elevated	Half-height	4	128
30	NSRP-South	Pacita	Elevated	Half-height	2	64
31	NSRP-South	Binan	Elevated	Half-height	2	64

No	Line	Station Name	Station Type	PSD Type	Sets	Doors
32	NSRP-South	Santa Rosa	Elevated	Half-height	2	64
33	NSRP-South	Cabuyao	Elevated	Half-height	4	128
34	NSRP-South	Banlic	Elevated	Half-height	2	64
35	NSRP-South	Calamba	Elevated	Half-height	4	128
Total					98	3136

The Contractor shall study the track alignment drawings and include in the design for curved platforms.

In the MCRP depot, the HH PSD of 2 car length (total 8 ASDs) shall be provided for training purpose. This shall be operational equipped with all the features and controls same as in the station.

(2) PSD system shall include but shall not be limited to:

a) Automated sliding screen doors of transparent glass type complete with fixed screen panels, emergency escape doors, platform end doors, threshold plate, rubber static gap filler to form a fully enclosed barrier along the platform.

b) Entry/Exit doors for driver's cab and platform end doors for access from/to the tracks

c) Appropriate individual and integrated control and monitoring system for driver and station staff.

d) Safety System with sensors, alarms and indicators

e) Passenger detection system within the gap between the train and the PSD

f) Power supply system with appropriate backup

g) Power supply, control and monitoring cables with appropriate cable rack or cable duct among facilities.

h) Structural frame and fixing accessories

i) Decoration board harmonized with the station design.

(3) The Contractor shall submit proposal for system configuration for PSD systems in accordance with the Employer's Requirements to the Engineer for Approval. The proposal includes non-documents such as material samples and prototypes.

10.1.5 Full-height PSD system

(1) Full-height PSD system shall include structural frame, sliding screen door, emergency door, fixed screen, entry/exit screen doors for driver's cab, device for door opening in emergency at each car end, sensors, control/monitoring system, alarms, sign, power supply and other necessary facilities.

(2) The Contractor shall submit interface table with technical proposal. At detail design, The Contractor shall coordinate with Interfacing Contractors for detailed interface requirements such as the civil, structural, station power supply and boundaries of provision in accordance with Employer's Requirements and station design criteria.

(3) Pairs of sliding screen doors (door-sets) shall be installed in the structural frames and located opposite each set of train passenger doors.

(4) A series of fixed screens shall be installed between each pair of sliding screen doors.

(5) A pair of Emergency Egress Doors (EED) shall be installed for each car length to provide a means of escape from the train, especially in the case of misalignment. The width of the EED shall be minimum 1100mm width.

(6) The contractor shall design and construct the drop wall structure between concrete slab and PSD for the full length of the platform. The drop wall structure shall be constructed of fire-resistance material. The weigh shall be supported by concrete slab and not by PSD. The contractor shall coordinate with the civil contractor for the construction of this drop wall structure from the concrete slab.

10.1.6 Half-height PSD system

(1) Half-height PSD system shall include structural frame, sliding screen door, emergency door, fixed screen, entry/exit screen doors for driver's cab, device for door opening in emergency at each car end, sensors, control/monitoring system, alarms, sign, power supply and other necessary facilities.

(2) The Contractor shall submit interface table with technical proposal. At detail design, The Contractor shall coordinate with Interfacing Contractors for detailed interface requirements such as the civil, structural, station power supply and boundaries of provision in accordance with Employer's Requirements and station design criteria.

(3) A series of fixed screens shall be installed between each pair of sliding screen doors.

(4) A pair of Emergency Egress Doors (EED) shall be installed for each car length adjacent to the PSDs to provide a means of escape from the train towards the track, especially in the case of misalignment. The width of the EED shall be minimum 1100mm width.

(5) The Contractor shall supply and install the cable containment below the platform edge for the running of cables and within the PSD rooms.

(6) The Contractor shall supply and install the LED lighting inside the top cover of the HH PSD at both trackside and platform side.

10.2 DESIGN CRITERIA AND STANDARD

10.2.1 Design Life, Reliability and Maintainability

(1) Design life for PSD system shall be more than 20 years with the need for refurbishment running not less than 15 years into this period.

(2) The Contractor shall guarantee and supply spare parts during design life.

(3) PSD system shall have failure rate of less than 1 in 1,000,000 operation cycle per door. One operation cycle means one complete opening and closing cycle.

(4) PSD system shall have MTTR as 60 minutes unless otherwise specified. This time shall not include the time taken for the technician to arrive at the fault reported site.

(5) With the exception of the structural frame and glass panels, replacement or rectification of faults of all components, sub-assemblies, or major assemblies shall be accessible entirely from the platform side. They shall be capable of maintenance or replacement within a time frame of 1 hour without delivery time. The contractor should demonstrate as training.

(6) If glass panels cannot be replaced from the platform side, it shall be possible to install a temporary safety screen from the platform side and such temporary safety screens shall be supplied at every station in adequate quantity.

(7) Power supplies required to control and operate PSD system at each station shall be provided in accordance with the specified requirements and shall be terminated by means of isolation by fuses.

(8) PSD system shall be designed to prevent any stray current corrosion and arising from environmental conditions.

10.2.2 Design Standard

(1) The Contractor shall submit to the Engineer for Approval the Standards he proposes to adopt for PSD. In general standards shall be; applicable Philippines Standards equivalent to appropriate Japanese Standards or alternative International Standards approved by the Engineer and shall include:

a) IEC 60529: Water protection specifications

b) IEC 60228: Conductor in insulated cables

c) IEC 61000: Electromagnetic compatibility

d) ISO 9001: Quality management

e) Standard on Fire Safety

f) Standard on Loading performance

g) IEC 60332-3 Test on electric cable

h) IEC 60754-1 Test on gas evolved from cable.

i) IEC 613034 Measurement of smoke density of cables

10.3 DESIGN REQUIREMENTS

10.3.1 General Requirements

(1) PSDs shall be installed for the full platform length the range of 180-200 meters and form an enclosure barrier up to the end walls at both platform ends.

(2) PSD system shall be designed to accommodate 8-car train. Sections outside the 8-car length shall be provided with fixed screen and EEDs. Each door-set shall comprise of a pair of sliding screen doors, equally spaced to correspond with the door openings of 8-car train. Each car (about 20m length) is provided with 4 doors on each side except express train which provided with 2 doors on each car.

(3) It is proposed to operate a 10-car train in the future. Therefore, PSD system shall have the expandability to accommodate 10-car train with minimum modification. The Contractor shall design a provisional system to accommodate 10-car in the future. The entry / exit doors for driver's cabs, adjacent doors and panels, and the platform end doors shall be relocatable to suit the future 10 car operation.

(4) PSD system shall be designed in conjunction with the signaling system initially for 8-car train and ultimately for 10 car train and for different types of trains.

(5) The weight of Full-height PSD shall be less than 3,500 kg per 4 doors. The weight of Half-height PSD shall be less than 2,500 kg per 4 doors.

(6) The threshold plate shall be a continuous element on the bottom support and shall be installed for the full length of each platform. Insulation floor mat shall be fixed over the PSD threshold to prevent passenger in contact with the metallic part of threshold while boarding or alighting. The insulation floor mat shall be positively fixed to the threshold with easy replacement in case of damaged.

(7) The Static Gap Filler shall be fixed to the threshold plate edge where located along the platform edge at each doorway and emergency escape door and shall be able to take up the loading exert by the passengers as well as the passengers on a wheelchair. The Static Gap Filler shall compose of solid part and comb part. The comb part at the outer edge shall be at least 15mm width compressible flaps section for against rubbing by the train body.

(8) PSD system shall have control and monitoring panels as specified below and shall include but not be limited to:

a) Center Interface Panel (CIP): This panel shall be installed in equipment room and have following functions.

i. Control of all of functions

ii. Interface between signaling system and PSD system.

iii. Output of alarm and monitoring signal.

iv. Provide Maintenance status indication.

v. Interface with other systems

b) Monitoring and Control Panel (MCP): This panel shall be installed in station office and have the following functions.

i. Individual and group control of sliding screen door

ii. Individual and group monitoring including alarm.

c) Local Control Panel for Driver (LCPD): This panel shall be installed on the track side of PSD for access by the driver and have the following functions.

i. Control of sliding screen door

ii. Monitoring of sliding screen door

d) Local Control Panel for Station Staff (LCPS): This panel shall be installed free standing or mounted on the fixed panel on the platform side of PSD and have the following functions. In case of emergency, station staff will be able to open/close the sliding doors and issue the Interlocked Override signal.

Both LCPD and LCPS shall be insulative coating and designed to be relocatable to suit the 10-car train operation in future. The LCPD and LCPS constitute an interlock and cannot be operated simultaneous.

e) Individual Local Control Panel (ILCP): This panel shall be installed on each PSD sliding screen door and have following functions.

i. Local/Remote control changeover

ii. Manual/Auto Changeover

iii. Control (Open/Close) of sliding screen door

iv. Maintenance status indication

f) The priority of operation is as follows.

i. 1: Manual release,

ii. 2: ILCP,

iii. 3: LCPS,

iv. 4: LCPD,

v. 5: MCP,

vi. 6: CIP (Control from Signaling system)

The failure of any control should not affect the other control.

(9) Each fully equipped door-set shall consist of bi-parting, power operated sliding screen doors. The sliding screen doors shall be synchronously controlled throughout the length of the platform. The sliding screen doors shall provide a clear opening 2000mm to match with different train door positions taking into consideration of the train stopping accuracy.

(10) Each door mechanism shall incorporate a mechanical latch, which shall automatically engage when the door is fully closed, preventing the doors from being opened by passengers on the platform. The mechanical latch shall release automatically when the door opening mechanism is operated.

(11) PSD shall be electrically insulated from passengers and cars. To prevent electric shock due to the electric leakage from PSD, the Contractor shall design the system to safeguard passengers from electric shock.

(12) All electrical equipment interconnections of PSD shall be made with mechanically retainable plugs and sockets, and all terminations shall be clearly marked with labels and tags. When similar plugs are situated adjacent to each other they shall be constructed in such a manner so as to prevent a plug being inserted into an incorrect socket.

(13) PSD screens and walls shall comply with the fire resistance regulations. All cables shall be low smoke halogen free type and fire retardant.

(14) The Contractor's design shall include window on the PSD panel for operating train doors in case of emergency. The windows shall be opened only with a key by an authorized person. The location of mechanism shall correspond to the location of the train door release installed on different types of trains.

(15) PSD system shall have the interface to transmit door condition status and data to the OCC and station control room or PSD maintenance base via optical fiber network backbone provided by Telecommunication contractor.

(16) PSD system shall interface with the cab or signaling system to identify and open the correct doors of the train type.

(17) Data communicating between PSD and Signaling shall include the following contents are shown in Table 10.3 and Table 10.4 but is not limited to.

Table 10.3 Data from Signaling to PSD

No	Name of Data
1	Traveling Direction
2	Train Number
3	Service Type (Normal or Out of Service etc.)
4	Service Number
5	Pattern of Door opening
6	Open command to PSD on right side
7	Open command to PSD on left side
8	Close command to PSD on right side
9	Close command to PSD on left side
10	Train type (commuter or limited express train)
11	Train configuration (8 cars or 10 cars)
12	Train Door Fault Alarm
13	Train door status "Train door on right side all Closed"
14	Train door status "Train door on left side all Closed"
15	Door Enable
16	Train door obstacle detection stop alarm
17	Other acknowledgement to PSD

Table 10.4 Data from PSD to Signaling

No	Name of Data
1	"PSD on right side all closed and locked"
2	"PSD on left side all closed and locked"
3	"PSD on right side do not all closed"
4	"PSD on left side do not all closed"
5	Interlock Override

No	Name of Data
6	Receipt of Open Command to PSD on right side
7	Receipt of Open Command to PSD on left side
8	Fault Alarm of individual PSD door on right side
9	Fault Alarm of individual PSD door on left side
10	Receipt of Close Command to PSD on right side
11	Receipt to Close Command to PSD on left side
12	PSD status "PSD on right side healthy"
13	PSD status "PSD on left side healthy"
14	PSD door obstacle detection stop alarm
15	Other acknowledgement to Cars

(18) At Bicutan station**,** the Contractor is required to provide PSD's for all 4 platforms. The two central platforms at Bicutan station will be used for MMSP trains. MMSP (Manila Metro Subway Project) trains will work with CBTC signaling. However, the MMSP trains will move to Calamba in ETCS signaling. Change from CBTC to ETCS signaling will take place at Bicutan station for MMSP trains going to Calamba. Similarly MMSP trains coming from Calamba and destination MMSP line will have changeover of signaling from ETCS to CBTC at Bicutan station.

The Contactor shall design and supply the PSD system to ensure smooth operation between the PSD and both MMSP (using CBTC) and NSCR (using ETCS) signaling systems.

(19) In Bicutan Station, as there are four platforms including two center platforms for MMSP trains and other two platforms for NSCR trains, the power distribution and control panels to the PSDs of MMSP platforms and NSCR platforms shall be separated and independent from each other.

10.3.2 Safety Requirements

(1) Passenger safety is the prime consideration in the design and construction of PSD system. In performance, door control and monitoring shall be safe in accordance with the Safety Plan.

(2) No part of any sliding screen door or its control system or any other component used in PSD system shall be capable of causing injury to passengers or personnel because of door operation. Particular attention shall be paid to detecting trapped obstacles in the sliding screen doors.

