



**Procurement Technical
Specification for Battery
System**

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Procurement Technical Specification of
Battery System for
DMRC RS15 Project

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1.0 Introduction

1.1 General

This document describes **Battery system** to be supplied for DMRC RS-15 Project for Delhi Metro Rail Corporation Limited (DMRC).

BEML shall carry out all required works and activities as Supplier for DMRC RS-15 project while the Subcontractor shall be responsible for all works required in this PTS with regard to Design, manufacture, supply, testing and commissioning of **Battery system** and shall be responsible for supporting the BEML activities as subcontractor for DMRC RS-15 Project. The supplies must be compatible with RS1, RS6 and RS13 rolling stock with modifications/ improvements required as per TS of RS15 contract.

The configuration of train formation is as follows.

- **T-M** - (Intermediate cars)
- **DT-M-T-M-M-DT** - (6 car formation)
- **DT-M-T-M-T-M-M-DT** - (8 car formation)

DT: Driving Trailer Car, M: Motor Car, T: Trailer Car

The train formation details for **80 cars** are as below:

- 40 'T+M' units (**80 cars**) to be integrated with existing RS1, RS6 & RS13 cars.

The scope of work also includes integration of existing 4/6 cars Broad Gauge Trains to 6/8 cars by integrating the new '**T + M**' unit similar to the existing system.

The 'T+M' car units being procured to convert the existing 4/6 Car Broad Gauge Trains procured under RS1, RS6 & RS13 contracts to 6/8 cars trains. The cars to be supplied under this tender thus shall be compatible with and suitable for integration with the existing RS1, RS6 & RS13 Broad Gauge type trains of DMRC supplied by MRM consortium and M/s BEML (RS6 & RS13 cars).

1.2 Climatic Conditions

The DMRC RS-13 Car shall operate reliably and safely under Delhi climatic conditions shown in Table.

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Description	Limiting Values
Maximum ambient temperature	47 °C (Refer note below)
Minimum temperature	3 °C
Humidity	100% saturation during rainy season
Rainfall	Rain occurs generally from June to September. Average annual rainfall is approximately 650mm, maximum rainfall in any 24hr period is 50mm.
Atmosphere during hot season	Extremely dusty
Maximum wind load	150 kg / m ²
Vibration & Shocks	The equipment, sub-systems & their mounting arrangements shall be designed to withstand satisfactorily the vibration and shocks encountered in service as specified in IEC 61373 and IEC 60571
S02 level in atmosphere	80— 120 mg/m ³
Suspended particulate matter in atmosphere	360 — 540 mg/ m ³

Note: The temperature of the metal surfaces of the vehicles when exposed directly to the sun, for long periods of time, may be assumed to rise to 70°C.

1.3 Operating Environments

The proposed DMRC RS-13 cars will operate with the track geometry shown in Table.

Track Gauge	1673 mm
Min. radius, on revenue track (Main line)	300 m
Min. radius in depot	200 m
Radius (equivalent) of min. vertical curve (convex or concave) mainline	1500 m
Max. gradient (Mainline)	3%
Max. gradient (Depot)	4%
Maximum design speed	90 KMPH
Maximum operational speed	80 KMPH
Round trip schedule speed with 30s station stops & 8% coasting, excluding terminal station turn	34 KMPH

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round time with fully loaded train	
Service acceleration rate	0.78 m/s ² ± 5%
Service deceleration rate	1.0 m/s ² ± 5%
Emergency deceleration rate	1.3 m/s ²
Jerk rate (maximum)	0.75 m/s ³
Expected running adhesion but not limited to	18%
Wheel diameter (new/worn)	860/780 mm
Bogie wheel base (approximately)	Min 2,400 mm
Average travel per year	1,50,000 Km

2. Definitions and Abbreviations

The following definitions and abbreviations are applicable to the PTS.

“DMRC” means the Employer for the Mass Rapid Transport System (MRTS) for Delhi.

“DMRC’s Representative” mean such persons appointed by DMRC to act as engineers for the purpose of the MRTS.

“BEML” means the Customer to procure the Battery for DMRC RS-15 Project.

“Subcontractor” means the subcontractor of Battery to BEML for DMRC RS-15 Project.

“GS” means Employer’s Requirements-General Specification of DMRC RS-15 contract for DMRC RS-13 Project

“TS” means Employer’s Requirements-Technical Specification of DMRC RS-15 contract for DMRC RS-15 Project

“PTS” means BEML’s Procurement Technical Specification.

3. Precedence of Documents

The PTS shall be read in conjunction with the General Terms and Conditions (GTC) of tender, GS, TS. 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

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GS and TS, 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	GTC,GS & TS
2	PTS

4. Scope of Supply

4.1 Hardware

The Battery for the Delhi Metro – RS15 project shall be **compatible** with and suitable for integration with the existing DMRC RS1 trains, RS4 & RS6 and RS13 units with required modifications/improvements as per RS15 contract.

The subcontractor shall also incorporate all the changes/modifications carried out in the **RS1, RS4 & RS6** and RS13 contract i.e., **all the variations, modifications, HECPs approved/would be approved by DMRC in accordance with ERTS Appendix TH and shall resolve & implement solutions for all NCR's, RSOI's and EIR's raised by DMRC.** The train configuration is 6 car (DT-M-T-M-M-DT) and/or 8 car (DT-M-T-M-T-M-M-DT).

Subcontractor shall consider ERGS & ERTS of RS15 contract during design of the Battery and the same **shall be compatible with and suitable for integration with the existing DMRC RS1 trains, RS4 & RS6 and RS13 units supplied by MRM consortium and BEML.** The Subcontractor shall provide, as a minimum, the following as per ERTS 9.2,

Part No.	Description	Quantity per M- car
909-21443	Battery – 110V	1 set
909-21444	Battery electrolyte Automatic topping up device	2 set/ project

Note: Supplies shall be in line with the supplies for DMRC RS1, RS4 & RS6 and RS13 contract.

