






**Procurement Technical
Specification
of Fire Detection System**

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**Procurement Technical Specification
of Fire Detection System for MRS1**

Approved	09.10.2019	V SYLAJA	
Reviewed	09.10.2019	K NAGARAJ	
Prepared	09.10.2019	DEVESH KUMAR	
	Date	Name	Signature




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1. Introduction

1.1. General

This document, Procurement Technical Specification (PTS) describes the complete technical requirement of Fire Detection System to be supplied for cars under the 'MRS1' contract (hereafter MRS1). The Fire Detection System shall comply in all respects with MRS1 Employer's Requirements General Specification (ERGS) and Employer's Requirements Technical Specification (ERTS).

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 Fire Detection 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 Fire Detection System and the training of Operation and Maintenance personnel of the owner on the Fire Detection System. The scope also covers supply of spares, special tools, testing and diagnostic equipment, jigs and fixtures for maintenance, repair and overhaul of Fire Detection 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.

As per ERTS 1.1.8 & ERTS 1.4, during initial phase of the project, all trains (including prototype train) shall be tested and commissioned for GoA2 modes of automation. Upgradation of all trains to GoA3/GoA4 modes shall be done subsequently (refer Note No. 6. of 'Attachment to Appendix FB-1' to 'Form of Bid'). The interface testing may have to be done separately for line 2 & 7 of Mumbai Metro.

The Fire Detection System shall be suitable for Unattended train operation conforming to Grade of Automation-GO A4 as specified in IEC62290-1:2006 or latest, including the training of operating and maintenance staff of the BEML/DMRC, for line 2 and 7 of the Mumbai Mass Rapid Transit System.

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)

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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 Fire Detection System shall be suitable for 8 car formation in future. The design details and performance parameters of Fire Detection System for 8 car train shall be submitted by the subcontractor during design stage itself and got approved from the Engineer.


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 shown in the following Table. Accordingly the Fire Detection System shall be designed to operate with satisfactory performance under the following climatic and environmental conditions,

Description	Limiting Values
Maximum ambient temperature (See note 1 below)	36 °C
Minimum temperature	14.3 °C
Humidity (See note 2 below)	≥ 95% RH
Rainfall	The annual precipitation is 2,078 mm with 34 % (709 mm) falling in the month of July.
Atmosphere during hot season	Extremely dusty including bird feathers
Maximum wind speed	150 km/hr.
Vibration & Shocks	The 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.
SO ₂ level in atmosphere	80 - 120 mg/m ³
Suspended particulate matter in atmosphere (TSPM)	360 - 540 mg/m ³
Life	The Metro car is designed for min.35 year of life. Accordingly, the subject items & accessories shall also not deteriorate in their performance for 35 years

Note:

1. 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.
2. Any moisture condensation shall not lead to any malfunction or failure.


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3. Adequate margin shall specially be built into the design particularly to take care of the higher ambient temperatures, high humidity, dusty and corrosive conditions, etc. prevailing in Mumbai area.
4. Smoke/ heat detectors should be sturdy and suitable to be used in rail cars. Detectors shall not malfunction in train operation. These shall be suitable for the external environment of Mumbai.

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 ² 0.75 m/s ² 0.40 m/s ²
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 ² 0.80 m/s ² 0.45 m/s ²
Average Service braking rate from 80 kmph to standstill for fully loaded (AW3) train on level tangent track.		1.0 m/s ²
Average Service braking rate from 80 kmph to standstill for AW2 train on level tangent track.		1.1 m/s ²
Average Emergency braking rate from 80 kmph to 0 kmph for fully loaded trains on level tangent track		1.3 m/s ²
Jerk rate(Maximum)		0.75 m/s ³
Annual running distance of one train (for design purpose)		150,000 km

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1.4. Signaling System (ERTS clause 3.18)

Train control system	CBTC based On board Continuous Automatic Train Control system (CATC) consisting of i) Automatic Train Protection ii) Automatic Train Operation (ATO) iii) Automatic Train Super-vision (ATS) iv) Attended/Unattended train operation (GoA2/GoA3/GoA4)
Train control mode	i) Automatic mode ii) Coded Manual modes iii) Restricted Manual mode iv) Run on Sight mode v) Cut-out mode vi) UTO vii) Standby
Conditions in stations	All stations shall have Platform Screen Doors (PSD's). These doors shall not be of full height and shall have provision to allow free flow of air for platform ventilation.

1.5. Current Collection System (ERTS clause 3.17)

System Particulars	For all sections and depot
Supply Voltage System	25kV AC single phase 50Hz
Current Collection	Through Pantograph
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

1.6. Track structure Parameters (ERTS clause: 3.14)

The MRS1 cars will operate with the track parameters as specified in the following table:


Description	Elevated and At-grade Corridor		Underground Corridor
	Ballasted	Ballast less (DFF)	Ballast less (DFF)
Track Laying Gauge	1435 mm		



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Rail Type (Main Line & Depot)	60 EI (UIC 60) 880/HH	60 EI (UIC 60) 1080/HH	60 EI (UIC 60) 1080/HH
Rail Profile	UIC 861-3		
Inclination Of Rail	1 in 20		
Sleeper Spacing (Main line)	600 mm ± 10mm	600 mm ± 10mm	700 mm ± 10mm
Sleeper Spacing (Depot)	650 mm ± 10mm	Not applicable	
Ballast Cushion Depth(Main line)	300mm	Not applicable	
Ballast Cushion Depth (Depot)	250mm	Not applicable	
Standard Rail Length	13m and 18m	18m	
Rail Panel Lengths	Longer than 200m		
Minimum Radius of Curvature	200m-Underground 110m-Elevated 100m-Depot		
Minimum Turn out Radius.- (Main line)	1 in 9 - 300m radius 1 in 7- 190m radius		
Minimum Turn Out Radius Depot	1 in 7 - 190m radius		
Maximum Cant Permissible	110 mm		
Maximum Cant Desirable	110 mm		
Maximum Cant Deficiency Permissible	85 mm		
Maximum Cant Deficiency Desirable	85 mm		
Maximum Permissible Cant Gradient	1 in 440		
Maximum Desirable Cant Gradient	1 in 720		
Turn-out Speed : Turnout (1 in 9) R-300	45 km/h	45 km/h	40 km/h
Turn-out Speed : Scissors (1 in 9) R-300	45 km/h	45 km/h	40 km/h
Turn-out Speed : In Depots (1 in 7) R-190	35 km/h	35 km/h	25 km/h
Turn-out Speed : Turnout (1 in 7) R-190	35 km/h	35 km/h	25 km/h
Turn-out Speed : Turnout(1 in 12) R-410	50 km/h	50 km/h	50 km/h
Turn-out Speed : Turnout(1 in 12) R-410	50 km/h	50 km/h	50 km/h
Turn-out Speed : Turnout (1 in 8.5) R- 218	30 km/h	30 km/h	30 km/h
Turn-out Speed : Turnout(1 in 8.5) R- 218	30 km/h	30 km/h	30 km/h
Maximum Gradient Main Line	4%		
Maximum Gradient Depot Connection	4%		
Minimum vertical curve radius of curvature	1500m		

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1.7. Principal Notional Vehicle Dimensions/ Leading Particulars (ERTS Clause 4.3.2)


Description		Dimension
Gauge		1,435 mm
Maximum Length over body(including end-fairings)	DM car	22,010 mm
	T and M cars	22,010 mm
Maximum Length over couplers for all cars		23,000 mm
Maximum Width over Body		3,200 mm
Minimum Passenger Saloon Headroom		2,050 mm
Locked down pantograph height for 25kV AC cars from rail level at Car Centre Line		4,048 mm
Maximum Floor height above rail level of any unloaded vehicle		1,130 mm
Minimum Floor height above rail level of fully loaded vehicle		1,100 mm
Maximum height of coupler above rail level for unloaded vehicle		815 mm
Minimum height of coupler above rail level for fully loaded vehicle		740 mm
Bogie Wheel Base	Maximum	2400 mm
	Minimum	2200 mm
Distance between bogie centres	Maximum	15,100 mm
	Minimum	14,400 mm
Wheel diameters	New	860 mm
	Fully worn	780 mm
Maximum axle load		17 Tonne (including all tolerances as per IEC 1133-1992)

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), its 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.


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- **"Contract"** means the contract between Subcontractor and BEML in relation to the supply of Fire Detection System for MRS1 project.
- **"BEML"** means the Contractor to procure the Fire Detection System for MRS1 Contract.
- **"Subcontractor"** means the supplier of Fire Detection 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.
- "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 Fire Detection 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
FAC	:	Front Automatic Coupler
FMEA	:	Failure Mode Effects Analysis
FMECA	:	Failure Mode Effects and Criticality Analysis
FRACAS	:	Failure Reporting And Corrective Action system
FAI	:	First Article Inspection
ISO	:	International Standards Organization
ITP	:	Inspection Test Plan
LRU	:	Line Replaceable Unit
MRTS	:	Mass Rapid Transit system
MDBF	:	Mean Distance Between Failures
MDBCF	:	Mean Distance Between Component Failures
MTTR	:	Mean Time To Repair
NCR	:	Non-Conformance Report
PHA	:	Preliminary Hazard Analysis
RDSO	:	Research Design and Standards Organisation (Ministry of Railways)
SOD	:	Schedule of Dimension
SPC	:	Semi-Permanent Coupler
TCMS	:	Train Control Management System

For further abbreviations, please refer to APPENDIX-TC of ERTS

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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.

During the pre-final design phase, the subcontractor shall supply one original copy each of the standards and codes in form of searchable pdf format to BEML and DMRC representative.

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.

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The Subcontractor shall provide BEML with the drawings of component of Fire Detection 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

6.1. Proven Design (ERTS clause 3.2)

The proposed Fire Detection System by the sub-contractor against this PTS shall satisfy the "Proven Design" clause 3.2.2 of ERTS. The proposed system shall have been in use and have established its satisfactory performance and reliability on at least three mass rapid transit systems in revenue service over a period of three years or more (in each MRTS) either outside the country of origin in three different countries or in an MRTS in India.


The subcontractor shall manufacture and supply the Fire Detection System only from such manufacturing units that have supplied the Fire Detection System that fulfill the proven design requirements as above (Refer ERTS clause 3.2.2).