(3) No single defect or failure of any part of PSD system shall produce a situation capable of causing injury to personnel. No spurious electrical signals shall cause any sliding screen door to be activated accidentally. The design of the PSD system for the hardware and software shall be at least to meet the Safety Integrity Level 2 (SIL

2) defined in IEC 61508 and IEC 62279. The vital interface signals like "All Door Closed and Locked", "Door Enable", "Door Open/Close commands", "Interlock Override" with Signaling, shall be hardwire, double cut and meet the Safety Integrity Level 4 (SIL4).

(4) PSD system shall contain sliding screen door monitoring devices for proving that all the sliding screen doors and emergency door are closed and latched. The mechanism to check the status of the sliding screen doors and other door shall be designed to be Safety Critical. Once all the sliding screen doors and other doors have proved to be closed and latched, a corresponding signal shall be transmitted to the Train, via the signaling system, to enable train departure.

(5) The closed and latched status of all sliding screen doors shall be continuously monitored by PSD system.

(6) In the event of a failure causing the loss of the 'closed and locked' signal, the mechanism shall be provided to enable authorized staff to temporarily override the door status after the door has been ascertained physically closed. A manual facility shall be provided on the platform LCPS, accessible only by authorized staff, to transmit a "Interlocked Override" (or Pseudo Door Closed and Locked) signal to the signaling system. This Interlocked Override signal shall be identical to the 'Closed and Locked' signal, to enable the Train to depart from the station. Use of the "Interlocked Override" signal shall be recorded in the system.

(7) Once the Train has completely left the station zone, following an activation of the Interlock Override signal, the PSD system shall immediately cancel/reset the Interlock Override signal, to ensure that the monitoring circuit reverts to the normal condition, including the fault condition if any. Each time the Interlock Override signal is activated a corresponding signal shall trigger an alarm at the station office.

(8) Monitoring of sliding screen door with current door condition (Open/close, failure, etc.) shall be implemented through PSD monitoring system. This monitoring shall include door position (open/close), normal/failure, power on/off, etc. In the event of failure, the monitoring system shall issue the alarm by sound and display to the staff. The monitoring system shall be provided at each station office.

(9) PSD shall maintain required insulation between PSD screen and passengers to prevent possible electric shock due to an electric potential difference between passenger in train and PSD screen. The required insulation value shall be more than 10M ohm when measured with a test voltage of 500V DC being applied between PSD surface and platform structure. In addition, to prevent electric shock due to the leakage current from the PSD system, PSD structure should be grounded or connected to the station earth. The ground wire, plate, rod and other necessary equipment shall be provided and installed by the Contractor. The Contractor is required to submit the PSD earthing and stray current analysis for approval. The Contractor may propose other alternative earthing arrangement.

(10) The Contractor shall provide a specification and type test results to demonstrate that the glass to be provided meets the requirements of the Hazard Analysis.

(11) In order to make passenger's aware, chime or sound shall be automatically activated during the time of opening and closing of sliding screen doors. The appropriate sounding system shall be provided by the Contractor.

(12) For safety reason, the Door Open/Close command, the All Door Closed and Locked circuits, Interlocked Override, shall be dual circuit designs.

(13) Door control and operating arrangements shall be designed to fail safe. The door shall not be allowed to open until DOOR ENABLE and DOORS OPEN command from Signaling are received.

(14) ALL DOORS CLOSED and LOCKED status shall only be sent to the Signaling after all doors and EED have been proved closed and locked.

(15) In the event of a door fault, it shall be possible for an authorized person to isolate the faulty door at the local door control and to allow rectification of the faulty door without interfering with normal train operation.

(16) All mechanisms and sub-systems within the PSD installations shall be designed according to fail-safe principles so that no component failure nor combination of two component failures shall result in a door being powered open except in response to a valid DOORS OPEN command.

(17) No component failure shall inhibit manual opening of any individual door when the release mechanism is operated.

(18) Passenger detection shall be provided in the gap between the train and the PSD. The train should not be allowed depart if any passenger is detected within the gap and alarm shall be sent to OCC.

10.3.3 Passenger Interface

(1) The sliding screen doors shall not exert a combined closing force greater than 140 N and a closing kinetic energy greater than 10 J. The limiting value of sliding screen door movement kinetic energy for the last 150 mm of door travel shall be less than 2 J per door.

(2) The time for unlatching and opening shall be no longer than 3 seconds. The time for closing and latching shall be no longer than 3.5 seconds and shall be achieved within a maximum speed of 0.5 m/s. Each door opening or closing speed shall not vary by more than +/-10% when compared with the speed of adjacent doors on the same platform. The opening/closing speeds of each sliding screen door shall be capable of individual adjustment.

(3) During all operating modes and under all power supply conditions, sliding screen door movements shall be smooth, controlled and devoid of jerks or any violent motion.

(4) The sliding screen doors shall include an obstruction detection system, which shall be capable of detecting any obstruction between a pair of sliding screen doors, and between sliding screen and train body. At least, the obstruction sensor between sliding screen doors shall detect for blind person's stick (Diameter: min.19mm) when it is trapped between sliding screen doors.

(5) If a door-set whilst closing detects an obstruction prior to achieving locked status according to the door monitoring device, then the door-set shall reopen to 0.5 m to enable removal of the obstruction. Following a short delay, the door-set shall attempt to close again. In the event that the door set fails to close following 3 consecutive attempts, further door set movement shall cease on the offending door in the open position. In the event that a door has stopped movement following this condition, further door set closure shall require another activation of the door close command. The sliding screen doors shall not slam after the removal of an obstruction or on loss of power supply. The number of attempts that door-sets make to close in the event

of an obstruction shall be adjustable from 1 to 20. The minimum reopening distance shall be adjustable from 0.3 m to full width.

(6) A means shall be provided on the trackside of each door-set, whether fully equipped or not, for the passengers to easily release the latch and open a door-set so as to gain access to the platform in an emergency. The manual release of the latch shall be achieved without the use of any tools or key or the need to break any seal. It shall be possible for authorized persons on the platform side to manually release the latch and open any door-set using a key given a Notice of No Objection by the Engineer. The force required to operate the latch shall not be more than 67N. No component failure shall inhibit manual opening of any sliding screen door when the release mechanism is operated.

(7) PSD system shall not have impact to the safety train operation.

10.3.4 Power Failure

(1) In case of failure of the normal power supply to PSD system, PSD system shall continue to operate from the uninterruptible power supply provided by the Contractor at each station for times of not less than five operations (open/close), not less than 2 hours for monitoring . In the event of loss of all power supply, the sliding screen doors shall remain in their same status, i.e., if the sliding screen doors were open, they shall remain open, and similarly if they were closed, they shall remain closed.

(2) In the event of failure of the normal power supply and/or the UPS supply to PSD system, the mechanism to manually unlatch the sliding screen doors, either by an authorized person on the platform side or from the trackside, shall not be affected.

10.4 CONTROL AND MONITORING

10.4.1 Opening and Closing Operation

(1) When a Train is correctly positioned at a platform, PSD system shall receive door command signals, which originate from the Train via the signaling system, to either open or close the sliding screen doors. The open and close command signals shall correspond with the operation of the train passenger doors, ensuring that the train passenger door operation synchronize with the sliding screen doors.

(2) The opening of the sliding screen doors shall be synchronized with the train passenger doors following a short delay, provided by the Train, ensuring that the sliding screens open first. The closing operation shall also be synchronized with the train passenger doors to ensure that the train passenger doors close first. Adjustable time delay shall be provided in the door circuit to achieve the required door operation. The time difference of both opening and closing of the sliding screen doors, compared with the operation of the train passenger doors, shall be identical on every station. A timing diagram shall be developed by both PSDs, Signaling and Train contractors to achieve the required synchronized result.

(3) In the event of a trackside signal transmission failure, preventing the Train from transmitting door control commands, local means shall be provided on the platform, which should be accessible only to the authorized staff, to manually activate either an open and close command of the sliding screen doors. In the event that a local door command is activated, a corresponding message shall be transmitted to the monitoring system.

10.4.2 Door Monitoring

(1) Door-set numbering

a) Each door-set shall be assigned and marked with an individual door number. In the event of a door-set failure, a corresponding message shall be triggered in the station office identifying a failure with the door number and the relative platform location. The number sequence allocated for each door-set shall be identical on each platform and at each station.

(2) Sliding screen door open indicator light

a) Each sliding screen door shall include an associated 'door open' indicator light, which shall be amber in color that shall be illuminated when the sliding screen door is open. It shall extinguish when the sliding screen door is proved closed, latched and flashing when the sliding screen door is moving.
b) The indicator shall be placed in a position above the associated sliding screen door and shall be clearly visible to the station personnel when standing at the end of a platform.

(3) Sliding screen door monitoring devices

a) Sliding screen door monitoring devices shall be positioned to ensure that they are not affected by displacement of the sliding screen door, or by normal wear of any part of the sliding screen doors in service. The sliding screen door monitoring device shall detect and prove that the sliding screen doors are fully closed.
b) The indication of all doors closed, locked and failure of doors and associated equipment with alarm shall be repeated in the station office for the fully equipped and controlled door-sets on each platform.

(4) Out of service indicator light

a) Each sliding screen door shall also incorporate an additional red status indicator light (red flashing when train stops) to identify either an 'out of service' condition or malfunction on that sliding screen door e.g. failure to open or close when instructed. The 'out of service' indicator light shall be located so as not to be confused with the 'door open' indicator.
b) If a sliding screen door is 'out of service', a remote indication of the 'out of service' condition shall be transmitted to the station office.

(5) PSD status monitoring and alarms in station office and OCC

The Contractor shall provide a means of monitoring PSD status in the station office at each station and OCC through the backbone. Point of interface is a port of Telecommunication equipment installed inside the Telecom equipment room. The Contractor shall provide display screen and audible alarm to draw the attention of the operator when an unexpected event occurs. It shall also incorporate a simple means of alarm acknowledgement for the operator to silence an incoming alarm.

(6) Master Clock

The PSD system shall connect to the Master Clock of the Telecommunication system to synchronize the time.

10.4.3 Door-set Isolation

(1) Each door set shall be provided with a local control key switch which shall enable the door set to operate in "automatic" mode, "maintenance" mode or "isolated" mode. The key shall be removable at all positions. A local control panel with open and close push button for door testing shall be installed in each door set.

a) When the local control key switch is set to "automatic" mode, the door shall operate automatically.

b) When the local control key switch is set to "maintenance" mode, the door shall not be operated from the system but can only be manually open/close from the push button.

c) When the local control key switch is set to "isolated" mode, the door shall be isolated from the System and bypass the All Door Closed and Locked loop.

10.5 STRUCTURAL INTEGRITY AND DURABILITY

10.5.1 General Requirements

(1) The PSD system shall be designed and installed to provide satisfactory operation and integrity under all specified loading conditions throughout the design life of the installation.

The design loads are as follows:

a) Crowd Loading: +1.5kN/m at a height from 1.1m to 1.5m for screens and sliding doors, without any deformation or reduction in operating performance.

b) i) Train Generated Loading: +1.0kN/m^2 ～ -1.0kN/m^2

ii) Wind loading for the elevated or ground station shall be taken into account of the strong tropical storms in Philippine to the local practice and requirement.

c) Pressure loading or wind loading to the local requirement, whichever is higher.

d) "+" means from platform towards train, "-" means from train towards platform.

e) The contractor shall prepare calculations for Approval to demonstrate that the PSD's can withstand the pressure from a train (10 cars) passing at 160 km/h.

f) Seismic Loading: ±0.18G (G : acceleration due to Gravity)

(2) The structural works shall include all the elements required to support, house or frame PSD installation.

(3) The structural frame shall be designed to resist torsion, lateral and vertical loading to prevent excessive deflection in any direction.

(4) Sliding screen doors shall be adjustable in the event of any long-term vertical loading on support elements causing vertical downward deflections. The door weight shall be kept to a practical minimum.

(5) The installation of PSD system shall accommodate the constructional and movement tolerances of the supporting and surrounding structures.

(6) The design of PSD system shall be such that the system as installed shall resist all expected combinations of loading conditions, throughout the Service Life of the system. As a minimum PSD system shall provide a satisfactory door operation when subjected to any combination of the design loads namely, air pressure generated by loading when trains enter into and depart from or when they pass through any station

or subjected to tropical storm while the PSD is still in operation. The Contractor shall carry out an analysis of the design value to be adopted taking into consideration the most onerous train operation speed and the physical characteristics of the train and the civil infrastructure.

(7) The design of PSD system shall also ensure that no permanent deformation is caused from the effects of cyclic and repetitive loading associated with crowd load, impact, wind and/or train movements thought the Service Life of PSD system.

(8) The structure of the PSD shall be designed to withstand the worst load combination including crowd load, train pressure, wind load, seismic load. Any element of PSD is not allowed to intrude into the different train kinematic envelopes under the worst load combination condition.

(9) Finite Element Analysis shall be carried out and submit to prove all the structure meet the loading and deflection requirements.

(10) Structure test on the prototype shall be carried out in the factory to demonstrate the design meeting all the loading and deflection requirement.

(11) The Contractor shall provide all the opening setting out including cable opening and for mounting of the PSD. The drilling of opening for the PSD mounting is by the PSD Contractor.

(12) The PSD structure shall be designed to accommodate all horizontal movements over the civil structure expansion joints on the platform.