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4.1 .1 One set of Battery:

- (1) Battery with centralized water topping system arrangement.
- (2) Rigid connection bars between cell to cell, crate to crate.
- (3) Connection Cables.
- (4) Terminal lugs for input (+, -) cable of vehicle side.
- (5) Integrated topping up facility: Suitable interconnection shall be provided so that topping up of all the cells can be carried out from a single point of battery box.
- (6) Terminal caps for proper insulation of Battery terminals
- (7) Supporting clamps for inlet, outlet connectors and inter cell & inter crate connector pipes
- (8) Fire/Flame retardant packing wood, Non-flammable, electrolyte proof of suitable thickness for securing the movement of crates in the battery tray/box: Valid test certificates shall be provided. Additional packing shims of suitable thickness shall also be provided.
- (9) Pre-charging of battery cells shall be done before installation of battery on train by Battery supplier.
- (10) Cell terminals to be applied with appropriate torque and an inspection check for application of torque with suitable marking for the same shall be carried out.

4.1.2 Battery electrolyte automatic topping up device:

The sub contractor shall provide two sets of battery electrolyte Automatic topping up devices (as per ERTS 9.2.6).

4.1.3 DLP and Commissioning Spares

The supplier shall submit list of DLP and commissioning spares for DMRC / BEML approval. The supplier shall position the approved DLP and commissioning spares at the designated depot of DMRC as per ERGS Chapter 8.

4.1.4 The following requirement shall be met by battery supplier as per ERTS section 9.2.

9.2.1 Batteries having a nominal voltage of 110V comprising of cells of Nickel cadmium type with cell casings of stainless steel or other alternative robust flame retardant material. They shall meet the requirements of IEC 60623 and IEC 60993 respectively or latest internationally accepted equivalent standard.

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9.2.2 The back up battery shall be provided to :

- (i) Maintaining full d.c. loads (13 KW) when the train runs over neutral sections of the overhead line in case of 25 kV ac system.
- (ii) Supply emergency load for at least **60 minutes** in case of failure of battery charger or its supply with the battery charged to 80% of its full capacity. Non-essential load shall be shed after 30 seconds of failure of battery charger supply.

9.2.3. Emergency loads shall include, but need not be limited to:

- i) Emergency lighting
- ii) All exterior lights
- iii) Ventilation fans, but not Air-conditioning
- iv) Communication systems including Public address, emergency help points and train radio.
- v) Propulsion and brake controls.
- vi) Door controls.
- vii) TIMS.
- viii) Cab console indicators, lighting and inter-locking.
- ix) ATP train borne equipment.
- x) Data recorder.
- xi) Safety proving circuit.

9.2.4 The design and control of the battery shall ensure that there is sufficient capacity left under all conditions to raise all the pantographs simultaneously. Adequate circuit protection shall be provided to ensure the battery load shall be disconnected when the battery voltage has dropped below 70% of the nominal voltage and when the auxiliary load is re-connected, the initial battery load shall not cause the battery output to oscillate.

9.2.5 Battery electrolyte capacity shall be such that the batteries will not require to have distilled water added more than once in every 90 days. The battery terminal voltage shall float on the 110V DC output of the auxiliary power supply of which the output voltage shall have fine adjustments and good stability to avoid over or under charging of the battery.

9.2.6 Two sets of battery electrolyte automatic topping up devices shall be provided. These devices shall be portable and easily operated by one person. They shall incorporate a feature to cut-off the electrolyte

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automatically when it has reached the correct level. The contractor shall submit details of this device for acceptance.

9.2.7 The control elements taking power from battery shall be capable of operating between 77V and 137.5V DC.

4.1.5 The battery shall supply emergency load of 13 KW (DC load of T+M unit) for at least 60 minutes in case of failure of battery charger or its supply with the battery charged to 80% of its full capacity.

4.1.6 Battery shall be divided into four sections and cells shall be accommodated in the Battery box tray of size 960Lx635Wx440H (Total four trays).

4.2 Software

Not Applicable

4.3 Interface Responsibilities

The location of mounting points and the design of equipment installation comprising of the Battery assembly shall be defined by the Subcontractor and approved by BEML/DMRC in order to avoid the mechanical interference with other equipment for the vehicle. The Subcontractor shall be responsible for the equipment and material to be supplied and recommended installation method and procedures.

BEML/ subcontractor shall be responsible for defining the technical requirements (refer to section 5) and the design constraints (refer to section 7) and shall be discussed with DMRC for approval. The Subcontractor shall be responsible for the design of the Battery system and the submission of design information (refer to section 7) and the performance of testing activities (refer to section 8) and the supply, installation and commissioning of Battery system (refer to section 4), and the maintenance and rectification of the Battery system (refer to section 5) during the defects liability period, etc.

The Subcontractor shall be responsible for the hardware interface required by BEML.

4.3.1 The battery shall work satisfactorily with RS1/RS4/RS6/RS13 on-board battery charger of SIV (Please refer to extract of HVN-Q16654-05A for Battery charger control except Temperature compensation which was dropped at later stage during design).

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4.3.2 The Battery shall be compatible with the existing external Battery chargers in the RS1/RS6/RS13 Depots.

4.4 Design Information

The Subcontractor shall provide all necessary documents, drawings for BEML/DMRC approval.

The Subcontractor shall provide the technical requirements and design information.

The drawings and documents shall be submitted to BEML including preliminary, pre-final, and final design submissions, the final contract document, and all other submission both in the paper copies and electronic format.

These drawings and documents shall be delivered in English with the data format of, respectively, AutoCAD release 14 and MS office version 7.0 (document - MS word, spread sheet – MS excel, data base files – MS Access, Presentation file – MS PowerPoint). The drawings shall contain minimum three (3) view points (for example, front view, top view and left view) for three (3) dimensional modeling. If available, the Subcontractor shall provide STEP file or CATIA file to BEML. All drawings and design calculations shall use SI unit.

