
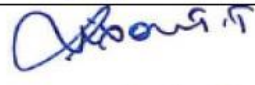



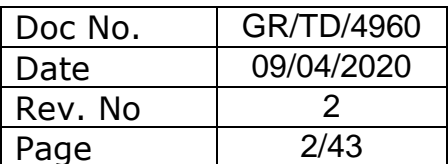


BEML LIMITED
BANGALORE
R & D CENTER

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**Procurement Technical Specification of
Fire& smoke Detection System for DMRC
RS15 Project**

	Name	Date	Signature
Approved By	V. SYLAJA	09.04.2020	
Reviewed By	LIXON THOMAS	09.04.2020	
Prepared By	DEVESH KUMAR	09.04.2020	

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1.0 Introduction

1.1 General

This document describes **Fire & smoke Detection System (FDS)** to be supplied for DMRC RS15 Project for Delhi Metro Rail Corporation Limited (DMRC).

BEML shall carry out all required works and activities as Supplier for DMRC RS15 project while the Subcontractor shall be responsible for all works required in this PTS with regard to Design, manufacture, supply, testing and commissioning of **Fire & smoke Detection System** and shall be responsible for supporting the BEML activities as subcontractor for DMRC RS-15 Project.

The configuration of train formation is as follows.

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

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

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

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

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

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

1.2 Climatic Conditions

The DMRC RS-15 Car shall operate reliably and safely under Delhi climatic conditions shown in Table.

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

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

1.3 Operating Environments

The proposed DMRC RS-15 cars will operate with the track geometry shown in Table.

Track Gauge	1673 mm
Min. radius, on revenue track (Main line)	300 m
Min. radius in depot	200 m
Radius (equivalent) of min. vertical curve (convex or concave) mainline	1500 m
Max. gradient (Mainline)	3%
Max. gradient (Depot)	4%
Maximum design speed	90 KMPH
Maximum operational speed	80 KMPH
Round trip schedule speed with 30s station stops & 8% coasting, excluding terminal station turn round time with fully loaded train	34 KMPH
Service acceleration rate	0.82 m/s ² ± 5%

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

2. Definition

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

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

“BEML” means the Customer to procure **Fire & smoke Detection System** for RS15Project

“Subcontractor” means the Supplier of **Fire & smoke Detection System** to BEML for RS15Project.

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

“ERTS” meansEmployer’s Requirements-Technical Specification of DMRC RS-15contract for DMRC RS-15Project

“PTS” means BEML’s Procurement Technical Specification.

“GTC” means General Terms and Conditions of the tender issued by BEML for procurement of the **Fire & smoke Detection System** for RS15contract.

3. Precedence of Documents

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

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

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

Order of precedence	Document Title
1	GTC, ERGS & ERTS
2	PTS

4. Qualifying Criteria for subcontractor and Vendor approval

4.1 Proven Design (ERTS clause 3.2.2)

(i) The subcontractor shall meet the qualification criteria as per ERTS 3.2.

(ii) The subcontractor should carried out design and manufacturing of sub-assemblies and those sub-assemblies proposed for Fire & smoke Detection System shall be of proven design. System and equipment offered in this tender shall have been in use and have established their performance reliability on a mass rapid transit system or suburban e.m.u.'s **in revenue service over a period of two years or more**. Where similar equipment or sub-systems of a different rating are already proven in service, then the design shall be based on such equipments. In case this stipulation is not fulfilled the tenderer shall furnish sufficient information to prove the basic soundness and reliability of the offered subsystem.

4.2 Vendor approval

Vendor approval from DMRC is mandatory for **Fire & smoke Detection System** supplier. 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.

5. Scope of Supply

The subcontractor shall be responsible for the providing all the equipments for **Fire & smoke Detection System** .

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5.1 Hardware

The Subcontractor shall be responsible for the providing of all equipments for the **Fire & smoke Detection System as per ERTS & requirement**. Subcontractor shall provide, as a minimum, but not limited to, the following;

Sl. No.	Items	Qty/ T-car	Qty/ M-car	Spec.
1	Smoke/Heat Detector (Multi-sensor)	06 nos. (Min)	06 nos. (Min)	ERTS 2.24.2, PTS 4.2.3
2	Fire Detection Control Unit (FDCU)	01 no.	01 no.	ERTS 2.24.1, ERTS 2.24.2
3	Display (HMI)	01 no.		ERTS 2.24.2
4	Sounder	01 no.		ERTS 2.24.2
5	Necessary hardware and software for Detection of Fire	As required		
6	Mating connector assy. (for all the items Sl. No. 1 to 5)	See Note.		

Note:

(1) no of detectors in saloon area is tentative and subcontractor to propose suitable qty. (Min. 06) to achieve required 1 min. detection time as per ARGE guideline.

(2) Mating connector assy. shall be supplied along with each item at Sl. No. 1 to 4.

(3) The above type and quantity of equipment can be modified by the proposal of subcontractor depending on how the system is considered.

(4) 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.

(a) Power cables (1.5 sq mm) for 110 V DC input power supply, Ethernet cables for train level wiring, multi-core shielded (2x 1.00 Sq mm and 3x 1.00 Sq mm) cables for serial interface for car-side wiring will be provided by BEML.

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5.2 System Requirement of Fire & smoke Detection System

5.2.1 Fire and Smoke Detection System (ERTS 2.24)

The proposed Fire & smoke Detection System shall meet the requirement of following clauses of ERTS but not limited to:

ERTS 2.24.1 Fire and smoke detection system shall be provided which would give audio-visual alarm to the driver (Train Operator) in case of fire/smoke detected in saloon.

ERTS 2.24.2 Fire and smoke detection system shall be consist of smoke/heat detectors, fire detection and control unit (FDCU), sounders, displays & software apart from small items like cables, connectors etc. Minimum 4 no. of Smoke & Heat detectors (multi-sensors) shall be installed in passenger area of each car. The sensivity of smoke detector has to fulfill the requirements of ARGE guidelines. The actuating temperature of heat detector shall be settable according to the international norms and standards. The FDCU shall interface with TCMS. 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.

ERTS 2.24.3 The system is designed to fulfill relevant standard and technical guidelines of EN 50155; EN 45545; EN 50126; EN54-5,7; EN50128, ISO 9001 & ARGE guidelines for fire detection in Rolling Stock.

