



BEML LIMITED
BANGALORE
R & D CENTER

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Procurement Technical Specification –
CCTV System for DMRC RS-15 Project

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1. Introduction

1.1 General

This document describes the **CCTV System** to be supplied for DMRC RS 15 contract for Delhi Metro Rail Corporation Limited (DMRC).

BEML shall carry out all required works and activities as Supplier for DMRC RS 15 project while the Subcontractor shall be responsible for all works required in this PTS with regard to Design, manufacture, supply, testing and commissioning of **CCTV 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) 40 'T+M' units (**80 cars**) to be integrated with existing RS1, RS6 & RS13 cars


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

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

1.2 Climatic Conditions

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

Description	Limiting Values
Maximum ambient temperature	47 °C (Refer note below)

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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 RS15 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	0.78 m/s ² ± 5%
Service deceleration rate	1.0 m/s ² ± 5%
Emergency deceleration rate	1.3 m/s ²

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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 CCTV System for RS15 Project

“Subcontractor” means the Supplier of CCTV System to BEML for RS15 Project.

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

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

“PTS” means BEML’s Procurement Technical Specification.

“GTC” means General Terms and Conditions of the tender issued by BEML for procurement of the CCTV system for RS15 contract.

3. Precedence of Documents

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

To the extent that any provision of GTC is inconsistent with any provisions of the 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.

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Order of precedence	Document Title
1	GTC,GS & TS
2	PTS

4. Scope of Supply


4.1.1 Hardware

The CCTV system proposed is car basis for the RS15 cars. The Subcontractor shall provide all components related to CCTV, but not limited to, the following as per ERTS 13.8 ~13.10:


Sl. No.	ITEM DESCRIPTION	QTY.	
		T car	M car
1	Saloon Camera (IP based)	4 sets	4 sets
2	Recorder (with PoE switch)	1 set	1 set
3	DC-DC converter for PoE switch (if used)	1 Set	1 Set
4	Software	Complete package for configuration of all aggregates.	
5	Equipment for downloading of data from Recorder.	1 set per depot.	
6	Male and Female connector, pin and socket, etc. along with cables between Saloon camera & Recorder (with PoE switch).	1 Set	1 Set
7	Spare parts, special tools and testing equipment	1 Set	1 Set

Table-1 : List of items for CCTV system.

- 1) The camera shall be suitably selected in respect of resolution, clarity of images, illumination conditions for on-train applications and shall be of proven design. Mounting of camera shall be unobtrusive, flushed with or recessed into the interior panel. The minimum angle of view shall not be less than 80° (Horizontal) & 50° (Vertical). The video recording frame rate (minimum of 25 FPS) shall be proposed. The IP Level shall be proposed.