10.6 ARCHITECTURAL REQUIREMENTS

10.6.1 General Requirements

(1) PSD system shall be constructed of robust, low maintenance, easily cleaning materials and harmonized with the station design.

(2) The materials used in PSD system shall:

a) not introduce a significant fire load into the station and shall not contravene appropriate codes and standards;

b) not cause fire to spread;

c) be constructed of materials, which minimize smoke and heat emission and shall not generate toxic gases during fires.

(3) The material of screen doors (sliding screen and fixed screen) shall be fireproof. The incombustibility shall be achieved by using materials as defined in relevant standards and shall be acceptable to the fire services department in Philippines.

(4) Where control equipment is located in separate equipment cubicles, this equipment shall be easily accessible from the platform for operation and maintenance purposes without requiring a track possession but secured against unauthorized access by means of lockable doors.

(5) The door thresholds shall be flush with the platform floor finished surfaces. The edges shall be resistant to wear, non-skid type and readily cleanable.

(6) The Full-height PSD system shall be equipped with a mechanism or a countermeasure to limit the loss of conditioned air past the edges of all doors when they are fully closed.

(7) All screens shall be constructed of toughened glass or laminated glass for safety. And the glass should be compliant with relevant international and local standards.

(8) For express train platforms (total 6 platforms) in Angeles, San Fernando and Apalit stations where trains pass through at 160 kph, the HH PSD shall be offset 1.5 meters from the platform edge. The height of Half-height PSD screens shall not less than 1.2 meters and not more than 1.3 meters above finished floor level. Passenger detection devices shall be provided within the gap area between the train and the HH PSD. The train is not allowed to depart should a trapped passenger is detected, and alarm shall be sent to OCC. The passenger detection devices shall withstand the heavy rain and sunlight in operation.

(9) For all other platforms where trains pass through at maximum 120kph, the HH PSD/Full Height PSD shall be set not closer than 100mm from the PSD gauge (as shown in MCRP-DWG-GEN-TK-0020). The height of HH PSD shall be at least 1500mm. The height of the full height PSD door panel shall be at least 2100mm.

(10) The Contractor shall supply and install the LED lighting at the edge and inside the top cover of the HH PSD at both trackside and platform side. This LED lighting shall be weatherproof and cover the whole length of the platform including at the FS, EED, FDP locations except at the ASD. This lighting shall be weatherproof and at diameter 20mm, color temperature 5000k, 200 lux on the floor. The platform side and trackside lighting circuits shall be independently controlled by timer and with bypass manual control.

10.6.2 Signage

(1) The Contractor shall provide all platform screen doors with appropriate signs relating to key features and the information requirements of passengers associated with the platform screen doors. All signs shall be provided with appropriate symbol and in English text. The contractor should discuss with civil contractor as an interface before detail design.

(2) Warning signage shall include but not be limited to:

a. "Do Not Lean Against the Door" on all sliding screens;

b. "Keep Fingers Away from Gap Between Sliding Screen and Fixed Screen" on all sliding screens;

c. "Warning that door may be opened inwards during an emergency" on all emergency hinged screens and the end walkway doors;

d. "Do not Stretch out Head or Hand beyond Screen" for Half-height PSD;

e. "Do not Lean any Object on Screen" for Half-height PSD.

(3) The Contractor shall coordinate with Interfacing Contractors on provision of signage and shall submit proposals for the overall signage requirements to the Engineer for Approval.

10.7 TESTING, COMMISSIONING AND VERIFICATION

10.7.1 General

(1) The Contractor shall provide and perform all forms of tests applicable to the Works.

(2) The materials, goods, equipment shall be subjected to inspection and the witnessing of tests by the Employer and the Engineer.

(3) The Engineer and/or any of his staff shall be given the opportunity to monitor all tests and shall be provided with all test records. Sufficient time shall be allowed within the testing programs for necessary alternations to equipment, systems, and designs to be undertaken, together with re-testing prior to final commissioning.

(4) Tests to be conducted by the Contractor shall be carried out in accordance with the Contractor's Test Plan given a Notice of No Objection by the Engineer.

(5) The inspections and tests shall be divided into four (4) basic stages:

a. type test;

b. factory acceptance tests carried out before delivery of equipment;

c. site acceptance and integration testing;

d. trial running

(6) First article inspection shall be carried out in the factory for inspection and approval before any mass production.

(7) The inspection and passing of work or equipment by the Engineer shall not relieve the Contractor from its obligations, responsibilities and liabilities to complete the Works in accordance with the Contract nor relieve of any of its obligations, responsibilities and liabilities under the Contract.

10.7.2 Test Plan and Procedures

(1) All test plans and procedures shall be submitted to the Engineer for Approval at least 30 days prior to conduction any test together with the exact time and date of such test. Test procedure shall explicitly show.

a. the date on which the Contractor proposes to conduct each of these listed tests;

b. the nature and purpose of test;

c. the extent of testing covered by each submission;

d. the method of testing and test requirement with the relevant standards;

e. the relevant drawing and document (or modification) status;

f. the location of testing;

g. test parameters to be measured with the relevant standards;

h. constraints to be applied during the test with the relevant standards;

i. defined pass/fail criteria with relevant standards;

j. format of the raw data for processing by the Contractor;

k. test instrumentation and test circuitry to be used during the test with the relevant standards.

(2) Test procedures shall be amended during the duration of the Contract to reflect changes in design or the identification of additional testing requirement.

10.7.3 Records of Tests

(1) Within 14 days after completion of any test all necessary information regarding the test shall be submitted in a report for the Engineer's Approval. If required by the Engineer, a manuscript copy of the test record shall be made available at the time of the test and given to the Engineer or at the earliest opportunity if the test has not been witnessed. On completion of each test or group of tests, the Contactor shall provide a test report detailing but not limited to:

a. the numbers and types of tests which are required under the Contract and the result to be achieved;

b. the tests actually carried out and the results actually achieved;

c. Confirmation of pass and failure with if necessary, a schedule of further tests or actions to be carried out by the Contractor.

(2) In addition to any other requirements, the report, and its supporting documentation held by the Contractor for the Engineer's Approval and audit, shall contain but shall not be limited to the following details:

a. material, system, facilities or part of the Works tested;

b. reference to test procedures and test schedule;

c. place of testing;

d. date and time of tests;

e. weather conditions in the case of in-site tests;

f. technical personnel supervising or carrying out the tests;

g. method of sampling;

h. properties tested;

i. readings and measurements taken during the tests;

j. test results, including any calculations and graphs;

k. specified acceptance criteria;

10.7.4 Type Tests

(1) Prototype test shall be carried out in the factory to demonstrate meeting all the performance, functions requirement. This shall include at least the automatic sliding doors and emergency escape doors.

(2) The Full-height and Half-height PSD shall be subject to an accelerated life test for not less than 1,000,000 complete open and close cycles. Upon full completion of this test, the door operational, drive, guide and running gear components shall be dismantled for inspection.

(3) Should the Contractor include any equipment not previously proven in service, then the Contractor shall undertake thorough type testing of pre-production units to the satisfaction of the Engineer. The Contractor shall identify in its design submissions

any equipment in this category, or equipment that differs significantly from that already in service elsewhere.

(4) Type tests shall be carried out on specific items to ensure that they perform their intended functions when subjected to all permutations and combinations of external conditions as defined in their design criteria. Type testing for specific items may be omitted where the Contractor is able to produce documentation from previous test that meets the requirements of the Contract.

(5) In addition to the above, Type tests also may be performed for subsystems, components and items of equipment installed in the overall system in substantial numbers. In this case the Test Program shall foresee a combined schedule of Type Tests and corresponding Routine Tests of individual units.

(6) Type tests Reports and Certificates shall explicitly state the mandatory contents of the routine test program and the individual inspection and measurement procedures that need to be performed on each individual item of identical series production devices or components.

10.7.5 Hardware Test

(1) General

a. All hardware equipment and materials shall be tested during manufacture and before delivery.

b. Four types of test are required for all the material and equipment supplied as namely:

i. Equipment test;

ii. Environment test;

iii. Factory acceptance test;

iv. Site acceptance and integrated test;

v. Trial running

(2) Equipment test

a. Routine tests shall be applied to all equipment during the process of manufacture. The routine tests shall include:

i. Visual inspection

Visual inspections shall be carried out to ensure that the equipment is of sound construction and meets the requirement.

ii. Diagnostic tests

Hardware diagnostic tests shall be carried out on each element of the system including all workstations, computers, computer peripherals, devices.

iii. Performance tests

Performance tests shall consist of a comprehensive series of measurements on the characteristics of the individual equipment to check if its performance is complying with the performance and functional requirements of the particular equipment concerned.

iv. Soak (Running) tests

Equipment shall be set up in a manner to simulate normal operating conditions, switch on, and to allow continuous operation for a minimum period of 100 hours. This period may be broken down into shorter period if compatible with the function of the equipment.

(3) Environmental test

a. All equipment supplied and the prototype of Full and Half-height PSD shall be met and tested in accordance with the EMC requirements (IEC 62236: Railway applications – Electromagnetic Compatibility).

b. All equipment supplied shall be tested for full operational ability under the conceivable environmental conditions. Water permeability test shall be carried out to ensure no water ingress into the PSD elements which may interrupt the operation.

c. If, during the environmental tests, any failure occurs or the equipment design is changed, it shall be reported to the Engineer who may at his discretion require repetition of the tests.

10.7.6 Software Test

(1) The Contractor shall carry out the software proofing tests based on the Test Plan give a Notice of No Objection by the Engineer. Tests shall include but not be limited to:

a. software communication protocol tests for each type of interface;

b. functional tests;

c. performance tests;

d. interface between master controller and slave controller including operation and monitoring devices.

10.7.7 Factory Acceptance Tests

(1) All materials, components, sub-assemblies, unit assemblies (including software, cables and wiring) shall be subject to factory acceptance test. Notification of these tests shall be submitted to the Engineer 30 days in advance of carrying out any test together with information on any previous testing which relates to the items being tested and the Engineer will then determine which test to witness or which, if any, items may be accepted based on previous supply or experience.

(2) Factory acceptance tests shall include but is not limited to:

a. physical inspection;

b. dimension check;

c. electrical check;

d. calibration;

e. output check;

f. operational performance including full functional software testing;

g. insulation test;

h. soak (running) test.

10.7.8 Site Acceptance Test and Integrated Test

(1) The site acceptance and Integrated tests shall be carried out on site after installation, which shall demonstrate that system and software meets the requirements of the Test Plan approved, in terms of functionality and performance.

(2) Site acceptance and Integrated tests shall include but not be limited to the following categories of tests:

a. Site acceptance test

i. The tests shall ensure all the equipment supplied under this Contract satisfy the function and performance requirements of the Contract when operated in a standalone manner without any interface to equipment/system supplied by other Contractors.

b. Integrated tests with other Contractors

i. The tests shall ensure all the interfaces with Interfacing Contractors satisfy the functional and performance requirements of the interface requirement.

c. Total system integration tests

i. Having completed the integrated tests with Interfacing Contractors individually, total system integration tests shall be performed to demonstrate that all system modules coordinate their works with each other in harmony and that all functional and performance requirements are satisfied. No clash, crash or abnormality shall result from having various combinations of possible operation being carried out simultaneously.

(3) The scope of the site acceptance and integrated tests shall cover but not be limited to the following:

a. Visual inspection to ensure the equipment is installed properly in accordance with the installation guidelines;

b. Electrical tests to ensure that the electrical connections of the cables, power modules, electronic modules, etc. are correct;

c. Operational performance including full functional software testing;

d. Communication test among data transmission equipment;

e. Functional tests on all control requirements;

f. Point-to-Point tests to ensure correct mapping among the database and the physical equipment I/O points. Failed I/O points to be listed to show that routing is still functioning;

g. End- to- End tests to ensure all the connected equipment can be controlled and/or monitored.

10.8 OPERATION AND MAINTENANCE SUPPORT

10.8.1 General

(1) The Contractor shall investigate all failures including major failures, repetitive failures and design defects and provide all necessary corrective actions during the Contract period.

(2) Operation shall investigate interference problems either from or to the systems of other Contract packages and provide all necessary corrective actions during the Contract period.

10.8.2 Operation and Maintenance Document

The Operation and specially the Maintenance Plan shall be prepared by the Contractor and submitted to the Engineer for Approval not later than 6 months after the agreement of the Contract.

The contractor shall supply all the keys for the opening/closing of the doors, access to the control panels and electrical distribution cubicles or keys required for the operation and maintenance in each station.

10.8.3 Operation and Maintenance Plan

(1) The Maintenance Plan shall describe the Contractor's proposed maintenance regime for preventive and corrective maintenance of the system, including, but not be limited to the followings:

1) Maintenance philosophy and approach

2) Frequency of each maintenance task

(2) The Contractor shall include the following information on each maintenance task described in the Maintenance Plan:

1) The equipment, sub-systems covered in the task;

2) Step-by-step procedure to carry out the task;

3) Tools and test equipment list of each task;

4) Diagrams and flowcharts by illustration, if applicable;

5) Recovery procedures, if applicable;

6) Precautions the maintenance personnel must follow; and

7) Estimated duration and required manpower.

(3) In addition to the Maintenance Plan, the Contractor shall also submit a Yearly Routine Maintenance Schedule to the Employer for Approval and shall indicate the schedule of maintenance tasks in a calendar year.