6.2. Qualifying Criteria (ERTS clause 3.2.2)

- (i) The subcontractor shall meet the qualification criteria as per ERTS 3.2.2.
- (ii) The subcontractor should be an OEM and should have carried out design and manufacturing of sub-assemblies and those sub-assemblies proposed for Fire Detection System shall be state-of-art & of proven design and shall have been in use and have established their satisfactory performance and reliability on at least three mass rapid transit systems in revenue service over a period of three years or more (in each MRTS) either outside the country of origin in three different countries or in an MRTS in India. Sub-systems/components used in existing rolling stock of an MRTS in India do not get automatically qualified for use unless specifically approved by the Engineer for this project. Proposed Fire Detection System should have been in service during the preceding three years or more in respect of Fire Detection System in similar metro system. 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 Fire Detection System shall be procured from the approved vendors 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.

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- (iii) The subcontractor shall clearly indicate in the reference list regarding supply experience of executed projects having GoA4/UTO mode.
- (iv) The subcontractor shall have established International Quality systems and certification like ISO 9001/ISO 14001/IRIS. The subcontractor shall submit supporting documents in this regard.
- (v) The subcontractor shall submit Inspection & Test Plan / Quality Manual followed.
- (vi) 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. The subcontractor shall submit detailed proposal in this regard.
- (vii) The subcontractor shall give an undertaking to supply spares for a minimum period of 10 years from the date of completion of the contract as per ERGS 8.12.

6.3. Vendor approval (ERTS clause 3.2.5)


Vendor approval from DMRC is mandatory for all sub-system suppliers. Accordingly the request for Vendor approval with all relevant references and details as per Vendor approval format (Refer Annexure-1) 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 vendor approval details submitted by the subcontractor.

7. Scope of Supply and Work

7.1. Hardware

The Subcontractor shall be responsible for the design, manufacture, supply, **installation support**, testing, commissioning and integrated testing of the Fire Detection System. The subcontractor shall provide all components related to the Fire Detection System, but not limited to, the following.

1. All components to meet the performance requirements of the Fire Detection System
2. Complete tools, Software, Hardware, Facilities, Jigs, Fixture diagnostic etc. for whole Fire Detection System shall be in line with contractual & Engineers Requirement.
3. Dust and Water-tightness and at least IP 65 or higher shall be ensured for all type of exterior equipment & enclosure/cubicles etc..
4. Enclosures & Mounting arrangements has to be provided by the subcontractor for the all the equipments supplied by subcontractor.
5. Cables between equipments:
 - i. Subcontractor shall supply if any special cable required **other than the following cables** between the FDS system equipments with the heat shrink tube, protective jacket, numbering tube, bundle name-tag, strain relief bushings, ferrules for terminal block and in case of lead cable, the brackets for fixing cable and fasteners must be supplied by the subcontractor.

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- a. Power cables (1.5 sq mm) for 110 V DC input power supply, Ethernet cables for train level wiring, multi-core shielded (2-core and 3-core 1.5 sq. mm.) cables (If required) for serial interface and fire-resistant two-core 1.5 sq. mm. shield cables for car-side wiring will be provided by BEML.
 - ii. Specification of cables proposed by the subcontractor shall be submitted with the tender. (Cables from sources approved by DMRC only will be used.) Specification and part no. of cables, inter-car Ethernet cable jumper assy. and jumper receptacle will be discussed and finalized during design.
 - iii. Cable Number/Tagging must be under transparent heat shrinkable tube and should have a life of 35 years. Same is also applicable for Name Plate or Name labels.
6. Mating connectors for vehicle side with all pins even if pin is not used, back shells and accessories.
 7. Non-screwed and self locking type connectors for complete system shall be ensured.
 8. Cable assembly instruction documents for Ethernet cables and any special cables etc.
 9. Unused connector shall be covered with protective cover plug (or dummy cap) to prevent dust form accommodating on the contacts.
 10. Earth pad / stud and fasteners for fastening (preferably which suits to M6 and 6 sq. mm. cable)
 11. Ethernet Jumper Receptacle and plug between two trains.
 12. Harness works of Ethernet connectors for the Fire Detection System (both equipment and vehicle sides)
 13. Name plates or Name Labels
 14. Rubber (packing or gasket) for the water-tightness when the subsystem or components are installed on the exterior of vehicle.
 15. One full set of connector and its contacts as mounted on the equipments for each car-type (DM, T & M cars) to carry out vehicle level voltage withstand test at BEML factory.

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

7.2. Mock-up (ERTS 4.2 & appendix TB)


~~The following mock-up shall be provided to End-user in accordance to ERTS 4.2 appendix TB requirement.~~

~~The subcontractor shall provide items and AUTO CAD/CATIA drawings applicable to Mock UP within the required date.~~

~~The subcontractor shall supply following materials to BEML Ltd Bangalore works by required date.~~

- ~~Dummy item of complete set of fire Detection system for DM-car including mounting fasteners~~

~~Note: Any design changes of Fire Detection system arising during Mock-up review and FAI shall be reflected in the production supplies.~~

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7.3. Simulator

NA

7.4. Deliverables

The subcontractor shall submit BEML all necessary documents and deliverables such as the detailed drawings, specification, calculations, back-up data, plan, procedure, reports, co-ordination & interface information which possibly affects performance, fitting for approval to the schedule accepted by BEML

i. Preliminary Design Review(PDR)

The Preliminary Design Review (PDR) shall include as following, but not limited to:

- a) Technical description of Fire detection System

ii. Pre-Final Design Review(PFDR)

The Pre-Final Design Review (PFDR) shall include as following, but not be limited to:

- a) Technical description of Fire detection System
b) Electrical Specification of Fire detection System
c) TCMS interface specification of Fire detection System

iii. Final Design Review (FDR).


The Final Design Review (FDR) shall include as following, but not be limited to:

- a) Test plan
b) Component type test procedure
c) Vehicle performance test procedure

7.5. Technical Requirement of Fire Detection System

The system requirements for Fire Detection shall meet, but not be limited to, the following sections in ERTS & ERGS:

- ERTS 1 Introduction
- ERTS 2 General Requirements
- ERTS 3 Design and Performance Requirements
- ERTS 4 Vehicle Body
- ERTS 6 Pneumatics, Air Supply & Brake System
- ERTS 7 Door and Door Control System
- ERTS 8 HV & Propulsion Equipment
- ERTS 9 Auxiliary Supply Equipment
- ERTS 10 Train Control Management System

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- ERTS 11 Heating, Ventilation and Air Conditioning
- ERTS 12 Electrical and Control Equipment
- ERTS 13 Communication System
- ERTS 14 Materials and Workmanship.
- ERTS 15 Inspections, Tests and Trials
- ERTS Appendix TA International Standards
- ERTS Appendix TB Car body Mock-ups
- ERTS Appendix TC Abbreviations
- ERTS Appendix TD Interfaces Between Rolling Stock, Signaling and Telecommunication Contractors
- ERTS Appendix TE Drawings and Documents
- ERTS Appendix TF Submittals
- ERTS Appendix TG Train Withdrawal Scenarios for 6-car Trains
- ERGS 2 Management plans
- ERGS 5 Design submission requirement
- ERGS 7 Inspection, testing and Commissioning
- ERGS 8 Supply of spares, special tools and Testing Equipment
- ERGS 9.1 Training Requirements
- ERGS 13 Storage, Packing, Crafting and Marking

Subcontractor shall submit the clause by clause compliance for the above chapters of ERTS & ERGS.


7.5.1. Basic requirements\Objective (ERTS 2.20)

The fire detection system shall be able to detect any fire originating inside the cars. The focus is on protection of passengers and staff in rolling stock. The objective is to detect incipient fires in an early stage in order to warn train operator/OCC.

A fire event shall be detected early during the development phase, the affected area shall be located exactly by identifying which sensor(s) is actuated and further system's actions shall be activated without any delay.

In case of fire, the entire air conditioning on the train must be switched off in order to prevent any transfer of smoke to other train parts. Ventilation shall be provided depending on whether the fire/smoke has been detected inside or outside of the passenger saloon area

The subcontractor shall provide the necessary hardware and software for detection of fire in the Metro Rolling stock.

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7.5.2. System design requirements(ERTS 2.20.1)

The fire detection system shall consist of dual smoke & heat detectors (multi-sensors) in passenger area, linear heat detectors (LHD) in technical areas (enclosures/cubicles) integrated with fire detection & control unit (FDCU). FDCU shall interface with TCMS in a redundant manner. The interface of the system shall be suitably ensured with overall system integration and GoA4 requirement.

All the major events (alarm, fault etc.) shall be recorded in TCMS and shall be retrievable on maintenance terminal for analyzing any issue.

The system shall provide a dynamic two detector dependency (smoke and/ or heat) in the passenger areas along with provision of drift compensation in order to decrease the risk of false or unwanted alarm.

Alarm sounder / beacons shall be provided in train at a suitable location as well as in OCC.

The subcontractor shall provide necessary diagnostic tools (software, hardware etc.) in order to identify failure immediately.

The system should generally be SIL2 compliant. Any change in SIL level shall be subject to the hazard analysis and acceptance or otherwise of the same by the Engineer whose decision shall be final and binding..

The Fire Detection system shall be able to permit addition of 2 cars, Trailer (T) and Motor (M) cars in the existing 6-car train set configuration and **software must support for 8 cars in addition to 6 car train set configuration.**

7.5.3. Fire Detectors (Smoke & Heat Detectors) for passenger area (ERTS 2.20.2)

Minimum 4 no. of smoke & Heat detectors (multi-sensors) shall be installed in passenger area of each car. The sensitivity of smoke detector has to fulfill the requirements of ARGE guideline. The actuating temperature of heat detector shall be settable according to the international norms and standards.

7.5.4. Linear heat detectors(LHD) for Enclosure/Cubicle (ERTS 2.20.3)


A linear heat detector suitable for Rolling Stock applications shall be provided in the electrical cabinets. The linear heat detector is to be actuated in case of any fire/overheating in the electrical cabinets.

LHD shall also be provided in underframe Electrical enclosures as mentioned in different chapters of ERTS. However, final decision on use of LHD/Heat detector in underframe Electrical enclosures will be taken during design stage.

ERTS 2.20.4

Provision for bypassing any fault/malfunctioning detector may be required, for which final decision shall be taken during design stage.

ERTS 2.20.5

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The number of smoke/heat detectors, LHD and their exact location may vary and shall be finalized during design stage.

The fire detector system and layout of the detectors should be able to meet the criteria for the performance to be as per the ARGE guidelines or any other applicable international standard.

ERTS 8.7.8 (VII): Transformer bushings shall be provided with heat-detectors/LHD unit as per ERTS clause 2.20.

ERTS 8.7.8 (VIII): Heat detectors/LHD on low voltage/high voltage terminal boxes linked to TCMS/fire detection & control unit (refer ERTS clause 2.20) so that their status is monitored. The above information shall also be logged in TCMS.