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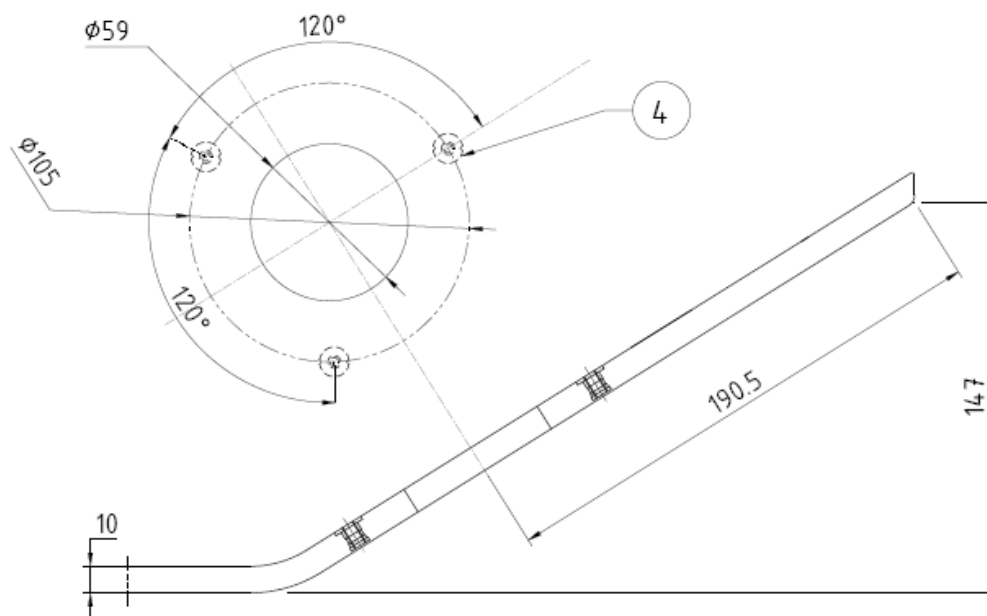
- 2) The subcontractor shall propose the quantity of cameras and appropriate location in the car to have 100% saloon area coverage with good image quality. The layout of M/T car are attached at the drawing sketch no GR-2670.
- 3) The picture quality will be level E as minimum at 100% Rotakin measured according to EN50132-7.
- 4) At least 2 additional spare Ports shall be provided on the CCTV System for future requirement.
- 5) In the event of any additional requirement of component/aggregate required for smooth operation of the CCTV system the same shall be provided by the sub contractor.
- 6) The visual images from each camera shall be recorded in non volatile memory without any limitation of repetitive writing of the data. The memory shall be expandable by simple plug in of commercially available memory media. The recording shall be easily downloadable. The subcontractor shall provide equipment & means for the same. One set of equipment shall be provided to each depot.
- 7) The recorder shall be provided with non volatile Solid state drive (SSD) of sufficient capacity to record the footage for a minimum of 15 days. Provision for expanding the memory capacity by simple plug in of commercially available memory media shall also be available.
- 8) The subcontractor shall provide relevant hardware such as bolts, nuts, washers and other fasteners required for installation as per the requirements of chapter 14 of ERTS.
- 9) The CCTV system shall fully meet the requirement of EMI/EMC & other requirements as per ERTS 2.15, 2.16 2.17, 2.18, 2.19, 2.20, 2.21 and ERTS Appendix TD 3.10.1.
- 10) The subcontractor shall provide valid type test certificates/documents and routine test certificates for the CCTV system aggregates.
- 11) The subcontractor shall be fully responsible for integrated testing and commissioning of the CCTV system at BEML works and at DMRC site.
- 12) The subcontractor shall be responsible to maintain the DLP and commissioning spares at DMRC site for CCTV system. The list of DLP and commissioning spares shall be furnished by the subcontractor for review and approval by DMRC/BEML.
- 13) The subcontractor shall provide all the following documents and shall also provide any other documents required by DMRC as per GS 5 and TS 3.

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- a) Description of CCTV system aggregates with drawings.
- b) Quality assurance plan (QAP)
- c) Software quality assurance plan (SQAP)
- d) Type test procedure for the CCTV system and aggregates
- e) Routine test procedure for CCTV system and aggregates
- f) Inspection and test plan (ITP)
- g) EMI/EMC test procedure & plan
- h) Factory tests , Depot tests and main line test procedures
- i) Testing and commissioning plan
- j) Interface plan
- k) Type test and Routine test reports
- l) Operation and maintenance manual
- m) Spare parts catalogue

- 14)** The supplier shall maintain the CCTV system aggregates and supply of spares for at least 10 years from the date of completion of the contract.
- 15)** The system shall be based on open environment/protocol like Ethernet for ensuring interchangeability of cameras. The system shall have self diagnostics and communicate the same suitably to the maintainer.
- 16)** An expected power consumption of the equipment should be declared as a realistic value at the tender level and/or early design concept phase. The sub-contractor shall make every effort to minimize the energy consumption of each equipment.
- 17)** The CCTV system (saloon camera, recorder with PoE switch and DC-DC converter) proposed shall be compatible for mechanical mounting and electrical interconnection interface with the CCTV system in existing RS13 cars (Please see below image for section of interior FRP panel for Saloon camera mounting). Any adaptations if required to suit to the mounting interface on car interior FRP panels (saloon camera) and cubicle frames (recorder with PoE switch and DC-DC converter) shall be taken care by the sub contractor. Details will be discussed during design stage.

