



**Procurement Technical  
Specification of Power  
Quality Measurement System**

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**Procurement Technical Specification of POWER QUALITY MEASUREMENT  
SYSTEM for MRS1**

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(i) REVISION DETAILS

REV. NO.	CLAUSE NO.	PAGE	CHANGES	DATE
0			FIRST ISSUE	24.10.2019
1			SECOND ISSUE	01.01.2020
2			THIRD ISSUE	01.05.2020
3			FOURTH ISSUE	15.05.2020
4			FIFTH ISSUE	22.05.2020

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## 1. Introduction

### 1.1. General

This document, Procurement Technical Specification (PTS) describes the complete technical requirement of On board set up of Power Quality Measurement system to be supplied for cars under the 'MRS1' contract (hereafter MRS1). The On board set up of Power Quality Measurement system shall comply in all respects with MRS1 Employer's Requirements General Specification (ERGS) and Employer's Requirements Technical Specification (ERTS). The supplied system shall meet the shock and vibration requirements as per EN 61373.

BEML shall carry out all required works and activities as Supplier for MRS1 contract while the subcontractor shall be responsible for all works required in this PTS with regard to Design, supply, testing and commissioning of On board set up of Power Quality Measurement system and shall be responsible for supporting the BEML activities as subcontractor for MRS1 contract.

The scope of work covers design, development, testing, manufacture, supply, commissioning and integrated testing of the On board set up of Power Quality Measurement system and the training of Operation and Maintenance personnel of the owner on the On board set up of Power Quality Measurement system. The scope also covers supply of spares, calibration required during defect liability period of On board set up of Power Quality Measurement system.

The scope of work shall include all items of work which may be required to meet the performance requirements, trouble free and efficient operation of trains and meeting the best international practices even if not specifically mentioned in the tender specifications as specified in ERTS 1.1.3 (i) to (ix) and ERTS 1.1.7.

The rake formation shall be as follows:

- |                                 |                         |
|---------------------------------|-------------------------|
| *DMC – TC – MC –                | - 3 car unit formation  |
| *DMC – TC – MC – MC – TC – DMC* | - 6 car train formation |

For increase in quantity (if required)


- |   |                         |
|---|-------------------------|
| – TC – MC –                               | - 2 car unit formation  |
| *DMC – TC – MC – TC – MC – MC – TC – DMC* | - 8 car train formation |

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

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

Each DMC shall 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.

The design of On board set up of Power Quality Measurement system shall be suitable for 8 car formation in future. The design details and performance parameters of On board set up of Power Quality Measurement system for 8 car train shall be submitted by the subcontractor during design stage itself and got approved from the Engineer.

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## 1.2. Climatic and Environmental Condition(ERTS clause 3.10)

The MRS1 cars shall operate reliably and safely under Mumbai climatic and Environmental conditions as per ERTS 3.10


## 1.3. Vehicle Performance Requirements (ERTS clause 3.22)

The vehicle performance requirements with fully loaded train and tangent track are as per the following table.

Item		All Corridors
Maximum design speed	With inflated secondary suspension	90 kmph
	With deflated secondary suspension	80 kmph
Maximum operational speed	With inflated secondary suspension	80 kmph
	With deflated secondary suspension	70 kmph
Minimum Design Average Acceleration rate for fully loaded (AW3) train on level tangent track shall be as under: 0 kmph to 40 kmph 0 kmph to 60 kmph 0 kmph to 80 kmph		1.0 m/s <sup>2</sup> 0.75 m/s <sup>2</sup> 0.40 m/s <sup>2</sup>
Minimum Operational Average Acceleration rate for AW2 loaded train on level tangent track shall be as under: 0 kmph to 35 kmph 0 kmph to 60 kmph 0 kmph to 80 kmph		1.20 m/s <sup>2</sup> 0.80 m/s <sup>2</sup> 0.45 m/s <sup>2</sup>
Average Service braking rate from 80 kmph to standstill for fully loaded (AW3) train on level tangent track.		1.0 m/s <sup>2</sup>
Average Service braking rate from 80 kmph to standstill for AW2 train on level tangent track.		1.1 m/s <sup>2</sup>
Average Emergency braking rate from 80 kmph to 0 kmph for fully loaded trains on level tangent track		1.3 m/s <sup>2</sup>
Jerk rate(Maximum)		0.75 m/s <sup>3</sup>
Annual running distance of one train (for design purpose)		150,000 km

## 1.4. Current Collection System (ERTS clause 3.17)

System Particulars	For all sections and depot
Supply Voltage System	25kV AC single phase 50Hz
Type of OHE	a. Auto tensioned flexible catenary for elevated and at-grade sections. b. Rigid catenary for underground sections. c. Flexible catenary for depot.


