



BEML LIMITED
BANGALORE
R & D CENTER

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**Procurement Technical Specification of
Rolling Stock Controller (RSC) System &
Wayside Monitoring & Diagnostic System
(WMDS) for Bangalore Metro Rail Project
(5RS-DM)- Phase-2,2A,2B**

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1.0 Introduction

1.1 General

This document, Procurement Technical Specification (PTS) establishes requirements for the supply configuration, customization, installation, integration, testing, training, Go-Live and post Go-Live support of **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)** to support remote monitoring of train information & remote control commands for train operation from the Operation Control Center (OCC) / Back-up Control Center (BCC) / Depot Control Center (DCC) and remote downloading of train diagnostic data at depots.

The system shall be suitable for Unattended Train Operation (UTO) conforming to Grade of Automation-GoA4 as specified in IEC62290 all parts (latest versions), including the training of operating and maintenance staff of the BEML/BMRCL for 5RS-DM Project.

SNo.	Lines/Corridor	Distance (km)	Number of 6-car Train sets (Cars)	Designated Depot
1	Line-6 (Kalenaagrahara – IIMB-Nagavara)	21.5 km	TS#16 (96 cars)	Kothanur Depot
2	Phase 2A (Central silk board junction – K.R.Puram)	19.8 km	TS#21 (126 cars)	Baiyappanahalli Depot
3	Phase 2B (K.R.Puram – Kempegowda International airport)	38.4 km	TS#16 (96 cars)	Airport Depot

The train rake formation will be as follows:

DMC-TC-MC-MC-TC-DMC - 6Car train formation

DMC: Driving Motor Car,
MC: Motor Car,
TC: Trailer Car

*: Front Automatic Coupler (FAC)
–: Semi-Permanent Coupler (SPC)

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Each DMC will be provided with Automatic couplers without electric head, at the front end of the train. The other end of DMC and either ends of TC & MC shall be equipped with semi-permanent couplers.

Please note that the BMRCL 5RS-DM Trains will operate on 750V DC Third Rail Traction System with bottom current collection for Underground, Elevated and At-grade section.

BEML will carry out all required works and activities as Supplier for 5RS-DM contract while the subcontractor shall be responsible for all works required in this PTS with regard to design, supply, testing, integrated testing and commissioning of **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)** and shall be responsible for supporting the BEML activities as subcontractor for 5RS-DM contract.

The subcontractor shall supply & set up servers & related workstations required for **Rolling Stock Controller (RSC) System at OCC / BCC / DCC & Wayside Monitoring & Diagnostic System (WMDS)** at two of the designated depots for assisting in operation and maintenance of the Rolling Stock under 5RSDM.

1.2. Location for Servers

RSC / WMDS Servers (Communication, Database, Web) cluster for **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)** shall be installed in proper racks in the Telecom Equipment Room (TER) / Central Equipment Room (CER) at the designated depots & related consoles/workstations in the OCC / BCC / DCC.

1.3. Power Supply

The **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)** setup being deployed in designated areas shall source power supply from distribution boards available in respective areas. Proper identification of supply points and approval from BMRCL is essential.

1.4. Communication Ports

Availability of suitable communication network ports in the switch rack provisioned by Signalling & Train Control (STC) contractor can be utilised in TER/CER Room for connectivity of the servers and extending network connectivity. Subcontractor shall identify suitable locations during site survey.

1.5. Interconnectivity between OCC, BCC & DCC

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Network for Interconnectivity between OCC, BCC & DCC will be provisioned by STC contractor.

1.6. On-board Radio Equipment & Wayside Network Equipmnet

Following provision of On-board Radio Equipment and Wayside Network is provided for **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)**

- (i) On-board Wi-Fi Equipment in both the Driving Motor Cars for transmission/download of train diagnostic data (Event log, TCMS trace data, RTDM data, Energy Consumption data, Event Recorder data, Equipment performance dats , on-board test result data stored onboard TCMS of the train) to the ground storage/server located in depots through wayside depot wireless network – BEML scope through separate subcontractor
- (ii) On-board Video Trnasmisison system (VTS) Radio Equipment in both the Driving Motor Cars for transmission of on-board TCMS data for Remote monitoring (Active train information, Information of selected train, Train history, TCMS VDU – Virtual cab function), Fault Notiifcation (Fault event management, daily fault events, notification of fault occurrence, fault record trend) & remote control (non-vital) commands for train operation through the wayside VTS network - Signalling & Train Control (STC) contractor scope.

1.7. Objective

The scope of work shall be on turnkey basis and shall include all items and work which may be required to meet the performance requirements, trouble free and efficient operation and meeting the best industrial practices even if not specifically mentioned.

The sub-contractor shall propose the quantity and parameters of the materials, networking hardware, firmware, software etc., to fulfill the above requirements.

1.8 Scope of Supply and Work

1.8.1 ERTS Requirements of Rolling Stock Controller (RSC) System

16.15.2 OCC GUI for Rolling Stock Controller

The Rolling Stock Controller (RSC) in OCC shall have facility of full TCMS functionality of any train on his workstation on demand through signalling network.

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Development of the GUI application in RSC workstation shall be responsibility of Rolling Stock Contractor. Contractor shall provide detailed information of the Rolling Stock - Signaling interface as implemented for the function of OCC GUI in at least two recently executed UTO Projects for reference during design stage.

24.6.2.12 Rolling Stock Contractor shall be responsible for development of the GUI (including hardware) for the RS controller (RSC) in the OCC (Operation Control Centre)/BCC (Backup Control Centre). Any other GUI(s) in OCC/BCC shall not be the scope of RS Contractor. Total number of the distinctively different screens with live buttons may be around ten. The exact number shall be confirmed in the design stage.

24.6.2.23 It is expected that complete duplication of the TCMS VDU screen with live buttons for executions the requisite commands shall be available on demand in the RSC GUI.

24.6.4.1.20 Rolling Stock Contractor shall propose a user-friendly Graphical User Interface (OCC GUI for RS Controller) in both OCC & BCC in the form of a conceptual schematic/wireframe that shall include page layouts, arrangement of the GUI's content, interface and navigational elements, and a description of how they work

together. The features of OCC GUI for Rolling Stock Controller shall be as under:

- a) The GUI shall have the capability to monitor the information of all trains within the network. The GUI shall employ different colors for highlighting different status of trains. The status of various subsystems, MCBs, Relays & Switches, Train Lines shall be displayed on GUI, and it shall be possible to acknowledge faulty trains immediately. It shall be possible to identify cause of Events/Alarms on GUI.
- b) The GUI shall make available both current faults and historical fault records with provision of sorting and filtering the list.
- c) There shall also be a provision to request on-board TCMS VDU screen on demand for display on RS controller screen with automatic refresh periodically not more than 1 second, with navigation feature and actionable button.
- d) A user-friendly Troubleshooting Directory (TSD) shall also be made available in the GUI.
- e) The GUI shall also make available remote-control commands via clickable screen button elements that shall be visibly different from non-clickable icons/shapes. It shall be possible to distinguish which remote control command is active/inactive. Remote control commands from OCC GUI for RS Controller shall be additional to the commands from ATS.
- f) The screen elements shall be dynamic dropdown menus to make optimum use of screen area.

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Transfer and display of OCC GUI from RS Controller workstation to LVS shall be responsibility of Signalling & Train Control Contractor for which Rolling Stock and Signalling & Train Control Contractors shall interface.

16.6.4 Fault Info Display

Real-time diagnostic information shall be made accessible on the train VDU and the OCC GUI to assist the operator to operate the train safely, quickly, efficiently, and to rectify resettable faults or failures.

24.6.2.17 In the event of invoking of the PEA, automatic pop up of image from the relevant cameras shall be ensured in the OCC/BCC on the LVS, screens of traffic controller and RSC. RS Contractor shall interface with Signalling & Train Control Contractor for invoking of CCTV images on RSC workstation.