10.8.4 Software Support

(1) General

1) In order to maintain the normal operational requirements given in this Particular Specification, the Contractor shall provide all changes, debugging, updates, modifications and upgrade of all the software developed (or delivered) for PSD including data configuration tables if such changes are necessary.

2) All changes and modifications of the software shall not degrade the performance or cause any adverse impacts for the system.

3) The Contractor shall maintain backup copies of all software developed (or delivered) for PSD.

4) The Contractor shall ensure that all new versions are fully tested, validated and given a Notice of No Objection by the Engineer prior to loading into the system.

5) The Contractor shall provide training for the Employer's staff for the use of new version as incorporated.

10.9 Interfacing Requirements with Civil

10.9.1 General

The Contractor shall liaise and coordinate with the Civil Works Contractors to ensure the effective and compatible coordination of all aspects of design, installation, testing and commissioning of work.

10.9.2 Contractor's Responsibility

(1) The Contractor shall ensure that all the interface items are included in the Interface Management Plan.

(2) Other items not mentioned in the interface items but are relevant to the design, installation, testing and commissioning of permanent works, shall also be included in the interface management plan.

(3) The PSD Contractor shall prepare the Interface Control Sheets with all Civil Contractors based on the Interface Works as tabled in 10.9.3.

(4) The Contractor shall interface with the civil contractors retarding location and spatial provisions for all PSD equipment and panels.

10.9.3 Interface Works

The responsibilities of the Civil Works Contractor and the PSD Contractor regarding the specification and provision of works pertaining to the interfaces are tabulated below:

10.9.3.1 Elevated Station (with Half-height PSD)

a) Works to be provided by Civil Works Contractor:

Item	**Works to be provided by the Civil Works Contractor**
Platform Edge	1. The Civil Works Contractor shall construct the full length of platform edge recess (about 50-150mm) from FFL including the return at platform ends. 2. The setting out of the platform edge shall make reference to the common survey control point or the as-built track center line. 3. Survey and joint survey with the PSD Contractor on the setting out of the platform edge. 4. To make good any part of the platform edge that is out of the tolerances. 5. To make provision and coordinate for the openings drilled or cast by the PSD contractor. 6. To provide the platform insulation 2000mm from the platform edge.
Platform Ends	Recess on the floor/wall for the mounting of the HH PSD Local Control Panel (LCP).

Item	**Works to be provided by the Civil Works Contractor**
Installation	Delivery The Civil Works Contractor shall provide to the PSD Contractor all reasonable access though the site for the delivery of APG materials and equipment within the Site including the free use of access roads and cranage facilities, provided that these facilities are normally available on the Site and at the time. APG Working Zone The Civil Works Contractor shall provide a clear 2 meter working zone along the platform edge during the APG installation period. APG Storage Areas The Civil Works Contractor shall protect the newly installed floor finishes and provide protection against damage to the glass panels during floor tile construction. The Civil Works Contractor shall provide temporary storage areas of $20m^2$ each on each platform throughout the entire APG installation period. Survey Control Points The Civil Works Contractor shall provide the survey control points for the APG setting out (at least three numbers of survey control points with co-ordinates and levels on each platform edge, i.e., one at each end of the platform and one at center line of platform). Removal of Debris The Civil Works Contractor shall provide clear passage for the removal of bulky item and debris by the PSD Contractor. Sealing of Penetrations The Civil Works Contractor shall provide wall and floor penetrations for APG cabling. The PSD Contractor shall seal the gaps on walls/floor openings after cable installation work. The Civil Works Contractor shall advise the material to be used for sealing that is compatible with the fire separation requirements of the corresponding areas.
PSD Rooms	The civil Contractor to provide, earthing terminals, air conditioning with redundancy, lighting, fire protection, concrete plinth, floor and wall finishes. Any air conditioning condensate pipes or other water pipes shall not be above any of the PSD Equipment.

Item	Works to be provided by the Civil Works Contractor
	The power supply shall be connected from the System Main Power Distribution Board. In NSCR stations the power supply shall be provided by Civil Contractor from the Main Switch Room. For detail scope refer ERG appendix -7 outline interface matrices. The clear height of the PSD Room is generally about 3m.
Platform floor	To provide the platform floor insulation and the sealing of gap between the PSD threshold and the floor tiles. All the floor tile level shall be aligned with the PSD threshold. To test the insulation value after installation

b) Works to be provided by PSD Contractor as below:

Item	Works to be provided by the PSD Contractor
Platform Edge	1. To install the bottom support within the platform edge recess (about 50-150mm from FFL, varies between stations) width and tolerances. 2. To cast the openings for the running of cables from trackside along the platform edge or from the platform slab below. 3. To provide the platform edge casting/drilling plans including dimensions and setting outs, 6 months before the casting of the platform. 4. To cast/drill the openings on the platform for the support of the HH PSD. The slab thickness at the platform edge is 100-150mm (varies between stations). The drilling shall not clash with the concrete rebars. The method of casting/drilling shall be coordinated and agreed with civil. 5. To provide the APG support loading for civil to verify the platform structure loading. 6. To provide and mount the cable containment below the platform slab and any necessary facility for the installation of the cable containment. 7. To survey and joint survey on the setting out of the platform edge by Civil.
LCP location	The dimensions and mounting details of APG Local Control Panel (LCP).
Delivery Route	**1.** Delivery route requirement. Dimension and weight of the equipment to be delivered via the delivery route.
Cable containment	1. Install the cable containment below the platform edge. 2. Provide the quantity and size of cable containment and cables

Item	Works to be provided by the PSD Contractor
	inside the station, 3. Cable containment from the PSD Room to the outside of the platform ends and from other rooms to the inside wall of the PSD Room. Exact location to be coordinated between 2 contractors. For detail scope refer ERG appendix -7 outline interface matrices
Electrical requirements	1. Power requirements (not exceed 27.5 KVA per station of two (2) platforms) 2. Grounding and bonding requirements 3. To supervise and assist in the testing of the insulation of the platform floor insulation membrane installed by the civil contractor

10.9.3.2 Underground Stations (with Full-height PSD)

a) Works to be provided by Civil Works Contractor

Item	Works to be provided by the Civil Works Contractor
Platform Edge	1. The Civil Works Contractor shall coordinate with the PSD contractor for the construction of the drop wall structure between the concrete slab and PSD. 2. The setting out of the platform edge shall make reference to the common survey control point or the as-built track center line. 3. Survey and joint survey with the PSD Contractor on the setting out of the platform edge and the openings. 4. To rectify the platform edge and openings that are found out of the tolerances. 5. To provide the platform floor insulation 2000mm from the platform edge.
Platform Ends	Recess on the floor/wall for the FH PSD Local Control Panel (LCP).
Cable Containment	Cable containment from the PSD Room to the platform ends and from other system (e.g., Signaling) rooms to the inside of the PSD Room.
Installation	Delivery The Civil Works Contractor shall provide to the PSD Contractor all reasonable access though the site for the delivery of APG materials and equipment within the Site including the free use of access roads

Item	Works to be provided by the Civil Works Contractor
	and cranage facilities, provided that these facilities are normally available on the Site and at the time. PSD Working Zone The Civil Works Contractor shall provide a clear 2 meter working zone along the platform edge during the APG installation period. APG Storage Areas. The Civil Works Contractor shall protect the newly installed floor finishes and provide protection against damage to the glass panels during floor tile construction. The Civil Works Contractor shall provide temporary storage areas of 20m2 each on each platform throughout the entire APG installation period. Survey Control Points The Civil Works Contractor shall provide the survey control points for the APG setting out (at least three numbers of survey control points with co-ordinates and levels on each platform edge, i.e., one at each end of the platform and one at center line of platform). <u>Removal of Debris</u> The Civil Works Contractor shall provide clear passage for the removal of bulky item and debris by the PSD Contractor. <u>Sealing of Penetrations</u> The Civil Works Contractor shall provide wall and floor penetrations for APG cabling. The PSD Contractor shall seal the gaps on walls/floor openings after cable installation work. The Civil Works Contractor shall advise the material to be used for sealing that is compatible with the fire separation requirements of the corresponding areas.
PSD Rooms	The civil Contractor to provide earthing terminals, air conditioning with redundancy, lighting, fire protection, concrete plinth, floor and wall finishes. Any air conditioning condensate pipes or other water pipes shall not be above any of the PSD Equipment.
Platform floor	To provide the platform floor insulation and the sealing of gap between the PSD threshold and the floor tiles. All the floor tile level shall be aligned with the PSD threshold. To test the insulation value after installation

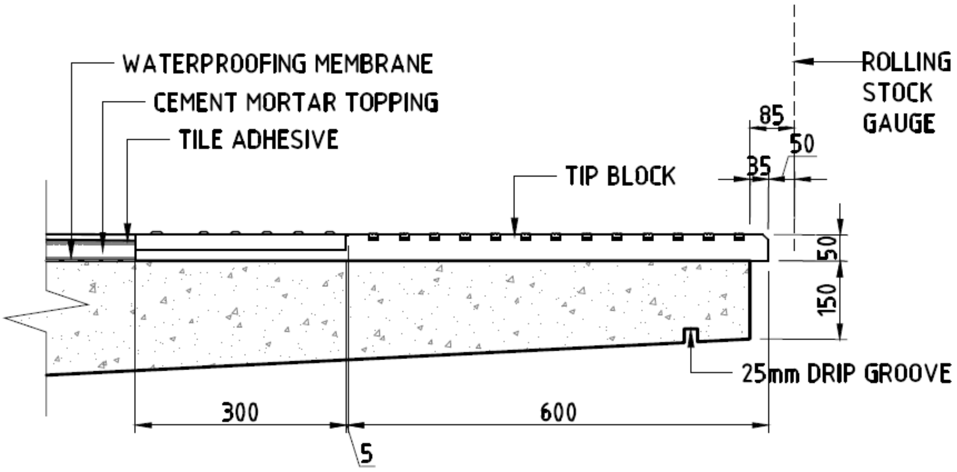
Item	Works to be provided by the Civil Works Contractor

b) Works and details to be provided by the PSD Contractor as below:

Item No.	Subject	Works and Details to be provided by the PSD Contractor
1	Platform Edge	1. To install the bottom support within the platform edge recess (about 50-150mm from FFL) width and tolerances. 2. To provide the drop wall structure between the concrete slab and PSD. 3. To provide cladding/finished on the drop wall structure on platform side if this is exposed below the ceiling. 4. To provide the trackside cover to seal any gap between the drop wall structure and PSD, to seal openings (if any) between each segment of PSD. 5. To cast/drill openings on the platform edge for the support of the PSD. The drilling shall not clash with the concrete rebars. The method to be coordinated and agreed with the civil contractor. 6. To survey and joint survey on the setting out of the platform edge and openings by Civil.
2	LCP location	The dimensions and mounting details of APG Local Control Panel (LCP).
3	Delivery Route	**1.** Delivery route requirement. **2.** Dimension and weight of the equipment to be delivered via the delivery route.
4	Cable containment	1. Install cable containment inside the PSD room. 2. Quantity and size of cable containment and cables
5	Electrical requirements	1. Power requirements (not exceed 27.5KVA per station of 2 platforms) 2. Grounding and bonding requirements 3. To supervise and assist in the testing of the insulation of the platform floor insulation membrane installed by the civil contractor.

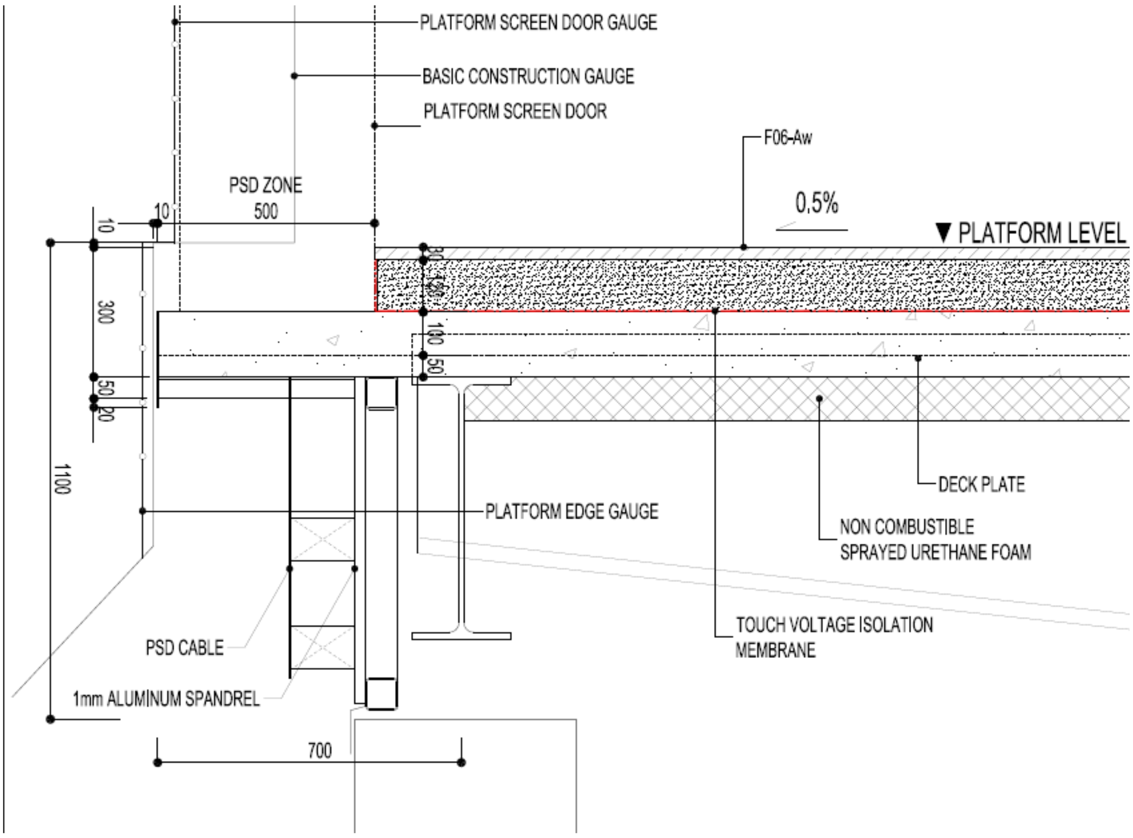
10.9.3.2 Platform edge civil details (for reference)