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Current Collection	Through Pantograph		
Height of Contact Wire from rail level	a. 4800mm min. and 5500mm max. for elevated, at-grade and depot sections. b. 4318mm min. for underground sections.		
Stagger	±200mm for Rigid Centenary; ±300mm for Flexible Centenary		
Nominal Voltage	25.0 KV AC		
Minimum voltage	19.0 kV AC		
Maximum voltage	27.5 kV AC		
Instantaneous minimum voltage	17.5 kV AC		
Occasional maximum voltage	31.0 kV AC		
Voltage for guaranteed performance	22.5 kV AC		
Variation in frequency	48 to 52 Hertz		

## 2. Definition and Abbreviations

The following definitions and abbreviations are applicable to the PTS.

### 2.1. Definitions

- **“Employer”** means Delhi Metro Rail Corporation Limited (DMRC), it’s legal successors and assignees
- **“Engineer”** means any person nominated or appointed from time to time by the Employer to act as the Engineer for the purposes of the Contract and notified as such in writing to the Contractor
- **"Engineer's Representative"** means any Assistant of the Employer appointed from time to time by the Employer.
- **"Contract"** means the contract between Subcontractor and BEML in relation to the supply of On board set up of Power Quality Measurement system for MRS1 project.
- **“BEML”** means the Contractor to On board set up of Power Quality Measurement system for MRS1 Contract.
- **“Subcontractor”** means the supplier of On board set up of Power Quality Measurement system to BEML for MRS1 Contract.
- **"Contractor"** means the persons or person appointed by the Employer to undertake the execution of the works for MRS1 project. In order to avoid misunderstanding of the roles of the Contractor in ERTS and ERGS, the term “Contractor” shall be read as “Subcontractor” in ERTS/ERGS for those ERTS/ERGS clauses referred to in this PTS.
- **“ERGS”** means Employer’s Requirements-General Specification of MRS1 contract.

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- “ERTS” means Employer’s Requirements-Technical Specification of MRS1 contract.
- “PTS” means BEML’s Procurement Technical Specification.
- “GTC” means General Terms & Conditions of the tender issued by BEML for procurement of the On board set up of Power Quality Measurement system for MRS1 contract.

## 2.2. Abbreviations

GoA	:	Grade of Automation
UTO	:	Unattended Train Operation
EMC	:	Electro-Magnetic Compatibility
ERGS	:	Employer's Requirements General Specifications
ERTS	:	Employer's Requirements Technical Specifications

## 3. Precedence of Documents

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

To the extent that any provision of the PTS is inconsistent with any provision of the General Terms & Conditions of the tender (GTC), the provisions of the 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	DMRC ERTS
2	DMRC ERGS
3	GTC
4	PTS

## 4. Standards and Codes (ERGS clause 1.6 & Appendix TA of ERTS)

All equipment and software supplied shall be in accordance with the requirements of the standards and codes specified in the ERTS. The subcontractor may propose an alternative equivalent international standard during the design stage. The acceptance of alternative standard will however be subject to review by BEML/DMRC. When a Standard or Code is referred to, it shall be assumed that the revision that is current during the design finalisation shall be applicable, unless otherwise stated.

Where no standard is identifiable, the subcontractor shall make a proposal, based on the best International practice, which shall be subject to review by BEML/DMRC.

During the preliminary design phase, the subcontractor shall submit a consolidated list of all the standards that he intends to use for the design, manufacturing and testing and other phases of the contract, for review of BEML/DMRC.

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## 5. Requirements of Documentation

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 On board set up of Power Quality Measurement system in a format readable with AutoCAD 2013 (latest), CATIA V5 on CD-ROM or e-mail as requested by the BEML or DMRC's Representative.

The drawings shall contain minimum three (3) view points (for example, front view, top view and left view) for three (3) dimensional modeling. The Subcontractor shall provide STEP file or CATIA file to BEML/DMRC.