16.4.5 List of Operator Control Functions

Control features available for the Train Operator's control via on-board HMI or for the OCC/BCC/DCC's control via remote HMI shall include, but not be limited to, the following:

- i) Train start up and Sleep Mode.
- ii) Control of various saloon and cab air conditioner parameters such as selective and/or collective starting and switching off, car temperature control, provide override control of operating mode etc.
- iii) Isolation of any particular passenger side door that has been detected as closed and locked.
- iv) Override control over automatic selection of the saloon light circuit(s).
- v) Resetting of minor faults in sub-systems
- vi) Parking brake control (apply & release)
- vii) Train Horn control including its isolation
- viii) Isolation of only service brake (per bogie) in conditions of brakes fail to release subject to proper hazard mitigation
- ix) Any other item as desired by the Project Manager

The Contractor shall submit detailed list of functions /features proposed to be controlled through TCMS for Project Manager's review and approval. (CDRL-16-6)

1.8.2 ERTS Requirements of Wayside Monitoring & Diagnostic System (WMDS)

16.13 Depot Wireless Communication System

16.13.1 General

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The Contractor shall provide equipment and install the complete system to enable

i. remote access of TCMS data and subsystem trace data on trains present in depot(s)

ii. remote downloading of TCMS data and subsystem trace data (data recorder logs, events logs stored on on-board TCMS memory, subsystem trace data, event data stored in event recorder, etc.) to depot server through wireless communication (Wi-Fi) network using a dedicated port on the On-board TCMS.

The Contractor shall interface with the supplier of Asset and Maintenance management system for data integration. The Contractor shall be responsible for complete set up, commissioning and satisfactory working of the system.

The data which shall be possible to be downloaded remotely via the depot wireless communication system shall include but not be limited to the following:

- a) Event data and fault data necessary for fault diagnostics and troubleshooting
- b) Trace data stored in subsystems and TCMS
- c) Energy data stored in TCMS
- d) Equipment performance data
- e) On-board test results
- f) Event recorder data
- g) Any other data as decided during design

The facilities of remote downloading shall be in addition to the hardwire downloading.

16.13.2 Scope of Supply

Contractor shall supply:

- i) Depot server

The data as above shall be downloaded on the depot servers. Two Depot server sets, each consisting of server, server racks, UPS, Switch hub, User console, in-rack networking etc., shall be provided by Rolling Stock Contractor for two depots (i.e. one set for each depot). Communication link with the on-board TCMS to the depot server shall be provided by the Contractor. A dedicated port shall be made available in the On-board TCMS to cater for depot wireless downloading. Necessary interfacing devices shall also be provided by the Contractor.

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ii) Depot Equipment – **Refer PTS cl. no. 1.6 above**

Within the depot(s) areas, the Contractor shall install and configure wireless network for accessing the diagnostic data, both directly from on-board TCMS memory and from the depot server via maintenance notebook computers.

All equipment required within depot(s) shall be supplied by the Rolling Stock Contractor for three depots. Any other networking equipments as defined in Appendix-D shall also be in the scope of Rolling Stock Contractor. Further details shall be worked out as approved by the Project Manager during design stage.

iii) On-board equipment – **Refer PTS cl. no. 1.6 above**

Any on-board equipment/access point/switches/router/antenna etc. shall be provided by Rolling Stock Contractor. On availability of train in the depot, the recorded data in TCMS shall be transferred to the depot server and subsequently to the Asset and Maintenance management system automatically. The data to be recorded in the depot server and to be integrated with the Asset and Maintenance management system shall be discussed and finalized in interface with Asset and Maintenance Management system supplier. The details shall be submitted for Project Manager's review. **(CDRL-16-9)**.

16.13.3 Required Features

i) Download Triggers

The remote downloading to depot server shall be initiated automatically when the train is in Wi-Fi zone in depot and it shall be possible to force downloading remotely by authorized metro personnel.

ii) High-Integrity data transfer

Integrity of the data shall not be affected during remote download and in case of any interruption or otherwise the data shall be suitably secured and retrievable.

iii) Auto resume of downloading

If the downloading of On-board TCMS data to depot server is interrupted or fails due to any reason, the next download attempt should start where the previous attempt was interrupted.

iv) Duplication of data in depot server shall be avoided. When availability of train is detected in the wireless zone, depot server should trigger the download and

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download only that data from On-board TCMS which has not been downloaded earlier to the depot server.

v) Asset and Maintenance management, issue of work orders etc. shall be linked with this software.

vi) The Contractor shall supply the multiuser software(s) required for analysis of the faults and predictions/judgments on likely faults/failures. The specification of the software shall be got approved from the Project Manager.

1.8.3 The Scope of Supply shall include:

The scope defines end to end supply of hardware and software, integration and operation of the solution at multiple locations. The scope also defines provision of web access from multiple locations and multiple users via all the leading internet browsers support.

The scope shall be on turnkey basis including but not limited to the following:

- (i) Complete setup of the system right from design, supply, configuration and customization, installation (in all respect), interface with other designated contractors / suppliers, Testing & commissioning and training for the work.
- (ii) Supply of required types and number of licenses of the tool that can meet all the user requirements.
- (iii) Provide End User Training (Train the trainer Approach), Basic System Administration Training, Prepare customized User Training Manuals.
- (iv) Deploy competent tool consultants to conduct workshops for requirement gathering, Solution Mapping and gap analysis.
- (v) Prepare Technical & Functional design documents and get design phase signoff.
- (vi) Implementation of all the required modules, GUI & dashboards.
- (vii) Integration with Asset and Maintenance Management system.
- (viii) Conduct User Acceptance Test (UAT) and resolve all the issues raised during the UAT phase.
- (ix) Prepare System for Go live. Setup production Environment. Migrate Final Development Environment to Production Environment.
- (x) Post Go-Live Support.

1.9 Signaling System

Item	Description
Train control system	CBTC based On Board Continuous Automatic Train Control system (CATC) consisting of

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Item	Description
	i) Automatic Train Protection (ATP) ii) Automatic Train Operation (ATO) iii) Automatic Train Super-vision (ATS) iv) Automatic Turn Back (ATB) iv) Attended/Unattended train operation (GoA2/ GoA4)
Train control mode	(i) Automatic mode (ii) Coded Manual mode (iii) Restricted Manual Forward mode (iv) Standby (v) Restricted Manual Reverse Mode (vi) Run on Sight mode (vii) Cut-out mode (viii) UTO (ix) OFF mode

2. Definitions and Abbreviations

The following definitions and abbreviations are applicable to the PTS.

2.1 Definitions

The following definitions and abbreviations are applicable to the PTS.

“BMRCL” means the Employer for the Mass Rapid Transport System (MRTS) for Bangalore

“BEML” means the Customer to procure the **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)** for BMRCL 5RS-DM contract.

“Subcontractor” means the subcontractor of **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)** to BEML for 5RS-DM BMRCL Project.

“ERGS” means Employer’s Requirements-General Specification of 5RS-DM BMRCL contract for BMRCL Metro Project

“ERTS” means Employer’s Requirements-Technical Specification of 5RS-DM BMRCL contract for BMRCL Metro Project

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“PTS” means BEML’s Procurement Technical Specification.

"GTC" General Terms & Conditions of BEML for the procurement of the on-board wifi equipments

"Engineer / Project Manager / BMRCL’s Representative " means any person nominated or appointed from time to time by the employer to act as the Engineer / Project Manager for the purpose of the contract and notified as such in writing to the contractor.

"Engineer's / Project Manager’s Representative" means any assistant of the Engineer / Project Manager appointed from time to time by the Engineer.