ERTS 2.24.4 Detail scheme of above system will be finalized during design stage with the approval of the Engineer.

5.2.2 Only 110V D.C. (+25%, -30%) would be made available on train for control power supply of Fire & smoke Detection System . The Fire & smoke Detection System shall continue to operate correctly with the 110 V DC car battery voltage supply.

5.2.3 The Fire & smoke Detection System and layout of the detectors should be fully meet the criteria/performance as per the ARGE guidelines.

5.2.4 The equipments of Fire & Smoke Detection System shall be of at least IP53 or better class as per IEC 60529.

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5.2 Software

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

- 1) Source code, or equivalent
- 2) Diagnostics & Test Software
- 3) Development Tools
- 4) Two back-up copies.

The Subcontractor shall provide the complete documentation and development tools and also meet the requirements of the specification with respect to the production, verification and validation of software for the **Fire & smoke Detection System** (refer to Section 6.10, ERGS 6.6, GCC 5.8 and ERTS 13,14.14).

5.3 Interface Responsibilities

5.3.1 Mechanical Interface

The location of mounting points and the design of equipment installation comprising of the **Fire & smoke 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 mounting method and providing all materials for mounting in the carbody.

5.3.2 Electrical Interface

BEML shall be responsible for defining the technical requirements (refer to section 6) and the design constraints (refer to section 7). The Subcontractor shall be responsible for the design of the **Fire & smoke Detection System** and the submission of design information (refer to section 7) and the performance of testing activities (refer to section 8) and the supply, installation and commissioning of the **Fire & smoke Detection System** (refer to section 5), and the maintenance and rectification of the **Fire & smoke Detection System** (refer to section 6) during the defect liability period, etc.

The Subcontractor shall submit the power consumption and inrush current of complete **Fire & smoke Detection System** set and the cable size to be installed in the **Fire & smoke Detection System** set to BEML. The Subcontractor shall propose the cable connection method and be approved by BEML.

The subcontractor to comply the requirements of ERTS Clause 12.4, 12.5, 12.6, 12.7 & 12.12.

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5.3.2.1 Fire & smoke Detection System Interface:

The Subcontractor shall be responsible for interface between the TIMS and other sub-system

- The Fire & smoke Detection System shall interface with TIMS.
- Interface with TIMS shall use RS485 serial interface (EIA-485) based on HDLC synchronous transmission (ISO3309/4335) protocol. The subcontractor shall meet the communication protocol requirements of TIMS supplier in accordance with the interface document provided by TIMS supplier. The information exchange shall be mutually agreed and discussed with TIMS supplier.
- Below Hardwire digital output shall be provided by Fire & smoke Detection System though potential free contacts in redundant manner to train side as minimum.
 - (i) "FIRE DETECTED IN T/M -CAR" to TIMS & HVAC.
 - (ii) "FAULT ALARM" to TIMS.

The subcontractor shall be responsible for the hardware interface and software interface with TIMS and other subsystem.

5.4 Design Information

The Subcontractor shall provide all necessary documents, drawings, software and deliverables for BEML. The Subcontractor shall provide the technical requirements and design information.

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

The Subcontractor shall furnish the following information in respect of printed circuit boards as a part of contract (refer to TS 14.12.6):

- Detail circuit diagram for the printed circuit boards and assemblies.

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- Detailed maintenance and troubleshooting procedures, including waveforms at critical locations of the circuitry.

The drawings, calculations and documents shall be written in English. All drawings and design calculations shall use SI unit (refer to section 6 and 7).

5.5 Testing

The Subcontractor shall perform, as a minimum, the following for the **Fire & smoke Detection System** ;

- (1) Routine and type tests of equipment and sub-systems
- (2) Type tests of complete vehicle for the **Fire & smoke Detection System** of the RS15 project.
- (3) Commissioning test for the **Fire & smoke Detection System** of the RS15 project.
- (4) Integration Tests in conjunction with all Designated Contractors.
- (5) Routine complete vehicle tests for the **Fire & smoke Detection System**
- (6) Routine commissioning test for the **Fire & smoke Detection System**
- (7) Service Trials

The detailed requirements are specified in the section 8.

5.6 Operation and Maintenance Manuals and Spare Parts Catalogues

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

- a) Volume 1 – Technical Manual
- b) Volume 2 – Operation Manual
- c) Volume 3 – Maintenance Manual
- d) Volume 4 – Fault Diagnostics Manual
- e) Volume 5 – Spare Parts Manual
- f) Volume 6 – Software Manual
- g) Volume 7 – Special Tools & Test Equipment Manual.

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

5.6.1 Submissions

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

5.6.2 Electronic Manuals

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

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

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

5.7 Spares, Special Tools and Testing Equipment

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

The subcontractor shall supply the following items of spares

- (1) Recommended spares
- (2) Consumable spares for maintenance of all trains during commissioning, service trials and up to completion of Warranty period
- (3) Special tools, Testing and Diagnostic equipment.
- (4) Special jigs, Fixtures & Gauges required for maintenance, repair and overhaul of the trains.
- (5) DLP and Commissioning spares

The detailed requirements are specified in ERGS 8.

5.8 Storage, Packing Crating and Marking

The subcontractor shall provide all packing, crating and markings in accordance with the requirements specified in ERGS 13 when handing over them, the Subcontractor hand over the **Fire & smoke Detection System** and the spare parts, special tools and testing equipment The subcontractor shall provide the instruction for proper storage, handling and logistic functions of components supplied by the subcontractor before handing over.

All items shall be labeled with the maker's name and the type and form of the piece or item, discrete serial number and rating, and the date of manufacture of the particular piece of equipment. For detail information, see ERTS 14.17.

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5.9 Training

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

5.9.1 Training Manual

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

5.10 Warranty

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

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

- Either 24 months from the date of acceptance or
- Up to expiry of the defect liability period of last train set/'T+M' unit (ERGS clause1.8.1), whichever is later.

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

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

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

Further, should any design modification be required to any components or equipment as a consequence of failure analysis, the period of 24 months shall recommence from the date when the modified part is commissioned into service and modification shall be carried out free of charge.

The subcontractor shall carry out all replacement and repairs under the warranty promptly and satisfactorily on notification of the defect by BEML so that no car is out of

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revenue service for more than 48 hours.