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- 18) The subcontractor shall provide O&M Manuals and necessary training to BEML & DMRC staff in case of change in the specification of CCTV system (compared to RS13 cars) or new system recommended by the subcontractor for RS15 project.
- 19) The subcontractor shall recommend/supply sufficient spares in case of change in the specification of CCTV system (compared to RS13 cars) recommended by the subcontractor for RS15 project.
- 20) Each car shall be provided with at least four surveillance camera devices at appropriate location to cover the maximum passenger saloon area for surveillance. ***It shall be possible to increase number of cameras by at least 2 per car by simple plug in to the system.*** Any hardware/software tool required for expanding the system shall be provided to enable the Employer to plug in additional cameras if so required in future. Accordingly sub contractor shall consider Recorder & PoE switch with enough no.of ports and storage capacity to meet the requirement of ERTS 13.8.3.
- 21) The rolling stock, including all sub-systems and equipment shall be of proven design. Subsystems and equipment offered in this tender shall have been in use and have established their performance reliability on a mass rapid transit system or suburban e.m.u.'s in revenue service over a period of two years or more. Where similar equipment or sub-systems of a different rating are already proven in service, then the design shall be

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based on such equipments. In case this stipulation is not fulfilled the tenderer shall furnish sufficient information to prove the basic soundness and reliability of the offered subsystem as per ERTS 3.2.2.

22) Efforts shall be made by sub contractor for indigenizing of CCTV supplies as per ERGS 1.1.8 Table 1D.

4.1.2 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 CCTV system (refer to ERGS 6.6, GCC 5.8 and ERTS 14.14).

4.2 Spare parts, Special Tools and Testing Equipment

The subcontractor shall supply any special tools / testing equipment required for the system.

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


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

Sub contractor shall propose the Consumable spares for CCTV system whose declared life is less than one year.

4. DLP & Commissioning spares

4.3 Split of Responsibilities

The subcontractor shall be responsible for the overall design and engineering to complete CCTV in accordance with his Scope of Supply and Work.

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The subcontractor shall be responsible for design change of his Scope of Supply and Work from the technical discussion between BEML and/or the DMRC and/or the subcontractor under the contracted price and delivery between BEML and the subcontractor.

The subcontractor shall be responsible for deputing his engineer to BEML or the place designated by BEML for the technical meeting required from BEML. The installation method and location point of all equipments comprising of CCTV shall be designed by the subcontractor and approved by BEML in order to avoid any mechanical interference with the other equipment of the vehicle.

In order to implement interface requirements, the subcontractor shall provide the information required by BEML and provide the interface data for ensuring the performance of the CCTV system and shall be responsible for the mechanical and functional interface requirement from other contractors.

The subcontractor shall be responsible for the Scope of Works as described below:

No.	Description	Details	Scope		Remarks
			BEML	Subcontractor	
1	System Interface	Installing CCTV to train	X2	X1	
		Vehicle Circuit	X2	X1	
2	Design	According to PTS		X1	
3	RAMS	According to PTS		X1	
4	Calculation documents	According to PTS		X1	
5	Approval of drawing	According to PTS	X2	X1	
6	Type & routine test	According to PTS		X1	
7	Manufacturing	According to PTS		X1	
8	Technical documentation	According to PTS		X1	

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9	Manual	According to PTS		X1	
10	Training	According to PTS		X1	
11	Warranty for each components	According to PTS		X1	

NOTE:

1) X1: Design leader, i.e. responsible for the design activity required for the specified element of the scope of supply including any calculation, drawing, documentation and test connected with the design.

2) X2: Design support, i.e. responsible for supporting the design leader by supplying of any relevant information required by the design leader to produce a satisfactory design.