1. Sample of Platform Edge for NSCR and NSCR-South stations:

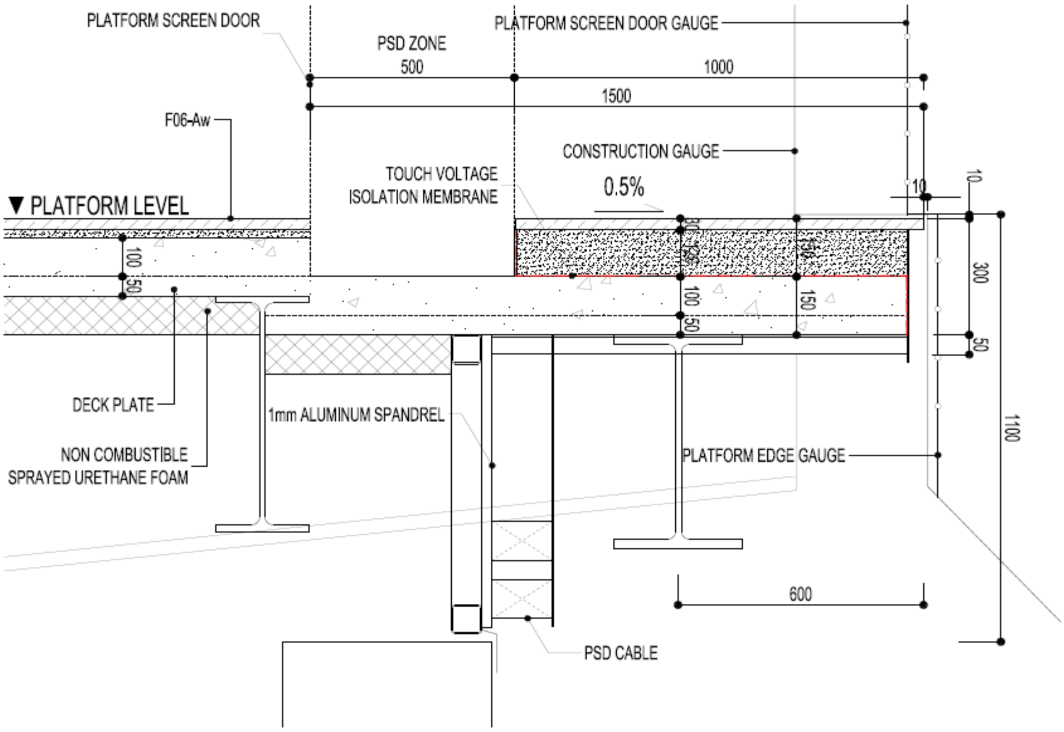


2. Sample of Platform Edge for MCRP stations:

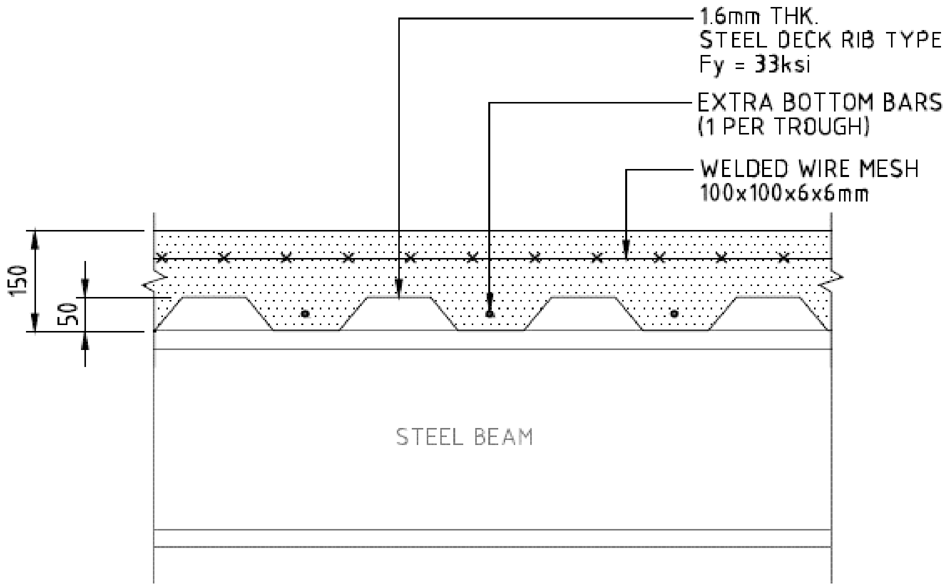
(a) Commuter train platform



(b) Express Train Platform



(c) Deck Plate Details (underside of slab)



Deck Details

End of Section

11 COMPUTERIZED MAINTENA*N*CE MANAGEMENT SYSTEM

11.1 Scope of Works

11.1.1 General

11.1.1.1 The Computerized Maintenance Management System (CMMS) is an industry standard management tool to record the assets, maintenance and reporting of the entire system. It shall be populated with an asset register, maintenance schedule and administrative schedule for all systems and be able to produce preventive maintenance programs and maintenance reports for the assets. The scope of work for CMMS Contractor shall cover the packages:

a) All systems in CP NS-01;
b) CP NS-02;
c) CP NS-03;
d) MCRP Civil Packages; CP N-01, CP N-02, CP N-03, CP N-04 and CP N-05.
e) NSRP - South Civil Packages; CP05, CP S-01, CP S-02, CP S-03a, CP S-03b, CP-03c, CP S-04, CP S-05, CP S-06 and CP S-07.
f) NSCR (integration of database for MMS and BIM).

11.1.1.2 The CMMS consisting of software and hardware for planning and management of all maintenance work and associated function.

11.1.1.3 The Contractor shall provide all tools (software and hardware), equipment, manuals and training necessary for the Employer to maintain and re-configure all configuration and customization data used in the system, if required in future.

11.1.1.4 The Computerized Maintenance Management System shall be designed and manufactured for efficient operation, ease of maintenance, and maximum availability, and shall provide trouble-free operation in the climate and environment of the Philippines.

11.1.1.5 The Contractor shall supply and install the full complement of equipment, to be fully operational as specified, corresponding to the required timeline plus produce operation and maintenance manuals and maintenance plan, clearly showing all required maintenance interventions and periodicities, including time required for each activity.

11.1.1.6 The Contractor shall review the Computerized Management Maintenance System as specified and recommend alternatives where deemed more appropriate for the maintenance of the assets.

11.1.1.7 The CMMS solution shall offer an unlimited user site license.

11.1.1.8 The CMMS must be a based on the rail industry platform.

11.1.1.9 The CMMS application shall be capable of tracking an unlimited number of equipment units and supporting an unlimited number of workstations from any number of locations.

11.1.1.10 The equipment shall be fit for the purpose and shall be available for operation with no or minimal maintenance. Where maintenance is needed, it shall be accomplished with the least equipment downtime.

11.1.1.11 The Contractor shall maintain configuration control records of the CMMS. The Contractor shall ensure that all equipment, including spare parts and consumables, is maintained at the same configuration throughout the Contract, including the Defects Notification Period of two (2) years after the Taking Over Certificate has been issued.

11.1.2 Scope of Supply

The technical specifications cover the requirements for the design, procurement, manufacture, installation, testing, commissioning and integration of the Computerized Management Maintenance System. The scope of supply shall include

11.1.2.1 Application and Data servers in dual redundant configuration and with the necessary software to be provided in the Mabalacat Depot and Banlic Depot.

11.1.2.2 CMMS Workstation and necessary software shall be provided at operator positions in the following locations including but not limited to and subject to the Engineer approval:

a) OCC;
b) Depots;
c) Warehouse;
d) Maintenance Workshops;
e) Maintenance Facilities Buildings; and
f) Maintenance Office at Stations.

11.1.2.3 The Contractor shall provide a schedule of peripheral equipment, including but not limited to printers for reporting, and any other requirement for comprehensive maintenance management. The Contractor shall state the performance requirement and quantity for equipment to be supplied and delivered which will be approved by the Engineer.

11.1.2.4 Field devices, used to collect configuration data and failure data from the railway assets or perform maintenance activities. The Contractor shall quantify and specify the field devices at the end of final design for Approval by the Engineer. Field device shall include but not limited to:

a) Cordless Bar code scanners;
b) Tablets;
c) Handheld devices; and
d) Maintenance laptops.

11.1.2.5 A software development server with all necessary software and hardware for creating, testing and modification of the configuration for real-time database, human machine interface (HMI) and also the source code of any project of any specific software. This software development server will be located in the Mabalacat Depot.

11.1.2.6 Workstation and laptops to be supplied with CMMS software license.

11.1.2.7 Integration of NSCR Maintenance Management System (MMS) with the MCRP and NSRP-South CMMS.

11.1.2.8 Integrated DRACAS (Data Reporting, Analysis and Corrective Action System) database.

11.1.2.9 Enterprise Asset Management.

11.1.2.10 Operation and maintenance manuals.

11.1.2.11 Training of the maintenance staff, and

11.1.2.12 Technical support during the initial two (2) years after receiving the Taking Over Certificate.

11.1.3 Environmental Conditions

The CMMS equipment shall be able to withstand at a minimum the environmental conditions stipulated below:

Table 11.1 – Environmental Conditions

1)	Conditions for interior/indoor Equipment:	
	a) Temperature Range (open Area)	0 to 40°C
	b) Equipment Room and Control Room	25 to 30°C
	c) Relative Humidity	Maximum 90%
2)	Conditions for exterior/outdoor Equipment:	
	a) Temperature Range	0 to 45°C
	b) Relative Humidity	Maximum 100%
	c) Solar radiation (heat-up and aging/deterioration)	1120 Watt/sqm
3)	Altitude:	100m or lower
4)	Reference Wind Velocity	40m/sec
5)	Lightning Area	Severe Lightning Area
6)	Salt Damage District	Around 10 km from coastline
7)	Vibration and shock	See Note 1
8)	Flood and Earthquake	Action Required

11.1.3.1 Note 1: All equipment shall be protected from the damage or performance degradation due to shock and vibration experienced in the railway environments as stated below:

a) Vibration: MIL-Std-810D, Method 514.3, Category 8, 025g (RMS) all axes 5 to 25Hz octaves per minute: and

b) Shock: Mil-Std-810D, Procedure I, half-sine pulse, 5g peak (X and Y axes), 1g peak (Z axis), 10ms.

11.1.4 System Assurance

11.1.4.1 The CMMS shall comply with reliability as Mean – Time – Between – Failures (MTBF) target of minimum 50000 hours plus availability target of 95% at least, under conditions below:

11.1.4.2 MTBF shall be evaluated to consider the following failures:

a) due to disturbance in light maintenance work more than one hour;
b) due to disturbance in heavy maintenance and/or repair works more than one day;

11.1.4.3 Availability shall be evaluated to exclude the following:

a) scheduled maintenance for the equipment and/or machine itself;
b) unavoidable time generated by delivery of parts or equipment and/or machines itself, by the time for decision making in MCRP and NSRP-South, by suspending of authority and by natural hazard, etc.

11.2 Abbreviations

Abbreviation	**Description**
BMS	Building Management System
COTS	Commercial Off the Shelf
DRACAS	Data Reporting, Analysis and Corrective Action System
HMI	Human Machine Interface
I/O	Input / Output
KPI	Key Index Performance
MMS	Maintenance Management System
MRO	Maintenance Repair and Operation
OCC	Operations Control Centre
PSCADA	Power SCADA
PLC	Programmable Logic Controller
RAID	Redundant Array of Independent Disks
RTU	Remote Terminal Unit
SCADA	Supervisory control and data acquisition

11.3 Design Criteria, Applicable Standards and Codes

11.3.1 Service-Proven

11.3.1.1 Railway maintenance equipment supplied shall be modern and service-proven in a similar railway application. The Contractor shall provide evidence that the CMMS equipment proposed is service-proven.

11.3.1.2 All the CMMS equipment's shall be made by manufacturers with a proven supply record to the railway industry, all replaceable piece parts used to make up any major parts will be demonstrated to have previous use within the industry.

11.3.1.3 Contractor shall provide documentary evidence for the Engineer's Approval in this regard.

11.3.1.4 The CMMS offered shall be designed and manufactured with the view of minimizing the use of consumables as much as possible. The Contractor shall search locally in the Philippines, for consumables and maximize their usage e.g. hardware, cables, connector etc.