6. Technical Requirements

6.1 General

The general requirements(EMI/EMC, software, fire, safety etc.) for the **Fire & smoke Detection System** shall be met to the requirements specified in ERGS and ERTS:

6.2 Fire and Smoke Detection System

The system requirements for the **Fire and Smoke Detection System** shall meet, but not be limited to, the following sections in TS:

- 1) TS 2.24 **Fire and Smoke Detection System**
- 2) TS 10.3 Microprocessor Control and Diagnostic System
- 3) TS 10 Train Integrated Management System (TIMS)
- 4) TS 10.2 TIMS Architecture
- 5) TS 11.10 Control equipment
- 6) TS 12.12 Safety Devices
- 7) TS 13.10 Interface
- 8) TS 14.1 General
- 9) TS 14.5 Fasteners
- 10) TS 14.7 Wires and Cables
- 11) TS 14.8 Terminal and Cable Termination
- 12) TS 14.9 Electrical Creepage and Clearance
- 13) TS 14.10 Protection & Earthing
- 14) TS 14.12 Electronic Equipment
- 15) TS 14.13 Microprocessors and Software-based Equipment
- 16) TS 14.14 Software
- 17) TS 14.15 Printed Circuit Board and Connectors
- 18) TS 14.16 Integrated Circuits
- 19) TS 14.17 Labels
- 20) TS 15 Inspection, Tests and Trials

The subcontractor shall be responsible for all performance of the **Fire and Smoke Detection System**. The detail system and function description shall be proposed and approved by BEML and DMRC.

6.3 SEM (System Engineering Management)

The subcontractor shall comply with the requirements specified in ERGS 2, 3, 4, 5, Appendix 1 and Appendix 2.

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6.4 Quality

6.4.1 General

All works for product shall be executed and controlled by a quality management system, which can assure the quality of the product. And, it is essential that the supplier of electronic components shall be certified as a minimum, ISO 9001/2 according to ERTS14.12.4. The requirement for quality described in this document was issued on the basis of general specification, technical specification of employer's requirement from DMRC, and ISO 9000 quality system requirements.

And the subcontractor shall follow and perform both this document and the contractual requirements.

If there are conflicts and/or different level of requirements between this quality requirement and contracts from DMRC, the contracts from DMRC has the priority than this document.

6.4.2 Quality System Requirements

Subcontractor shall maintain and perform appropriate quality system for the quality assurance of product in the step of following matters.

- Design
- Development
- Production
- installation
- Servicing

The Quality Assurance System shall be applied without prejudice to, or without in any way limiting, any quality assurance system that the subcontractor already maintains.

6.4.3 Quality (Assurance) Plan

6.4.3.1 The subcontractor shall issue a quality assurance plan (QAP) and submit it to BEML for approval.

6.4.3.2 Following matters, but not be limited to, shall be focused in his QAP.

- a) Process control, b) Purchasing control, c) Quality audit,
- d) Inspection and test including ITP, e) Quality record,
- f) Design Control, g) Nonconformity control.

In addition, following contents shall be included in the QAP appropriately.

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- (i) A summary of his product for this project
- (ii) Quality control organization for this project
- (iii) All quality assurance and quality control procedures proposed by the Subcontractor for his use in the execution of the works.
- (iv) A list of all the Codes of Practice, Standards and Specifications that the Subcontractor proposes to apply to his work.
- (v) The subcontractor's proposals for internal quality assurance audits
- (vi) A statement detailing the records that the subcontractor proposes to keep the time during which they will be prepared and the subsequent period and manner in which they will be stored.
- (vii) Inspection and test plans for every activity requiring inspection and test. The Plans shall identify the level of inspection required, Quality Control Points and Quality Hold Points.
- (viii) Procedure for maintenance of records of inspection/tests.

6.4.4 Inspection and Test

6.4.4.1 Inspection and test plan shall be submitted to BEML prior to any commencement of the related works for review and approval.

A) Inspection and test plan shall include and identify at least following contents:

- (a) The sequence of inspection/test activities.
- (b) The inspection and test requirements of either activities or materials.
- (c) The acceptance criteria or relevant specification.
- (d) The level of inspection required including the provision for witnessing by BEML and DMRC/his representative.
- (e) Any certification requirements or records to be kept or submitted.
- (f) Records of any nonconformity identified during inspection or testing.

B) Witness and hold point

BEML will designate witness/hold point of BEML and/or DMRC and notify them to the subcontractor.

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6.4.4.2 Notification of inspection/test

According to the ITP submitted, the subcontractor shall make a notification in writing for inspection and test before 1 month of any commencement of inspection and test activities on the designated witness/hold points of BEML and/or DMRC.

6.4.4.3 Quality records

Inspection/test reports will be classified as follows:

- a) Type test records and routine test records shall be submitted for approval.
- b) Routine test records shall be kept by the subcontractor and also submitted to BEML whenever requested by BEML and/or DMRC.

6.4.5 Quality Audit

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

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

6.4.6 Extra Requirements

The subcontractor shall nominate to manage QA affairs of this project and notify nominated personnel/department/telephone number/facsimile number/email(if any) address to BEML.

6.5 System Assurance (SA)

6.5.1 Safety Assurance Program & Plan

The subcontractor shall provide BEML with all information for the completion of Safety Assurance Program & Plan and also comply with Safety Assurance Program & Plan defined by BEML according to the requirements specified in ERGS 2.7 and ERTS 2.4.

The Safety Assurance Program Plan shall cover design, manufacture, testing, commissioning and integrated testing, and minimizing the magnitude and seriousness of events or malfunctions of the FDS.

The Plan shall include Hazard Analysis Plan, Fire Control Program, EMC/EMI Control Plan and Reliability and Maintainability Plan.

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The subcontractor shall comply with ERGS 2.7 &ERTS 2.4.

6.5.2 Hazard Analysis

The subcontractor shall provide the Hazard analysis of the **Fire and Smoke Detection System** and assist the contractor to perform the interface hazard analysis compliant with the requirements specified in ERTS 2.5.