2.2 Abbreviations

ATC:	Automatic Train Control
BCC:	Backup Control Center
BMRCL:	Bangalore Metro Rail Corporation Limited
CCTV:	Closed Circuit Television
CDRL:	Contract Data Requirement List
CTC:	Centralized Train Control
DCC:	Depot Control Center
DLMP :	Defect Liability Maintenance Period
EMC:	Electro-Magnetic Compatibility
EMI:	Electro-Magnetic Interference
ERGS:	Employer's Requirement General Specification
ERTS:	Employer's Requirement Technical Specification
FAI:	First Article Inspection
FDR:	Final Design
FMEA:	Failure Mode and Effects Analysis
FMECA:	Failure Modes, Effects and Criticality Analysis
FRACAS:	Failure Reporting And Corrective Action System
GoA:	Grade of Automation
GCC:	General Condition of Contract
GUI :	Graphic User Interface

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LRU: Line Replaceable Unit

MDBF: Mean Distance Between Failures

MDBCF: Mean Distance Between Component Failures

MTTR: Mean Time To Repair

N/A: Not Applicable

OCC: Operation control Center

PDR: Preliminary Design

PFDR: Pre-Final Design

PTS: Procurement Technical Specification

RSC: Rolling Stock Controller

SCC: Special Condition of Contract

SOD: Schedule of Dimension

TCMS: Train Control and Management System

TBD: To Be Determined

UTO: Unattended Train Operation

VTS: Video Trnasmisison system

WMDS: Wayside Monitoring & Diagnostic System

3. Precedence of Documents

The PTS shall be read in conjunction with the General Terms and Conditions (GTC) of tender, ERGS, ERTS. To the extent that any provision of the PTS is inconsistent with any provision of the Commercial Specification, the provisions of the General Terms and Conditions (GTC) shall prevail.

To the extent that any provision of GTC is inconsistent with any provisions of the ERGS and ERTS, the provisions of GTC shall prevail.

In the event of any conflict between requirements of particular parts of this PTS, the Subcontractor shall seek clarification from BEML.

Order of precedence	Document Title
1	BMRCL 5RS-DM ERTS
2	BMRCL 5RS-DM ERGS
3	GTC

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4	PTS
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This PTS shall in no way relieve the subcontractor from any requirements specified in the ERTS and ERGS.

The complete requirements are those found in the above documents. It shall be the subcontractor's responsibility to ensure that equipment, documentation, and services furnished against this PTS are in full compliance with all the above documents.

Also, in the event of any conflict among the requirements of particular parts of the PTS, ERTS and ERGS, the subcontractor shall seek clarification with BEML prior to making a contract. After making a contract, the subcontractor shall comply with BEML's Interpretation for any discrepancies.

4. Standards and Codes (Appendix A of ERTS)

- A list of international standards used and applied to the material and workmanship to be supplied will be prepared and updated during the design stage. This list will be mutually agreed to.
- During the design phase, the Contractor shall provide original copies of the standards used, with transfer of rights to BMRCL, as part of the Contract.
- The standards shall preferably be provided in electronic format (soft copy). However, in case the same is not available, with the Project Manager's consent, original printed copy can be provided.
- Where international or national standards are quoted and specified in the Contract, the Contractor may propose to work to equivalent internationally or nationally recognized standards. Not systematically, but, if necessary, the Project Manager can require the Contractor to prove the equivalence between the European and other standards. Submission for Approval are to be supported by a copy of the proposed standards, a detailed comparison of the quoted and proposed standards and, where applicable, an English translation of the proposed standard.
- Last version of the standards is required and also in case of standard replacements by more recent and equivalent standards.

5. Requirements of Documentation (Appendix 4 of ERGS)

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- All drawings, documents and information by Subcontractor shall be prepared in English and submitted to BEML for approval as per Appendix 4 of ERGS.
- Except for drawings, all documents and information to be submitted shall be of Microsoft Office format on CD-ROM or e-mail.
- The Subcontractor shall provide BEML with the drawings of component of ATMS in a format readable with AutoCAD 2016 (latest), CATIA V5 on CD-ROM or e-mail as requested by the BEML or BMRCL's Representative.
- The drawings shall contain minimum three (3) viewpoints (for example, front view, top view and left view) for three (3) dimensional modelling. The Subcontractor shall provide STEP file or CATIA file to BEML/BMRCL.
- Media for Electronic File Submission: One copy shall be submitted unless otherwise stated in DVD/USB stick.
- The hard copy of all documents shall be the contractual copy.

Document Type	Electronic Data Format
Text Documents	MS office 2007 Professional version or latest version
Spread Sheets	MS office 2007 Professional version or latest version
Data Base Files	MS office 2007 Professional version or latest version
Presentation Files	MS office 2007 Professional version or latest version
Program Ver 2.0a	Primavera Enterprise (latest version) for Windows (latest)
AutoCAD Graphics	AutoCAD 2016 or latest version
Photographic	Adobe Photoshop, Ver.7.0 or latest version
Desktop Publishing	Page Maker 6.5,5 or latest version
CADD Drawing	AutoCAD 2016 or latest version

6. Qualifying Criteria for Subcontractor/Vendor Approval

6.1 Proven Design

- The proposed **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)** by the sub-contractor against this PTS shall satisfy the "Proven Design" clause 5.1.2 of ERTS. The proposed system shall have been in use and have established its satisfactory performance and reliability on at least three mass rapid transit systems in revenue service over a period of three years or more (in each

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MRTS) either outside the country of origin in three different countries or in an MRTS in India.

- ii. The subcontractor shall manufacture and supply the **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)** only from such manufacturing units that have supplied the equipment that fulfil the proven design requirements as above (Refer ERTS clause 5.1.2).

6.2 Qualifying Criteria

- i. The Subcontractor shall meet the qualification criteria as per ERTS 5.1.2.
- ii. The subcontractor should be an OEM and should have carried out design and integration of proposed **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)** which shall be state-of-art & of proven design.
- iii. Proposed **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)** shall have been in use and have established their satisfactory performance and reliability on at least three mass rapid transit systems in revenue service over a period of three years or more (in each MRTS) either outside the country of origin in three different countries or in an MRTS in India. Sub-systems/components used in existing rolling stock of an MRTS in India do not get automatically qualified for use unless specifically approved by the Project Manager for this project.
- iv. Proposed system should have been in service during the preceding three years or more in similar metro system. The subcontractor shall provide detailed information of the Rolling Stock - Signaling interface as implemented for function of OCC GUI in at least two recently executed UTO Projects for reference during design stage.
- v. If required by the Project Manager, Contractor shall provide certificate of satisfactory performance for a period of three years or more from the Metro Operators Where similar sub-systems of a different rating are already proven in service as per the above criteria then the design shall be based on such sub-systems.
- vi. In case the subcontractor proposes to use sub-system(s) that do not fulfil the above said criteria then the subcontractor shall furnish sufficient information to prove the basic soundness and reliability of the offered sub-system(s) for review of the Project Manager. The Project Manager's decision on subcontractor's proposal shall be final and binding

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- vii. The sub-contractor shall have established International Quality systems and certification of minimum CMMI L3.
- viii. The subcontractor shall submit supporting documents in this regard. The subcontractor shall have established International Quality systems and certification like ISO 9001/ISO 14001/IRIS.
- ix. The subcontractor shall submit supporting documents in this regard. The subcontractor shall submit Inspection & Test Plan / Quality Manual followed.
- x. The subcontractor shall undertake to provide support during Testing & Commissioning, service trials, revenue service and DLMP period. The subcontractor shall submit detailed proposal in this regard.

6.3 Vendor Approval (ERTS Clause 5.1.5)

- i. Notice for No Objection (NNO) from Project Manager is mandatory for all sub-system suppliers. Accordingly, the request for NNO with all relevant references and details as per NNO format shall be submitted along with the technical offer along with Company profile, Product range and the organization structure. The acceptance of the technical offer is subject to approval of the Vendor by Project Manager based on the NNO details submitted by the subcontractor.
- ii. The sub-contractor shall provide all the required documents for obtaining the vendor approval for the Antennae as per ERTS 5.1.5.
- iii. The sub-contractor shall submit clause by clause compliance of the applicable clauses of this General Specifications and Technical Specifications from the Original Equipment Manufacturer (OEM) of the sub-systems. The Contractor shall also submit detailed Bill of Material including the make, model, type number, ratings, replacement schedule, country of origin / manufacturing of the proposed sub-assemblies, as well as drawings of sub-assemblies, etc as relevant to the sub-system. Submission of the above information is pre-requisite for completion and issuance of No Objection Certificate for Pre-final Design stage as per ERGS 3.8.3.
- iv. The clause-by-clause compliance submission & Vendor Approval document of this PTS will be submitted for Vendor approval of Project Manager. The technical bid proposal shall include the duly filled in vendor approval format.
- v. Project Manager may accord approval based on the sub-contractor credentials; subcontractor shall note the acceptance of the technical offer is subject to approval of the Vendor by Project Manager.