11.3.1.5 The Contractor shall be recognized by reputable transit agencies as a market leader for Enterprise Asset Management (EAM) and Computerized Maintenance Management Solution (CMMS) software.

11.3.2 Standards and Codes

Table 11.2 – Standards and Codes

EN 50128	Railway Applications. Software for railway control and protection systems.
EN 60870	Telecontrol Equipment and Systems
EN 61508	Functional Safety of electrical-electronic programmable electronic safety-related systems
BS 5940	Part 1: 1980 – Specification for design and dimensions of office workstations, desks, tables and chairs. Specific limits and basic ergonomic and functional requirements for adjustable and fixed height chairs, desks, tables and worktops for general purposes and machine operators. Also covers drawers and footrests.
BS EN ISO 9001	Specification for design/development, production, installation and service.
BS EN ISO 9000-3	Guide to the application of BS 5750 Part 1: to the development, supply and maintenance of software.
BS 7671	Requirements for electrical installation
ISO 55000:2014(E)	Asset Management-Overview, Principle and Terminology
ISO 55001:2014(E)	Asset Management-Management Systems- Requirements
ISO 55002:2014 (E)	Asset Management- Management Systems- Guidelines for the application of ISO 55001

11.4 System Descriptions and Performance Requirements

11.4.1 System Description

11.4.1.1 The CMMS shall provide the means to schedule and undertake preventative and corrective maintenance activities.

11.4.1.2 The CMMS shall interact with other systems of the railway network, such as Signaling, TMS, Communications, BMS and PSCADA as an asset register to monitor performance and maintenance activities.

11.4.1.3 The CMMS shall capture and maintenance processes including but not limited to:

a) Preventive and Corrective maintenance;
b) Maintenance Planning, Records and Analysis;
c) Work Order Generation;
d) Failure Logs;
e) Engineering/Maintenance Projects;
f) Material Management;
g) Maintenance Repair Operations/Overhaul (MRO) parts reorder;
h) MRO parts cycle count; and
i) MRO parts receiving.

11.4.1.4 For managing the Depot maintenance activities, the CMMS shall provide access to an Asset Maintenance database via terminal facilities at Malabacat Depot and Banlic Depot.

11.4.1.5 The Contractor shall configure the System with all necessary operator's login accounts with appropriate user control authorities to be consistent with responsibilities of the controllers. The configuration shall include but not limited to the following operator's login accounts:

a) Storekeeper;
b) Technician;
c) Engineer Controller / Supervisor;
d) Production Manager;
e) Maintenance Operator;
f) Performance Maintenance Analyst;
g) Scheduler;
h) Planner;
i) Maintenance Supervisor;
j) Chief Controller; and
k) DRACAS Team

11.4.1.6 Below is the list of CMMS functions available to users under normal operating mode, but shall not be limited to the following and shall be subject to the approval of the Engineer and O&M requirement.

Table 11.3 CMMS User Interface

	Storekeeper	Technician	Engineer Controller	Maintenance Operator	DRACAS
All Fault Monitor			X	X	X
All Fault Control			X	X	
All Fault Configure			X		X
Record Asset History		X	X	X	X
Control the Maintainable Assets (Asset Database)			X		
Schedule Tasks			X	X	
Generate Work Orders			X	X	
Manage Inventory	X		X		
Manage Resources			X	X	
Generate Reports	X	X	X	X	X
Close Reports	X	X	X	X	X
Log onto the CMMS servers to access logs			X	X	X
Log onto the CMMS servers to view additional Faults			X	X	X
Log onto the CMMS server to make changes to the configuration.			X		
Handover/Takeback Control of CMMS			X		

11.4.1.7 The CMMS shall have its database setup to contain information, including but not limited to, equipment records maintenance schedule, maintenance procedure, inventory item records, etc. one month before the commencement of the Trial Run period.

11.4.1.8 The CMMS database shall be configured to include manufacturers data for a production period of over a year, with tests and equipment failures during that period included.

11.4.2 CMMS Functionality

The CMMS shall have the following specific functionality requirements but not limited to:

11.4.2.1 Recording Asset History: Asset history shall be automatically recorded based on the closing depot of a Work Order. Such a Work Order shall include failure symptoms and findings, maintenance tasks undertaken, man-hours spent, materials used etc. Requirements shall include:

a) Allow input of user-specified key information for future analysis;
b) Record the maintenance down time of the equipment;
c) Specify Work Order priority;
d) Provide functionality of attaching items associated with Work Order (such as photos, reports etc.); and
e) Update and maintain information such as identity, configuration etc. of replaceable items.

11.4.2.2 Collect and store the event recorder data for the rolling stock. Requirement shall include:

a) Store the failure logs from the train.
b) Collect the passenger load pattern of the train from the event recorder.
c) Store operational data of the train.

11.4.2.3 Control the Maintainable Assets through an Asset Database: The CMMS shall incorporate a user defined line wide asset database, including an asset management system, able to monitor and record asset lifecycle, performance and reliability. Requirements shall include:

a) Define and record detailed information of the assets in hierarchical structure with an unlimited number of breakdown levels;
b) Classify assets by different fields or attributes such as physical, and functional locations; and
c) Track life-to-date accountability for assets such as labour costs and material costs with roll-up function to a higher level of asset hierarchy or break down function to a lower level of asset hierarchy
d) Allow easy expansion of the asset register by the general user.

11.4.2.4 Scheduling Tasks: The system shall schedule, raise and allocate work orders for scheduled maintenance based on a calendar or device operating hours. Functional requirements shall include:

a) Plan maintenance based on different user-defined parameters (such as date / time, kilometer, KPIs etc.);
b) Implement predictive maintenance strategy based on the records of the above user-defined parameters;
c) View the parameters history;
d) Allow authorized user to amend the parameters;
e) Allow easy update of maintenance schedules; and
f) Schedule Calibration and testing for tools and equipment.

11.4.2.5 Generate Work Orders: The system shall allow the maintenance staff to open, close and track work orders for preventative and corrective maintenance work. Requirements shall include:

a) Generate automatic or manual maintenance work order;
b) Monitor the above work order;
c) Allow authorized users to alter / delete work order;
d) Interface with each subsystems and Other Work Contractors to receive alarm data and operating status correctly from the respective Server.

11.4.2.6 Managing Inventory: The system shall maintain a spares inventory by monitoring and maintaining stock levels, as defined by the user. The planning and controlling activities shall include requirements such as:

a) Capture the spare part information such as manufacturer, part number, materials cost etc.;
b) Identify spares and utilise by grouping them together;
c) Reserve required parts when a work order is generated;
d) Generate alarms when stock levels drop below a pre-defined level;
e) Generate purchase order for items below the pre-defined stock levels;
f) Automatically update inventory level;
g) Allow access to materials catalogue; and
h) Record safety information for spare parts.

11.4.2.7 Managing Resources: The system shall be capable of managing the maintenance resources (staff, equipment). Requirements shall include:

a) Compare and match required work orders load with available resource;
b) Project resource requirements to develop maintenance plan; and
c) Generate and review individual / team maintenance schedules.

11.4.2.8 Report Generation: The system shall have the ability to generate and schedule the production of user-defined customized reports, including DRACAS reports.

11.4.3 Performance Criteria for CMMS

11.4.3.1 System Loading and Capacity

a) The design capacity of number of I/O points of the CMMS should be as a minimum 100,000 points.
b) Buffers full condition shall not cause the system to become unavailable.
c) Single failure to any network devices (such as routers, switches, RTUs and PLCs etc.) shall not affect system operation.
d) Change-over shall be automatic and seamless to the operator. The affected units shall be isolated and new data paths shall be established to maintain the operation of CMMS uninterrupted. No data shall be lost and the operator shall not have to log in again. No disruption to the operator shall be visible on the HMI.
e) Under normal conditions, the CPU loading of any server shall be less than 35% on average when measured over a period of 5 minutes.
f) Buffering shall be controlled so that a full buffering condition will not cause the failure of the CMMS.
g) Under worst case conditions, the CPU loading of any server shall be less than 70% on average when measured over a period of 5 minutes.
h) Each application server and workstation shall provide at least a free space of 100% of the total required space for operational data plus projected storage of them for a minimum of 5 years. In any case, this shall not be less than 200GB at each of the workstation and 1TB at each of the servers.
i) Time synchronization mechanism shall be provided among CMMS equipment (including associated field devices) in OCC, Depot and Master Station.
j) The means of time synchronization shall be the Master Clock System (MCS).
k) Maximum time difference between the internal clocks in any two CMMS devices at the same location shall be 10ms.
l) The system shall automatically update and synchronize the clocks of various CMMS components.
m) The Contractor shall perform clock synchronization tests during T&C.

11.4.3.2 System Response

a) The update time of digital status or messages on the real time event window of the CMMS workstations shall not exceed 2 seconds. This will be measured from the time the signal is received at the interface point to the point it is displayed/updated on the CMMS.
b) The update time of analogue information shall not exceed 5 seconds. Metering status shall be updated every 60 seconds.
c) A control command initiated by the operators shall reach the point of interface within 2 seconds. This will be measure from the rime the command is sent by the operator to the point it is received by the interface.
d) The CMMS shall complete the refresh of the monitor for a new display within between 2 to 4 seconds from the time of the operator's request for the changes of display.
e) The CMMS shall be able to process all expected data points with change of state in one second. The status shall be shown at the CMMS Workstations within the required response time for status indication.
f) Execution of any data enquiry functions such as archival and retrieval of historical data, printing or trending functions shall not degrade the performance of the CMMS as outlined above.
g) The CMMS shall not stop operating or "hang" due to a malfunction of event changes.
h) The CMMS shall not become locked or "hang" due to a failure of executing a command.
i) A system wide failure shall not affect the functionality of the CMMS.
j) The CMMS shall continuously perform self- checks to detect any malfunctions within the system hardware and software.
k) In a hot-standby server configuration, switchover of the standby server to active server and reaching full operational mode shall be less than 5 seconds. The server switchover shall be seamless and transparent to operators. No data shall be lost during the switchover.
l) A complete shutdown following the correct procedure shall take less than 5 minutes.
m) The recovery from a complete system shut-down to fully functioning CMMS operation shall be accomplished within 15 minutes.

11.4.3.3 HMI Selection and Update

a) The operator shall be able to select the full static and dynamic graphic (such as functions loading and status updates).
b) These shall be presented on the CMMS window such that:
   i. They do not exceed 5 seconds for a station schematic;
   ii. They do not exceed 10 seconds for the overall schematic; and
   iii. They do not exceed 15 seconds for the management of HMI.
c) Items such as the menu list, symbols and icons which are selected by operator shall be displayed on the screen within 1 second.

11.4.4 Hardware Requirements

11.4.4.1 CMMS Application and Database Servers

a) The CMMS design shall include, but not limited to, all Application, Database and Application Test servers.

b) Servers shall be at commercial grade from internationally recognized Supplier and have applications in similar environments subject to Engineers Approval. They shall also be adequate to achieve the system Reliability and performance requirements. The servers shall include all necessary hardware and software that shall be required to perform the data acquisition.

c) The servers with redundant configuration shall be running in active/standby mode. The active server shall continuously maintain synchronization of the acquired equipment data with the standby servers. In the event of failure of the active server, the standby server shall automatically take over without any interruption to the System operations.

d) The active and stand-by servers shall be located in Equipment Room in Depots and shall be updated on real-time.

e) Each real time database server shall provide sufficient hard-disk space for storage of historical data for at least 2 years including 20% spare space. There shall be no loss of data in the event of failure of any one server.

f) Each real time database server shall also include necessary hardware and software to facilitate the long-term archive of the historical data into optical disk and retrieve the data upon the request from the CMMS Workstations.

g) Each server (application / database) shall be equipped with following the hardware components of higher specification:

   i. Central Processing Units;
   ii. Main memory with additional slots for expansion;
   iii. Internal hard disks configured for RAID configuration;
   iv. Media Disks R//W Drives;
   v. Dual Gigabit Ethernet ports;
   vi. HD LED monitors, size and type as detailed in Ergonomic studies; and
   vii. Keyboard and mouse as detailed in the Ergonomic Study.

h) The above proposals are indicative only and the latest proven model shall be proposed in final design.

11.4.4.2 **CMMS Workstation**

a) The Workstations shall be provided with the necessary software and tools to enable the modification of system HMI and database configuration.

b) The Workstations shall enable system maintenance and diagnostic activities for the CMMS.

c) The Workstations shall equip with following hardware components or the similar components of higher specification:

   i. Central Processing Units;
   ii. Main memory with additional slots for expansion;
   iii. Internal hard disks configured for RAID configuration;
   iv. Media Disk R/W drives;
   v. Dual Gigabit Ethernet ports;
   vi. Dual HD LED monitors, size and type as detailed in Ergonomic Study; and

vii. Keyboard and mouse as detailed in the Ergonomic studies.

d) The above proposals are indicative only and the latest proven model shall be proposed in final design.

e) The workstations shall be suitable for 24/7 operation (24 hours, 7 days a week) and shall be of proven high quality and reliability. The system shall be energy efficient, COTS, designed for multi-tasking and intensive graphics applications.

11.4.5 Uninterruptible Power Supply (UPS) for CMMS

11.4.5.1 Uninterruptible Power Supply system for the CMMS shall be provided to ensure the availability of the system.

11.4.6 Software Requirements

11.4.6.1 CMMS software shall be a service lifecycle management software tool that manages the product data from project inception with systems configuration capability through the life of the maintained assets.