The Following analysis shall be prepared and submitted by the subcontractor for the DMRC's acceptance,

- (i) Preliminary hazard analysis.
- (ii) Interface hazard analysis (excluding EMI)
- (iii) Subsystem hazard analysis.
- (iv) Operating hazard analysis including maintenance.
- (v) Quantitative fault tree analysis
- (vi) Failure modes effects and criticality analysis(FMECA)

The Subcontractor shall prepare a Fire Safety Design Report for review and acceptance by BEML and DMRC. This shall be revised and updated for the preliminary, pre-final and final design stage.

6.5.3 Reliability: General

The subcontractor shall comply with the Reliability and maintainability requirements prepared by BEML in accordance with the requirements specified in ERTS 2.7

The Subcontractor shall perform reliability and maintainability analysis up to the point of interface with other contractor's system. The Subcontractor shall verify, after system design has been completed that the reliability and maintainability requirement will be met.

6.5.4 Quantitative Reliability

The subcontractor shall comply with the Quantitative reliability levels for the train and equipment in accordance with the requirements specified in ERTS 2.7.

The Subcontractor shall demonstrate by quantitative methods achievement of the specified levels of reliability for the train and specific individual items of equipment.7.

The achieved level of reliability after a stabilization period of 6 months after putting into revenue service shall ensure that no delay to service of three minutes or more, and no premature withdrawal of a train from service, shall occur in less than 80,000km/train, during the Defect Liability Period.

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Reliability shall be monitored during revenue service operation of the trains. The Subcontractor shall collect the data on each and every deficiency and failure observed by both, himself and maintenance personnel from handing over the first train to the end of the Defect Liability Period of the last train. Each and every component that fails during this period shall be subject to a failure analysis to determine the cause of failure.

Correction shall be made to components or subsystems that fail to attain proposed reliability levels or in which tangible deficiency or failure trends can be identified at no additional cost to the Subcontractor.

6.5.5 Maintainability

The subcontractor shall comply with the Maintainability requirements specified in ERTS 2.12. The Subcontractor shall develop a comprehensive maintenance program for the trains. The maintenance regime proposed for the train shall be developed during the design process.

- a) Conceptual Design Stage: A Failure Mode Effect Analysis (FMEA) will be required, based on function and derived from the specification.
- b) Pre-final Design Stage: FMEA, include required maintenance derived from each failure mode, shall be developed.
- c) Final Design Stage: The Subcontractor shall allocate time and manpower requirements for **Fire and Smoke Detection System**.

The Subcontractor shall indicate the periodicity, down-times, and manpower requirements for the maintenance inspections and services he considers necessary to maintain his product in maximum operational condition.

6.5.6 Reliability and Maintainability Demonstrations

The subcontractor shall assist BEML to complete a Final Report to enable the Employer's Representative to assess acceptability of the vehicle and its components for reliability, maintainability and system safety. The detailed requirements are specified in ERTS 2.9.

6.5.7 Maintenance

The subcontractor shall comply with the Maintenance requirements specified in ERTS 2.12.

The sub-contractor shall support maintenance for high availability. If some failure needs the sub-contractor support, the sub-contractor should dispatch engineer at the

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earliest. Also, if the sub-contractor needs to provide some training for BEML / DMRC maintenance engineer, the sub-contractor shall perform it.

6.6 EMC

The subcontractor shall comply with the EMC requirements specified in ERTS2.15, 2.16 2.17, 2.18, 2.19, 2.20 and 2.21.

The performance category 'A' of immunity level is preferred.

6.6.1. Introduction

The Subcontractor who provides electronic/electrical equipments to BEML for DMRC project shall make and submit EMC control plan. The EMC control plan, at least, must include the following information (section6.6.2-6.6.8).

The Subcontractor shall ensure that his equipment is designed and constructed in accordance with the EMC control plan.

6.6.2. Guideline for EMI/EMC Plan

The following guideline is the minimum to be included on the EMI/EMC plan.

- Measures to reduce conducted, induced and radiated emissions to acceptable levels as specified by the relevant international standards.
- Measures to increase immunity of the train and all its system.
- Basic protective measures proposed for electrical/electronic equipments and components.
- Measures to be adopted for selected systems and components.
- Measures to test EMI/EMC.
- Analysis of EMI/EMC impacts on the design of train, all other train borne equipment and track-side equipment as well as the general environment.
- Grounding bonding, shielding, filtering and cabling arrangement.
- The name and title of a person acting as single point of contact on EMC matters. Any subsequent change of nominated person shall be subjected to approval
- An organization chart.

6.6.3. Design for EMC

The Sub-contractor must ensure that all intra-system EMI are taken care of through proper design and other special measures. The Sub-contractor shall ensure that all train equipment is designed and constructed in accordance with the latest issues or version of internationally recognized EMC standards, including but not limited to

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CISPR, EN50082, EN50121, EN50123, EN50155, 1EC60571-1, IEC61000, RIA12, RIA13, RIA18, R1A22, or equivalents, to ensure proper functioning.

The subcontractor shall submit the valid test reports.

6.6.4. EMI/EMC Tests

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

All system must be tested for emission and immunities in accordance with the appropriate international standards for equipment operating in railway or similar industrial environment (see section 6.6.5).

6.6.5. Test Items (Standard) for each System

The Subcontractor shall define a test level for each test. The Subcontractor shall test his system by the level.

1) Overall Compliance

- EN50121-1
- EN50121-2
- EN50121-3

2) Specific Standard

Test Item		Standard	Remark
Immunity	Electrostatic discharge	IEC 61000-4-2	
	Radio frequency fields	IEC 61000-4-3	
	Electrical fast transient/burst	IEC 61000-4-4	
	Surge	IEC 61000-4-5	
	Conducted RE	IEC 61 000-4-6	
	Power frequency magnetic field	IEC 61 000-4-8	
	Pulse magnetic field	IEC 61000-4-9	
	Damped oscillatory magnetic field	IEC 61000-4-10	
	Voltage dips, short interruptions	IEC 61000-4-11	
	Oscillatory Waves	IEC 61000-4-12	
Emission	Radiated emission	EN50121-2 or CI SPR1 6/ RIA18	

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	Conducted emission	EN50121-3-1	
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6.6.6. Safety-related System Interference

Special attention must be given to the interference with safety-related operations and equipment such as the signaling systems. Special tests must be designed to ensure that the full range of emissions, whether conducted, induced, or radiated, individually or in combination with one another, conform with the specific requirements of these safety-related systems. Adequate safety margins must be ensured between the immunity levels of these safety-related systems and the emission levels of the rolling stock specified by prevailing international standards.