The Subcontractor shall require the interface information, which possibly affects performance, fitting and form, from BEML. The subcontractor shall comply with the requirements specified in ERGS & ERTS.

The Subcontractor shall provide Final As-Built drawings as per ERGS 5.13

4.5 Testing

The Subcontractor shall perform, as a minimum, the following for Battery,

- (1) Routine and type tests of equipment and sub-systems.
- (2) Type complete vehicle tests for Battery
- (3) Type Commissioning test for Battery

The following tests shall be carried out by BEML with assistance of subcontractor.

- (1) Routine complete vehicle tests for Battery of each Train.
- (2) Routine commissioning test for Battery of each Train.

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(3) Service Trials.

The detailed requirements are specified in the section 8.

The supplies shall be compatible with the existing RS1 rolling stock fleet for operating 6 car and 8 car train formation.

4.6 Operation and Maintenance Manuals and Spare Parts Catalogues

(Not applicable for RS15 contract). However, the subcontractor shall provide O&M Manuals and Spare Parts Catalogues in case of change in the specification/Design of Battery system (compared to RS1/RS6/RS13 cars) or new system recommended by the subcontractor for RS15 project as given below.

The subcontractor shall provide the operation/maintenance/ spare parts manuals and spare parts catalogues for the Battery both in the hardcopies and electronic format as required in RS15 ERTS & ERGS. The subcontractor shall provide the following O & M manual:

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

The subcontractor shall include detailed step wise procedure for replacement of individual cells of a battery bank in the Maintenance Manual.

The subcontractor shall provide the Operation/maintenance manuals and spare parts catalogues to BEML for approval of DMRC.

4.6.1 Submissions

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

4.6.2 Electronic Manuals

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

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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.

The Documents Management System and Language used shall be subject to Employer's Representative's Review.

4.7 Spares, Special Tools and Testing Equipment

The subcontractor shall hand over the Spares, Special tools and testing equipment in accordance with the delivery schedule of BEML. The supplier shall maintain the Battery system and supply of spares for at least 10 years from the date of completion of the contract.

The subcontractor shall supply the following items of spares as per the list at Annexure-3 of this PTS.

- (1) Unit Exchange Spares (refer to ERGS Appendix 6)
- (2) Mandatory Spares (refer to ERGS Appendix 6)
- (3) Consumable spares for maintenance of all trains during commissioning, service trials and up to completion of Warranty period
- (4) DLP & Commissioning spares

The detailed requirements are specified in ERGS 8 and section 4.7.

4.7.1 The subcontractor shall recommend/supply sufficient spares in case of change in the specification/new design of Battery system (compared to RS1/RS6/RS13 cars) recommended by the subcontractor for RS15 project.

4.8 Storage, Packing, Crating and Marking

The subcontractor shall provide all packing, crating and markings in accordance with the requirements specified in ERGS 13. When handing over, hand over the complete Battery 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 complete Battery.

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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. (See ERTS 14.17)

4.9 Training

(Not applicable for RS15 contract). However, the subcontractor shall provide necessary training to BEML & DMRC staff in case of change in the specification/Design of Battery system (compared to RS1/RS6/RS13 cars) or new system recommended by the subcontractor for RS15 project.

The subcontractor shall provide the training for Employer's operating staff and maintenance staff, BEML staff according to the requirements specified in ERGS 9.

4.9.1 Training Manual

The subcontractor shall provide one original and five colored copies and electronic copies of the Training manual for use by the Employer for conducting in-house training. The Manuals shall cover all requirements specified in ERGS 9. After completion of the training, training aids and materials used shall become the property of BEML to enable and further training to take place.

4.10 Warranty

The subcontractor shall be responsible for any defect or failure of equipments provided in the cars, due to defective design, material or workmanship up to warranty period of 18 months from the date of taking over of each train as per ERGS 1.8.1..

The warranty period of spares or any other item / equipment delivered shall be:

- Either 24 months from the date of acceptance or
- Up to expiry of the defect liability period of last train set/'T+M' unit (ERGS clause 1.8.1), whichever is later.

The repair and/or replacement of failed components and equipment and installation of repaired/ replaced components/equipment shall be taken by the subcontractor on his own charge at the Site.

The subcontractor shall bear custom duty, freight charges and all other expenses involved in collection of defective components and equipment from the Site, and transportation to the manufacturer's works in India or abroad and its return to Site

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after repairs. Further, should any design modification be required to any components or equipment as a consequence of failure analysis, the period of 18 months shall recommence from the date when the modified part is commissioned into service and modification shall be carried out free of charge.

The subcontractor shall carry out all replacement and repairs under the warranty promptly and satisfactorily on notification of the defect by BEML so that no car is out of revenue service for more than 48 hours.

The detailed requirements are specified in ERGS 1.8 and General Terms and Conditions (GTC).

5. Technical Requirements

5.1 General

The subcontractor shall be responsible for meeting all the technical requirements in PTS for Battery system design.

The general requirements for Battery system shall be met to the requirements specified in ERGS and ERTS.

- GS 2.3 & TS 2.2 Interface Activities
- GS 2.5 & TS 2.3 Quality Assurance
- GS 2.7 & TS 2.4 System Safety
- GS 2.7, TS 2.7 & TS2.8 –TS 2.11 Reliability & Availability
- GS 2.7, TS 2.7 & TS2.12 –TS 2.13 Maintainability
- TS 2.22 & TS 15.18 Noise and Vibration
- TS 2.23 & TS 15.19 Fire and Toxicity Standards

5.2 Battery

The system requirements for battery shall meet, but not be limited to, the following sections in ERTS:

- (1) TS 1 Introduction
- (2) TS 2 General Requirements
- (3) TS 3 Design and Performance Requirements
- (4) TS 9.1 Auxiliary Supply System
- (5) TS 9.1.4 Auxiliary Converter
- (6) TS 9.3 Battery Charger
- (7) TS 9.2 Back-up Batteries

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- (8) TS 14 Material and Workmanship
(9) TS 15 Inspection, Tests and Trials

5.3 Noise

The subcontractor shall comply with the Noise and Vibration requirements specified in ERTS 2.22.