11.4.6.2 The CMMS software shall be able to capture, organise and configure operational assets information for the purpose of railway systems operation and maintenance.

11.4.6.3 The CMMS software shall be able to be interfaced with BIM software packages, requirements management software and Enterprise Document Management Systems Approved by the Engineer.

11.4.6.4 The CMMS software shall be able to download and upload BIM 3D model and information using file format medium and data exchange template to be approved by Engineer.

11.4.6.5 The CMMS software shall be able to interface with multiCad data inputs from various system Contractors.

11.4.6.6 The CMMS software shall be able to be interfaced with legacy software EAM software of the operator (SAP, ORACLE etc.) if required.

11.4.6.7 The CMMS software shall be from a proven Product Lifecycle solution platform with relevant references to operation and maintenance of assets in the same or similar industry.

11.4.6.8 The CMMS software shall be scalable and open to be integrated to other services and providers or partners.

11.4.6.9 The CMMS software shall cover the following functions, but not limited to:

a) 3D modelling;
b) CMMS software shall be able to interface with multi Cad data inputs from various system contractors.
c) Asset information from 3D model;
d) BOQ/ Bill of material, breakdown structure;
e) Work Instruction, Cards, Flow;
f) Serialised part / component / installation / software numbers or versions;
g) Functional configuration;
h) Operation and Maintenance (Tasks, Manpower / hours, Tools, Equipment, Material);
i) Training, maintenance, overhaul Manuals;
j) Asset Register and its change management / engineering change management;
k) Logs and History;
l) RAMS functions like Availability, MTBF, MTTR etc.;
m) DRACAS;

n) Performance;
o) Reporting, Analytics and Dashboarding; and
p) CMMS must be supplied with rail operation and maintenance reports that include track, rolling stock and facility asset failure analysis.

11.4.6.10 CMMS shall be capable of O&M automation and manual logs and history data inputs.

11.4.6.11 The Contractor shall identify their use of existing or COTS software for the CMMS software and submit the software list at detailed design.

11.4.6.12 The proposed software shall be assessed for applicability in terms of operating environment, architecture etc.

11.4.6.13 For COTS software, the Contractor shall provide test and analytics evidence, as well as on site simulation, to prove that the use of these software will not threaten the safety of the system.

11.4.6.14 The CMMS software platforms shall be window-based software.

11.4.6.15 The proposed software architecture shall be maintainable and scalable so that it allows for future growth and expansion. New components shall be able to be added without critically affecting the application of the operating environment.

11.4.6.16 The CMMS shall support a multi-user environment, enabling multiple operators to access the System simultaneously. Access authentication shall be implemented in the software to control access to the System and to control the authority of the operators for the System operations.

11.4.6.17 The CMMS shall support hierarchical access controls by means of log-in ID and password, subject to approval by the Engineer.

11.4.6.18 The operation rules of the system shall not be hard coded in the application code. Common modules shall be developed to facilitate ease of maintenance.

11.4.6.19 The Contractor shall ensure that all requirements associated with functions and functional relationships are documented. The Contractor shall also ensure that all equipment is interfaced to operate as intended.

11.4.6.20 The Contractor shall analyze the relationship of all components of the system to ensure system performance requirements are met. Diagrams of equipment and software relations shall be prepared with internal and external data flow.

11.4.6.21 Modular software design shall be adopted to permit easy addition of further software modules to meet future expansion requirements. Standard versions of programming languages shall be used to allow software application to be added easier.

11.4.6.22 Software shall be designed so that processes wait for data only up to a configurable time period. If data is not available by then, the system may retry, ensuring however that operation and system performance is not affected by it.

11.4.6.23 The Operating System shall include the following features:

a) Support multi-tasking, multiple users and cross-process communication in real time;
b) Conform to standards for Open Systems;
c) Support all I/O devices; and
d) Support virtual memory management.

11.4.6.24 The Contractor shall provide a comprehensive data exchange solution. The solution shall ensure data integrity, with no loss and duplication of data.

11.4.6.25 Software processes shall be recorded in internal logs. These logs shall be configurable to record various information on alarms and processes status. Information may be used for processes and fault analysis by the maintainer.

11.4.6.26 Equipment shall come with self-test and diagnostic capabilities, where possible. Self-tests shall be initiated each time the equipment is powered up.

11.4.6.27 The CMMS version upgrades shall be supplied and installed by the software contractor for every two years as part of the support and warranty at no additional cost.

11.4.6.28 The CMMS system shall have the functionality for asset condition-based maintenance and analysis including tracking and update of condition scores for all assets.

11.4.6.29 The CMMS shall offer the following ways to determine asset condition (will vary by asset type):

a) Physical condition inspections
b) Asset age decay curves
c) System-generated condition scores.

11.4.6.30 The system shall support collecting asset inventory, and asset condition rating data, via mobile device iOS and Android platforms.

11.4.6.31 The CMMS system shall be supplied with sample asset age and condition decay curves for railway specific asset classes.

11.4.6.32 The system shall have the ability to automatically generate condition scores for each asset based upon the historical maintenance condition data collected in the system.

11.4.6.33 The condition scoring calculation shall be able to generate values based upon multiple data elements, including the following minimum criteria: usage, preventive maintenance compliance, and physical inspection rating.

11.5 Interface Requirements

11.5.1.1 This Interface Specification describes the interface between the Computerised Maintenance Management System (CMMS) with each subsystems and Other Work Contractors.

11.5.1.2 This Interface Specification shall be read in conjunction with the relevant sections of the respective Contractor Contract Specifications (for example but not limited to the ERT and ERG Specification). The Contractor shall ensure that all requirements of their Specifications pertaining to interfaces are fully resolved and implemented, this includes but shall not be limited to Requirements Management, Configuration Management and Systems Assurance.

11.5.1.3 This Interface Specification outlines the interfacing requirements during the execution of the Works between the CMMS with each subsystems and Other Work Contractors. However, the requirements herein specified are by no means exhaustive and it remains the responsibilities of the Contractor to execute the Consolidated Detailed Interface Matrix (CDIM) and jointly develop and update the Interface Control Document after the commencement of the Works and throughout the execution of Works to ensure that:

a) All interface issue between both parties are satisfactorily identified, captured and resolved;

b) All tolerances related to the interface between the Systems meet the requirements and standard listed in the ERT and ERG;

c) Works provisions related to the design, supply, installation, testing, operation and maintenance of the CMMS and systems works are fully coordinated;

d) The CDIM will continue to be a live document, subject to modification and addition by common agreement between the Package Contractors as the Works proceed;

e) Facilities/provisions supplied under the Contracts and this Interface Specification are fully compatible with each other.

11.5.1.4 The Contractors shall review and comment on any design or construction information received which may include but not be limited to System Architecture Design (SAD), interface protocols, data communication interface design and other relevant drawings.

11.5.1.5 Notification by Contractor to the Engineer shall be given if there is any change with contractual implication.

11.5.1.6 Contractor shall immediately notify the Engineer should he note any ambiguity, error or non-compatibility.

11.5.1.7 All information exchange between both parties shall be copied to the Engineer for information.

11.5.1.8 The Contractor shall take the lead in developing the interface documents as listed in both parties specification. The Contractor shall provide input to and shall review the interface documents prepared by both parties.

11.5.1.9 The Contractor shall arrange and attend regular interface meetings with both parties when necessary. The minutes of meetings and the action plans shall be prepared by the meeting initiator and submitted to the Engineer.

11.5.1.10 Both parties shall provide all interface requirements, as, listed in the subsequent sections of this Interface Specification and in the Interface Control Document, in the agreed timescales.

11.5.1.11 The Contractor shall ensure the timely, understandable and complete transparent exchange of information and the settlement of any differences.

11.5.1.12 The CMMS shall provide the communication protocol, data structure and the server address and database details for each subsystems and Other Work Contractors to design and develop an interface function to receiving alarm data and operating status correctly from the respective Server.

11.5.1.13 Each subsystems and Other Work Contractors shall ensure software platform for servers, workstations, and others sub-systems are compatible to meet the CMMS interface requirements.

11.5.1.14 Each subsystems shall provide information and data to populate the CMMS Database Server which shall include but not be limited to:

a) Asset Register
b) Maintenance Schedular
c) Administrative Schedular

11.5.1.15 Each subsystems shall provide an Asset Register to the CMMS to populate the CMMS Database Server which shall include but not be limited to:

a) Part Name
b) Part number
c) Functional use
d) System, sub-system, equipment and component level hierarchy for populating the CMMS Database configuration
e) 2D/3D CAD files
f) Maintenance requirements
g) Maintenance history
h) Spares stock holding
i) Supplier data.

11.5.1.16 Each subsystems shall provide a System Maintenance Schedule for populating the CMMS Database Server. The Schedule shall include but not be limited to:

a) Preventive Maintenance
b) Inspection of equipment
c) Servicing of equipment at stations, viaduct, and tunnels
d) Servicing of Depots equipment
e) Servicing of On Board equipment

11.5.1.17 Each subsystem shall provide an Administrative Schedule to the CMMS Contractor to populate the CMMS Database Server which shall include but not be limited to:

a) Personnel Details
b) Operational Manuals
c) Training Manuals
d) Warranties
e) Work Schedule
f) Job Cards.

11.6 DRACAS Database

11.6.1 The DRACAS Database shall facilitate failure reporting to establish a historical database of events, causes, failure analyses, and corrective actions.

11.6.2 The DRACAS Database shall have the following minimum features:

a) User configurable system and adaptable to changes in process
b) Customizable process flows, Workflow & Approvals, and Audit tracking
c) Highly secured based and compliant with the strict data security requirements
d) The collected data is accessible throughout the organization/industry/world
e) Alerting Mechanism for automatic notifications
f) Dashboard for dynamic status presentation with drill-down options
g) System / Serial No. traceability (incidents and problems)
h) Statistical reporting outputs
i) Corrective / Preventive Action Mechanism
j) Support RAM Analysis (MTBF, MTTR, Availability, Failure / Incident Trends Analysis)
k) World Wide Web and Intranet Capabilities (including Mobile devices)
l) Export/Import data in MS Access, Excel, HTML, Oracle, Text, ASCII, etc.

11.6.3 The following is a sample of basic standard fields or similar fields the DRACAS Databases shall comprise of:

11.6.3.1 Events Table.

The primary purpose of the DRACAS application is to record downtime events for a particular system. The fields of the Events Table shall cover the below as described in Table 11.4.

Table 11.4 Events Table Field Descriptions

Field Name	Description
Date	User input. The date the event occurred. Enter in a MM/DD/YY format.
Serial Number	User input. The serial number of equipment having event.
Weekly Operational Time	User input. Enter the number of hours the equipment is scheduled to be in operation.
Time	User input. The starting time of the event. Entered in 24-hour time (HH:MM:SS). Seconds are not required.
Duration	User input. The duration of the event. Entered in a HH:MM:SS format. Seconds are not required.
System	Automatic input based upon the serial number.
Subsystem	User input. The optional subsystem code (if the part is at a subsystem level) involved in the event. Related to the System codes.

Assembly	User input. The optional assembly code (if the part is at an assembly level) involved in the event. Related to the selected System and Subsystem codes.
Operator	User input. Name of the operator when the event occurred.
FSE Name	User input. Name of 'field service engineer' who responded to the event.
FSR#	User input. The 'field service report' number.
Subassembly	User input. The optional subassembly code (if the part is at a subassembly level) involved in the event. Related to the selected System, Subsystem, and Assembly codes.
Sub-subassembly	User input. The optional sub-subassembly code (if the part is at a sub-subassembly level) involved in the event. Related to the selected System, Subsystem, Assembly, and Subassembly codes.
Reliability/Fault Code	User input. The problem reliability code or Failure mode code.
Down Time Category	User input. Downtime code. Either scheduled or unscheduled. Scheduled downtime should be used for holidays, weekends, or any other time when the system is not scheduled to be in operation.
Part Number	User input. The equipment part number.
Relevant Failure	User input. Whether the failure was relevant or not. Y for yes; N for no.
PM	User input. Whether the downtime was due to preventive maintenance. Y for yes; N for no.
Problem	User input. The description of the problem.
Repair Action	User input. The description of the repair action.

11.6.3.2 Failure/Fault Event Table.

The Failure/Fault Event Record shall allow the operator to view, modify, or add records for faults or failures that occurs. The fields of the Failure/Fault Event Table shall cover the fields as described in Table 11.5 but will not be limited to the following. The Failure/Fault Event Table fields and format shall be subject to the Engineer's approval.

Table 11.5 Problems Field Descriptions

Field Name	**Description**
Title/Description	User input. Simple title or description of event.
Initial Status	User input. Required. Status of problem when first reported. If problem is being added from Event screen, date of event is entered automatically as initial status date.
Fault Category	User input. Event category.
Error Codes	User input. Error code for selected tool.
Assignee	User input. Staff member who assigned this problem.
Information log dates	Date when Containment information status was declared.
Root Cause Solution – Original	Original (planned) date for fixing problem.
Root Cause Solution – Current	Current date for fixing problem.
Completion Date	Completion date for fixing problem.
Comments	User input. Memo area for problem comments. Can be any number of characters.

11.6.4 Reporting

11.6.4.1 The reporting mechanism for this database shall be flexible with the minimum following reports:

a) Trend charts to show a number of events during a time period.
b) Event history to show a list of events for during a time period.
c) Problem history to show a list of problems during a time period.
d) Reliability statistics to demonstrate the system performance in terms of MTTR, MTBF, mean time to failure (MTTF), availability, etc.