The subsystems and components which could possibly give rise to the level of emissions under both normal and fault conditions (conducted, induced or radiated) that may affect the safety-related systems must be identified. The quantified risk assessment must be carried out as part of the Hazard Analysis to determine the probabilities and effects of such interference. Measures must be taken to reduce such emissions. The reliability of subsystems and components as well as the additional measures, e.g., filter, must be investigated.

These shall include both long and short-term reliability and shall conform to guidelines given in, but not limited to:

- (i) IEC60571-3 Electronic Equipment Used on Rail Vehicles,
- (ii) IEC60300-1 Dependability Program Management,
- (iii) IEC60319 Presentation of Reliability Data on Electronic Components (or Parts)
- (iv) IEC60300-3-2 Dependability Management — Pt. 3 Application Guide Sect. 2 Collection of Dependability Data from the Field.

The probabilities of various conditions which could lead to an unsafe operation must be determined. An appropriate technical construction file suitable for safety audit must be developed to demonstrate EMC compliance to the Employer's Representative (TS 2.18).

6.6.7. Non-Safety-Related System Interference

The Contractor shall take appropriate measures to ensure that EMC is achieved between the rolling stock and all other train-borne and track-side equipment. Particular attention must be given to:

(i) Communications Equipment

The train-borne electrical and electronic equipment shall not produce significant interference affecting proper operation of telephone, public address system, train to

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CCC and passenger information systems due to influence arising from radiation, conduction, inductive-, capacitive- or electrostatic-coupling. The limits in CCITT (The Consultative Committee on International Telegraphy and Telephony) directives must be complied with at all times.

(ii) Supervisory & Control Equipment

The Contractor must ensure that electromagnetic compatibility is achieved with the supervisory & control equipment. These shall include induced or radiated coupling to sensors and in-built test equipment including VDU and computer systems, low-frequency induced and high-frequency radiated coupling through common-mode, differential-mode, or ground-loop mechanisms (ERTS 2.19)

6.6.8. Environmental EMC

- The train-borne electronic and electrical equipment shall not produce significant interference with radio, television, tape recorders or players, heart pace-makers, radar, computer systems, magnetic media, portable and cellular telephones, pagers, etc., in the passenger saloon or externally. This includes action by static electricity, magnetic fields and electric fields.
- Effect of emission on explosive or volatile/flammable material must be considered. BS6656 (Prevention of Inadvertent Ignition of Flammable Atmospheres by Radio-Frequency Radiation) and other related standards shall be adhered to.
- Effect of the low-frequency magnetic field produced by traction on Delhi MRTS grounding system as well as electrolytic weakening of underground structures should be considered wherever applicable (ERTS 2.20).

6.7 Noise and Vibration

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

6.8 Fire

The **Fire and Smoke Detection Systems** shall comply with the Fire performance requirements specified in ERTS 2.23 and ERTS 2.5.8.

Materials used in the **Fire and Smoke Detection System** shall conform to fire safety requirements of EN 45545, latest editions, or the latest edition of other equivalent international standards, subject to the acceptance of the Engineer as per ERTS 2.5.8.

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Subcontractor shall accomplish each fire tests of materials according to the international standards of these requirements.

Subcontractor shall submit data sheet according to BEML's guide format which will be provided.

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

6.8.1 Other

The Subcontractor shall comply to ERTS 12.5 (Wires & Cables).

The insulation of all wires and cables including those used within equipment / subsystem shall be halogen-free flame- retardant and formulated to minimize generation of smoke, noxious emissions and corrosive fumes, in the case of overheating or fire. Cables shall all comply NF F 63-808 (for low voltages, and NF F 63-826 (for high voltages) or other international standards like EN 50264 approved by the Engineer(ERTS12.5.2).

Fire resistant cables shall be proposed for circuits, which should survive for long periods during fire, as per applicable international standards. The cables and wires for **Fire and Smoke Detection System** shall be fire resistant cables (ERTS12.5.3).

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.

6.9 Design Information

The Subcontractor shall provide BEML all necessary drawings, reports, calculations, specifications, technical data and similar documents of design, system assurance, quality assurance, manufacturing, test and training with respect to PTS.

These drawings and documents shall be delivered in English with the data format of, respectively, AutoCAD release 14 and MS office version 7.0 (document - MS word, spread sheet — MS excel, data base files — MS Access Presentation file — MS PowerPoint).

6.9.1 General

The Subcontractor shall provide all necessary documents, drawings, software and deliverables for BEML.

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Subcontractor shall require the interface information, which possibly affects performance, fitting, and form, from BEML.

The detailed requirements are specified in ERGS 5 and ERTS 3.

The Subcontractor shall provide but not be limited to the following general information to satisfy BEML that the Subcontractor have the ability to supply the **Fire and Smoke Detection System** in accordance with the requirement of PTS, before contract award the Subcontractor shall provide BEML for review and approval the following information.

- (a) Project Management Plan
 - 1) Data Submission Plan
 - 2) Design Submission Plan
 - 3) Type Test & FAI Plan
 - 4) Mass Production after Testing and Delivery Plan
 - 5) O&M Manual Plan
 - 6) As Built-In Drawing Plan
- (b) Inspection and Test Plan (hereinafter, ITP)
- (c) Quality Assurance Plan (hereinafter, QAP)
- (d) Technical system/product/function description (including Lay-Out drawing)
- (e) Clause by Clause commentary for PTS

6.9.1.1 Design

The Subcontractor shall comply with PTS.

The Subcontractor shall provide, but not be limited to, the following design information of the **Fire and Smoke Detection System**.

- (a) Detailed Drawing.
 - 1) All Types of Detectors
 - 2) FDCU
 - 3) Other aggregates of FDS.
- (b) Analysis & Calculation data.
 - 1) Smoke & heat detectors simulation
- (c) Standard applied to the **Fire and Smoke Detection System**
- (d) Interface with other system such TIMS, Vehicle Circuits, HVAC, etc.
- (e) Type test procedure & record sheet
- (f) Type test report
- (g) Routine test procedure & record sheet
- (h) Routine test report
- (i) Certificate of conformity
- (j) Material certification

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- (k) Spare parts catalogs
- (l) Training manual of special tools and test equipment
- (m) Training manual.
- (n) Operation and maintenance information for special tools and test equipment
- (o) Dismounting and mounting instruction

6.9.2 Design and Performance Requirements

The subcontractor shall develop the design based on the specification of ERTS3 and on sound proven and reliable engineering practices. The design details shall be submitted with technical data and calculations to BEML and DMRC for review and acceptance.