ERTS 8.9.12 (VI): Redundant Temperature/Heat sensor/LHD location shall be in proximity of IGBTs and shall be linked to TCMS/Fire Detection & Control Unit (refer ERTS clause 2.20) so that their status is monitored.

ERTS 8.10.12: Each traction motor shall be provided with redundant thermistor for determination of temperature of stator winding. It should be possible to replace the thermistors in the depot without lifting the car. Traction motor terminal boxes shall be provided with heat-detectors/LHD linked to TCMS/fire detection & control unit (refer ERTS clause 2.20) so that their status is monitored.

ERTS 9.2.14: Heat detectors/LHD in SIV and battery charger shall be provided and status shall be linked to TCMS/Fire detection & Control unit (refer ERTS clause 2.20) so that their status is monitored.

ERTS 11.10.3 (V): Heat detectors/temperature sensors shall be used and integrated to TCMS/Fire Detection Control Unit for real time monitoring of all connections/points of the HVAC cables in vicinity of return air duct.

ERTS 15.26.2: Fire Detection System Functional Tests

The aim of these tests is to prove functionality and positioning of smoke and heat detectors in passenger areas and heat detectors/LHD in electric cabinets (enclosures/cubicles). The tests shall conform to the requirements of the ARGE Guideline (Part-1 for "Fire detection in Rolling Stock" and Part-3 for "System functionality fire detection & fire fighting in Rolling Stock") or any other applicable international standard.

Type tests shall be conducted for the following:

- (i) Dual Smoke and Heat detectors (multi-sensors),
- (ii) Heat Detectors,
- (iii) Linear Heat Detectors (LHD).

ERTS 14.6.12: Enclosures/cubicles shall be provided with Linear Heat Detectors (LHD) or heat detectors (refer ERTS clause 2.20) to protect against any abnormal increase of temperature within the enclosed cubicles which may lead to risk of fire.


ERTS 10.1.5:

SIL Compliance

TCMS shall be SIL2 compliant for all vital and safety related control and monitoring functions including but not limited to the following hardware, software and control functions:

VATC (Vehicle Automatic Train Control) operation mode (ATP, ATO and UTO etc.),

Fire alarm transmission via VATC,

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ERTS 11.2.10: Provision shall be made to shut off the fresh air intake and re-circulate the internal air of the saloon, during an emergency condition, such as fire outside the train causing excessive heat and smoke to be drawn into the vehicle. Operation of such provision shall be made from the OCC in UTO mode of operation and from operative driving console in non UTO mode of operation. The closing time of the fresh air damper shall preferably be less than 10 seconds from the receipt of smoke signal to avoid ingress of large quantity of smoke inside the car. Location of the smoke detectors and the logic for smoke signal shall be designed in such a way that possibility of false alarm is avoided. Full details of the system proposed shall be given. Provision shall be available to bypass the smoke detectors though TCMS.

7.5.5. Others.

In the event of any additional requirement of component/aggregate required for smooth operation of the Fire detection system the same shall be provided by the subcontractor.

The subcontractor shall provide valid type test certificates/documents and routine test certificates for the Fire detection system aggregates.

The subcontractor shall be fully responsible for integrated testing and commissioning of the Fire detection system and **software must support for both 6 car as well as 8 car train set configuration** at BEML works and at MRS1 site.

The subcontractor shall be responsible for interfacing with all other aggregate suppliers for integrating the system.


The subcontractor shall share complete details of fire detection system with the 3rd party fire consultant nominated by BEML for evaluation & certification of the FDS system.

The subcontractor 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 subcontractor for review and approval by BEML/DMRC.

The subcontractor shall provide relevant hardware such as bolts, nuts, washers and other fasteners required for the installation.

The subcontractor shall provide following documents and shall also provide any other documents required by BEML/ DMRC.

- a) Description of Fire detection system aggregates with drawings.
- b) Quality assurance plan (QAP)
- c) Software quality assurance plan (SQAP)
- d) Type test procedure for the Fire detection system and aggregates
- e) Routine test procedure for Fire detection system and aggregates
- f) EMI/EMC test procedure & plan
- g) Factory tests , Depot tests and main line test procedures
- h) Testing and commissioning plan

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- i) Type test and Routine test reports
- j) Operation and maintenance manual
- k) Spare parts catalog

The supplier shall maintain the Fire detection system aggregates and supply of spares for at least 10 years from the date of completion of the contract.

The subcontractor shall provide training in operation and maintenance to BEML and DMRC/MRS1 staff.

All drawings, documents and information by Subcontractor shall be prepared in English and submitted to BEML/DMRC for approval.

7.6. Split of Responsibilities

When subcontractor submits the design submission, BEML will complete the review of the design package at the intermediate and each design levels after which the review comments in writing or on marked-up drawing and specification will be furnished to the subcontractor within 2 weeks. If the design submission is acceptable to BEML, it will be submitted to end user for approval and it will be reviewed by them for 4 weeks. Subcontractor shall re-submit the revised document incorporating end-clients comments issued during first review within 2 weeks, if any. Subcontractor shall supply requested documents / drawings during approval process within 1-2 weeks from each request. Subcontractor must establish the project schedule (including design completion schedule) by considering this review turnaround time.

In the event that the submission is rejected the subcontractor shall improve the design to the acceptable completion level and resubmit it for review within 1-2 weeks. Any adjustment in design activities to recover the lost time due to the resubmission shall be the full responsibility of the subcontractor and shall submit the catch-up plan for no schedule impact.


Upon receipt of the review comments, the subcontractor shall resubmit the updated documents and drawings, if required these documents must be supported through other calculation / drawings document. Each re-submission shall be enclosed with response sheet format of response sheet will be advised by BEML during the design review process. For avoidance of doubt, in any case reply of subcontractor along with revised documents incorporating end-client request shall be submitted not later than 2 weeks.

The subcontractor shall be responsible for meeting the requirement of constructional details, material, and workmanship. All materials and workmanship shall be in every respect in accordance with the proven up-to date best practice.

The subcontractor should take whole responsibility for occurring liquidated damage due to delays with regard to design data submission, production, supply, design error and so on.

7.7. Interface

Fire Detection system has to interfaced mechanically and electrically with different subsystems such as car structure, interior, exterior & cab equipment layout arrangement, interior panels, Vehicle Control Circuits, communication system, HVAC, TCMS etc., The subcontractor must participate in the interface meeting/workshops in order to discuss and finalize the interface issues to the satisfaction of BEML/Engineer and shall be implemented in the system design.

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7.7.1. Mechanical Interface

The location of the mounting points and the design of equipment installation comprising of the Fire Detection 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 Fire Detection 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 Fire Detection system, the submission of design information (drawings, technical documents and 3 dimensional modeling data) and the execution of test & inspection in a timely manner without any delay. Any changes of Fire Detection 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, TS, GS 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.


7.7.2. Electrical Interface

The subcontractor shall provide the interface specification between Vehicle equipment, TCMS.

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

The following is a brief of requirements for Electrical Interface

- Power requirements.
- Technical specification.
- Rated current, voltage characteristic and consumption.
- Cable specification (Power, control and grounding).
- Connector (male and female) with pin and socket part no.
- Signal input/output list and interface specification.
- Connector/terminal arrangement

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- Cable inlet/outlet diagram. (Size for cable gland of holes)
- Connector Working Procedure for Workmanship

The following is a brief of the requirements for TCMS.

- Control circuit logic shall permit testing and monitoring of the operation
- Carrying out self-tests to ensure the integrity of equipment
- The status and fault information shall be transmitted and recorded in TCMS.

7.7.3. Interface Responsibilities

The location of mounting points and the design of equipment installation comprising of the Fire Detection system shall be defined by the Subcontractor and approved by BEML 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 shall be responsible for defining the technical requirements and the design constraints.

The Subcontractor shall be responsible for the design of the Fire Detection system and the submission of design information and the performance of testing activities and the supply, installation and commissioning of Fire Detection system and the maintenance and rectification of the Fire Detection system during the defects liability period, etc. The Subcontractor shall be responsible for the hardware interface required by BEML. The Subcontractor shall be responsible of deputing his engineer to BEML for the technical meeting.

1. ERTS 12.4.3

Control equipment panels inside the Car/Cab shall be with IP53 or better protection level. Main and auxiliary contacts of contactors and relays shall be with adequate protection against dust ingress. The distribution panel in the underframe shall be with IP65 protection. The IP of display & indicators shall be not less than IP 53.

2. ERTS 12.4.4

The panels with components shall be tested in accordance with IEC-60077, IEC-61373 and IEC-60529

3. ERTS 12.5.6


The proposed cables shall be proven on Metro Rolling Stock. The subcontractor shall submit the voltage grade, size and type of cable for different applications along with the proposed specification for the cable for review by the engineer.

4. ERTS 12.7.5

An earth fault detection system shall be proposed by the subcontractor for review. Protection devices shall also prevent fires resulting from short circuit, or other electrical defects.

5. ERTS 12.7.8

Earth fault protection shall be provided on control, auxiliary and traction power circuit, so that it shall be possible to continue operation for a limited period even where there is one

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earth fault on the circuit. For this purpose, the earthing of the circuits may be provided through the coils of earth fault detection relays and the supply battery.

6. ERTS 14.1.5

All relays/MCBs/equipment etc. shall be suitably de-rated for specific temperature including the proximity effect.

7. ERTS 14.12.1

Following type test shall be carried out on electronics used in the train. As a minimum, all electronic equipment shall comply with IEC 60571/EN 50155: Electronic equipment used on rail vehicles, for design, manufacture and testing, and shall use components purchase against an internationally recognized quality assurance and reliability certification procedure.

- i. Dry heat test: The dry heat test shall be conducted for class T3 and temperature shall be considered 80°C against 70°C specified in IEC/EN. An extra performance check at 95°C shall also be carried out for 10 minutes over temperature value. LCD/LED display unit may be tested into 70°C and an extra performance check at 85°C shall also be carried out 10minutes over temperature value.
- ii. Salt Mist test (ST3 category)
 - a) Cycle Humidity test (IEC 60571).
 - b) Dust and sand test & Mould growth tests: The test shall be done as per IEC 60068 & IEC 60721. The dust settlement rate shall be taken as 6gm/m²/day and dust particle size shall not be larger than 100 microns.

8. ERTS 14.17.4

The labels shall be clearly stamped, cast or engraved and securely attached to the equipment. Where appropriate, equipment shall be labeled with warning of high temperature and electric shock risk. Warning labels shall be multilingual (regional language (s) and English and/or Hindi).

7.7.4. TCMS communication Interface

The following is a brief of requirement for communication interface


- Control circuit logic shall permit testing and monitoring of the operation.
- Carrying out self-test to ensure the integrity of the equipment
- The status and fault information shall be transmitted and recorded to TCMS
- Possible to download TDR data from TCMS.