5.4 Weight

5.4.1 Target Weight Limit

The subcontractor shall submit estimated weights, list and center of gravity and be approved by BEML. The actual weights must not exceed 2% compared to the agreed weights.

No.	Equipment Weight Limitation	Remark
1	Storage Battery	Weights to be as per RS1,RS4, RS6 and RS13 supplies

5.5 RAMS Requirements

The sub-contractor shall meet RAMS (Reliability, Availability, Maintainability and Safety) requirements given in the Technical Specification (TS) and the General Specification. Also, the sub-contractor should provide all information related to the RAMS requirements.

The sub-contractor shall comply with, but not limited to, the following requirements:

5.5.1 Reliability Analysis

The sub-contractor shall submit reliability prediction to demonstrate by quantitative methods above the achievement of the specified levels of reliability for the scope of supply. The reliability data shall be based on actual operating information for the equipment. If the equipment in question has no previous operating experience, operational data from a similar piece of equipment shall be used. In this case, the reliability data shall be taken from equipment having approximately the same electrical and mechanical characteristics and operating under similar conditions. Under these circumstances, sub-contractor will use this data and must be approved by BEML.

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In the case where there is no operating experience with similar equipment, reliability data shall be estimated and provided in accordance with the latest revision of reliability data-book such as MIL-HDBK-217, NPRD, EPRD, PRISM or similar.

In addition, the sub-contractor shall submit a list of typical train withdrawal scenarios for review and acceptance by the BEML. The list shall include all anticipated failure scenarios, which can affect safety, punctuality and passenger comfort. Also, a list of typical train withdrawal scenarios should be based on the reliability analysis.

The reliability block diagrams and prediction of reliability performance shall be developed and submitted to the BEML for acceptance. The reliability block diagrams shall include all elements essential to the successful performance of the system and the interrelationships and interface of these elements.

5.5.2 Reliability Target

The MDBCFC (Mean Distance between Component Failure) per train-set/T+M unit of battery shall meet the following table, considering 150,000 train-km of annual running mileage.

	MDBCFC (train-km)
After 6 months of start of revenue service	10,000,000

The reliability performance shall be assessed by the following measure:

$$\text{MDBCFC} = \frac{\sum \text{Traveled kilometer per train - set}}{\sum \text{Number of Service Failures}}$$

Where,

Mean Distance Between Component Failures (MDBCFC): The MDBCFC of a system is the ratio of the total operating distance accumulated by the total population of identical items in the available fleet of the trains to the total number of Service failures occurring within the population identical items.

Service Failure: Any relevant failure or combination of relevant failures during revenue service to determine availability for revenue service, which results in one of the following:

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- Unavailability of the train to start revenue service after successful completion of pre-departure checkout;
- Withdrawal of the train from revenue services;
- A delay equivalent to or exceeding 3 minutes from the Schedule / Time table as noted at the destination station for the one way trip.

The Battery aggregates / equipments shall achieve the reliability targets specified in the ERTS 2.

5.5.3 Maintainability Requirements

5.5.3.1 Design 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.

The design shall also minimize Mean Time To Repair (MTTR) and costs throughout design life. MTTR is the ratio of cumulative time, including the access time expended during a time interval to the total number of relevant failures.

The sub-contractor shall also comply with the maintenance requirement of ERTS 2.12.

5.5.3.2 Maintainability Target

- 1) The LRU replacement should be less than 30 minutes
- 2) The mean time to repair (MTTR) of battery should be less than 1 hour
- 3) Corrective Maintenance Operation that does not require a car lifting shall be less than 4 hours.
- 4) Corrective Maintenance Operation that does require a car lifting shall be less than 6 hours.