## 6. Qualifying Criteria for subcontractor and Vendor approval

The Power Quality Measurement System for MRS1 project shall be of proven design and the supplier should have similar supply experience in at least one MRTS satisfactorily. The project should be presently in revenue operation. However qualification criteria can be relaxed based on BEML /DMRC discretion.


- (i) The subcontractor shall meet the qualification criteria as mentioned hereunder.
- (ii) The subcontractor should be an OEM and should have carried out design and manufacturing of sub-assemblies and those sub-assemblies proposed for On board set up of Power Quality Measurement system shall be state-of-art & of proven design and shall have been in use and have established their satisfactory performance in at least one MRTS. 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 Engineer for this project. To this effect, the subcontractor shall submit purchase order copies and satisfactory performance certificates from the customers / Metro Corporations along with the technical offer. 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.

The components for On board set up of Power Quality Measurement system shall be procured from the reputed vendors. The components shall be proven for onboard Rolling stock application and meeting the accuracy requirement and sourced from only such manufacturing units that have supplied the sub-systems that fulfill the proven design requirements as above. The contract envisages commencement of manufacturing only after completion of Pre-final design. Accordingly, the number of years in revenue service and operation for the above requirements shall be calculated as on the contracted Key Date No. 3.1 corresponding to Pre-Final Design Completion.

In case the subcontractor proposes to use sub-system(s) that do not fulfill 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 Engineer. The Engineer's decision on subcontractor's proposal shall be final and binding.

- (iv) The subcontractor shall undertake to provide support during Testing & Commissioning, service trials, revenue service and DLP period either by themselves or through sister company or a partner in India as per Annexure- B of NNO format (Refer Annexure-1). The subcontractor shall submit detailed proposal in this regard.



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- (v) The subcontractor shall give an undertaking to supply spares for a minimum period of 10 years from the date of last car supplied by BEML.

### 6.1. Vendor approval (ERTS clause 3.2.5)

Notice for No Objection (NNO) from DMRC 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 DMRC-based on the NNO details submitted by the subcontractor.

## 7. Scope of Supply and Work

MRS1 Project specification establishes requirements for the design, development, manufacture, supply, testing, delivery, commissioning and integrated testing of light weight fully furnished modern passenger cars with microprocessor control 3-phase induction motor drive. The detailed technical requirements are mentioned in ERTS and General Specifications are mentioned in ERGS. BEML Limited wants to procure Power Quality Measurement System to comply with the requirements as mentioned below:-


### 7.1. Hardware

The Subcontractor shall be responsible for the design, manufacture, supply, testing, commissioning and integrated testing of the On board set up of Power Quality Measurement System as per ERTS 8.1.12.1, 8.1.12.2 & 8.1.12.3.


The train power collection system is being installed with Protection class Instrument Transformers for protecting the current collection system. The details of the potential transformer and the incoming High Voltage cable are placed at ANNEXURE-3. This cable is primarily connected with the current collection system (at roof) and the Main transformer positioned below the carbody. This cable primarily runs inside the carbody for the whole length and for mechanical protection it is guided through a stainless steel pipe inside the car.

The tapping for the secondary winding of the installed Potential Transformer will be made available as voltage input (nominal voltage is 100V) to the Power Quality Analyser. The subcontractor shall provide all components related to the Power Quality Measurement system, but not limited to, the following:-

- a) **A suitable current measuring device (CT/scope)** with accuracy of atleast 1% to be used in the interior part of the train should be supplied with a mounting clip/tool to securely fit on the cable. The cable shall be as per the relevant EN/Equivalent Standards. The nominal current load in the primary cable will be 200A. However, the current measuring device should be able to measure the current accurately even at scant load conditions.
- b) **A Power Quality Analyser** with the following features is desired:-
  - i. sampling rate 100 kilo samples/per sec.
  - ii. Analyze data at least at 50<sup>th</sup> Order harmonics.
  - iii. Accuracy of the analyser shall be at least 0.1%