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

BEML and the subcontractor will comply with and be responsible for the interface requirement and develop the interface specification on his scope of supply.


The Critical requirement of TS must be reviewed and complied fully by Sub-contractor.

7.7.5. During Neutral section Opening/Closing, Fire Detection System functionality will not be

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affected/ disturbed.

- 7.7.6.** Selection of LHD or Heat detector at applicable/appropriate location will be finalized during design stage based on taking consideration of feasibility and other constraints.
- 7.7.7.** The subcontractor shall fully meet the requirement of ERTS & ERGS for the proposed Fire Detection system for MRS1 contract.
- 7.7.8.** The Fire Detection system shall fully meet the requirement of EMI/EMC as per ERTS 2.17, ERTS 15.27 (EMC Testing).
- 7.7.9.** All the equipment must comply clause 2.16.1 of ERTS i.e. No degradation of performance shall be permissible during the tests.
- 7.7.10.** The subcontractor shall comply with the Noise & Vibration requirements as specified in ERTS 2.18 & 15.25.
- 7.7.11.** The subcontractor shall comply with the RAMS requirements as specified in ERTS 2.
- 7.7.12.** Fire Detection system shall have its own data terminal port for fault downloading / software uploading (Including application software/firmware) both at Fire Detection system and TCMS for single point downloading/uploading as per ERTS 10.9.2, 10.9.5.
- 7.7.13.** The Fire Detection system shall have provision of single point downloading the data log stored in the internal memory using TCMS interface as per ERTS 10.9.2, 10.9.5.
- 7.7.14.** Time stamping of date of software(s) as well as version of software(s) used in different subsystems of the train and their compatibility shall be ensured by TCMS as per ERTS 10.6.4.
- 7.7.15.** All the software(s) used in train, diagnostics, monitoring or analysis purpose shall be compatible with latest Windows version and upgradable for higher versions of Windows as per ERTS 10.9.6
- 7.7.16.** The sub contractor shall be fully responsible for integrated testing and commissioning including Commissioning Type tests and Commissioning Routine tests of the Fire Detection system at BEML works (Factory test) and at MRS1 site (Depot & Main line tests) for 6-car and 8-car train formation. **Software should be compatible for testing of 6 car as well as 8 car train set configuration without any problem.**
- 7.7.17.** 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.
- 7.7.18.** The sub contractor shall provide all the documents for MRS1 project and shall also provide any other documents required by DMRC as per ERGS 2, ERGS 5, ERGS 6, ERGS 7, ERGS 8, ERGS 9, ERGS 12, Appendix- 4, 6, 7 & 9 of ERGS and ERTS 13.
- a) Design documents – Preliminary, Pre-final & Final.
 - b) Description of Fire Protection system with drawings.
 - c) Quality assurance plan (QAP)
 - d) Software quality assurance plan (SQAP)
 - e) Type test procedure for Fire Detection system and aggregates
 - f) Routine test procedure for Fire Detection system and aggregates
 - g) Inspection and test plan (ITP)
 - h) Factory tests , Depot tests and main line test procedures

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- i) Testing and commissioning plan
- j) Interface plan
- k) Type test and Routine test reports
- l) Operation and maintenance manual
- m) Spare parts catalogue
- n) Special tools & Testing equipment
- o) Any other documents requested by BEML/DMRC.

7.7.19. The sub contractor shall provide valid type test certificates/documents and routine test certificates/documents for the Fire detection system aggregates.

7.7.20. The supplier shall maintain the Fire detection system aggregates and supply of spares for at least 10 years from the date of completion of the contract as per ERGS 8.12.

7.7.21. The supplier shall provide the spares of Fire Detection system aggregates as per Annexure-2 according to Cost center G.

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

7.7.23. The subcontractor shall provide the complete software documentation including source code details and developmental details as per ERGS 6.6, ERTS Chapter 13, 14.14 & GCC 5.8. The software & the source code shall be deposited in a locker and maintained by BEML/-DMRC.

7.7.24. Only 110V D.C. (+25%, -30%) would be made available on train for control power supply of Fire Detection system. The Fire Detection system shall continue to operate correctly with the 110 V DC car battery voltage supply as per ERTS 12.1.1 and 12.3.2.

7.7.25. ERTS 12.2.3: The control logic shall ensure that the vital train control functions (such as couplers, door system, brakes, propulsion power removal, PEA etc.) are executed using conventional relay control and dedicated hardwired train line signals. All vital circuits including above shall be double wire, double break. The identified safety critical signals shall be carried using redundant train line pairs.

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

7.7.27. Interface with TCMS shall be Ethernet based communication system with TRDP protocol or latest version and shall be compliant to a common standard or standards as per ERTS 10.3.3 & 10.2.1.


In addition to Ethernet interface, hard wire communication is also required between Fire Detection System & TCMS.

7.8. Software

7.8.1. Software Update:

Additional software update due to DMRC's requirements shall be made free of charge during warranty period. The sub-contractor shall support (free of charge) and update all software pertaining to Fire detection System and any other required software until the system becomes stable and the Employer satisfies with the system. It includes both subcontractors' error and the Employer's any reasonable requests.

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

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(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.

7.9. Testing

The Subcontractor shall carry out, as a minimum, the followings for Fire Detection System.

- (1) Routine and type tests of Fire Detection System.
- (2) Type complete vehicle tests for Fire Detection System of the first train-set
- (3) Type Commissioning test Fire Detection System of the first train-set

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

- (1) Routine complete vehicle tests for Fire Detection System of each Train.
- (2) Routine commissioning test for Fire Detection System of each Train.
- (3) Service Trials.

Testing & commissioning shall also be included for the following:

- (1) ARGE test.
- (2) FDS function test.
- (3) LHD integrity test for Cubicle/ enclosure.

The detailed requirements are specified in the ERGS 7 & ERTS 15.


7.10. Operation and Maintenance Manuals and Spare Parts Catalogues

The Subcontractor shall provide the Operation/Maintenance Manuals and Spare Parts Catalogues of the Fire Detection System both in the hard copies and electronic format. The requirement for Operation/Maintenance Manuals and Spare Parts Catalogues shall be provided for Approval of BEML according to the time schedule defined by BEML.

7.11. Spares, Special Tools and Testing Equipment

7.11.1. The Subcontractor shall hand over the Spares, Special tools and testing equipment in accordance with the delivery schedule of BEML. The Subcontractor shall supply the following items of spares (as per Annexure-2, in line with Cost centre G)

- (i) Unit Exchange Spares
- (ii) Consumable spares for maintenance of all trains during commissioning, service trials and up to completion of Warranty period
- (iii) Mandatory spares
- (iv) Recommended spares
- (v) Overhauling spares

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(vi) Special tools, Testing and Diagnostic equipment

(vii) Special Jigs, Fixtures & Gauges required for maintenance, repair and overhaul of various equipment, sub-systems in particular and the complete trains in totality

The detailed requirements are specified in ERGS 8.

7.11.2. Employer at his sole discretion may exercise the option to increase/decrease the quantities (to any extent) of spares indicated under milestones G1, G2, G3, G4, G5 and G6. For increased quantities, payment to the subcontractor shall be on the basis of actual supplies made and quoted unit rates and no escalation or any other additional sums shall be payable. Any decrease in quantities, if considered by the Employer, shall be intimated by Employer within two years of the commencement date. However increase in quantities may be intimated at any time during the execution of Contract and the delivery period for the enhanced quantities only shall be mutually agreed

The actual requirements (list & qty) as per above MRS1 cost centre 'G' contract conditions are subject to DMRC/BEML approval. The subcontractor shall comply with the same.

7.12. 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. The detailed requirements are specified in ERGS 13.

7.13. Training


The subcontractor shall provide the training for DMRC's operating staff and maintenance staff. The training activities and works shall be approved by BEML.

The detailed requirements are specified in ERGS 9.

The Subcontractor shall provide the training materials (presentation, student guide, Instructor's guide) and training activity for the required days to assure that the Employer's staff is thoroughly trained in the operation, maintenance, and overhaul of the equipment supplied under this PTS. The Subcontractor shall propose the required days for the supplied equipment for Operation and Maintenance staffs.

Additionally the Subcontractor shall be quoted on daily basis for the further training course for Employer's staffs.

1) The subcontractor shall submit CV of instructor and training material of proposed

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training at least 6 weeks in advance of actual training schedule.

- 2) Subcontractor shall depute the trainer(s) to the end user works/depots at Mumbai and/or BEML's plant for based on the relevant duration of each training course.
- 3) The Subcontractor shall provide the training according to BEML's Training Plan for End user.
- 4) The Subcontractor shall provide, but not be limited to, training materials (Hard copies & Electronic files), tools and equipment.
- 5) In addition to the training material, subcontractor shall provide computer based interactive tutorial module. These interactive tutorials modules may include animation, videos, flash programs, etc.
- 6) Repair service training should provide the explanation and practical experience about the technical competence and operation of the system for the trainees who are responsible for troubleshooting and repairs.
- 7) Subcontractor should provide training program about operating and maintaining all the system devices provided. Training should be provided enough so that the corporate personnel may practice and learn how to use the operation, interface with other devices and testers.
- 8) The program should also contain the theoretical background and practical experiences for troubleshooting, repairing procedure and preventive maintenance to the trainees, who should be provided with the training about personally operating the systems and using testers/maintenance devices in case failing to troubleshoot.
- 9) Sub-contractor shall also submit training evaluation module
- 10) The training material and the entire training program shall be approved by BEML.
- 11) Subcontractor shall propose necessary hours for each subject.
- 12) If End user or BEML request more training courses, subcontractor should provide them.
- 13) All expenses for trainings are to be borne by Subcontractor.


The Technical Documents and Training section, specification requires some very specific guidelines for the development of the technical documentation. These guidelines are but not limited to the following:

This section lists extensive requirements for the development and implementation of the training.