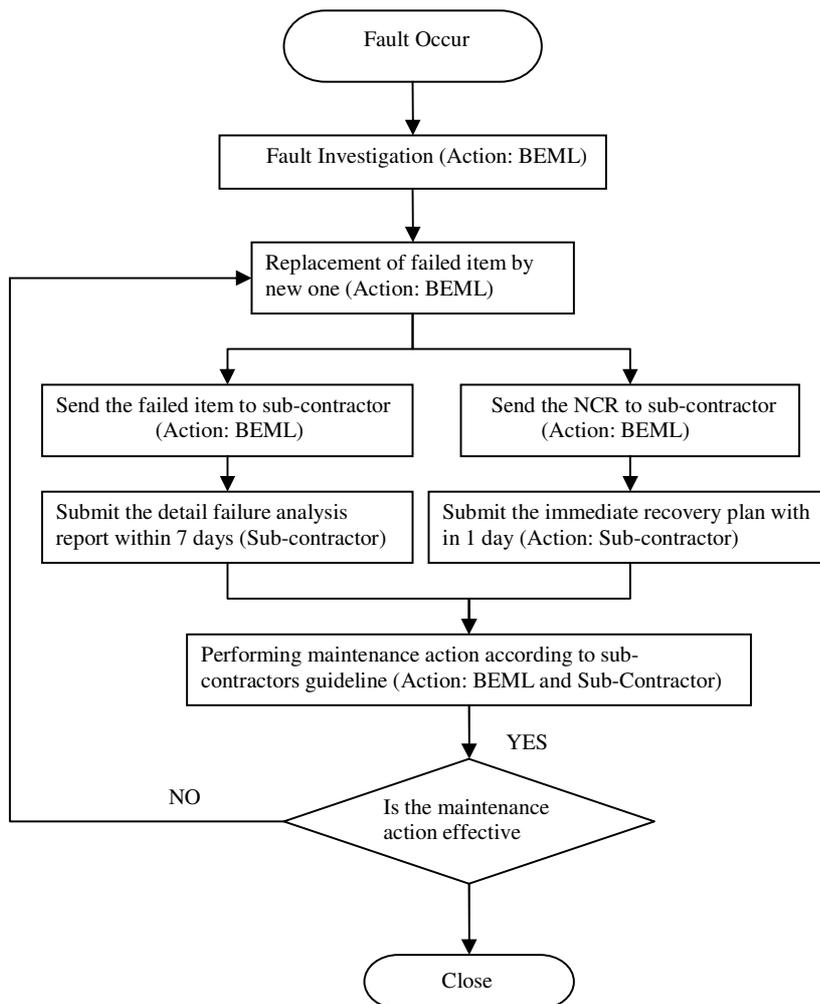
5.5.4 Life Cycle Costs

The sub-contractor shall provide equipment that has minimum total Life Cycle Cost. The sub-contractor shall submit all information for Life Cycle Cost calculation in accordance with RAMS Guideline. (See ERTS 2.24)

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5.5.5 Reliability and Maintainability Demonstrations

During Defects Liability Period, the values of the R&M target shall be calculated from the records of all faults and service failures. In the event that the R&M target is not achieved, the sub-contractor shall, at his own expense, take whatever action to meet the R&M target specified.



The sub-contractor shall provide an active support for high availability. The procedure of BEML is same as figure. Therefore, the sub-contractor should be complied with BEML's procedure.

A service engineer shall be made available with minimum testing equipments (charger, discharger units & necessary tools etc.) at Delhi Depot. In the event of some failure needs, the sub-contractor should dispatch engineer as soon as

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possible. Also, if the sub-contractor needs to provide some training for BEML's maintenance engineer, the sub-contractor shall perform it.

5.5.6 Safety Requirements

The sub-contractor shall perform all system safety tasks required to meet the Technical Specification and ensure that the safety critical hazards for scope of supply shall be eliminated or reduced to the level of ALARP.

To meet the safety requirement, the sub-contractor shall submit the following documentations as a minimum;

- 1) Hazard Analysis including Subsystem Hazard Analysis, Operating and Support Hazard Analysis and Interface Hazard Analysis
- 2) FMECA (Failure Mode, Effects and Criticality Analysis)

The Guideline for preparing the safety related documentations will be provided in the RAMS Guideline at early design stage.

The sub-contractor shall submit the safety related documentations in fully compliance with RAMS Guideline.

5.5.7 RAMS Deliverables

The sub-contractor shall submit the following RAMS Deliverables in accordance with RAMS Guideline.

- Product Breakdown Structure during Preliminary Design Stage
- Reliability Analysis including a list of typical train withdrawal scenarios, Reliability Block Diagram and Reliability Prediction during both Pre-final Design Stage and Final design Stage
- Preventive and Corrective Maintenance Analysis during both Pre-final Design Stage and Final design Stage
- Hazard Analysis including Subsystem Hazard Analysis, Operating and Support Hazard Analysis and Interface Hazard Analysis during both Pre-final Design Stage and Final design Stage
- FMECA (Failure Mode, Effects and Criticality Analysis) during both Pre-final design stage and Final design Stage
- Life Cycle Cost Analysis during Final design Stage.

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5.6 Fire

The Fire Performance Test Procedure and Criteria shall be met, but not be limited to, the following requirement:

The Battery shall comply with the Fire performance requirements specified in ERTS 2.23 and ERTS 2.5.8.

Materials used in the Battery system shall conform to fire safety requirements of EN 45545, latest editions, or the latest edition of other equivalent international standards, subject to the acceptance of the Engineer as per ERTS 2.5.8.

Subcontractor shall accomplish fire test reports of each material according to the international standards of these requirements.

Particularly, the fire load of all non-metallic materials within the Battery shall be verified and controlled during design and production by the subcontractor in accordance with the requirement defined by BEML/DMRC.

5.6.4 Other

ERTS 12.5 Wires and Cables:

ERTS 12.5.2: The insulation of all wires and cables including those used within equipment / subsystem shall be halogen-free flame- retardant and formulated to minimize generation of smoke, noxious emissions and corrosive fumes, in the case of overheating or fire. Cables shall all comply NF F 63-808 (for low voltages, and NF F 63-826 (for high voltages) or other international standards like EN 50264 approved by the Engineer.

The Cable markers provided shall be fire retardant heat shrinkable type. The cable markers shall be protected against fading by providing Fire retardant heat shrinkable clear sleeve.

5.7 EMC requirements

The Sub-contractor shall ensure that the Battery is designed and constructed in accordance with the latest issues or version of internationally recognized EMC standards, including but not limited to EN50121, EN50155, or equivalents, to ensure proper functioning.

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5.8 Software requirements

Not Applicable.

6. Quality assurance program

The Supplier shall comply with the requirements of QAP (Quality Assurance Program), which is to assure the quality of products supplied from the subcontractor to BEML.

If necessary, details of QAP need to be discussed with BEML's Quality Control Team. The Supplier shall provide the following information about Capital Spare Parts, Warranty Spare Parts and Consumable Parts in full compliance with the Technical Specification.

6.1 Organization

The organization of the Contractor's Quality Assurance (QA) Program shall have sufficient, well-defined responsibility and organization. It shall report directly to the General Manager of the Contractor's facility or the Contractor'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 processing, delivery, or installation of a nonconforming 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 Contractor's high level management starting with the General Manager or equivalent.

6.2 Certification of personnel

The Contractor's 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 (Non-destructive tests), etc. shall be certified for such work. Records of personnel certifications shall be maintained and monitored by the Contractor's Quality Assurance personnel. These records shall be made available to the Engineer of BEML for review.

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6.3 Evidence of compliance

The Contractor'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.

6.4 Certificates of compliance

The Contractor 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 is installed to the product), Barcode number of the product(if barcode system is specified in the specification of product), Project name, Contractor'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 Contractor, stating the product complies in all respects with the specification of the product. 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 Contractor.