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- iv. shall have high input impedance (at voltage input) so as to avoid burdening the Potential Transformer
  - v. shall not send back noise signals etc., back to potential transformer.
  - vi. The analyser shall be as per the relevant EN/Equivalent standards.
- c) **A suitable data acquisition/storage** system capable of storing data for at least 24 hours. This feature may be an integrated part of Power Quality Analyser.
- d) **The power conversion modules** required for the measurement device, power quality analyser, data acquisition module.
- e) **A suitable user terminal(Laptop)** along with necessary tools and software package for generating reports/charts/maps for downloading/storage, reviewing, study and analysis.
- f) Optionally, the supplier should specify whether the software package shall be able to generate summative report of two or more power quality analysers in order to generate the report at train level.
- g) Technical Specification of Power Quality Measurement system subject to DMRC approval.
- h) 2D/3D drawing and Installation Document.
- i) Warranty Support.
- j) Power Quality Measurement System shall be suitable to meet EN 61373 shock and Vibrations requirements for on Board installations.
- k) *If supplier chooses to provide solution in terms of ERTS clause 8.1.13, measurement data shall be sent over Ethernet using TRDP protocol to TCMS for display. Standard M12 connector shall be used for connecting to TCMS network Details of interfacing with TCMS shall be finalized during design stage. A suitable schema may be submitted in technical bid proposal.*
- l) Accuracy analysis for the complete system shall be submitted in technical bid proposal.
- m) Instrument Transformer Details, Power Analyser, Data Acquisitions system, storage module, software tools etc., shall be part of technical bid proposal.
- n) Dust and Water-tightness and at least IP 65 or higher shall be ensured for all type of exterior equipment mounted equipments etc.
- o) Enclosures & Mounting arrangements has to be provided by the subcontractor for the all the equipments supplied by subcontractor.
- p) **Cables between equipments:**
- 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.
  - 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. Mating connectors for vehicle side with all pins even if pin is not used, back shells and accessories.
  - iv. Non-screwed and self locking type connectors for complete system shall be ensured.
  - v. Cable Assembly instruction documents for Ethernet cables and any special cables etc.,

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- vi. Unused connectors such as PTE connector shall be covered with protective cover plug (or dummy cap) to prevent dust from accommodating on the contacts.
- vii. Earth pad / stud and fasteners for fastening (preferably which suits to M6 and 6 sq. mm. cable)
- q) Harness works of Ethernet connectors if any for the On board set up of Power Quality Measurement System.
- r) Name plates or Name Labels
- s) Rubber (packing or gasket) for the water-tightness when the subsystem or components are installed on the exterior of vehicle.
- t) One full set of connector and its contacts as mounted on the equipment to carry out vehicle level voltage withstand test at BEML factory.
- u) The complete shall be portable to retrofit to carry out the power quality analysis on any desired train.

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

The Subcontractor shall provide, as a minimum, the following:


#### 7.1.1. On board set up of Power Quality Measurement system

Item	Qty	Spec.
(1) On board set up of <b>Power Quality measurement system comprising (at least 7.1.a to 7.1.d above) measuring instruments, data acquisition systems with capability of storing min. 24 hour data and power analyser (with provision for permanent installation and necessary software/analysis tool)</b> to measure, record and analyse the power quality. The measurement with these instruments shall include but not limited to Time, kW, kVAR, kVA, THD, TDD, Total pf and Displacement pf. The Power Quality Analyser supplied shall have the adequate capability to analyse higher order harmonics (up to 50 <sup>th</sup> ) with minimum accuracy of 0.1% and sampling rate of 100 kilo samples/sec.	4 sets	ERTS 8.1.12.1
(2) Mating connectors (male / female connectors along with male / female crimp contacts, etc).	As applicable	
(3) Spare parts, Special Tools and Testing equipment	As applicable	
(4) Required Software (complete package including manual, software documentation, training)	As applicable	

**Note: One set means Power Quality Measurement System for One Train set. One Train set has two T-Cars and each having one unit of Power collection Points (Pantographs). However, only two nos. User terminals are required.**

#### 7.1.2. Wires & Cables

ITEMS	QTY.	SPEC.
(a) The subcontractor shall supply the following cables for car side wiring <ul style="list-style-type: none"> <li>(i) Special multi-core cables &amp; Ethernet cables, if any between the Camera and Detection &amp;</li> </ul>	As applicable	ERTS 12.5 ERTS 14.7

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<p>warning system.</p> <p>(ii) Any other cables other than below mentioned cables at (b).</p> <p>(b) Power cables (1.5 sq mm) for 110 V DC input power supply and multi-core shielded (2-core and 3-core 1.5 sq. mm.) cables for serial interface will be provided by BEML.</p> <p>(c) Specification of cables proposed by the subcontractor shall be submitted with the tender.</p> <p>(Cables from sources approved by DMRC only shall be used.)</p>		
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**Note- Wires and cables shall be quoted as separate line item. Supplier shall provide type of cable. BEML can choose to use type of cables available with BEML if found suitable. If BEML chooses to use cables from it's own stock. Wire and Cable price shall not be considered for commercial evaluation.**

## 7.2. Technical Requirements

### 7.2.1. General

The subcontractor shall be responsible for meeting all the relevant technical requirements in PTS, ERTS & ERGS and submission of required data for On board set up of Power Quality Measurement system.