- (a) Specifies include;
 - General Program Outline

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- Instructor Manuals with Lesson Plans
 - Participant Manuals
 - Supplemental training materials
 - Training aids
 - Classroom attendance requirements
- (b) Specific Objectives for operating and maintenance personnel;
- Proficiency in operation, inspections, maintenance, servicing, troubleshooting and repair of FDS to instruct and train other personnel
 - Qualify individuals as Qualified Maintenance Person (QMP) or Qualified Person (QP)
 - i. Daily and periodic inspections
 - Understand and effectively use the technical documents developed
 - Select, order and stock replacement parts
- (c) Course Categories
- Introduction and Familiarization
 - Major systems and sub-systems
 - Operation and fault isolation
 - i. Fault isolation via TCMS/Hardware switches
 - Servicing and maintenance
 - i. Detail maintenance and fault isolation via TCMS/Hardware switches
 - Special tools and test equipment
- (d) Personnel by function
- Maintenance
 - i. Field – daily inspections and running repairs
 - ii. Electrical
 - iii. Non-electrical
 - iv. Shop – periodic inspection and heavy repair
- (e) Classroom and hands-on
- Sufficient time in both to do all diagnostics correct malfunction and use special tools
- (f) Instructor qualifications
- Fluent in English
 - Experienced trainers
 - Adult education techniques

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(g) Lesson Plans to include:


- Student prerequisites
- Safety, fault isolation and inspections up to 5 year level
- Time frames for each unit
- List of training aids and other training technology
- Set-up time and equipment lists for hands-on
- Safety, protective equipment, hazards
- Instructor preparation
- Student preparation
- Evaluations of students
- Lesson summary
- Student application of material
- Student assignments

(h) Training Aids and Standards (all training aids and lesson plans become the property of End-User)

- Manuals, catalogs, OEM's
- ii. Fire Detection system compatible format (no overhead projections)
- iii. Specifics – visual aids
 - b) Component locations, cut-away, schematics, wiring diagrams
 - c) Flow direction on hydraulic, pneumatic, air conditioning
 - d) Maintenance schedules, diagnostic process diagrams, special tools usage, test equipment application
 - e) Engineer approval electronic medium for review
- iv. Mock-ups units for hands-on
 - a) Nomenclature, operation, inspection, maintenance, troubleshooting repairs
- v. Training aids list
 - a) Test equipment considered training aids used to troubleshoot, diagnose, inspect, vehicle operation except meters, meggers, oscilloscopes, laptops)
 - b) Actual mechanically-operable devices without dismantling – non-examples as diagrams, cut-away views
- vi. Schematic wiring diagrams sectionalized – single line functional diagrams for each system and component

(i) Classroom Instruction:

- Outlined in classroom and hands-on information

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- Qualified instructors

(j) Field Instruction

- Instructor must be qualified
- All materials available and ready
- Access to cars per authority
- Participants must demonstrate competency


It is subcontractor's responsibility to provide sufficient support and information for obtaining No Objection Advice for Training pertaining to sub-supplier in accordance with GS.

7.14. Engineering Support

Subcontractor shall depute the engineer(s) for the following;

- 1) The Subcontractor shall depute the technical experts for design review meetings and for technical discussions to sort out design / technical issues whenever required. Following are tentative meetings duration which might be required during design approval.
 - CDR meeting: 2 ~ 3 days
 - PDR meeting: 2 ~ 3 days
 - PFDR meeting: 5 ~ 6 days, two times
 - FDR meeting: 8 ~ 10 days, two times
 - Other interface meeting, if necessary with TCMS, HVAC & PA/PIS system etc.
- 2) Installation guide for first train: Depending on manufacturing schedule
- 3) Testing
 - Equipment Type / Routine test (at subcontractor's place)
 - Combination test with TCMS at any time whenever required
 - Factory Acceptance (Complete car) test: Full support depending on the test schedule
 - On-Site (Depot at Mumbai & Mainline) Test: Full support depending on the test schedule
 - Subcontractor shall provide additional days to resolve faults and defects of Fire Detection system.
- 4) The Subcontractor shall depute the design engineer(s) / technical experts for design review meetings and for technical discussions to sort out design / technical issues as per above requirements. All costs related to the meetings shall be borne by the Subcontractor.

8. General Requirements

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8.1. Weight

8.1.1. Target Weight Limit

The subcontractor shall specify the following equipment weight limit.

<i>Items</i>	<i>Weight</i>
Fire Detection System	
(1) Fire Detection Control Unit(FDCU)	
(2) Heat & Smoke Detector Unit	
(3) Linear Heat Detector(LHD)	
(4) Alarm sounders / Beacons	

8.1.2. Subcontractor Weight Control Activity

- (a) Experience equipment actual weight report.

The subcontractor shall provide the actual weight and basic specification of all equipment within two weeks after contracting that subcontractor has already manufactured for mass production in last five projects.

- (b) Monthly Weight Progress Report.

The subcontractor shall also submit the weight and center of gravity revision history sheet to BEML on a monthly basis that includes previous figure (weight and center of gravity) of breakdown list, updated figure, the detail reason about updated figure etc.

If the subcontractor were required the evidence by BEML such as weight calculation data, center of gravity calculation data etc, and the subcontractor should provide the evidence.


- (c) Equipment Weighing Test

The subcontractor shall submit the actual weight of equipment to BEML on a monthly basis during manufacture stage.

The actual measured weight must not deviate by +0/-4% of the estimated weights. Overweight tolerance is not permitted.

8.2. Electrical Requirement

- a) Load current for minimum switching of each switch, relay and contactor to sub-system should be over 10mA.
- b) Scope of mating connector assy.
 - Mating connector such as plug or receptacle including accessories (pin / socket / clamp / back shell) should be supplied for train side connectors.
 - All the part number of connector assy. should be listed in the bill of material
 - Connector pin or socket crimp size should match with train side cable conductor size. And electrical capacity should be considered and selected under responsibility of sub-system supplier.

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- Unless otherwise mentioned, each control line and communication/signal line of train side is 1.5 sq. mm. cable conductor size. However, power cable will depend on system's load capacity.
- Contact material of connector shall be gold-plated.
- c) Scope of wire/cable.
 - Any other special cable for connection of Fire Detection system than regular cables supplied by car builder shall be supplied by subcontractor.
 - If the subcontractor supplies its product as a "harness system", the same has to be informed and supplied drawings need to clearly indicate it.
 - 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.
- d) Surge Suppressor
- e) All relays, contactors and magnet valves such as inductive loads should have suppressor to be protected by arc. The kind of suppressor can be used with varistor, diode or others.
- f) Subsystem should have an obligation to inform the rating/inrush current and time constant to train side regarding each load when requested.
- g) Circuit breaker installed on train side is for circuit wiring. If system needs a sensitive circuit protection such as fuse or others, it is restricted to install into their own system.
- h) All the workmanship guides to ensure the subcontractor's system functionality associated with shielding method, connector crimping, protection methods against electrical interference should be supplied to car builder in order to get a proper application when requested.
- i) Except for electronic equipment, all cable termination shall be of the crimped type in accordance with BS 4579: Part 1: 1988, Compression joints in copper conductors, or other service proven type. Soldered connections will not be accepted as per ERTS 14.8.1.
- j) Variable resistors shall be avoided wherever possible.
- k) The requirement of Microprocessors and Software-based Equipment shall be met as per ERTS 14.13.
- l) The requirement of PCB and connectors shall be met as per ERTS 14.15.
- m) All electrical circuits shall be fully insulated from the superstructure on both the positive and negative sides and the super-structure shall not be used as any portion of an earth return circuit as per ERTS 12.7.7.
- n) The subcontractor shall meet the requirements of ERTS Chapter 14: Material and Workmanship although other requirements are not described here in PTS.

8.3. Fastener Requirements

- a) Normally screw threads smaller than M5 size shall not be used. Screw and bolt heads shall be of hexagonal form on all M5 and larger screws. Screws smaller than M10 shall be of high tensile material.

8.4. Label Requirements

- a) All items shall be labeled in English with the maker's name and type and form of the piece or item, discrete serial number and rating data and the date of manufacture of the particular piece of equipment. It is desirable that the labels used for different equipment / subsystems / systems on the train are of standard pattern.

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- b) The labels shall be clearly stamped, cast or engraved and securely attached to the equipment. Where appropriate equipment shall be labeled with warnings of high temperature and electric shock risk. Wiring labels shall be multilingual (regional language(s) and English and/or Hindi) as per ERTS 14.17.

8.5. Product breakdown structure

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

Breakdown of the material used in each component include:


- Identity
- Equipment name
- Quantity in vehicle
- Supplier part number
- Part Price(for LCC calculation)
- Quantity recommended for spare part

8.6. Project Management

Along with the technical offer, the subcontractor shall submit a Project Management Plan which shall provide a clear over-view of the Contractor's organization, the management system and methods to be used for completion of the works. The organization resources for the design, procurement, manufacture, installation, testing and commissioning, and setting to work, shall be clearly defined.

The Project Management Plan shall provide the following information.

- A diagram showing the organizational structure for the management of the Contract, with locations, names and position titles of staff and their line and staff relationship. The diagram shall include associate organizations and sub-suppliers and show clearly the individuals and lines of responsibility linking the various groups. It shall also identify the persons designated as contacts with BEML.
- The names, qualifications, positions and current resumes of key executive, supervisory and engineering staff to be employed full-time for the works.
- A narrative describing the sequence, nature and inter-relationship of the main Contract activities including timing for exchange of information.
- Procedure for documentation control.

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- The subcontractor shall nominate a suitably qualified and experienced English speaking engineer from his staff to be Project Manager. The proposed Project Manager shall have total experience of minimum 15 years and shall have been the Project Head in at least one Rolling Stock Project in last 10 years. The proposed project Manager shall be the employee of the subcontractor. The CV of the Project manager shall be submitted along with the technical offer.
- To fulfill the subcontractor's obligations during the Testing and Commissioning and the Defect Liability Period, the subcontractor shall nominate experienced maintenance engineers and organize deployment before undertaking testing and commissioning in depots at Mumbai. Separate maintenance engineer shall be positioned in each depot.
- The subcontractor shall submit relevant CVs of the Design Manager, Production Manager, Quality Manager, Interface Manager and Maintenance Engineer in addition to the Project manager in the technical offer.

8.7. RAMS requirements

The sub-contractor shall meet RAMS (Reliability, Availability, Maintainability and Safety) requirements given in the ERTS and the ERGS. 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:

8.7.1. Reliability Analysis

The reliability data shall be based on actual operating information for the equipment.

In addition, the subcontractor shall submit a list of typical train withdrawal scenarios as per ERTS Appendix TG 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 submitted to 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.

The subcontractor shall submit reliability prediction to demonstrate by quantitative methods above the achievement of the specified levels of reliability for the scope of supply.

8.7.2. Reliability Target

The fleet average levels of MDBF, during Defect Liability Periods are as specified in Clause-2.8.2 of ERTS.

Duration	Minimum fleet average MDBF (train-km)
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After 6 months of start of revenue service plus stabilization period of 6 months as per ERTS 2.8.2 (iv)	1,00,000
After 12 months of start of revenue service plus stabilization period of 6 months as per ERTS 2.8.2 (iv)	1,25,000

The sub-contractor shall achieve the following two reliability targets during Defect Liability Periods specified in ERTS 2.8.