4.4 Design Information


The subcontractor shall provide BEML with all necessary documents, drawings, software, reports, calculations, technical data and similar documents of design, system assurance, quality assurance, manufacturing and testing with respect to PTS according to the time schedule defined by BEML for submission and approval of DMRC.

The drawings and documents shall be written in English with data format of respectively, latest AutoCAD release and MS office (document - MS word, spread sheet — MS excel, data base files — MS Access, Presentation file — MS PowerPoint).

4.4.1. General

The subcontractor shall provide, but not be limited to, the following general information in accordance with the schedule approved by BEML before contract award. In order to satisfy BEML that the subcontractor has the ability to supply the CCTV system in accordance with the requirement of PTS, before contract award the subcontractor shall provide BEML for review and approval the following information.

- (a) Vendor approval documents
- (b) Project Management Plan
 - 1) Data Submission Plan
 - 2) Design Submission Plan
 - 3) 1st Production Plan


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- 4) Type Test & FAI Plan
- 5) Mass Production after Testing and Delivery Plan
- 6) O&M Manual Plan
- 7) As Built-In Drawing Plan
- 8) Training Plan
- (c) Preliminary Inspection and Test Plan (hereinafter, ITP)
- (d) Preliminary Quality Assurance Plan (hereinafter, QAP)
- (e) Preliminary Technical system/product/function description (including Lay-Out Drawing)
- (f) Subcontractor's Option Suggestion about PTS requirements
- (g) Clause by Clause comments for PTS

4.4.2 Design

The subcontractor shall comply with PTS, ERTS 3, ERGS 5 and shall provide, but not be limited to, the following design information of the CCTV system in accordance with the time schedule approved by BEML for approval by DMRC.

- (a) Product Description & Detailed Drawings for the following:
 - 1) Saloon camera assembly
 - 2) Video recorder assembly and PCB
 - 3) PoE Switch
 - 4) DC-DC converter (if used)
- (b) Analysis & Calculation data.
 - 1) Analysis of saloon Camera views
- (c) Standard applied to the CCTV system
- (d) Interface with other system such as TIMS and Vehicle circuit.
- (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
- (k) Spare parts catalogs
- (l) Training manual of special tools and test equipment
- (m) Training manual of the CCTV system
- (n) Operation and maintenance information for special tools and test equipment
- (o) Dismounting and mounting instruction.
- (p) Final As-Built drawings as per ERGS 5.13

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4.5 Testing

The subcontractor shall be responsible for performance tests of the CCTV System. BEML and/or DMRC and/or DMRC's representative have the right to witness any of these tests at any stage of test progress.

BEML and/or DMRC and/or DMRC's representative will carry out the First Article Inspection (FAI) on complete CCTV System under the subcontractor's responsibility.

The subcontractor shall carry out the type test and routine test of equipment and assembly. The commissioning test of the complete vehicle at BEML, and the commissioning test at depot & Mainline in Delhi will be performed by subcontractor for the CCTV system.

The subcontractor shall provide the required information for testing and carrying out the tests and retrofit problems during the tests in accordance with PTS.

In the event that any test for the CCTV system is failed, the subcontractor shall, at his own expense, take whatever action is deemed such as, rectification, readjustment or design changes to the satisfaction of BEML and DMRC, in order to meet the testing requirements.


4.6 Operation and Maintenance Manual

(Not applicable for RS15 contract)

The subcontractor shall provide necessary requirements for Operation and Maintenance Manual and Spare Parts Catalogues for the CCTV system and special tool with hard copies and electronic format. The requirement for Operating and Maintenance Manuals and Spare Parts Catalogues shall be provided for approval by BEML. The subcontractor shall provide the following O&M Manuals.

- 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.

Details are to be referred in PTS clause 5.6.

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4.7 Warranty

Refer General terms and conditions (GTC) of the tender.

4.8 Training

NA

The subcontractor shall provide training to the BEML personnel and the maintenance staff of DMRC in the operation and maintenance of CCTV system as specified in ERGS 9.