6.5 Calibration

The Contractor 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

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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.

6.6 Procedure documents

The Contractor 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 subcontractors, 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.

6.7 Quality assurance activities

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

6.7.1 Procurement

The Contractor 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-testing.
- e) Approving special processes.

The Contractor shall require each supplier to be responsible for maintaining and retaining records. Furthermore, the Contractor 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

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testing records in connection with the purchase of raw materials by the subcontractors.

6.7.2 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 Contractor's Inspection and Test Plan (ITP) upon review of the Contractor'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.

6.7.3 Production conformance testing

The Contractor'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.

6.7.4 Receiving inspection

The Contractor's receiving inspection activity 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 Contractor 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.

6.7.5 Shipping inspection

The Contractor'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 Contractor's QA/QC personnel.

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6.7.6 Changes

The Contractor shall ensure that inspection and tests are based on the latest approved revision or change to drawings and specifications. The Contractor 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.

6.7.7 Identification of status

The Contractor 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.

6.7.8 Handling

The Contractor'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.

6.7.9 Non-conformance Control

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

The contractor shall assure that non-conforming materials are not used. To assure prompt Correction, Corrective action, Compensation and any necessary actions for any nonconformity caused by the Contractor or Contractor's sub-suppliers, the Contractor shall establish nonconformity control procedure and include it in the QAP.

All non-conforming 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

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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.

6.7.10 Quality Audit

The subcontractor shall permit Quality Audit by BEML and/or the Customer of BEML. The scope of the audit will be only the field related with the implementation of this project and the subcontractor's QAP.

If any Nonconformity is detected while the audit, Corrective Action request will be issued to the subcontractor. For the Corrective Action Request, the Contractor shall prepare and submit appropriate action plan within 10 (ten) days, perform the action plan and reply the result to BEML QC team.

6.8 Inspection and Test Plan (Herein After ITP)

ITP shall be submitted to BEML QC team for review and approval as following no later than 30 days after purchase order by BEML.

- (1) The ITP includes all the major inspection and test activities planned prior and during the design, procurement and installation phases. The (ITP) will include, as a minimum, the following:
 - (a) Introduction of ITP (purpose, application scope and etc)
 - (b) Description of Symbols, Abbreviations and Definitions
 - (c) Sampling Procedure if it is necessary
 - (d) Inspection/Test Notification procedure
 - (e) General Inspection/Test process/flow
 - (f) Manufacturing and Inspection/Test flow (block diagram) which describes manufacturing flows and inspection/test points.

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- (g) Description of Inspection and test activity and item
- (h) Kinds of Inspection and Test such as Design Qualification/ verification test (Type test), FAI, Routine inspection/test
- (i) Inspection/Test Level such as 100%, Sampling, 1/Lot and etc
- (j) References of the inspection/test such as specification, procedure etc
- (k) Responsible entity of the inspections and tests
- (l) Places of the Inspection and test
- (m) Witness/hold points of BEML and/or the Customer of BEML
- (n) Description of Reports /checklists required and the Submission

A table format is recommended to describe the Items (g) to (n).

(2) Witness/Hold point of Inspection/Test

After review of the ITP received from the Contractor, BEML will designate witness/hold point (if required) of BEML and/or the Customer of BEML and notify them to the subcontractor.

- Witness point of Inspection/test

To be witnessed randomly by BEML and/or the Customer of BEML. It requires the notification of inspection/test schedule written by the subcontractor. The subcontractor can proceed with his next process without agreement with BEML and/or the Customer of BEML if there is no written answer or intention from BEML and/or the Customer of BEML to witness the notified inspection/test.

- Hold point of Inspection/test

To be witnessed by BEML and/or the Customer of BEML. It requires the notification of inspection/test schedule written by the subcontractor to BEML. In case of hold point, subcontractor can do the next process after acceptance of the inspection/test or waiver (or agreement) by BEML and/or the Customer of BEML. Generally, Type Test (Design verification/qualification test) and First Article Inspection (FAI) are designated as the Hold Point.

(3) Inspection/Test Notification of Witness/Hold point

After receiving of ITP, BEML will inform Notification schedule and procedure to the subcontractor according to the Main Contract between BEML and the Customer of BEML.

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7. Design Information

7.1 General

The subcontractor shall submit, not limited to, the following general information.

Document/Deliverables	Reference/ description
Testing plan	ERGS 7, ERTS 15
Schedule of tests	ERGS 7, ERTS 15
Test procedure of type & routing test of equipment, type test of complete vehicles, commissioning test of complete vehicles	ERGS 7, ERTS 15
List of spares, special tools, testing and diagnostic equipment	ERG 8
All relevant drawings, manuals and full operation instructions for the special tools, testing and diagnostic equipment.	ERGS 8
Training proposal	ERGS 9
Training course	ERGS 9
Training manual	ERGS 9
Operation and maintenance manuals and spare parts catalogue	ERGS 12
All As built drawings	ERGS 5
All tools, equipment and manuals necessary for maintenance	ERGS 8.4
The requirements for the completion of the project management plan, interface management plan, work plan, quality assurance plan, safety assurance plan and site safety plan, environmental plan, inspection, tests and commissioning plan	ERG S 2

7.2 Design

7.2.1 General

The design of battery shall basically comply with ERTS 3, ERTS 9.1, ERTS 9.1.4, ERTS 9.2, ERTS 9.3, ERTS 9 and relevant specification of ERGS and ERTS.

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The design submission shall be submitted to BEML according to the following three stages;

- (1) Preliminary design submission stage (refer to ERGS 5.7)
- (2) Pre-final design submission stage (ERGS 5.8)
- (3) Final design submission stage (ERGS 5.9)

The subcontractor shall submit, not limit to, the following design information.