The MDBCf (Mean Distance Between Component Failure) per 6 car train-set shall be as follows:

Equipment	MDBCf(train-km)
After 6 months of start of revenue service plus stabilization period of 6 months as per ERTS 2.8.2 (iv)	17,50,000
After 12 months of start of revenue service plus stabilization period of 6 months as per ERTS 2.8.2 (iv)	21,00,000

* Operation Conditions as per ERTS 3.22

- Annual Operation Distance : 150,000 km

The reliability performance shall be assessed by the following measure:

$$MDBCf = \frac{\sum \text{Travelled kilometer per train set}}{\sum \text{Number of Service Failures}}$$


Where,

Mean Distance Between Component Failure (MDBCf): The MDBCf 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 relevant failures occurring within the population identical items.

Service Failure: Any relevant failure or combination of relevant failures during revenue service operations, simulated revenue operations, or during pre-departure equipment status checkouts to determine availability for revenue service, which results in one of the following:

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

Pattern Failure: Repeated occurrence of three or more relevant failures of the same replaceable part, item or equipment in same manner in identical or equivalent applications when they occur at a rate which is inconsistent with the predicted failure rate of the part, item or equipment.

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The detailed methodology for identification of pattern failures shall be finalized during the design stage. The decision of the Engineer shall be final.

The sub-contractor shall submit 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.

For each case of de-boarding of commuters on account of reasons attributable to the subcontractor, Employer may at his sole discretion impose a penalty of Rs 15 lakh. Engineer's decision to impose the penalty shall be final as specified in ERTS 2.7.9. Same will be imposed on the subcontractor.

8.7.3. Maintainability Requirements

8.7.3.1. 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.


8.7.3.2. Maintenance Interval

Maintenance Type	Interval (Service time or Running Distance)
A Service Check	Every 15 days or 6,000km
B1 Service Check	Every 45 days or 18,000km
B4 Service Check	Every 180 days or 72,000km
B8 Service Check	Every 360 days or 150,000 km
Intermediate Overhaul	Every 3 years or 450,000km
Periodic Overhaul	Every 6 years or 900,000 km

Preventive Maintenance Interval should be compliance with the interval specified in the above table.

8.7.3.3. Maintainability Target

- 1) The LRU replacement should be less than 30 minutes
- 2) The mean time to repair (MTTR) of equipment should be less than the specified value as follows:

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Equipment		MTTR (hour)	
Fire Detection System		1.2	


- 3) Corrective Maintenance Operation that does not require car lifting shall be less than 4 hours as per ERTS 2.12.12.
- 4) Corrective Maintenance Operation that does require car lifting, excluding time required for shunting shall be less than 6 hours as per ERTS 2.12.12.
- 5) The Least Replaceable Units (LRU's) for the equipments/systems should not take more than 30 minutes for replacement. In order to achieve this requirement, quick release connections such as plugs and adaptor shall be provided between LRU's and the equipment

8.7.4. 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 to be provided by BEML. The Life Cycle Cost which contains preventive and corrective maintenance activities shall be in compliance with the Maintenance Manuals prepared by the Contractor.

8.7.5. 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.

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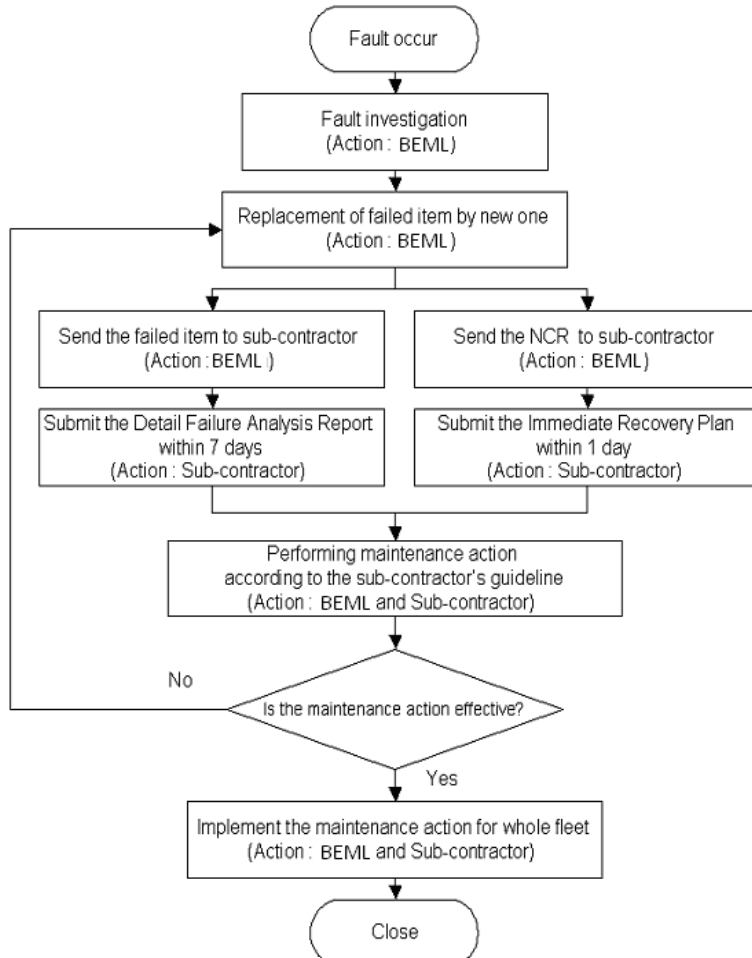


Figure 1. Maintenance Procedure of BEML

The sub-contractor shall support an active A/S for high availability. The A/S procedure of BEML is same as figure1. Therefore, the sub-contractor should be complied with BEML's procedure. If some failure needed the sub-contractor's support, the sub-contractor should dispatch engineer as soon as possible. Also, if the sub-contractor needs some training for BEML's maintenance engineer, the sub-contractor shall perform it.


The sub-contractor shall provide sufficient spare part for high availability. The sub-contractor shall submit a spare part list and recommended quantity at the maintenance depots at Mumbai.

The sub-contractor also has to comply the ERGS clause 1.8.4 & 1.8.5.

8.7.6. Safety Requirements

The subcontractor shall submit safety assurance plan for Fire Detection system. This shall cover design, manufacture, testing, commissioning of the system. This shall also indicate features minimizing the magnitude and seriousness of events or malfunctions, which could result in injury to passengers and damage to the equipment but cannot be completely eliminated.

To meet the safety requirement, the Subcontractor shall submit the following documentations as a minimum.

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- 1) System Safety assurance plan as per Clause-2.4 of ERTS.
- 2) Hazard Analysis including preliminary hazard analysis, sub-system Hazard Analysis, operating and support hazard Analysis and interface hazard analysis as per clause 2.5 of ERTS.
- 3) FMECA (Failure Mode, Effects and Criticality Analysis)
- 4) Fault Tree Analysis (FTA) for Safety Critical Events

The subcontractor shall fully compliance with the RAMS (Reliability, Availability, Maintainability and Safety) requirements given in the Clause -2.4 to 2.14 of ERTS.

8.7.7. RAMS Deliverables

The subcontractor shall submit the following RAMS Deliverables.


- 1) RAMS Plan during preliminary design
- 2) Product Breakdown Structure during Preliminary Design Stage
- 3) Reliability Analysis with train withdrawal scenarios as per Appendix-TG of ERTS
- 4) Reliability Block Diagram and Reliability Prediction during Pre-final Design Stage
- 5) Hazard Analysis including PHA, Subsystem Hazard Analysis, Operating and Support Hazard Analysis and Interface Hazard Analysis during Pre-final Design Stage
- 6) Preventive and Corrective Maintenance Analysis during Pre-final Design Stage.
- 7) Master Maintenance Schedule during Pre-final Design Stage
- 8) FMECA (Failure Mode, Effects and Criticality Analysis) during Pre-final Design Stage
- 9) LRUs list during pre-final design stage
- 10) Safety FTA during Final design Stage
- 11) Life Cycle Cost Analysis during Final design Stage

8.8. Software requirement


8.8.1. General Software Management

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

- i. Diagnostics & Maintenance Software (10 copies if license is limited)
- ii. User Manual for Diagnostics & Maintenance Software
- iii. Two back-up copies of application (executable) software whenever software change is implemented
- iv. API (Application Programming Interface) / SDK (Software development Kit) documentation for necessary interface with Radio System (BBRS) / CBTC and Rolling Stock Controller (RSC).
- v. Test Software specified in ERGS 6.9
- vi. Uploading tools of executable software and it's manual
- vii. Software Training in line with chapter 6 & 9 of ERGS to satisfy DMRC's needs and expectation.
- viii. Interface with TCMS as per ERTS 10.
- ix. Provision to download the desired data for the entire train including data logged in sub-system (Fire Detection system) through TCMS port/remote wireless by Maintenance terminal PC.

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- x. Single point uploading and data downloading through TCMS port/remote wireless should be provided by the supplier.
 - xi. Provision for other diagnostic access by maintenance staff via the notebook computer.
 - xii. Provide all necessary software & tools for downloading the data, modifying parameters settings/uploading parameters, uploading software etc. through its port and also through TCMS port/Wireless by Maintenance Terminal PC.
 - xiii. Provide the necessary software tool to read the downloaded trace data through its port and also through TCMS port & remote wireless access by Maintenance Terminal PC.
 - xiv. Necessary software for all diagnostic functions (3 sets minimum).
 - xv. Provide CBT (Computer Based Training) software package comprising training and assessment modules as per ERTS 2.13.3.
- 8.8.1.2.** All software to be developed or modified (re-engineered software) shall follow the standardization requirements of EN 50128 or latest version (Railway Applications: Software of Railway Control and Protection Systems). The subcontractor shall define within the Software Quality Assurance Plan what techniques and measures are to be applied for software development. The Plan shall require the subcontractor to provide all changes, bug fixes, up-dates, modifications, amendments and new versions of the programmers, as required by the Engineer. Engineer may also direct to provide the copy of previous version of software till such time the new version of software is proven.
- 8.8.1.3.** Software design and development shall also be carried out at Pre-final design stage. Subcontractor shall comply with 2.10, 6, 8.7 and 9 of ERGS and 14.14 of ERTS. MRS1 General Specification (GS 6.6.1) specifies that "It shall be possible for the Employer/Project Owner to modify/change various parameters/logics used in the software and implement the changes on trains. Full facilities including any software/hardware tools, simulation/test bench which are essential for this purpose shall be supplied within the quoted cost to each Depot." So, Subcontractor have to require to adopt the design of "parameter changes" by using certain application software (e.g. maintenance terminal software) and, Subcontractor have to submit the information of sets of software parameters such as description, default value, minimum / maximum values of each parameters and what effects is expected to parameter change and so on for DMRC's acceptance. Subcontractor must accept DMRC prefers a set of software parameterization.
- 8.8.1.4.** subcontractor to submit the design details of signal flow diagram, flow charts, functional block diagram, details of signal and it's interpretations of application software to reconfigure software parameters and full compliance to ERGS clause 6.6
- 8.8.1.5.** The subcontractor shall, within 25 days of the commencement date, Notice to Proceed, submit a Software Quality Assurance Plan for review by BEML.
- 8.8.1.6.** As defined in EN 50128, all software produced or supplied for the Project shall be subject to a defined quality framework. ISO 9000-3 shall be considered appropriate for low criticality software (safety integrity level 0 or 1) whilst the application of a more stringent framework shall be required for higher criticality software (safety integrity level 2 or above). The quality framework requirements for safety integrity level 2 and above are supplementary to the requirements of EN 50128. SIL level of all softwares used in different sub systems shall be defined and certified.