7. Scope of Supply and Work

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7.1 The scope of work includes all items of work which may be required to meet the performance requirements, trouble free and efficient operation of the system(s) and meeting the best international practices even if not specifically mentioned in the tender specifications.

The subcontractor shall also provide, not limiting to the following:

S No.	EQUIPMENT	Quantity
1	Rolling Stock Controller (RSC) System at OCC, BCC, DCC comprising all equipment hardware (including main server & backup server cluster, desktop computer and laptops for user interface, network components etc) & software tool with licenses	1 Set
S No.	EQUIPMENT	Quantity
2	Wayside Monitoring & Diagnostic System (WMDS) at depot comprising all equipment hardware (including main server, backup server, desktop computer and laptops for user interface, network components etc) & software tool with licenses	2 Sets (One set per depot)
3	Survey of OCC/BCC/DCC & depots for system setup.	-
4	Documentation and support material associated with the design, operation & maintenance and training.	-
5	Installation, Testing & Commissioning of Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS) .	

7.2 The Subcontractor shall be responsible for the design, supply, configuration and customization, testing, installation, commissioning and integrated testing, providing onsite warranty. Obtaining all satisfactory clearances from Project Manager/Engineer/Employer shall rest on sub-contractor.

- a) Integration of sytem with wayside network.
- b) Metal alloy cable trays, cable ties, cable conduits etc., should be used wherever it is applicable.
- c) Metal/alloy base stand for wayside equipment shall be supplied and installed and the design and installation of the base should consider the existing trays and other ground mounted equipments.
- e) Online Uninterrupted power supply (UPS) system shall be provided to all active elements to ensure interruption free operations during temporary power failures.
- f) Each active equipment shall have 30% extra capacity for future requirements.

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- g) Maintenance for entire period of Warranty by providing requisite personnel is also the responsibility of the sub-contractor.

The sub-contractor has to design, assess and optimize the solutions based on the actual conditions at the depots. are for understanding purpose only. The sub-contractor must familiarize the complete requirements in quantity as well as quality during the bidding.

The Sub-Contractor shall have the entire responsibility on turn-key basis for Solution - Design, Development, Execution, supply of all requisite materials, networking hardware, firmware and software and Support. The networking hardware, firmware and software shall be of latest versions / iterations. The technical support of subcontractor shall be made available of subcontractor's staff in the depots for meeting warranty obligations.

7.3 Hardware

The sub-contractor shall offer the best and latest hardware configuration required for the complete set up. During the bidding, the details and Bill of Materials of networking equipments, associated hardwares, firmware and softwares from reputed OEMs shall be submitted (OEM recommendations sheet shall be included). Prior to deployment of the hardware equipments, approval for the configuration shall be obtained by BEML/BMRCL.

1. The Contractor shall provide all equipment hardware (including main server, backup server, desktop computer and laptops for user interface, network components etc).
2. The server system shall be configured on High Availability Disaster Recovery (HADR) mode. The selection of the following hardware components shall be based on functional requirement meeting the recommendations of the software OEMs and the customization requirements:-
 - a) Processors, Motherboards
 - b) RAM
 - c) Memories for database, hosting, server configuration etc.,
3. The optimum network configuration should include ability to produce 50 millisecond or faster packet response between client and server.
4. Workstations: Quantity 7Nos. (1 each for OCC, BCC and three depot DCC and 1 each for BEML at each depot). The typical configuration of a workstations:-

Item	Description
Processor:	Minimum of Intel i5, 4 Core, 11 th Generation OR latest

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Item	Description
Chipset:	Latest compatible to processor and RAM
RAM:	Minimum of 8 GB or higher, DDR4 OR latest
Data storage:	1TB HDD or higher, 7200 rpm OR latest
Monitor:	LED technology or better; Min. 22 inches
Human Machine Interface:	104/105 keys keyboard, Optical Mouse
Operating System:	Windows 11 Pro OR latest
UPS system	Online UPS (with battery); backup for 30mins.
Pre-loaded with reputable and latest available (i) Office suite (ii) Firewall (iii) Anti-virus (iv) relevant software packages etc.,	

5. All components to meet the performance and functional requirements of the equipments mentioned in this document
6. Complete tools, Software, Hardware, Facilities, Jigs, Fixture diagnostic etc. shall be in line with contractual & Engineers Requirement.
7. Enclosures & Mounting arrangements has to be provided by the subcontractor for the all the equipments supplied by subcontractor.
8. A suitable sized rack/enclosure shall be supplied for installation of equipment.
9. All the end devices shall be provided with redundant connection. Accordingly, the network configuration shall have switch arrangements.
10. There shall be two High Availability stack switches in server room which shall be able to connect to all end devices in redundant manner. These switches shall be able to communicate with Master Clock available with Signaling Network and shall have the ability to time broadcast to all the connected end devices.
11. The network configuration shall not have any packet loss.
12. All communication cables shall have ability to transmit data simultaneously on both ways and shall have ability to allow multiple broadcasts.
13. Rack shall be supplied with suitable online UPS.
14. Cables:-
 - i. Subcontractor shall supply the cable harness (if applicable) with the heat shrink tube, protective jacket, numbering tube, bundle name-tag, strain relief bushings, ferrules for terminal block and in case of lead cable, the brackets for fixing cable and fasteners must be supplied by the subcontractor.

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- ii. Cable Number/Tagging must be under transparent heat shrinkable tube and should have a life of 35 years. Same is also applicable for Name Plate or Name labels.
- iii. Wherever applicable, suitable armoured cable shall be used considering damages from pests, insects, chemicals, degradation affected by environmental conditions.
 - a. Cables drawn in pull pit must be drawn along with recommended conduit used for underground cabling.
 - b. Similarly, cables drawn alongside tracks on via duct must use conduit used for underground cabling.
 - c. Armoured cables with long shelf life and operating life should be used. Certificate of OEM regarding this must be submitted.
- 15. Mating connectors with all pins even if pin is not used, back shells and accessories.
- 16. Non-screwed and self-locking type connectors for complete system shall be ensured.
- 17. Cable Assembly instruction documents for LAN Cables and any special cables etc.,
- 18. Unused connectors such as PTE connector shall be covered with protective cover plug (or dummy cap) to prevent dust from accommodating on the contacts.
- 19. Earth pad / stud and fasteners for fastening (to be discussed and finalized during implementation stage.)
- 20. Any other items required to meet contractually.

All information and contact details of the sub-suppliers shall be provided to contact the sub-suppliers after expiry of WARRANTY.

7.5 Eligible equipments:

- a) All the equipment to be installed must bear reputed brands. All Network equipment should be of the same make / same OEM. All items to be used for the Network should be compatible with each other including existing components, Necessary Drivers and Software required to run the equipment should be supplied by the subcontractor during installation without any additional cost.

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- b) All accessories bundled by the manufacturer with the equipment and its test reports shall accompany the equipment.
- c) OEM should have been supporting the products under its own name and brand since last 5 years.
- d) Latest version/ model of equipment are to be selected in design of proposed solution. Used/re-manufactured equipment will not be accepted.
- e) The model of the Items already earmarked by OEM for withdrawal from the market / reaching their end of life and end of support in next five years (from the date of handing over) and the models which are still under quality testing should not be offered.
- f) The bill of materials (BOM) and bill of quantities (BOQ) shall be submitted during bidding. The sub-contractor may include any other item felt necessary for providing the solution. These may be clearly mentioned by the sub-contractor under the heading “other items”.
- g) Make and Model of the equipment offered shall be mentioned in the solution along with the respective technical specifications.
- h) The Models of the Items offered should strictly conform to the specifications given in the product literature and these models should be supported for the entire warranty period of the contract.
- i) When the configuration/ feature required is not available in a particular Item model, the next available higher configuration model or equivalent shall be offered.
- j) The quoted products should be latest version and should not be end of life and end of support for next 5 years. Certificate of OEM for the same should be submitted along with technical bid. Details of OEM support pack should be provided for this purpose. OEM support pack should be tune with the Service Level Agreement (SLA) for entire period of warranty.