The general requirements for On board set up of Power Quality Measurement system shall be met to the requirements specified in ERGS and ERTS.

- Interface Activities
- Quality Assurance
- System Safety
- Reliability & Availability
- Maintainability
- Noise and Vibration
- Fire and Toxicity Standards
- Electro-Magnetic Compatibility

### 7.2.2. System Requirements for On board set up of Power Quality Measurement System

The system requirements for On board set up of Power Quality Measuring System shall meet, but not be limited to, the following sections in ERTS:

**ERTS 8.1.12.1** Two trains on each line shall be instrumented with separate Power Quality measuring instruments, data acquisition systems and power analyser (with provision for permanent installation and necessary software/analysis tool) to measure, record and analyse the power quality. The measurement with these instruments shall include but not limited to Time, kW, kVAR, kVA,

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THD, TDD, Total pf and Displacement pf. The instruments supplied shall have the adequate capability of measuring and data acquisition to analyse higher order harmonics (up to 50<sup>th</sup>) and measure power quality parameters mentioned above with minimum accuracy of 0.1% and sampling rate of 100 kHz. Details of instruments shall be finalized during design stage.

**ERTS 8.1.12.2** Other trains shall also have necessary provisions (suitable space, wiring etc.) for installation and recording power quality parameters as per para 8.1.12.1 above.

**ERTS 8.1.12.3** If Contractor proposes to measure the power quality parameters as mentioned in para 8.1.12.1 above, through TCMS. In such case, TCMS shall have the adequate capability of measuring and data acquisition to analyse higher order harmonics (up to 50<sup>th</sup>) and measure power quality parameters mentioned above with minimum accuracy of 0.1% and sampling rate of 100 kHz. Also, a suitable power analyser, software/analysis tool shall be built in. However, this proposal shall be subjected to approval of the Engineer.

**7.2.3.** The subcontractor shall fully meet the requirement of ERTS & ERGS for the proposed On board set up of Power Quality Measurement system for MRS1 contract.

**7.2.4.** In case supplier's proposal is in line with with ERTS 8.1.12.3, The sub contractor shall meet the requirements but not be limited to ERTS 10.3, 10.4, 10.6 & 10.7 with regard to TCMS interface.

**7.2.5.** The software supplied shall be compatible with latest Windows version and upgradable for higher versions of Windows as per ERTS 10.9.6

**7.2.6.** The sub contractor shall be fully responsible for integrated testing and commissioning including Commissioning Type tests and Commissioning Routine tests of the On board set up of Power Quality Measuring Instrument system at BEML works (Factory test) and at MRS1 site (Depot & Main line tests) for 6-car and 8-car train formation.

**7.2.7.** The sub contractor shall be responsible to maintain the DLP and commissioning spares at MRS1 site. The list of DLP and commissioning spares shall be furnished by the sub contractor for review and approval by BEML/ DMRC.

**7.2.8.** The sub contractor shall provide all the documents for MRS1 project and shall also provide any other documents required by DMRC

- a) System Details and technical description containing information on measuring component accuracy and overall measurement accuracy.
- b) Installation details with drawings.
- c) Operation and maintenance manual
- d) Spare parts catalogue
- e) Special tools & Testing equipment (if applicable)
- f) Any other documents requested by BEML/DMRC.


**7.2.9.** The sub contractor shall provide valid type test certificates/documents and routine test certificates/documents for the Components of Power Quality Measuring system.

**7.2.10.** The supplier shall ensure that maintain spares for at least 10 years from the date of completion of the contract as per ERGS 8.12.

**7.2.11.** The sub contractor shall provide training in operation and maintenance to BEML and DMRC staff.

**7.2.12.** Only 110V D.C. (+25%, -30%) or/and 230 VAC (1 phase) would be made available on train for power supply of On board set up of Power Quality Measuring system.