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8.8.1.7. Subcontractor has to submit the SIL Justification Document regardless of SIL rating in order to justify the appropriate SIL rating and for approval. Subcontractor has to have an appointed Independent Safety Assessor (ISA – in accordance with EN50128). The ISA for system will produce a number of software assessment reports (depending on the SIL Level and the agreed Software Assessment Plan for system). These reports will culminate in a Final Assessment Report for system will contain the ISA's conclusion on the software system's fitness for purpose and the integrity of its development in compliance with EN50128. The Final Software Assessment Report shall be submitted.

8.8.1.8. Subcontractor shall provide the properties and all requested material for BEML's software quality & safety audit to Subcontractor. Corrective action against NCR and OBS should be returned to BEML within one week after software audit. And also, Implementation of corrective actions against to Identified NCR (Non conformance Report) and OBS (Observations) should be finalized within one-month after software audit. BEML will not pay the amount of money for software development without the completion of the identified NCR and OBS.


8.8.1.9. The Subcontractor shall be obliged to take care of any software change if BEML and DMRC request the change for the correction of software during commissioning phase, commissioning and Warranty Period, etc. The change shall be implemented by the Subcontractor. In the event, when any non-conformity arises to the specified requirements, the Subcontractor shall take remedial measures at its own cost within the schedule to be agreed with BEML. The Subcontractor shall provide all tools, Laptop computers or any special device to upload /download the software, TCMS data, equipment, manuals and training necessary for the Project Owner, Employer and Engineer to maintain and re-configure all software provided under this Contract. The documentation of software shall be supplied after the expiry of the warranty period.

8.8.1.10. The Subcontractor shall be obliged to abide by the software change control procedure in order to enhance the regulation of software change in train-set. It should be not allowed to upload the changed software into train-set without the approval by BEML/ DMRC under software change control by BEML. Subcontractor has to supply test report of system integration testing or bench testing of the updated software performed subcontractor's premises before formal release of the updated software. The required documentation for approval on software change will be defined in the later stage. At the minimum, Problem Report, Engineering Change Proposal (ECP), Software Release Certification, Software Regression Testing Procedure/Report, internal testing report, and updated software documents etc. It will be incumbent upon the Subcontractor to take responsibility for any changes required to software.

8.8.1.11. For Re-Use of existing Software, Re-Engineered Software, Test Software subcontractor shall comply to ERGS 6.7, ERGS 6.8 and ERGS 6.9 respectively. Subcontractor shall comply to ERGS 6.10 for Software Rights

8.8.1.12. As a minimum, the following software documentation shall be furnished.

- Software Quality Assurance Plan
- Software Verification and Validation Plan
- Software Configuration Management Plan
- Software Requirement Specification

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- System Integration Test Specification
- Software Design Specification
- Software Test Specification
- Software Module Design Specification
- Software Module Test Specification
- Software Module Test Report
- Software Test Report
- System Integration Test Report
- Software Verification and Validation Report
- Software Safety Operational Report


8.8.1.13. The subcontractor shall comply with the detailed Software Quality Assurance Management Plan provided by BEML.

8.9. Fire Safety

The subcontractor shall submit a Fire-safety Plan providing the list of Non-metallic material items, wires & cables that are proposed to be used in the Fire Detection system with details of material, applied mass, fire safety compliance (Flammability, smoke, toxicity) and fire load calculations, during the preliminary design phase.

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 Metro for underground operations with front evacuation, subject to the acceptance of the Engineer as per ERTS 2.5.8 & 2.19.

1. Flammable materials shall be well contained with IP 65 protection as per ERTS 2.19.1 (iii)
2. **The cables used for Fire Detection System should have AX performance as specified in BS 6387. Alternatively, BS EN 50200 may be used. The minimum integrity time under BS EN 50200 should be 120 minutes."**
3. 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 minimise generation of smoke, noxious emissions and corrosive fumes, in the case of overheating or fire in compliance with EN 45545 (Category 4-A, Hazard level HL3) latest edition. All Cables shall comply NF F 63-808 (for low voltages), and NF F 63-826 (for high voltages) or other international standards like EN 50264(Part 1 to 3) and EN 50306(Part 1 to 4) as approved by the Engineer.
4. ERTS 12.5.3: Fire resistant cables shall be proposed for circuits, which should survive for long periods during fire, as per applicable international standards. As a minimum, the cables and wires for Public Address System, emergency lighting, door opening and warning systems shall be fire resistant in compliant to EN 50200.

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5. ERTS 10.1.11: The cables which are intended to be used in emergency circuit for alarms and communication shall have intrinsic fire resistant property in compliance with EN 50200.
6. Fire resistant cables which should survive for long periods during fire and compliant to EN 50200 shall be ensured for complete Fire Detection system in line with ERTS clause 13.1.1 (xxiii).

8.9.1. Fire Load Calculation

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

Fire load calculation for all non-metallic materials have to be calculated with heat release rate data tested in accordance with EN 45545 HL3. The calculations shall be included in the Fire safety plan submitted as the source of heat value.

8.9.2. Fire Performance Deliverables

The fire performance deliverables shall be provided in accordance with following table.

Sl. No.	Deliverables	Remarks	Submission Schedule
1	Fire safety plan	As per EN45545 HL3	Preliminary Design stage
2	Fire safety Test Reports of the items including heat release rate for standard items common with other projects of the subcontractor	As per EN45545 HL3	Pre-Final Design stage
3	Fire safety Test Reports of the items including heat release rate for all other items	As per EN45545 HL3	Final Design stage


8.10. EMC Requirement

8.10.1. General Requirements

The subcontractor shall meet all EMC requirements specified in the ERTS 2.17, ERTS 15.27 and ERTS Appendix TD 3.12 where applicable and shall work together with BEML to assure that all electronic and electrical equipment on the rolling stock works properly without any interference.

8.10.2. EMC Control Plan

The subcontractor shall submit an EMC Control Plan for the BEML's review and acceptance and it shall include an EMC analysis report including various measures to reduce conducted,

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induced and radiated emissions to acceptable levels as specified by the relevant international standards. The plan shall specify measures to increase immunity of the subsystems in scope of supply. All train borne equipment on the vehicle shall be designed and constructed to fulfill the requirements of EN 50121-3-2 and any standards where applicable.

8.10.3. EMC Laboratory Tests

Emission and Immunity tests for all individual equipments on vehicles shall be performed under normal operating condition according to EN 50121-3-2 and the test specification and the test report shall be provided to BEML for review and acceptance.

Train Level EMC test as per EN 50121-3-1 and ERTS will be performed by car-builder (or) nominated testing agency. In case of any EMI/EMC issue on the sub-contractor's aggregates, the mitigation measures shall be designed and implemented by sub-contractor at no additional cost & no schedule impact to BEML.

8.11. Maintenance Requirement

During the design stage, the subcontractor shall submit downtime and manpower requirements for the maintenance inspections, service checks and Overhaul considered necessary for maintaining the trains under normal operational conditions. The service check and Overhaul sessions shall include all routine and heavy maintenance activities including inspections, minor / major overhauls and half-life overhaul. And if the equipment has half-life overhaul, the interval of the equipment shall be defined by Sub-Contractor. The subcontractor shall perform the maintainability demonstration, as applicable to his equipment, at his own expense.


Maintenance schedule, and items to be attended in a schedule, should be clearly defined by subcontractor for all components of the FDS. The schedules frequency should be synchronized with the train maintenance schedule program. Consumable spares, and arrangements for cleaning the filters etc. should be provided.

8.12. Spares, Special Tools and Testing Equipment

8.12.1. The Sub-Contractor shall supply the following items of spares (as per Annexure-2, in-line with Cost centre G):

1. Unit Exchange Spares;
2. Consumable spares
3. Mandatory spares;
4. Recommended spares;
5. Overhauling spares;
6. Special tools, Testing and Diagnostic equipment;
7. Special Jigs, Fixtures & Gauges required for maintenance, repair and overhaul of various equipment, sub-systems in particular and the complete trains in totality;

8.12.2. Unit exchange Spares

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The subcontractor shall supply Unit exchange spares for maintenance of all trains as per GS 8.2

8.12.3. Consumable Spares

The Subcontractor shall supply consumable spares for maintenance of all trains during commissioning, service trails and up to completion of warranty period as per GS 8.3.

The consumable spares shall include lubricants, oils, grease, sealants, filter media, gaskets and any other items, whose declared life is less than one year.

Recommended list shall be furnished by the Subcontractor as part of design submission.

8.12.4. Mandatory spares

The subcontractor shall supply mandatory spares as per GS 8.4

8.12.5. Recommended spares

The subcontractor shall supply recommended spares as per GS 8.5. Subcontractor shall provide list of recommended spares which are not covered under consumables and mandatory spares but are expected to be required during two years after expiry of warranty period.

8.12.6. Overhauling spares

The subcontractor shall supply overhauling spares as per GS 8.6. Subcontractor shall supply the overhauling kits for five (5) metro trains. Overhauling kits for all those equipments, systems, sub-systems of trains that will need overhauling during intermediate overhaul of the train will be included in these kits.

8.12.7. Special Tools, Testing and Diagnostic equipments

The subcontractor shall supply Special tools, testing & equipments as per GS 8.7.


Subcontractor shall provide a recommended list and supply one (1) set of fixed and two (2) sets of portable and hand held special tools, testing and diagnostic equipments for preventive and breakdown maintenance, overhauling and diagnostics of various equipment provided in the cars.

Recommended list shall be furnished by the Subcontractor as part of design submission.

8.12.8. Special Jigs, Fixtures and Gauges

The subcontractor shall supply special Jigs, Fixtures and gauges as per GS 8.8.