The design of subcontractor shall meet the requirements specified in ERTS 3.

6.9.3 Design Submission Requirements

The documents, drawings and CAD data shall be provided in both paper copies and electronic format.

The format and quantity of the document and drawings shall meet the requirements specified below;

- Document & drawings; the format specified in ERGS5.3 and Appendix 4 of General specification (Drawing and CAD standard).

6.10 Software

The subcontractor shall provide BEML with all information for the completion of Software Assurance Plan and also comply with the Software Assurance Plan defined according to the requirements specified in ERGS 2.8 and ERTS 14.14.

Software shall be written in a structured manner and fully documented during all stages of its design and development, with at least two levels of documentation above source code level.

All software to be developed or modified shall follow the standardization requirements of EN 50128 (Railway Applications: Software of Railway Control and Protection Systems).

Independent review, verification and testing, using real and synthetic data, shall be performed at the software module and system level.

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Sufficient software documentation shall be provided to give BEML and DMRC a full understanding of the software function and operation.

The subcontractor shall provide all tools, equipment, manuals and training necessary for DMRC to maintain and re-configure all software provided under the contract.

After loading, and the satisfactory functioning of the software, the subcontractor shall supply two back-up copies of the software, including any new versions and adopted.

All test software, with the exclusion of built-in test software, shall be produced in accordance with a quality system controlled under the requirements of ISO 9000-3.

The subcontractor shall comply with the requirements specified in ERGS 6 and ERTS 14.14.

6.11 Weight

The weight of the **Fire and Smoke Detection System** shall be verified and controlled by the subcontractor in accordance with the requirements defined by BEML to comply with the requirements specified in ERTS 3.22.

The Subcontractor shall comply with all weight reductions judged by necessary by BEML. Any unit exceeding the permissible weight shall be rejected. Overweight tolerance is not permitted.

The subcontractor shall submit the list which describes the exact weights of all equipment. The subcontractor shall maintain and publish a weight control document. The weight control document shall list the weight and center of gravity of all components with tolerances.

6.12 Materials and workmanship

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

Protection of materials against all types of corrosion shall be appropriate for the environment of Delhi and the operating conditions of the cars.

The requirements for material and workmanship of the **Fire and Smoke Detection System** shall meet, but not be limited to, the ERTS 14 “Material and Workmanship”

7. Design Information

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7.1 General

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

Document /Deliverables	Reference /Description
Testing plan	ERGS7, ERTS 15
Schedule of Tests	ERGS7, ERTS 15
Test procedure of; Type and routine test of equipment, Type test of complete vehicles, Commissioning test of complete vehicles	ERGS7, ERTS 15
List of Spares, Special Tools and Testing and Diagnostic equipment	ERGS 8 & As per Attachment-IV of PTS
Spares, Special Tools and Testing and Diagnostic equipment	ERGS8
All relevant drawings, manuals and full operation instructions for the Special Tools, Testing and Diagnostic Equipment	ERGS8
Training Proposal & Training Course	ERGS9
Training Manual	ERGS 9
Operation and Maintenance Manuals and Spare parts catalogues	ERGS 12
All as-built drawings	ERGS 5
All tools, equipment and manuals necessary for the maintenance and configuration of software	ERGS 6
The requirements for the completion of Project Management Plan, Interface Management Plan, Work Plan, Quality Assurance Plan, Safety Assurance Plan and Site Safety Plan, Software Quality Assurance Plan, Environmental Plan, Inspection, Test and commissioning Plan	ERGS 2

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7.2 Design

7.2.1 General

The design of the **Fire and Smoke Detection System** shall basically comply with ERTS 2.24 and relevant specification of ERGS and ERTS.

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

- (1) Preliminary design submission stage
- (2) Pre-final design submission stage
- (3) Final design submission stage
- (4) As-build drawings.

The subcontractor shall submit, not limit to, the following design information of the **Fire and Smoke Detection System**

Submission Stage	Document / Deliverables
Before Design	(1) Subcontractor's proposal system construction. (2) Simulation study for detectors arrangement as per ARGE guideline.

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Preliminary Design Submission	<p>(1) System description, which should describe the following information;</p> <ul style="list-style-type: none"> - Function of each system, sub-system, equipment. - Interface between elements of the system - Control Mechanism. - Assemble Drawing. - Miscellaneous item& drawing. - Power consumption. - Weight. - Inrush Current. - Communication method - Earthing method - Interface Data <p>(2) System requirement specification FDS</p> <p>(3) Function Description FDS</p> <p>(4) Component List with temperature specification.</p> <p>(5) Schematic diagram (Electrical diagram)</p> <p>(6) Verify the tender designs and calculations.</p> <p>(7) Reliability and maintainability proven data and letters.</p> <p>(8) The detailed requirements will be specified later by BEML</p>
Pre-final Design Submission	<p>(1) Upgraded System description; At this stage, the information described at the preliminary stage should be fixed and finalized,</p> <p>(2) Sufficient software documentation to fully understand software function and operation</p> <p>(3) The evidence of or proposals for design verification</p> <p>(4) Detailed maintenance and troubleshooting procedures, including wave-forms at critical locations of the circuitry.</p> <p>(5) The detailed requirements will be specified later by BEML.</p>
Final Design Submission	<p>(1) Completed calculations and analyses, studies, investigations and reports.</p> <p>(2) The detailed requirements will be specified later by BEML.</p>

The subcontractor shall submit all data for each design submission to BEML as soon as possible so that they can be confirmed by BEML.

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

7.2.3 Requirement of Electronic Equipment

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As minimum, all electronic equipment shall comply with IEC 60571 Electronic Equipment used on Rail Vehicles, for design, manufacture and testing, and shall use components purchased against an internationally recognized quality assurance and reliability certification procedure. However, the dry heat test temperature shall be 80°C as against 70°C specified in IEC.

Electronic components shall only be purchased from suppliers having as a minimum, ISO 9001/2 certification (ERTS 14.12).