11.6.4.2 The list of report types shall be proposed by the Contractor and shall be subject to the approval of the Engineer.

11.6.4.3 Report generation facilities shall be provided to enable operators to perform the following functions:

a) Construct reports
b) Set-up pro-forma type reports
c) Store, archive and retrieve reports
d) View reports
e) Print reports (automatically, periodically or on request) and
f) Export reports (format of file to be approved by the Engineer)

11.6.4.4 It shall be possible to construct reports which include any of the following

a) Real time data
b) Stored or archived data
c) Descriptive text, including but not limited to, titles, page header, footer
d) Data derived by manipulation of any of the above

11.6.4.5 Reports shall be available in a removable storage medium to assist in the preparation of the following:

a) Reports on incidents
b) Reports on outstanding permits to work

11.6.4.6 Reports shall be either displayed on a screen or printed.

11.6.4.7 Reports shall be able to present the data in textual, tabular or graphical (trend) formats, as appropriate to each data type and as defined by the engineer.

11.6.4.8 It shall be possible to define reports offline.

11.6.4.9 Displaying or printing of a report shall be initiated either by specifying the report by name, or by selection from a display showing all reports that are available.

11.6.4.10 Display, printing or archiving of a report from this display shall be accomplished in less than three keystrokes.

11.6.4.11 It shall be possible to recover archived reports and manipulate and view them in the same manner as current reports.

11.6.4.12 None of the reporting functions shall affect the on-line system or its performance.

End of Section

12 INTEGRATED OPERATIONAL CONTROL CENTER AND DEPOT CONTROL CENTER

12.1 Introduction

12.1.1 The complete E & M systems for the Clark International Airport to Calamba line will ultimately be controlled from an Integrated Operations Control Center (IOCC) located at Mabalacat Depot provided by the Contractor. The contractor shall take the lead in the interface of the IOCC. The existing OCC theatre at Mabalacat will be designed and upgraded to IOCC. Therefore, the Mabalacat OCC shall be deigned keeping in view the future requirement of IOCC and adequate provision for all facilities will be provided from the beginning for use of the Mabalacat theatre as IOCC at later stage.

As the railway is progressively commissioned, the various control and monitoring functions will be implemented from individual OCC's and then ultimately migrated to the IOCC as follows:

i) NSCR will initially be controlled from an OCC at Malanday Depot in Valenzuela,

ii) MCRP will initially be controlled from the OCC at Mabalacat Depot.

iii) NSRP – South will initially be controlled from an OCC at Banlic.

The system from Malolos to Tutuban (including Blumentritt) which is controlled from the OCC within Malanday Depot will eventually be transferred to the Integrated Control Center (IOCC) located in Clark Depot, The Contractor shall allow provision for the seamless switchover of control from the OCC in Malanday to the Clark Integrated Control Center. The Contractor shall submit in their design how this will be achieved in coordination with the NSCR E&M System Contractor.

12.1.2 Each Depot (Mabalacat and Banlic) shall have its own Depot Control Center (DCC). The Contractor shall provide E&M facilities in the Depot for efficient operations and management.

12.2 Scope of Works

12.2.1 The Contractor shall combine and consolidate all E&M railway control systems along the route between New Clark City, Clark, and Calamba to allow central control of the line from the IOCC at Mabalacat. which includes:

1. An Integrated ATS and OCC to unify the operational control and monitoring of the three lines N1, N2 and SC
2. Power Supply monitoring and control
3. Passenger Information Displays and PA system
4. Centralized Radio Management and dispatcher for complete line
5. Centralized alarms for disaster management
6. Common video wall to cover display of track layout with train status, Power SCADA and CCTV
7. Centralized trackside alarms management
8. NMS for all subsystems
9. Suitable positions and seating arrangement for all IOCC functions
10. Centralized CMMS
11. Also included to be integrated are systems outside of the E&M systems like BMS which uses the Backbone Transmission Network. The Contractor shall integrate the Central BMS which is provided by other contractors that resides in each OCC for N1, N2, and SC shall

be combined and consolidate to the IOCC. The Contractor shall also consolidate any of the Control and Monitoring Systems that can be combined like the P-SCADA and BMS and shall integrate it also to the IOCC.

12. PABX and Landline telephones for communication with all stations, Depots and adjacent railway/MRTS lines

12.2.2 The contractor shall comply with the requirements covered in other chapters of ERT.

12.2.3 The Contractor shall prepare and implement the requirements of a detailed Migration Plan covering strategy, timeline, testing, and decommissioning during the transfer of the OCC functions to the IOCC.

12.2.4 All migration works shall be coordinated and agreed with the O&M Concessionaire. Redundant equipment from the decommissioned OCC's shall be returned to the Employer. The migration plan shall be submitted to the Engineer for approval.

12.2.5 Following the migration, the integrated combined consoles and displays shall cover the complete railways from Clark to Calamba.

12.2.6 Effective inter-disciplinary checks will be required to ensure the objectives for integration are realized.

12.2.7 Provisions of the space and associated works should be planned, to accommodate various equipment in the IOCC. Ergonomic studies will be required as part of the design of the IOCC which shall cover the likes of desk layout, lighting levels, and environment designs. These studies and all designs shall be submitted to the Engineer for approval.

12.2.8 Provisions shall be made in the IOCC to accommodate the future requirements for the extension to New Clark City.

12.2.9 The System equipment, rooms and E&M facilities design and installation shall also be in line and complaint with the RAMS Project requirements as defined in the ERG.

12.2.10 The functionality of the operating systems shall be driven by operational requirements. This Technical Specifications for IOCC systems equipment have been developed to international norms and standards. Other Equivalent standards shall also be allowed subject to review by the Engineer.

The Contractor shall propose all designs and functionality required to effectively operate the line. The Contractor shall submit suitable designs and plans for undertaking this work, at detail design stage, for the review of the Engineer.

The contractor shall design and supply all furniture, accessories, finishes as detailed in the document.

12.2.11 The contractor shall comply to requirements of DCC for managing operations within the Depot for all Depot operations.

12.3 Design Requirements

The Contractor shall assemble an interdisciplinary team, including competence in ergonomics and shall ensure an appropriate balance and representation of skills. The ergonomics input shall encourage a user-friendly approach within the Control Room Design Process.

Suitable time and resources shall be made available for iterative ergonomics input throughout the Control Room Design Process lifecycle.

Task Analysis of comparable operations shall be conducted by competent personnel at an early stage of the design programme.

Functional Analysis covering user and systems shall be conducted by competent personnel during the early stages of the design programme.

Consideration shall be given to accommodating the needs of staff with disabilities.

A system for documentation of ergonomics input shall be developed and maintained throughout the Control Room Design Process lifecycle.

The Contractor shall propose and make the provisions in designs the functionality required for effectively integrating the individual OCC's into the IOCC to establish centralized operations for the entire network.

The Contractor shall, in turn, make available the necessary design information to ensure compatible interfacing activities take place with interfacing Contractors. The Contractor shall allow provision for the seamless switchover of control from the separate OCC's.

Design proposals of how the OCC will be integrated including the Workstations and Overview panel diagrams shall be produced. Provisions shall be made in hardware and software to support IOCC functionality.

12.3.1 The contractor shall build adequate redundancy for each system so that (i) failure of one device/component does not render the system inoperable, and (ii) it is easy to identify, isolate and attend to failed device/component without affecting the operation from redundant system.

12.3.2 Standards

The Table below, although not exhaustive, contains standards, codes and reference documentation applicable to the Operations Control Center in Malanday Depot.

Table 12.1 – Standards

ISO 11064 Parts 1-7	Ergonomic Design of Control Centers
IEC 60964	Control Room Design
ISO 9241 Parts 1-17	Ergonomic requirements for office work with visual display terminals (VDTs)
ISO 9355 Parts 1 and 2	Ergonomic requirements for the design of display and control actuators
ISO 13407	Human centered design process for interactive systems
ISO 14738	Anthropometric requirements for the design of workstations and machinery
EN 547 Parts 1-3	Safety of machinery - Human body measurements
CIBSE	Code for Interior Lighting, 1994, ISBN 0900953640
ISO 13406-2	Ergonomics Requirements for work with visual displays based on flat panels - Part 2: Ergonomic requirements for flat panel displays

BS 5459-Part 2: 2000	Specifications for Performance Requirements and Tests for Office Furniture - Part 2: Office pedestal seating for use by persons weighing up to 150kg and for use up to 24 hours a day including type-review tests for individual components
DIN EN 985:2002	Textile Floor Coverings: Castor Chair Test
BS ISO 2094: 1999	Textile floor coverings. Determination of thickness loss under dynamic loading

12.3.3 Functionality

The IOCC Functionality can be summarised as 'The ability to direct train operations in order to provide a scheduled service under normal operating conditions and to maintain the best possible service in the case of disruptions.' Routes will normally be called automatically by the Train Control system in accordance with the assigned timetable. Train Control/Operator interaction will normally only be required to manage perturbations and failures. The functionality of the IOCC shall be driven by operational requirements and is based around 24 hours x 7 days a week (365/days/year) operation. therefore, system equipment, rooms and E&M facilities design for the OCC shall meet these operational requirements. The E&M Contractor shall provide the following:

1) Graphical user interfaces to assist the control operators to monitor and optimize train operations.
2) The means to prepare, store and activate timetables.
3) The capability to display train performance versus the active timetable and the facility to alert the operators to any excess service interval arising at any point on the Line.
4) The capability for the Operator to modify the timetables in response to disruptions; and
5) The facility to graphically display the status of the Signaling system to the control operators on polychrome video display units.

Design, supply and Implementation of the IOCC Human/Machine Interface (HMI) as well as IOCC Room (Operator's Furniture/Consoles/Chairs, filing cabinets, Almirahs, Layout, Wall Display, etc.) according to proven International Ergonomic Design Principles as a minimum in accordance with the standards indicated in the Table 12.1 or equivalent Standards. The design and quantity of the furniture shall be submitted by the Contractor for review by the Engineer.

12.4 Control Center Layout

The Contractor shall undertake Human Factors, Ergonomics and Human Machine Interface studies, in order to optimise working arrangements and design of the IOCC layout in accordance with relevant standards. The study reports and designs shall be submitted to the Engineer for review, prior to implementation.

The studies shall address, but shall not be limited to, the following issues:

1) All activities in the IOCC relating to the operation of the line.
2) Efficiency of operation of the IOCC.
3) Ensuring optimum arrangements to minimize fatigue and stress and to maximize the equality of working conditions; and
4) Task analysis covering human/machine interaction both for normal operating conditions and in the event of emergency situations e.g., breakdown, fire, derailment etc.

Following submission and review of these studies and assessments, detailed designs shall be submitted to the Engineer for review.

The Contractor shall submit both 2D and 3D analyses of their proposals for the design for the OCC room for review by the Engineer prior to commencement of the construction activities and, if required by the Engineer, a walk-through software simulation of the OCC room designs.

The final configuration of the workstations and OCC manning/layouts shall be agreed in conjunction with the appointed O&M Concessionaire.

12.5 Workstation General Functionality

Workstations shall be designed according to human capabilities, limitations and needs. Workstation dimensions shall support the user population ranging from 5th percentile Philippine female to 95th percentile Philippine male.

Workstation design shall consider the five postures commonly adopted by Control Room Operators:

1) Bent forwards.
2) Erect.
3) Relaxed.
4) Reclined; and
5) Standing.

The layout of Workstations shall take account of maintenance access requirements. Workstations shall be safe, taking account of electrical safety, stability and heat conduction.

The design of workstation-mounted display equipment shall take account of the greater viewing distances to be found in Control Rooms when operating with multiple displays, compared with workstations where a single monitor is used.

Workstation design shall be suitable for right and left-handed users.

When using one-handed control devices, there shall be adequate workstation space and cabling facilities to place devices to the left or right of the user.

Seats shall, as a minimum, meet requirements for the type of task required to be performed.

Workstations shall take into account the needs of employees with disabilities, where appropriate.

Human abilities, characteristics, limitations, skills and task needs shall be taken into account when designing the human-machine interface (HMI).

The operator shall at all times be the highest authority in the human-machine interface with the exception of when in automatic mode. However, the operator may take manual control at any time.

The user shall at all times be provided with the necessary information such that they are able to have a comprehensive and robust understanding of the system and its associated sub-systems. All workstations, printers, voice and data facilities within the IOCC shall be provided by the NS-01 Contractor.

12.6 Control Room Design, Materials Finishes and Facilities

The CP NS-01 Contractor shall be responsible for the supply and installation of all finishes and E&M services in the Control Room.

12.7 Each Depot (Mabalacat, Malanday, and Banlic) (Malanday Depot and DCC provided by others) shall have its own Depot Control Center (DCC) where the train movements in each Depot shall be controlled. For that purpose, each DCC shall have as a minimum:

i) Visibility on location and schedule (including any delays) of trains on the mainline;

ii) Depot/Mainline Transfer Track;

iii) Depot train control terminal;

iv) Depot OCS power control/P-SCADA functions;

v) CCTV monitoring;

vi) Radio Communication facilities;

vii) Telephone communications including a direct line to the Integrated OCC; and

viii) Network Management System (NMS) Integrated with the PABX

End of Section