Subcontractor shall provide a recommended list and supply, as minimum, one (1) set of fixed Special Jigs, Fixtures and Test Benches and two (2) sets of hand held and portable tooling, measuring and diagnostic equipment and Gauges separately for preventive and breakdown maintenance, overhauling and diagnostics of various equipments provided in the cars.

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Recommended list shall be furnished by the Subcontractor as part of design submission.

8.12.9. Commissioning and DLP 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.

8.13. Quality Assurance Program

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

8.13.1. Quality Assurance Plan

The Subcontractor shall develop and submit to BEML QC team for review and approval a Quality Assurance Plan (QAP) based on ISO 9001 and GS 2.5. The subcontractor shall have the following

- a) Organization chart
- b) Certification of Personnel
- c) Evidence of Compliance
- d) Certificates of compliance
- e) Calibration of measurement equipment and tools


The subcontractor shall comply with the detailed Quality Assurance Plan provided by BEML.

8.13.2. Quality Assurance activities

The Subcontractor shall address, as a minimum, the following activities and shall provide a means of self-correcting any shortcomings in his Quality Assurance Plan (QAP) as per GS 2.6.

- a) Procurement
- b) Manufacturing Inspection
- c) Production Conformance Testing
- d) Receiving Inspection
- e) Shipping Inspection
- f) Ensure inspection with latest Revision/Changes.
- g) Identification of items using tags etc.,
- h) Handling (storing, preserving, packaging, marking and shipping).
- i) Non-conformance Control.

8.13.3. Quality Audit

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The Subcontractor shall permit Quality Audit by BEML and/or the Employer 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 Subcontractor shall prepare and submit appropriate action plan within 10 (ten) days, perform the action plan and reply the result to BEML QC team.

8.13.4. Inspection and Test Plan (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. Subcontractor shall comply with ERTS 15.

A) The ITP includes all the major inspection and test activities planned prior and during the design, procurement and installation phases.

B) Witness/Hold point of Inspection/Test

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


C) 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 Employer of BEML.


9. Testing

9.1. General

- 1) The Subcontractor shall be responsible for undertaking and passing all necessary testing activities for Fire detection system.
- 2) The subcontractor has the responsibilities to dispatch their engineers(s) at their own cost to perform the tests viz., equipment type test, FAI, vehicle level performance type test and static & dynamic commissioning type test until successful completion.
- 3) The Subcontractor shall develop, organize and implement the test that verify the Fire Detection system to meet all functional, safety, systems reliability and performance requirements.
- 4) The tests and commissioning are conducted according to Guideline for the performance test of railroad/ Standard for the performance test of urban railway, Guideline for the manufacturing inspection of railroad and ERTS.
- 5) BEML and/or End user have the right to witness any of these tests and inspections at any stage of the test & inspection process.

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- 6) All test & inspection specifications and reports including all repair activities and check-lists shall be submitted to and approved by BEML and end-user.
- 7) The Subcontractor shall ensure that the equipment is compliant to all requirements prior to inviting for testing and FAI. The pre-test result prior to official testing/FAI shall be submitted with the invitation letter to request Employer's witness.
- 8) If any inspections or tests indicate that specific hardware, software, or documentation does not meet the specified requirements, the appropriate items shall be repaired, replaced, upgraded, or added by the Subcontractor with its own cost, as necessary to correct the noted deficiencies. After correction of a deficiency, all tests necessary to verify the effectiveness of the corrective action shall be repeated.
- 9) Prior to the start of testing, BEML and End user shall have all approved test plans and procedures for the test and all relevant prerequisite testing shall have been completed by subcontractor.
- 10) Type test of sub-supplier equipment and train level will be responsibility of sub-supplier; sub-supplier shall depute their engineers to conduct the vehicle level type test at BEML's Factory and Depot at Mumbai/Mainline for testing as per schedule prepared by BEML's project management team. Sub-supplier shall continuously update themselves about the type test schedule of Factory and Site as it may happen that first schedule could not be followed due to rise of unexpected hindrance.
- 11) Sub-supplier shall arrange all necessary tools & instruments for relevant field test.
- 12) If there is a problem during testing & commissioning and thus BEML request dispatching engineer to solve the problem, the subcontractor should dispatch engineer within 24 hours.
- 13) The test requirements shall meet, but not be limited to, the following sections in the ERTS and ERGS:
 - (a) ERTS Chapter 14 : Electrical and Control Equipment
 - (b) ERTS Chapter 15 Inspection, Tests and Trials
 - (c) ERTS Appendix TA International Standards
 - (d) ERGS Chapter 7 Testing and Commissioning
- 14) Combination with TCMS, Signaling and Train Radio:
Subcontractor has to attend the combination test with engineer and proper equipment based on the detailed test schedule and location.
- 15) Before the type commissioning test, complete car at the vehicle level, the subcontractor shall meet the TCMS combination test between TCMS and their equipment. One or several equipments including connector, power cables etc should

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be delivered to TCMS supplier's test place before the testing period by subcontractor. Subcontractor's engineer shall attend the combination test for technical support for example software changes or equipment installation in accordance with TCMS supplier's requirement.

9.1.1. 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.

9.2. First Article 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 ERTS 15.1.

The supplier shall offer the first set of Fire Detection system aggregates for First Article Inspection (FAI) by BEML and DMRC. After clearance from BEML, mass production shall be taken up.

9.3. Test Procedure

Each Test procedure shall include all information necessary to ensure the successful, accurate and safe performance of the described test as stipulated in TS 15.4.1. At a minimum, each test procedure shall include:

- 1) Relevant specification applicable to each of the tests.
- 2) Type, routine and special tests to be carried out.
- 3) Description of the tests, scheduled dates, and locations of the tests.
- 4) Test parameters to be measured.
- 5) Constraints to be applied during the test.
- 6) Defined pass/fail criteria
- 7) Facilities, equipment, and test and measurement tools.
- 8) Test procedures shall be amended, as required by the subcontractor the throughout the duration of the Contract, to reflect changes in system design or the identification of additional testing requirements.
- 9) Scope and objectives for each test
- 10) Prerequisites for test to be conducted
- 11) Organization/entity and person(s) conducting the test


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- 12) Safety Precautions
- 13) Identification of the specification section(s) that are verified by the test
- 14) Scope of test (what is being tested and how many)
- 15) Test equipment required (by model number, make) and latest calibration information
- 16) Other personnel required
- 17) Any special conditions required, including condition of the equipment under test
- 18) Reference drawings, schematics, or documents
- 19) Clearly understood step-by-step instructions for performing the test, test equipment set-up
- 20) Clear pass/fail criteria, including applicable tolerances, nonconformance correction, retest provisions
- 21) Data sheets to record test results, including confirmation of test equipment certification
- 22) Raw data correlation procedures
- 23) Sample test report format

Test procedure shall be submitted to BEML for review and acceptance during PFDR and FDR and at least ninety (90) days in advance of the notification of the actual testing. All procedures must be approved prior to notifying the test witness request.

9.4. Test Reports

- 1) All test reports of the component, system, factory and field acceptance test for Fire Detection system shall be prepared by the Subcontractor and they shall be submitted to BEML. The Test reports shall include, but not be limited to, the followings:
 - (a) The reference to the corresponding Test Procedure
 - (b) The date of the test was executed
 - (c) Description of any test conditions, input data, or tester actions
 - (d) Details of test instruments used (Make, Model) along with calibration certificate.
 - (e) The test results for each test including a Passed / Failed indication
 - (f) Identification of the Subcontractor's test engineer
 - (g) Action and the result of the action for comments by End user's representative
 - (h) Copies of any deficiency reports generated as a result of the execution of the correction.
 - (i) Configuration data that fully describes the hardware and software that was tested, including software version and identifiers for every software module
- 2) Written reports of all tests performed shall be submitted within Fourteen (14) days of test performance to BEML for acceptance.
- 3) Records of all inspection and testing shall be kept completely by the Subcontractor and

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available to End user during the performance of this Subcontract and for a minimum of ten (10) years after expiration of the warranty period.

9.5. 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 at Mumbai 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

9.6. Factory tests of complete cars

9.6.1. Type Test, Completed car, unit and Train Tests

The individual cars, complete units and trains (**software must be compatible for testing of 6-car & 8-car train set configuration**) shall be type tested by Subcontractor for Fire detection system aggregates in accordance with IEC 61133 and ERTS 15.

The Subcontractor, Design Engineer, shall also participate in this testing to ensure that Fire detection system aggregates meet the performance requirements specified at the contract and do not introduce any adverse effects into the train.

9.6.2. Routine Test, Completed car, unit and Train Tests

The individual cars, units, complete trains (**software must be compatible for testing of 6-car & 8-car train set configuration**) shall be routine tested by Subcontractor for Fire detection system aggregates in accordance with IEC 61133 and in accordance with ERTS 15. The Subcontractor shall be responsible for correcting any interfacing defects.


9.7. Testing and Commissioning of cars/trains in Depot

9.7.1. Type Commissioning Tests

The subcontractor shall carry out commissioning **Type Test** on the complete 6-car & 8-car trains in accordance with IEC 61133 & ERTS 15 and software must be compatible to do the same.

9.7.2. Routine Commissioning Tests

The subcontractor shall carry out commissioning **Routine Test** on the complete 6-car & 8-car trains in accordance with IEC 61133 & ERTS 15.

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9.8. 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.

9.9. Service Trials

BEML will perform the service trial for MRS1 corridor 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.

10. Submittals – Technical offer:


The Subcontractor shall provide as a minimum, the following along with the technical offer. The submittals check-list as per Annexure-3 of this PTS shall also be submitted.

- Complete Technical offer for Fire Detection system along with Technical description, specification drawings, weight and power consumption details.
- Clause wise compliance against
 - a) PTS - Doc no. GR/TD/4669
 - b) ERTS & ERGS.

in the following format

- Complied: “Complied” shall be indicated by the supplier where the supplier is able to comply with the clause.
- Noted: Where a clause merely provides information.
- -“Complied with comments” will be considered as fully complied for the clause with no additional commercial impact.
- Offers with Non-compliance and deviations to any of the ERTS, ERGS & PTS clauses with regard to Fire Detection system, are liable for rejection.
- Supply details with references for same / similar design for the last 3 years for metro projects along with performance certificates from Employer’s (Metro Corporation) to support the qualification criteria as per section 6 of this document.
- The list of spares as detailed at clause 7.11 of this PTS

11. Attachment

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- ERGS
- ERTS
- Annexure-1 : Vendor Approval Format
- Annexure-2 : List of spares
- Annexure-3 : Submittals check list
- Annexure-4 : Under frame & Passenger Compartment Layout