7.6 Functional Requirements:

- a) The Contractor shall provide all complete Hardware and Software equipment's enabling the system to remotely monitor the real-time status of train information (Train Operation Data), Fault report (Alarm & Event data), TCMS VDU – Virtual Cab, remote control commands for train operation & download all the stored TCMS data (Event log, TCMS trace data,

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- RTDM, Energy Consumption, Equipment Performance, On-board test result, Event recorder data) and its linked files.
- b) UPS power of atleast 30 mins to all equipments of proposed system. For servers, UPS shall be capable to power up to 15 mins.
 - c) The Contractor shall be responsible for the complete set up and commissioning and satisfactory working of the system till the expiry of Warranty period.
 - d) The integrity of the data shall not be affected during remote download and in case of any interruption or otherwise the data shall be suitably secured and retrievable.
 - e) The sub-contractor shall be fully responsible for integrated testing and commissioning at BMRCL site (Depots).
 - f) The sub-contractor shall provide valid certificates/documents for the supplied equipments.
 - g) The sub-contractor shall provide training to BEML and Project Owner/Employer/Engineer.
 - h) An expected power consumption of the equipments should be declared as a realistic value at the tender level and/or early design concept phase.
 - i) Unused connectors of equipments shall be covered with protective cover plug or dummy cap to prevent dust from accumulating on the contacts.

7.7 Software

The Subcontractor shall be responsible for the provision of all software for the **Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS)**.

The Sub-contractor shall provide, as a minimum the following:-

- a) **Application Software:** Subcontractor shall provide the full access to application software(s) and any other software /hardware tools & software documentation as per the time schedule discussed & agreed by BMRCL, BEML and Subcontractor.
- b) **RESTful API for interface with Asset and Maintenance Management System (AMS)**
- c) **Diagnostics & Test Software:**
The Subcontractor shall provide the requirements of the specification with respect to the production, verification and validation of software.

Software supplied shall be designed structurally, logically, fully documented and thoroughly tested in a systematic manner such that they can achieve

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high quality in terms of safety, reliability, testability, traceability and maintainability.

The Sub-contractor shall be responsible for design, manufacture and supply as well as testing.

Any additional/separate items/equipments which the subcontractor may require for the proper operation of this equipment to meet the intent of the specification and which are not furnished by BEML shall be provided at no additional cost by Sub-contractor.

- d) **Two back-up copies.**

7.8 License Requirement

Any Licenses if required the same shall be in the name of Bangalore Metro Rail Corporation Limited, Bangalore.

These licenses shall be free for lifetime and will not have a termination date. All hardware, software and Firmware licenses will be perpetual, surviving bankruptcy, sale, merger, or dissolution of any of the entities providing hardware, software and Firmware to the 5RSDM project. No additional license fee will be payable by BEML for meeting performance requirement / Minor modification / addition during warranty period.

8. Technical Requirement of Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS).

- a) The train-borne data shall be transferred through VTS channel and be properly displayed on workstations located in OCC, BCC & DCC.
- b) The GUI for real-time monitoring shall provide real-time monitoring function during main line operation. On-board TCMS transfers the train status, event data and operating information statistics periodically to the data servers. The servers shall be able to preprocess, mine, analyze the retrieved data and display the result on the GUI according to the operator's demand. The real-time monitoring function shall be available to operators regardless of the mainline operation mode.
- c) TCMS VDU – Virtual cab function: To display emulated VDU screen (no controls) according to the operator's demand from OCC / BCC which shall be refreshed periodically. It shall be able to demonstrate the same content as the real-time on-board TCMS VDU. This function shall be available when

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- the train operates in UTO mode only. This shall also include Troubleshooting Directory Screen in VDU.
- d) Remote commands as per ERTS 16.4.5 from GUI for train operation shall be available when the train operates in UTO mode only.
 - e) The remote downloading shall be manual triggered / automatically scheduled.
 - f) Refer Doc. HXN-L11673-03 (TCMS ICD Requirement for Wayside System) – Annexure 3.
 - g) Further, details will be discussed during design stage.

9. General Requirements of Rolling Stock Controller (RSC) System & Wayside Monitoring & Diagnostic System (WMDS).

- (i) The sub-contractor shall supply the necessary disconnection boxes, terminal block, cables, flexible conduit assemblies complete with connectors and cables.
- (ii) All Electric Wiring should be with Fire Retardant, Halogen Free Cables only. Conduit used for Electric Wiring shall be of material Polyamide 6, Fire Retardant & Halogen Free as per IEC 61386.
- (iii) Cable Number/Tagging must be under transparent heat shrinkable tube and should have a life of 35 years. Same is also applicable for Name Plate or Name labels.
- (iv) The Equipment shall have the min. IP rating of IP54(Interior mounted) / IP67 (Exterior mounted).
- (v) The system shall be suitable for installation on the Trains running in DC Electrified Section.
- (vi) **Radio Interference Test:** The equipment shall be tested for Radio-Frequency Interference Susceptibility Test as per Clause 10.2.8.1. of IEC 60571.
- (vii) **Supply Over-Voltage, Surge and Electrostatic Discharge test:**The equipment shall be tested for Supply Over-Voltage, Surges and Electrostatic Discharge test as per clause 10.2.6 of IEC 60571.
- (viii) **Transient Burst Susceptibility test:** The equipment shall be tested for transient Burst Susceptibility test as per 10.2.7. IEC 60571
- (ix) **Vibration and Shock Requirement:**The equipment shall meet the vibration and Shock testing Requirements as defined in IEC 61373.

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- (x) **System Acceptance Test:** On completion of installation of First Complete System in a rake, System Acceptance Test shall be carried out as per System Acceptance Test Procedure proposed by manufacturer duly reviewed and approved by Employer.

9.1 Label Requirements

- a) All items shall be labeled in English with the maker's name and type and form of the piece or item, discrete serial number and rating data and the date of manufacture of the particular piece of equipment. It is desirable that the labels used for different equipment / subsystems / systems on the train are of standard pattern.
- b) The labels shall be clearly stamped, cast or engraved and securely attached to the equipment. Where appropriate equipment shall be labeled with warnings of high temperature and electric shock risk. Wiring labels shall be multilingual (regional language(s) and English and/or Hindi).

9.2 Product breakdown structure

The sub-contractor shall provide a list of technical breakdown of their sub-systems into components (Least Replaceable Units or LRU's). This breakdown stops at the lowest to a level where a failure can be associated with a remove action of maintenance.

Breakdown of the material used in each component include:-

- Identity
- Equipment name
- Quantity in vehicle
- Supplier part number
- Part Price
- Quantity recommended for spare part

9.3 Maintainability Requirements

The design of all components will be such that maintenance is reduced to a minimum, and components will be so arranged that those requiring attention are easily accessible, and readily removable. All equipment should be designed using the Least Replacement Unit (LRU) principle whereby the repair of a fault merely involves the replacement of a faulty module.

9.4 Commissioning and WARRANTY Spares

The subcontractor shall supply commissioning and WARRANTY spares. Subcontractor shall submit to BEML for review and approval of BEML/BMRCL a list

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of minimum spare parts that he intends to make available during the installation, commissioning and warranty period.

The Subcontractor shall keep on site, at his own cost throughout the installation, commissioning and warranty period, stocks of spare parts to enable rapid replacement of any item found to be defective or in any way in non-conformance with the specification.

9.5 Acceptance Tests

- Supplier shall submit detailed field validation schemes (ITP Hardware) for approval.
- Inspection, validation and acceptance of the system (laboratory & field) shall be done for validation, Repetition of error/value.

9.6 Field Validation Tests

- Field validation test shall be carried out.
- If field validation/tests show any deficiencies in the system from the specifications, the supplier shall rectify the deficiencies within a reasonable time to complete the commission in the specified periods.
- The decision of the BMRCL regarding validation and testing of the system shall be final and binding on the supplier.