4.8.1 Training Manual

The subcontractor shall provide one original and five colored copies and electronic copies of the Training manual for use by the Employer for conducting in-house training. The Manuals shall cover all requirements specified in ERGS 9.

After completion of the training, training aids and materials used shall become the property of BEML to enable and further training to take place.

4.9 Quality Plan

The Subcontractor shall provide BEML all the requirements specified in the PTS with respect to Quality Assurance Requirements.

4.10 Handing over of CCTV System


The Subcontractor shall hand over the complete CCTV system to BEML in accordance with the time schedule approved by BEML. The subcontractor shall provide the instruction for proper storage, handling and logistic function of components supplied by the subcontractor two months before handing over the first batch of the complete CCTV system.

5. Technical Requirements

5.1 General

The subcontractor shall be responsible for meeting all the technical requirements in PTS and submission of all the required data for CCTV system design.

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

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- 1) ERGS 1 - General
- 2) ERGS 5 - Design Submission Requirement.
- 3) ERGS 6 - Software Management and Control.
- 4) ERGS 7 - Inspection, Testing and Commissioning.
- 5) ERGS 8 - Supply Of Spares, Special Tools And Testing Equipment.
- 6) ERGS 9 – Training.
- 7) ERGS 12 - Operation and Maintenance Manuals.
- 8) ERGS 13 - Storage, Packing, Crating and Marking.
- 9) ERTS 2 - General Requirements.
- 10) ERTS 3 - Design and Performance Requirements.
- 11) ERTS 4.14.1 - General consideration (Saloon interior).
- 12) ERTS 12 - Electrical and Control Equipments.
- 13) ERTS 13.8~13.10 – Passenger Saloon Surveillance System & Interface
- 14) ERTS 14 - Material and Workmanship.
- 15) ERTS 15 - Inspection, Tests and Trials.
- 16) Appendix TA - International Standards.

5.1.1 Requirements of CCTV system as per ERTS 13.8 & 13.9


13.8 Passenger Saloon Surveillance System

13.8.1 The Passenger Saloon Surveillance System (PSSS) shall comprise of a close circuit television (CCTV) network using surveillance cameras, recorder, routers and cables and other accessories for each individual cars. The fully expended system shall be designed for minimum 25 fps or more. The picture quality will be level E as minimum at 100% Rotakin measured according to EN50132-7. The design shall be finalized during design stage.

13.8.2. Each car shall be provided with at least four surveillance camera devices (one additional in cab in case of DT cars) at appropriate location to cover the maximum passenger saloon area for surveillance. It shall be possible to increase number of cameras by atleast 2 per car by simple plug in to the system. Any hardware/software tool required for expanding the system shall be provided to enable the Employer to plug in additional cameras if so required in future. Employer's Engineers shall be trained for interfacing and commission the same with no extra cost.

The camera shall be suitably selected in respect of best HD resolution, clarity of images, illumination conditions, iris control, Wide Dynamic Range (WDR) etc. for on-train applications and shall be of proven design. The design of camera shall be finalized during design stage. Mounting of camera shall be unobtrusive, flushed with, or recessed into the interior panel. Screen shall have facility to enable multiple views of the platform simultaneously. The system shall be based on open environment/protocol like Ethernet for ensuring interchangeability of cameras. The system shall have self-diagnostics and communicate the same suitably to the maintainer.

13.8.3 The visual images from each camera shall be recorded in non-volatile solid state drive memory in a video recorder without any limitation of repetitive writing of the data.

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The capacity of the recorder shall be of at least 15 days and shall have the provision of First in First out (FIFO). The memory shall be expandable by simple plug in of commercially available memory media. The records shall be easily downloadable. The Contractor shall provide equipment and means for the same.

13.9 Details of storage module used for PA/PIS & PSSS and its capacity, limitation (if any) shall be submitted for review and approval by the Engineer. Storage module used shall be of latest version & latest art of technology.