Subcontractor to comply the requirement of ERTS clauses 14.12, 14.13, 14.15, 14.16.

7.3 SEM (System Engineering Management)

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

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

Classification	Document /Deliverables
Proposal, plan, prediction	Acoustical information for noise prediction model
	Design proposal for noise, vibration and fire
	Breakdown list and weight of each component
	Detailed prediction of the power output from fire flash over
	Fire load schedule based on fire load density of materials of components
	EMC plan
	Material analysis on component level
	RAM data
	Hazard log & Register of train failure
	RAM modeling & Prediction
	RAM Table
	Hazard analysis
	FMECA
	FTA
Detail, test procedures-	Description of noise test Procedure
	Description of fire test procedure
	Design documentation related to EMI/EMC
	Test specification of EMI/EMC
Test Reports	Noise test report

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	Report on weight measurement
	Certificate of fire tested non-metallic materials of components
	Test reports of EMI/EMC

8. Testing

8.1 General

8.1.1 General

The subcontractor shall provide BEML with all information for the completion of Inspection, Testing and Commissioning Plan and also comply with the plan defined according to the requirements specified in ERGS 7.1 and ERTS 15.2.

The **Fire & smoke Detection System** of individual cars and complete train-set shall be type and routine tested in accordance with IEC 61133 in accordance with the requirement specified in ERTS 15.1.1.

The **Fire & smoke Detection System** shall be type and routine tested in accordance with the IEC Publications or other appropriate international standards in accordance with the requirements specified in ERTS 15.1.2.

The type tests for the **Fire & smoke Detection System** at both the component level and complete train level shall be re-performed by the Subcontractor under BEML and DMRC participation, if DMRC want to witness the tests even though the tests were accepted by BEML.

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

Type tests for **Fire & smoke Detection System** may be waived if these were carried out earlier on equipments of identical design, witnessed by a reputed organization, and the service performance of such equipments was found to be reliable. The subcontractor submits a proposal in this regard to the BEML and DMRC for review. The waiver of Type test is entirely at the discretion of the BEML and DMRC.

BEML and DMRC reserve the right to witness any or all of the tests, and to require submission of any or all test specifications and reports. BEML and DMRC reserves the right to reasonably call for additional tests (fire performance and noise performance

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test, EMC and Software Integration test) if considered necessary in accordance with the requirements specified in ERTS 15.1.6 and ER15.2.3.

All defects and shortfalls in the subcontractor's system, discovered during all tests, shall be rectified and re-tested to the satisfaction of BEML and DMRC.

The subcontractor shall provide full instrumentation to conduct all tests and carry out modifications as required.

All test procedures, reports including all maintenance activities and check lists shall be submitted and approved by BEML and DMRC within the defined period.

The results of all tests shall be submitted to BEML and DMRC, who will record his conclusions as to whether or not the equipment being tested has passed satisfactorily.

The subcontractor shall produce a test report, in three copies, and in an approved format, within an defined period following the test, for acceptance by BEML and DMRC. The detailed requirements are specified in ERGS 7 and ERTS 15.

8.1.2 Inspection

All the materials, fittings, equipment, manufacturing processes, and assembly workmanship shall be subject to inspection by BEML and DMRC, wherever carried out in accordance with the requirements specified in ERGS 7.

8.1.3 Inspection Hold Points

The subcontractor shall propose a set of inspection hold points in the Inspection, Testing and Commissioning Plan in accordance with the requirements specified in GS 7.

8.1.4 Test Procedure

Following items shall be complied

- (1) All test equipment shall carry an appropriate and valid calibration label.
- (2) The subcontractor shall sign all reports of Tests
- (3) The subcontractor shall present a comprehensive Testing and Commissioning Program.
- (4) Test procedures shall be amended, as required by the subcontractor throughout the duration of the Contract, to reflect changes in system design or the identification of additional testing requirements.

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- (5) All costs including labor, supervision of testing, provision of specialized equipment and materials, and the cost of hiring Consultants and the services of other specialized personnel or independent assessors etc shall be borne by the subcontractor. The subcontractor shall also bear any expenses incurred due to re-testing caused by defects or failure of equipment or any other account to meet the requirements of the contract.

The detailed requirements are specified in ERGS 7 and ERTS 15.

8.1.5 Sequence of Tests

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

8.2 Routine and type tests of equipment and sub-systems

Fire & smoke Detection System shall be Type and Routine tested in accordance with IEC60571.

8.2.1 Type Test, Fire & smoke Detection System

This test is required to verify that the **Fire & smoke Detection System** operate in accordance with the Approved Design Data.

Type test of each component shall be performed by the Subcontractor under BEML and DMRC participation in accordance with the requirements specified in ERTS 15. Subcontractor has responsibility for the type test of the component. During test the criteria shall be observed and recorded in a log book and necessary alterations and adjustments carried out.

The subcontractor shall perform, as a minimum, the following test in accordance with the requirements specified in ERTS 15;

- (1) Visual Test
- (2) Electrical Test (Insulation & Dielectric test)
- (3) Functional Test/Performance test
- (4) Dimensional Inspection

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- (5) EMI/EMC Test
- (6) Software Test
- (7) Fire performance Test
- (8) Vibration, shock and bump Test as per IEC 61373
- (9) Temperature Test at 80°C (refer to ERTS 14.12.1)
- (10) Ingress Protection level test (min. IP 53) as per IEC 60529
- (10) Others

8.2.2 Routine Test, Fire & smoke Detection System

This test is required to verify that the **Fire & smoke Detection System** have been built in such a way that it satisfies the requirements of the Approved Design Data as verified by the Type Test.

Routine test of each component shall be performed by the Subcontractor in accordance with the requirements specified in ERTS 15.1.2.

During test, the criteria shall be observed and recorded in a log book and necessary alterations and adjustments carried out.

Records from Routine test shall be held by the Subcontractor and made available timely for BEML and DMRC's inspection. Copies of the approved routine test results shall be submitted together with the associated log book. Additional copies of records of all tests/inspections result shall also be held at the Subcontractor work to be made available to BEML and DMRC on demand.

This test basically includes function test, visual inspection and dimensional inspection but not be limited.