Submission Stage	Document / Deliverables
Preliminary Design Submission	(1) System description of battery system (2) Detailed specifications and drawings of all equipment (Battery assembly, cabling, connector, etc) (3) Connection diagram (4) Battery capacity Calculations (5) Notice for mounting , (6) Documentation for charging (7) Documentation for dis-charging (8) Service history (9) Reliability and maintainability proven data and letters
Pre-final Design Submission	(1) Upgraded System description; At this stage, the information described at the preliminary stage shall be fixed and finalized. (2) The evidence of or proposals for design verification (3) Test specification of Battery The detailed requirements will be specified later by BEML.
Final Design Submission	(1) Completed calculations and analysis, studies, investigations and reports (2) The detailed requirements will be specified later by BEML.

The subcontractor shall submit all data for each design submission to BEML as soon as possible so that they can be confirmed by BEML. BEML will furnish the review comments about the submission to the subcontractor.

The subcontractor shall meet with BEML to discuss the review comments. Should BEML deem the submission to be unacceptable, the subcontractor shall revise and re-submit the submission as soon as possible.

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7.2.2 Requirement of Battery

The design of the battery shall comply with the requirement ERTS & ERGS, IEC60623 and IEC60993 respectively.

7.3 SEM (System Engineering Management)

The Subcontractor shall submit, not limit to, the following design information: The technical requirements of noise, vibration, fire, weight, safety, reliability, maintainability and availability shall be submitted.

The subcontractor shall submit, not limit to, the following general information.

Classification	Document/ Deliverables
Proposal , plan & prediction	Design proposal for noise, Vibration and fire
	Breakdown list and weight of each component
	Detailed prediction of the power output from the flash over
	Fire load schedule based on fire load density of materials of components
	Material analysis on component level
	RAM data
	Hazard log & register of train failure
	RAM modeling & prediction
	RAM Table
	Hazard analysis
	FMECA
	FTA
Detail test procedures	Description of noise test procedure
	Description of fire test procedure
Test Reports	Report on weight measurement
	Certificate of fire tested non-metallic materials of components

8 Testing

8.1 General

8.1.1 General

The subcontractor shall provide BEML with all information for the completion of Inspection, Testing and Commissioning Plan and also comply with the plan defined according to the requirements specified in GS 7.1 and TS 15.

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The type tests for the Battery system at both the component level and complete train level, for 6/8 car operational line, shall be re-performed by the Subcontractor under BEML and DMRC participation, if DMRC want to witness the tests even though the tests were accepted by BEML.

All such tests shall be carried out at the subcontractor's cost, wherever performed, in the presence of and to the satisfaction of BEML and DMRC, who reserves the right to witness any or all of the tests.

All defects and shortfalls discovered during the tests shall be rectified and re-tested to the satisfaction of BEML and DMRC. The subcontractor shall provide full instrumentation to conduct all tests and carry out modifications as required. All test procedures, reports including all maintenance activities and check lists shall be submitted and approved by BEML and DMRC within the defined period.

The results of all tests shall be submitted to BEML and DMRC, who will record his conclusions as to whether or not the equipment being tested has passed satisfactorily. The subcontractor shall produce a test report, in three copies, and in an approved format, within an defined period following the test, for acceptance by BEML and DMRC.

The detailed requirements are specified in ERGS 7 and ERTS15.

8.1.2 Inspection

All the materials, fittings, equipment, manufacturing processes, and assembly workmanship shall be subject to inspection by BEML and DMRC, wherever carried out in accordance with the requirements specified in ERGS 7.1.

8.1.3 Inspection Hold Points

The subcontractor shall propose a set of inspection hold points in the Inspection, Testing and Commissioning Plan in accordance with the requirements specified in ERGS 7.1.

8.1.4 Test Procedure

Following items shall be complied

- (1) All test equipment shall carry an appropriate and valid calibration label.
- (2) The subcontractor shall sign all reports of Tests

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- (3) The subcontractor shall present a comprehensive Testing and Commissioning Program.
- (4) Test procedures shall be amended, as required by the subcontractor throughout the duration of the Contract, to reflect changes in system design or the identification of additional testing requirements.
- (5) All costs including labor, supervision of testing, provision of specialized equipment and materials, and the cost of hiring Consultants and the services of other specialized personnel or independent assessors etc shall be borne by the subcontractor.

The subcontractor shall also bear any expenses incurred due to re-testing caused by defects or failure of equipment or any other account to meet the requirements of the contract.

The detailed requirements are specified in ERGS 7.1.

8.1.5 Sequence of Tests

- (1) Routine and type test of equipment and sub-systems in accordance with relevant standard and specifications in Contractor/Sub-contractor's factories.
- (2) Factory and Site Tests of complete cars in accordance with IEC 61133.
- (3) Testing and commissioning of cars/trains in Depot in accordance with IEC 61133.
- (4) Integration Tests in conjunction with all Designated Contractors.
- (5) Instrumentation and Dynamometer Tests, and Oscillation Trials on Prototype rakes only.
- (6) Service Trials

8.2 Routine and type tests of equipment and sub-systems

The Battery shall comply with the requirement ERTS & ERGS.

8.2.1 Type Test, Battery

- a) This test is required to verify that the battery operates in accordance with the Approved Design Data. Type test shall be performed by the Subcontractor under BEML and DMRC participation as per IEC 60623 in accordance with the requirements specified in ERTS 15.
- b) Subcontractor has responsibility for the type test of the component. During test the criteria shall be observed and recorded in a log book and necessary alterations and adjustments carried out.

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- c) The subcontractor shall also perform the following additional tests with the requirements specified in accordance to IEC 60623,
- (1) Charging procedure for test purpose.
 - (2) Discharge performance at 47⁰C (at 0.2C₅ rate).
 - (3) Discharge performance at 47⁰C (at 1C₅ rate).
 - (4) Special Discharge test at 47⁰C.
 - (5) Special Discharge test at 0⁰C.
 - (6) High rate current discharge test at 47⁰C.
 - (7) Charge retention at 47⁰C.
 - (8) Charge acceptance at constant voltage at 47⁰C.
 - (9) Endurance test at 47⁰C.
- d) In the event DMRC requests any other additional tests, the subcontractor shall carry out the same at no additional cost.