9.7 Tools

The supplier shall supply all the requisite tools or equipment as a part of the technical offer.

9.8 Interface

- a) The subcontractor shall interface with other designated Contractors for matters including, but not limited to Space, Power, UPS, Data communication, etc.
- b) The subcontractor shall also interface with the Signaling and Train control Contractor for remote monitoring of on-board TCMS data & remote control commands for train operation through the Wayside network.
- c) The subcontractor shall also interface with the Depot wireless network contractor of BEML for remoted downloading of on-board TCMS data through the depot wayside network.
- d) The subcontractor must participate in the interface meeting/workshops in order to discuss and finalize the interface issues to the satisfaction of BEML/Engineer and shall be implemented in the system design.

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9.9 Depot Interface

The Subcontractor shall be responsible for all costs of labor and material, for defect identification and location, and for removal, repair or replacement of defective parts, and for alteration, repairs, tests and adjustments in connection therewith made to fully comply with the requirement in PTS and Contract Specification, All such replaced or repaired shall be guaranteed for the remainder of the WARRANTY.

The following is a brief of requirements for Interface:-

- a) Outline dimension.
- b) Electrical connection position.
- c) Demands, free space for installation and maintenance of cover.
- d) Weight and center of gravity.
- e) Earth position, size and type
- f) Thickness of flitting frame & Size and distance dimension of fitting hole.
- g) Cooling & clearance for ventilation
- h) Anti-vibration material such as rubber (if required).

9.10 Electrical/Communication Interface

The subcontractor shall provide the interface specification.

Time to time BEML will facilitate direct face to face meeting between other sub-supplier either at sub-contractors works, BEML works, and other sub-supplier works or at Employer place. Subcontractor is responsible to resolve the interface issues to achieve the requirement.

The following is a brief of requirements for Electrical Interface:-

- a) Power requirements.
- b) Technical specification.
- c) Rated current, voltage characteristic and consumption.
- d) Cable specification (Power, control and grounding).
- e) Connector (male and female) with pin and socket part no.
- f) Signal input/output list and interface specification.
- g) Connector/terminal arrangement
- h) Cable inlet/outlet diagram.(Size for cable gland of holes)
- i) Connector Working Procedure for Workmanship.

9.11 Interface Responsibilities

S.N	Designated/Subsystem	Interface Responsibility
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.	contractor	Subcontractor	Other subsystem contractor / Designated contractor
1	Signaling & Telecommunications	O	Δ
2	Asset and Maintenance Management System Contractor	O	Δ
3	Train Control Management System supplier	O	Δ
4	Depot Wireless Communication system supplier	O	Δ
5	Other Contactors if any.	O	Δ

O – Leader Δ - Support

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- a) The location of placement and the design of equipment installation shall be defined by the Subcontractor and approved by Engineer in order to avoid the interference with other equipments/works. The Subcontractor shall be responsible for the equipment and material to be supplied and recommended installation method and procedures.
- b) The Subcontractor shall be responsible for the design submission and the performance of testing activities and the supply, installation and commissioning and the maintenance and rectification during the warranty period, etc. The Subcontractor shall be responsible for the hardware interface. The Subcontractor shall be responsible of deputing his engineer to BEML/site for the technical meeting.
- c) The Subcontractor shall be responsible for interface with Signaling & Telecommunications, Asset and Maintenance Management System Contractor, TCMS & Depot Wireless Communication system supplier etc., as per below table.
- d) The subcontractor shall meet the communication protocol requirements of the leader of interface design in accordance with the interface document requirements
- e) Sub-contractor must ensure Integration, Testing, Interface
- f) Finalization of Interface Control Document (ICD) for complete system covering all aspects of Engineer's Requirement, Operating principle etc. shall be in the scope of work of sub-contractor.

9.12 Equipment Interface Responsibility:

Subcontractor will provide BEML with all required information in order to verify the mechanical and electrical interface between vehicle and subcontractor equipment.

BEML will integrate the complete vehicle circuit diagrams, which will be reviewed and agreed by subcontractor for interface and EMC Consideration.

BEML will provide external wiring installations between the box and other equipment modules. Subcontractor shall supply the miscellaneous parts, such as the anti-vibration mounting resilient pads, nameplates, the test connections with male and female connection including pins/sockets to be used for the external connection of subcontractor equipment.

Interface document made by subcontractor will include, but not limited to, the following interface factors;

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- Mechanical Interface

- Outline dimension.
- Size and distance dimension of mounting hole
- Electrical connection position.
- Fastening Hardware & torque values.
- Requirement of space for installation and maintenance of equipment.
- Weight and center of gravity.
- Earthing position.
- Thickness of fitting frame/ bracket.
- Cooling requirement, if any.

- Electrical interface

- Power requirements
- Technical specification
- Rated current & voltage characteristic, power consumption
- Cable specification (power, control, grounding)
- Connector (male and female) with pin and socket part no.
- Signal input/output list.
- Connector/terminal arrangement
- Cable inlet/outlet dia. (Size for cable gland or holes)

If the delayed submission of interface documents cause the delay of delivery schedule or cost effect for the Project, Subcontractor shall take full responsibility for it.

9.13 Equipment Handling:

Subcontractor shall provide the instructions for handling and mounting & dismounting of equipment in Subcontractor scope of supply.

In case of requirements of any special tools for installation of equipment, same shall be informed to BEML and provided before first equipment delivery.

9.14 Commissioning and Testing:

Subcontractor shall be responsible for Testing & commissioning and integrated testing for Subcontractor scope of supply.

Subcontractor to submit all type test reports for all the components /aggregates and all the necessary test reports after testing & commissioning in both hard copy

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and soft copy.

10.EMI/ EMC Test

The sub-contractor shall perform the EMI/EMC test of equipment in accordance with the requirements specified in ERTS 3.12,20.29 and Appendix D & ERGS.

All equipment is required to pass the full EMI/EMC tests on one train at locations adjacent to television and radio transmission stations, airport and other transmitting control station. These tests shall include simulated fault conditions.

All system must be tested for emission and immunities in accordance with the appropriate international standards for equipment operating in railway or similar industrial environment.

The subcontractor shall specify the equipment that shall be connected with EMC connectors and the same shall be discussed during design stage.

The equipments shall be compliant for magnetic flux emission norms to human exposure as per EN50500 standard for measurement at train level and EN45502,ICNIRP guidelines for limiting values.

11.Fire protection performances

Materials used in the construction of components shall be selected to reduce to the maximum extent practical the heat load, rate of heat release, propensity to ignite, rate of flame spread, smoke emission and toxicity of combustion gases as per ERTS clause 3.14

The subcontractor shall furnish the relevant data, fire load calculations (as per formats shared), certifications etc., of the items considered in fire load calculations separately for above & below the floor level as per ERTS 3.14. For complete requirements of Fire Performance refer to ERTS 3.14.

The maximum heat release rate per car shall be restricted to low levels.

Fire load calculation for all non-metallic materials have to be calculated with heat release rate data tested in accordance with EN 45545 HL3 & details shall be submitted.

12.Life Cycle Cost

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The subcontractor shall comply the requirements as per the ERTS 3.16 and submit the Life Cycle Cost calculation document (as per format shared) in the technical offer for Scope of equipment .

The sub-contractor shall develop a life cycle cost plan in accordance with IEC 60300-3-3 with an aim to minimize the overall life cycle cost whilst meeting the safety, quality and reliability requirement of this particular specification.

Recycling of the material at the end of the Rolling Stock life shall be taken into account following recommendations of the UIC project PROSPER (Procedure for Rolling Stock Procurement with Environmental Requirements). Material recycling rate and material to be incinerated shall be indicated.

The LCC shall include, the capital cost, cost of operation (including energy consumption), maintenance (both material and labour), depreciation, refurbishment, inflation etc. Per unit energy consumption cost may be considered as INR. 5.0.

The subcontractor shall declare the useful life (years) / life class of the electronic equipment as per EN 50155 for Life Cycle Cost (LCC) evaluation.