The subcontractor shall perform, as a minimum, the following test in accordance with the requirements specified in ERTS 15

- (1) Visual Test
- (2) Electrical Test(insulation & Dielectric test)
- (3) Functional Test/Performance test
- (4) Dimensional Inspection
- (5) Others

8.2.3 Fire Performance Test

The sub-contractor shall perform the fire performance tests of the **Fire & smoke Detection System** in accordance with the requirements specified in ERTS 2.5.8, 2.23 & 15.19.

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8.2.4 Noise and Vibration Performance Test

The sub-contractor shall perform the noise performance test of the **Fire & smoke Detection System** in accordance with the requirements specified in ERTS 2.22.

BEML will perform the noise performance test on the completed car, unit and train. So the sub-contractor shall be responsible to assist for BEML to achieve the noise criteria.

8.2.5 EMI/EMC Test

The sub-contractor shall perform the EMI/EMC test of the **Fire & smoke Detection System** in accordance with the requirements specified in ERTS 2.15, 2.16, 2.17, 2.18, 2.19, 2.20 and section 6.6.

BEML will perform the EMI/EMC tests on the completed car, unit and train. So, the sub-contractor shall be responsible to assist for BEML to achieve the EMI/EMC design requirements.

8.2.6 Software verification and testing

The sub-contractor shall perform the independent review, verification and testing at the software module and system level according to ERTS 14.14 and the software testing on the completed 6 car / 8 car train formation. The subcontractor shall be responsible to assist for BEML to achieve the performance criteria.

8.3 Factory and Site Tests of complete cars

8.3.1 Type Test, Completed car, unit and Train Tests

The individual cars and complete trains shall be type tested a by Subcontractor for the **Fire & smoke Detection System** in accordance with IEC 61133 and other standards as per ERTS 2.24.3.

The Subcontractor, Design Engineer, shall participate in this testing to ensure that the **Fire & smoke Detection System** meet the performance requirements specified at the contract and do not introduce any adverse effects into the train. The Subcontractor shall provide the Design Engineer with a full record of the modification status and software versions fitted to a train at the time that the type test for complete vehicle is conducted. Subcontractor shall be responsible for correcting any interfacing defects.

The other tests are described as followings and the acceptance criteria shall be defined by Subcontractor.

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8.3.2 Routine Test, Completed car, unit and Train Tests

The individual cars and complete trains, for both Corridors shall be routine tested by Subcontractor for the **Fire & smoke Detection System** test in accordance with IEC 61133 and other standards as per ERTS 2.24.3.

If BEML or DMRC request, the Subcontractor shall participate in this test. The Subcontractor shall be responsible for correcting any interfacing defects.

These tests will be a subset of those tests performed at Type Test, complete vehicle to demonstrate that the principal features of the **Fire & smoke Detection System** are compliant with the ERGS and ERTS. This test shall include but not be limited to a test of all safety system.

8.4 Testing and Commissioning of cars/trains in India

8.4.1 Type Commissioning Tests

On the first train or trains delivered in Delhi, Subcontractor shall undertake Type Test for the **Fire & smoke Detection System** of Commissioning Tests to adequately demonstrate that the requirements of GS, TS for the **Fire & smoke Detection System** have been satisfied under the Subcontractor's responsibility. The commissioning shall include tests on the train in accordance with IEC 61133 and other standards as per ERTS 2.24.3.

The Subcontractor's design engineer shall also participate in this testing to ensure that the **Fire & smoke Detection System** meet the performance requirements specified at the contract and do not introduce any adverse effects into the railway and its environment. This testing shall demonstrate compatibility between the **Fire & smoke Detection System** and the interfacing system specified in the Appendix TD. The Subcontractor shall be responsible for correcting any interfacing defects.

8.4.2 Routine Commissioning Tests

Following delivery of the trains to the Site will be commissioned by BEML and at an appropriate time the Engineer will witness certain of these tests to satisfy himself that the **Fire & smoke Detection System** are acceptable for operating in passenger service. The commissioning shall include tests on the train in accordance with IEC 61133 and other standards as per ERTS 2.24.3.

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This test for the **Fire & smoke Detection System** shall be performed Subcontractor. The Subcontractor shall be responsible for correcting any interfacing defects.

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These tests will be a subset of those tests performed at Type Commissioning Test to demonstrate that the principal features of the **Fire & smoke Detection System** are compliant with the ERGS and ERTS. This test shall include but not be limited to a test of all safety system.

8.5 Integration Test

BEML will perform the integration test with the assistance of sub-contractor according to ERGS 7 and ERTS 15.1.9.

The subcontractor shall submit all information for the integration test to BEML. If needed, the concerned engineer from subcontractor shall participate in the test.

8.6 Instrumentation and Dynamometer Tests and Oscillation Trials

Prototype trains of both Metro and Rail Corridor shall be subjected to Instrumentation Tests after Commissioning, in accordance with ERTS 1.2 and ERTS 15.

BEML will perform others of instrumentation and Dynamometer Tests and Oscillation trials with the assistance of sub-contractor according to ERGS 7 and ERTS 15.1.8.

The subcontractor shall submit all information for the tests to BEML. If needed, the concerned engineer from subcontractor shall participate in the test.

8.7 Service Trials

BEML will perform the service trial both in the Rail Corridor and Metro Corridor and the sub-contractor shall supply the sufficient information and assistance if necessary according to ERGS 7 and ERTS 15.1.10.

The subcontractor shall submit all information for the service trials to BEML. If needed, the concerned engineer from subcontractor shall participate in the service trial.

9. Others

The delivery format of all deliverables (design submission, maintenance manuals, training manuals and etc) shall be approved by BEML.

The indefinite specifications can be clarified after the discussion between BEML and the subcontractor.

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10. Submittals – Technical offer:

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

- 1) Technical offer for **Fire & smoke Detection System** consisting of system working principle, circuit / block diagram, wiring diagram and outline drawings of **Fire & smoke Detection System** .
- 2) Clause wise compliance against PTS Doc no. **GR/TD/4960**.
- 3) Clause-wise compliance for relevant clauses in ERGS and ERTS.
- 4) List of DLP and commissioning spares as per ERGS Chapter 8.
- 5) List of Spares as per section 5.7.
- 6) Duly Filled Notice for No Objection (NNO) format (Annexure-1 of PTS) along with supportive documents (Performance Certificates of experiences).