8.2.2 Routine Test, Battery

This test is required to verify that the Battery has been built in such a way that it satisfies the requirements of the Approved Design Data as verified by the Type Test.

During test, the criteria shall be observed and recorded in a logbook and necessary alterations and adjustments carried out. Records from Routine test shall be held by the Subcontractor and made available timely for BEML and DMRC's inspection.

Copies of the approved routine test results shall be submitted together with the associated logbook. Additional copies of records of all tests/inspections result shall also be held at the Subcontractor work to be made available to BEML and DMRC on demand.

This test basically includes but not limited to functional test, visual inspection, dimensional inspection, open circuit voltage & polarity check and leakage test of water pipes.

8.2.3 Fire Performance Test

The sub-contractor shall perform the fire performance tests of battery in accordance with the requirements specified in ERTS 2.5.8, 2.23 and 15.19.

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8.2.4 Capacity Guarantee Test

This test requirement shall meet, but not be limited to, the following sections in ERGS and ERTS:

- (1) ERTS 9.2. Back-up Batteries

8.2.5 Shock and vibration test

The sub-contractor shall perform the Withstanding Vibration and Shock test of battery in accordance with the requirements specified in IEC 61373. The test results shall be submitted for approval.

8.2.6 Others

The subcontractor shall carry out any other tests as specified in IEC 60623 and IEC 60993.

8.3 Integration Test

BEML will perform the integration test with the assistance of sub-contractor according to ERGS 7 and ERTS 15. The subcontractor shall submit all information for the integration test to BEML. If needed, the concerned engineer from subcontractor shall participate in the test.

8.4 Service Trials

BEML will perform the service trial for DMRC 8 car train and the sub-contractor shall supply the sufficient information and assistance if necessary according to ERGS 7 and ERTS 15. The subcontractor shall submit all information for the service trials to BEML. If needed, the concerned engineer from subcontractor shall participate in the service trial.

9. HECPs, SECPs, RSOI's, NCR's & EIRS

The Battery supplier shall address the following Quality / Design / Field issues reported in the RS1/RS4/RS6/RS13 cars.

- 1) Zero voltage cells
- 2) Electrolyte spillage
- 3) Cracks in wooden crates
- 4) Improvement of quality of water filling pipe of centralized water filling system

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Supplier shall also incorporate all the changes/modifications carried out in the RS1, RS4 & RS6 and RS13 contract (All the variations, modifications, HECPs & SECPs approved/would be approved by DMRC) in accordance with TS Appendix TH and shall resolve & implement solutions for all RSOI's and EIR's (EIR no. 51 & 66) raised by DMRC / BEML.

HECPs, SECPs, RSOI's, NCR's & EIR's of RS1/RS4/RS6/RS13 shall be addressed and implemented in Design stage itself for RS15 supplies.

The sub contractor shall conform to the RS15 Employer's Requirements — Technical and General Specifications and shall conform to all approved/would be approved variations, modifications and Hardware/Software Engineering Change Proposals against the contracts 'RS1', 'RS6' and 'RS13' in line with ERTS. In case of any contradiction between ERTS and approved/would be approved modifications (Hardware/Software Engineering Change Proposals) against the contracts 'RS1', 'RS6' and 'RS13', the later will prevail as per ERTS 1.1.8

At the end of DLP period, sub contractor shall submit all the latest approved HECPs / SECPs of train system / sub-system done during DLP period in soft copy (PDF/ word/ auto-cad) duly hyperlinked with index in a hard disk as per ERGS 5.15.4.

10. Qualification criteria & Indigenization

10.1. Qualification criteria (as per ERTS 3.2.2):

The rolling stock, including all sub-systems and equipment shall be of proven design. Subsystems and equipment offered in this tender shall have been in use and have established their performance reliability on a mass rapid transit system or suburban e.m.u.'s in revenue service over a period of two years or more. Where similar equipment or sub-systems of a different rating are already proven in service, then the design shall be based on such equipments. In case this stipulation is not fulfilled, the tenderer shall furnish sufficient information to prove the basic soundness and reliability of the offered subsystem as per ERTS 3.2.2.

10.2. Indigenization (as per ERGS 1.1.8):

The subcontractor shall make efforts to source maximum number of equipment and materials from India, as specified in the Table 1.C recommended items for indigenization of ERGS 1.1.8, Battery to be indigenized to meet the required performance requirements and quality standards and facilitate ease in maintenance and easy availability of spares.

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11. Submittals – Technical offer:

The sub contractor shall provide the following as the part of technical offer:

- 1) Complete technical offer for battery system.
- 2) Battery Drawing (GA drawings indicating dimensions of cell and crate and overall battery set).
- 3) Battery design & sizing calculations for DMRC approval.
- 4) Battery discharge curves/graphs for,

60 minutes emergency load of 13 KW @ 3 deg C and 47 deg. C.
- 5) Document/specification of packing material and relevant test reports for conformance to Fire retardant property.
- 6) Clause wise compliance against PTS Doc no. **GR/TD/3022**.
- 7) Clause-wise compliance for relevant clauses in ERGS and ERTS of RS15.
- 8) Confirmation to TS Appendix-TH along with Details of compliance and action taken for implementation of HECP's, SECP's, RSOI's, NCR's, EIR's and any other field issues of RS1/RS4/RS6/RS13 reported by DMRC/BEML in the Design stage for RS15 supplies.
- 9) List of DLP and commissioning spares as per ERGS Chapter 8.
- 10) Satisfactory Performance certificate from DMRC for previous supplies.
- 11) List of Spares as per section 4.7 & Annexure-3 of this PTS

12. List of Documents and Drawings Supplied

- I. Annexure-1 : ERGS & ERTS
- II. Annexure-2: Extract of HVN- Q16654-05A for Battery charger control.
- III. Annexure-3: List of Spares