Items/equipment having an OEM rated design-life that will lapse during the course of the Defect Liability and Maintenance Period (DLMP) shall be replaced by the sub-contractor (on or before expiry) as part of the obligations of the comprehensive maintenance scope.

List of such items shall be submitted as part of Spares in the technical offer for DLMP and shall be updated based on the final design.

13.Design Submission & Approval Responsibilities

BEML & Subcontractor shall have an approval of their respective drawings and design documents from BMRCL in accordance with ERGS & ERTS - “Design submission requirement” of ERGS and scope of supply.

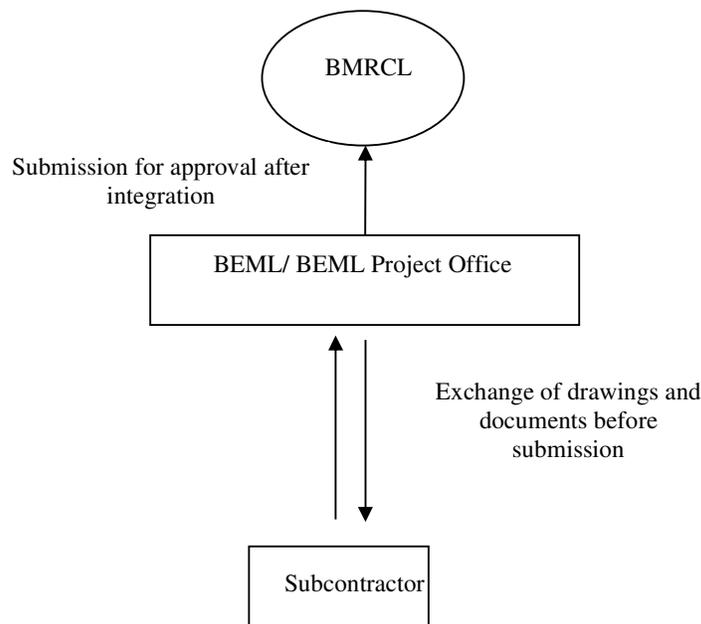
BEML & Subcontractor shall be responsible for the approval of design documents and drawings for respective scope of areas. BEML and Subcontractor will exchange their documents and drawings & review the same before submission to BMRCL for a preliminary interface checking of mechanical and electrical parameters.

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The drawings and documents related to interface shall be combined and integrated with the main principal part of system to form one combined material for submission to the client for approval.

The sub contractor shall comply ERGS clause 3.11 and within two weeks of the receipt of the Project Manager's comments (BMRCL/BEML) the subcontractor shall revise and re-submit the entire submission, unless otherwise agreed with the Project Manager (BEML/BMRCL).

The work procedure for design submission to be followed is as below:



14.Operation & Maintenance Manuals and Spare Parts Catalogues

The Subcontractor shall provide the operation/maintenance/ spare parts manuals and spare parts catalogues of the equipment both in the hard copies and electronic format (editable copy of word document in BEML provided template) as required in ERGS chapter 6. The subcontractor shall provide the following O & M manual:

- a) Volume 1 – Technical Manual
- b) Volume 2 – Operation Manual
- c) Volume 3 – Maintenance Manual

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- d) Volume 4 – Fault Diagnostics Manual
- e) Volume 5 – Spare Parts Manual
- f) Volume 6 – Software Manual
- g) Volume 7 – Special Tools & Test Equipment Manual
- h) Volume 8 – OEM manuals

The subcontractor shall provide the operation/maintenance manuals and spare parts catalogues to BEML for approval of BMRCL according to the time schedule defined by BEML.

Submissions:

The Supplier shall submit the draft of all manuals to BEML for approval of BMRCL/BEML. The final manuals shall be provided after duly incorporating the changes indicated.

Electronic Manuals:

The subcontractor shall provide manuals in electronic format (editable copy of word document in BEML provided template). This is in addition to the submission of manuals in hard-copies.

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.

15. Storage, Packing Crating and Marking:

The subcontractor shall provide all packing, crating and markings in accordance with the requirements specified in ERGS chapter 9. When handing over, hand over the complete equipment and the spare parts, special tools and testing equipment.

The subcontractor shall provide the instruction for proper storage, handling and logistic functions of components supplied by the subcontractor before handing over the first set of complete equipment. All items shall be labeled with the maker's name and the type and form of the piece or item, discrete serial number and rating, and the date of manufacture of the particular piece of equipment. For detail information refer to ERGS 9.

16. Quality:

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16.1 General: Quality Assurance Program:

This section describes quality assurance program required to assure the quality of products supplied from the Supplier to BEML. The supplier shall assure the quality of product and maintain quality system to achieve high quality of the product.

16.2 Quality Assurance Plan:

The Supplier shall develop and submit to BEML QC team for review and approval a Quality Assurance Plan (QAP) based on ISO 9001/2000, EN ISO 10007 standard and ERGS, ERTS.

Submission of QAP shall not be later than 30(thirty) days after purchase order by BEML. The plan shall illustrate how the Supplier intends to meet the quality assurance requirements of this Technical Specification and shall include as a minimum:

- a) An organizational chart, including a definition of the responsibilities of personnel thereon, for receiving inspection, defect material handling (especially related to material found malfunctioning during production conformance testing), production conformance testing verification, process specification implementation, equipment calibrations, etc.
- b) The methods and procedures used to control the daily manufacturing processes and material quality.
- c) Flow charts of paperwork for the acceptance or rejection of material, for identification and disposition of Unacceptable items resulting from inspections, for the specific accountability of material found malfunctioning during production conformance testing, and configuration verification of the items to be Included in the submittal and etc.
- d) Forms to be used to convey, track and account for design changes implemented in the product regardless of their state of completion and any other forms necessary for the program. Each form shall be serial numbered.

The Quality Assurance plan shall have a live document status. Any changes must be submitted to Quality Control team of BEML. Changes affecting the project will be subject to approval by Quality Control team of BEML.

Organization:

The organization of the Supplier's Quality Assurance (QA) Program shall have sufficient, well-defined responsibility and organization. It shall report directly to the General Manager of the Supplier's facility or the Supplier's Project Manager. The QA/QC personnel shall have complete freedom to identify and evaluate problems; to recommend solutions; to verify implementation of solutions; and to control further

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processing, delivery, or installation of a Non-conforming or deficient item until proper and documented disposition has been obtained.

The QA/QC organization shall be arranged to promote a control function that operates in an independent, objective manner unbiased by schedule, cost, and authority limitations imposed by personnel other than the Suppliers high level management starting with the General Manager or equivalent.

16.3 Certification of Personnel:

The Suppliers QA/QC personnel performing inspections and tests shall be certified for such work. Certification of personnel shall be by the virtue of those skills which are obtained by experience or training and verified by testing. Manufacturing personnel performing special processes, such as welding, brazing, painting, crimping, NDT (Nondestructive tests), etc. shall be certified for such work. Records of personnel certifications shall be maintained and monitored by the Suppliers Quality Assurance personnel. These records shall be made available to the Engineer of BEML for review.

16.4 Evidence of Compliance:

The Supplier's QA/QC personnel shall maintain objective, verifiable evidence of compliance with the Technical Specification as it pertains to hardware configuration, purchasing, inspecting, handling, assembling, fabricating, production conformance testing, storing, shipping and warranty/repair work in the interest of quality.

16.5 Certificates Of compliance:

The Supplier shall submit to BEML the certificate of compliance for each delivery lot of products. The certificate shall contain inspection/test result data in accordance with the specification of the product. The inspection/test result shall be summarized to an inspection / test report (or record) in which the specification and inspection/test result are described clearly.

And, the inspection / test report (or record) shall contain information, as a minimum, of Product name (description), Part number, Serial number(if specified or necessary), Drawing number, Specification number, Revision number of drawing & specification, Software name(description) & Software version of the product (if software's installed to the product), Barcode number of the product(if barcode system is specified in the specification of product), Project name, Supplier's & Manufacturer's name, Inspection / test date, Acceptance decision, Name & Signature of inspector and approver and etc.

Each shall clearly identify the lot certified by the certificate and be signed by an authorized representative of the Supplier, stating the product complies in all respects with the specification of the product.