**7.2.13.** Sufficient memory capacity shall be built in to record the data of complete 6-car / 8-car train for

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a minimum of 24 hours. Provision for expanding the memory capacity by simple plug in of commercially available memory media shall also be available. The recorder shall have provision of safe shutdown during power supply interruption / shutdown. The Recorder, Analyzer tool should have the capability of adding different supplier system as well.

**7.2.14.** All the stainless steel items / enclosures shall be at least of grade SUS 316

**7.2.15. Software Update:**

Software update shall be provided free of charge during warranty period.

The subcontractor shall provide necessary support to resolve all pending or new interface related issues arising during the operation of the trains till completion of Defect Liability Period (DLP) which are expected throughout the project execution stage and shall extend up to 6 months after commencement of UTO operation based on operational requirements.

**7.2.16. Mechanical Interface**


The location of the mounting points and the design of equipment installation comprising of the On board set up of Power Quality Measuring system shall be defined by the Subcontractor and approved by BEML in order to avoid the mechanical interference with other equipment for the vehicle.

Subcontractor shall be responsible for confirming the mounting method and providing all materials for mounting the On board set up of Power Quality Measuring system as specified in the drawings. BEML shall be responsible for defining the technical and the design constraints and the technical requirements. The Subcontractor shall be responsible for the optimum design of the On board set up of Power Quality Measuring system, the submission of design information (drawings, technical documents and 3D modeling data) and the execution of test & inspection in a timely manner without any delay. Any changes of On board set up of Power Quality Measuring system design shall be submitted in a timely manner for approval. The Subcontractor shall have full responsibility to declare and clarify if there is any required information or data from vehicle side and/or running/operating conditions to prevent any design defect under revenue service in the main line.

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, ERTS, ERGS and Contract Specification, All such replaced or repaired shall be guaranteed for the remainder of the warranty period.

The following is a brief of requirements for Mechanical Interface

- Outline dimension.
- Electrical connection position.
- Fastening, point & torque.
- Demands, free space for installation and maintenance of cover.
- Weight and center of gravity.
- Earth position, size and type
- Thickness of flitting frame & Size and distance dimension of fitting hole.
- Cooling & clearance for ventilation
- Interface with interior facilities & train body
- Anti-vibration material such as rubber

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### 7.2.17. Electrical/Communication Interface

The following is a brief of requirements for Electrical Interface

- Power requirements.
- Technical specification.
- Rating, voltage characteristic and consumption.
- Cable specification (Power, control and grounding).
- Connector (male and female) with pin and socket part no.
- Connector/terminal arrangement
- Cable inlet/outlet diagram.(Size for cable gland of holes)
- Connector Working Procedure for Workmanship

### 7.2.18. Installation Details

We intend to measure the current from the incoming transformer cable routed inside the T-Car. The Power Quality analyser, data acquisition module and other accessories shall be suitably packed and be able to mount inside the car securely. The complete set shall be portable so as to retrofit in ease for the purpose of Power Quality analysis in the desired trains.

## 7.3. Commissioning and DLP Spares, Calibration etc.,

### 7.3.1. Spares

The subcontractor shall supply commissioning and DLP spares as per ERGS 8.11.

Subcontractor shall submit to BEML for review and approval of BEML/DMRC a list of minimum spare parts that he intends to make available during the installation, commissioning and defect liability period.

The Subcontractor shall keep on site, at his own cost throughout the installation, commissioning and defect liability 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.


### 7.3.2. Calibration

The subcontractor shall provide the calibration certificate, periodical calibration requirements table and if necessary to carry out calibration during commissioning and Defect liability Period without any additional cost.

## 7.4. Storage, Packing Crating and Marking

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

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

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The detailed requirements are specified in ERGS 13.

## 7.5. Fire Safety

The materials used shall conform to Fire Safety requirements of EN 45545 Part 1 to 7(Category 4-A, Hazard level HL3) latest editions as a minimum or better international standards applicable for similar applications.

## 8. Attachments

- i. ERGS
- ii. ERTS
- iii. Annexure-1 : Notice for No Objection (NNO) Format
- iv. Annexure-2 : Technical Offer Submittals check list.
- v. Annexure-3 : Specifications of Existing Protection class Transformer and 'input HV cable'.

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