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Each certificate shall contain the information specified for samples, the name and address of the organization performing the tests, the date of the tests and the quantity of materials shipped and also, if a test is performed by a licensed test laboratory, the test certificate issued by the laboratory shall be attached to the certificate of compliance of the Supplier.

16.6 Calibration:

The Supplier shall demonstrate an effective time or usage cycled calibration program for testing of measurement equipment and tools. Validity of measurements and tests shall be ensured through the use of suitable inspection, measurement and test equipment of the range and type necessary to determine conformance of items with the specification. At intervals established to ensure continued validity, measuring devices shall be verified or calibrated against certified standards. Tooling used as a media of inspection shall be included in this program. Furthermore, every device so verified shall bear an indication attesting to the current status and showing the date (or other basis) on which inspection or recalibration is next required. Devices suspected of being out of calibration before the stated recalibration date shall be promptly recalibrated. Inspections performed with devices proven to be out of calibration must be re-inspected. All calibration certifications shall be recorded and become part of the Quality Assurance records.

16.7 Procedure Documents:

The Supplier shall establish and maintain written procedures defining his Quality Assurance Program. The procedures shall encompass all phases of the program to include, but not be limited to, control of suppliers, inspection, production and process control, functional testing, discrepancy control, measuring and test equipment calibration, configuration control, quality assurance records, shipping inspection and other quality specifications to meet the requirements of the Contract. All such documents shall be made available to the Engineer of BEML upon request.

16.8 Quality Assurance Activities:

The Supplier shall address, as a minimum, the following activities and shall provide a means of self-correcting any shortcomings in his Quality Assurance Plan (QAP) as per ERGS 2.5

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16.9 Procurement:

The Supplier shall document in writing the methods to be used for the selection and control of suppliers. These methods shall identify a means of:

- a) Selecting qualified procurement sources.
- b) Communicating and approving all product quality requirements and changes thereof.
- c) Monitoring the supplier's quality performance through the evaluation of procured items against purchase order requirements and/or through audits.
- d) Providing for early and effective information feedback and correction of non conformances, especially of items found malfunctioning during production conformance testing.
- e) Approving special processes.

The Supplier shall require each supplier to be responsible for maintaining and retaining records. Furthermore, the Supplier shall require each supplier, as a minimum, to submit with each shipment appropriate certifications, final inspection results and test results. Requirements shall be included for chemical or physical testing records in connection with the purchase of raw materials by the suppliers.

16.10 Manufacturing Inspection:

Inspection shall occur at appropriate points in the manufacturing sequence to ensure quality consideration for compliance with drawings, test specifications, process specifications and quality standards. BEML may designate inspection hold (or witness) points into the Supplier's Inspection and Test Plan (ITP) upon review of the Supplier's efforts. Inspection/test shall be 100% (one hundred percent) unless there is a specified sampling plan in the specification of BEML. Non-conforming materials shall be identified as discrepant, and shall be segregated and reviewed for disposition.

16.11 Production Conformance Testing:

The Supplier's QA/QC personnel shall perform all Production Conformance inspections/tests and verify proper configuration of the equipment inspected/tested. If any item does not satisfy all performance or design criteria, the item shall be re-inspected/retested until the inspections/tests are passed with the necessary adjustments or repairs documented and certified by a witness.

16.12 Receiving Inspection:

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The Supplier's receiving inspection activities shall provide for the inspection of all incoming materials. These inspection measures shall be used to preclude the use of incorrect or discrepant materials and to ensure that only correct and accepted items are used and installed. All material certifications and test reports used as the basis for acceptance by the Supplier shall be preserved. Inspection measures shall identify any item at any stage of production to an applicable drawing, specification or other pertinent technical document. Permanent physical identification shall be used to the maximum extent possible.

16.13 Shipping Inspection:

The Supplier's Quality Assurance Program shall provide and enforce procedures for the proper inspection of all products to assure completion and conformance as required by the Contract prior to shipment. All shipments shall be prepared as required to preclude damage during shipment. The inspections and preparation for shipment shall be verified by the Supplier's QA/QC personnel.

16.14 Ensure Inspection with Latest Revisions/ Changes:

The Supplier shall ensure that inspection and tests are based on the latest approved revision or change to drawings and specifications. The Supplier shall ensure that obsolete drawings and change requirements are promptly removed from all points of issue and use. Means of recording the effective points of changes shall be employed.

16.15 Identification of Items using tags etc.

The Supplier shall maintain a system for identifying the progressive inspection status of materials, components, sub-assemblies and assemblies as to their acceptance, rejection or non-inspection. The system shall provide for ensuring that required inspections and tests are performed and that the status of items with regard to inspections and test performance is known throughout manufacturing, installation and testing. Nonconforming items shall be identified by physical segregation and status indicators such as tags, serialization, markings, stamps and inspection records. The identification system shall ensure that only items that have passed the required inspection and tests are used or installed.

16.16 Handling:

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The Supplier's Quality Assurance Program shall provide for adequate surveillance work and inspection instructions for the handling, storing, preserving, packaging, marking and shipping to protect the quality of products.

16.17 Non-conformance Control:

The Supplier shall establish and maintain an effective and positive system for controlling nonconforming material and workmanship, including procedures for its identification, segregation and disposition.

The supplier shall assure that nonconforming materials are not used. To assure prompt Correction, Corrective action Compensation and any necessary actions for any nonconformity caused by the Supplier or Supplier's suppliers, the Supplier shall establish nonconformity control procedure and includes it in the QAP.

All nonconforming issues shall be positively identified to prevent unauthorized use, shipment or intermingling with conforming material.

Corrective action and related information shall be documented and made available to BEML upon request. Corrective action shall extend to the performance of all sub-suppliers and include as a minimum:

- a) Immediate response, prompt action and prevention of recurrence for nonconformity.
- b) Analysis of data and examination of discrepant products to determine extent and causes with corrective action implemented in an expeditious manner prior the next shipment, order or inspection.
- c) Submission of detail documents (specifications, drawings, repair procedure, analyzed data, test/inspection data, measures, action plan and etc) required to resolve nonconformity detected.
- d) Introduction of required improvements and corrections, initial review of the adequacy of such measures, and monitoring of the effectiveness of corrective action taken.
- e) Analysis of trends in processes or performance of work to prevent nonconforming products.

17. Warranty

Warranty shall be covered for complete scope of supply and work effective from the date of commissioning of the complete supply and work.

WARRANTY obligations are deemed to be completed only on acceptance of the same by Project Manager/Engineer/Employer.

All the equipments including batteries, cables shall carry onsite warranty up to

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completion of warranty period of 5RSDM project whichever is later, except mentioned otherwise, against defective workmanship and materials, faulty designs or inferior quality of materials. It shall be repaired and/or replaced at site free of charges. All OEM warranties shall be extended to the 5RSDM project. The warranty period will commence from the date of go live / commissioning.

18. Submittals – Technical Offer:

The sub contractor shall provide the following as part of technical offer for technical evaluation,

- 1) Complete Technical offer along with drawings.
- 2) Clause wise compliance against the following,

- a) PTS - Doc no. GR/TD/6981
- b) BMRCL ERGS
- c) BMRCL ERTS (Including Appendices)

- Complied: “Complied” shall be indicated by the bidder where the bidder is able to comply fully with the clause.
- Noted: Where a clause merely provides information, and no other comment is necessary, “Noted” will suffice.

However “Noted” and/ or “any comments” shall be regarded as compliance from the subcontractor for his Scope of supply/ work.

Offers with Non-compliance and deviations to any of the ERTS, ERGS, PTS & Interface clauses are liable for rejection.

19. List of Documents and Drawings attached- Appendices/Annexures:

- ERGS BMRCL-5RS-DM.
- ERTS BMRCL-5RS-DM.
- Vendor approval form.
- LCC format
- RAMS formats
- Requirements during Defect Liability period (shall start from start of revenue service of last trainset) - Annexure-1

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- **Submittals Check Sheet - Annexure-2**
- HXN-L11673-03 (TCMS ICD Requirement for Wayside System) – **Annexure-3**