5.2 RAMS Requirements

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

The subcontractor shall comply and provide the documents as per ERTS 2.7, ERTS 2.8 and ERTS 2.9.


5.2.1 RAMS Deliverables

The subcontractor shall submit the following RAMS Deliverables in accordance with RAMS Guideline (especially format and methodology) to be provided by BEML.

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

5.3 Fire

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

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

Subcontractor shall accomplish 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 CCTV system shall be verified and controlled during design and production by the subcontractor in accordance with the requirement defined by BEML/DMRC.

5.3.1 Other

ERTS 12.5 Wires and Cables

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

Fire resistant cables shall be proposed for circuits, which should survive for long periods during fire, as per applicable international standards.

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

5.4 EMC requirements

5.4.1 EMC general

The subcontractor shall submit EMC Control Plan which contains sufficient information to demonstrate clearly the supplier's proposals for achieving EMI/EMC in the design, manufacture, testing of the system and evaluate and ensure that the requirements for the electromagnetic compatibility and interference as specified in the ERTS and ERGS for BEML's approval.

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All systems delivered by supplier on the vehicle shall be designed and constructed to fulfill the requirements of EN 50121-3-2 and also emission (radiated and conducted) and Immunity tests for all individual equipments provided by contractor shall be performed under normal operating condition according to EN 50121-3-2. The test specification and test report shall be approved by BEML.

5.4.2. EMC test requirements

The subcontractor is required to conduct type tests as well as full EMC tests on the complete system. Tests to be conducted shall include but not be limited to satisfying the latest versions of the following standards or equivalent:

Specific standards:


Immunity	IEC 61000-4-2
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 61000-4-6
Power frequency magnetic field	IEC 61000-4-8
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	EN55011
	CISPR 16 /RIA 18

5.5 Software requirement

The subcontractor shall provide, as a minimum, the followings:

- 1) Diagnostics & Maintenance Software
- 2) User Manual for Diagnostics & Maintenance Software
- 3) Two backup copies-of application software
- 4) Test Software specified in Chapter 6.9 of GS

All software supplied for the system designed structurally and logically, fully documented, thoroughly tested in a systematic manner such that they can

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achieve high quality in terms of safety, reliability, testability, traceability and maintainability. The ISO 9000-3 shall be applied to develop software. For effectiveness of ISO 9000-3, subcontractor shall perform internal software quality audit in compliance with ISO 9000-3.

Software design and development shall also be carried out at Pre-final design stage. For Operation and Maintenance Manual for Software, subcontractor has to comply with Chapter 12 of ERGS.

Subcontractor shall comply with Chapter 6 of ERGS and Chapter 14.13, Chapter 14.14 of ERTS. Especially, Subcontractor shall submit Software Quality Assurance Plan.


The control software shall comply with the requirements of EN 50128 standard. All documents relating to SIL rating shall be furnished to BEML.

Subcontractor have to submit the SIL Justification Document in order to justify the appropriate SIL rating and for approval. Subcontractor has to have an appointed Independent Safety Assessor (ISA — in accordance with EN50121). 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.

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.

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 their own cost within the schedule to be agreed with BEML.

It shall be possible to download the CCTV records (CCTV footage) through Laptop PC and high speed USB port.

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The subcontractor shall provide application tool to view the CCTV records in a computer / laptop PC.

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.


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

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

The subcontractor shall submit a Software Quality Assurance Plan in accordance with the requirements of Chapter 6 of ERGS, and Chapter 14.14.4 of the ERTS.

The subcontractor shall provide all tools, Laptop computers or any special device to upload / download the software, equipment, manuals and training necessary for the Employer and Engineer to maintain and re-configure all software provided under this Contract. The documentation of software may be supplied after the expiry of the warranty period, under terms and conditions to be mutually agreed at Contract pre-award stage.

When a fault is discovered in delivered software, or an error in the associated documentation, the subcontractor shall take the necessary steps to rectify such faults and errors at the earliest opportunity. The subcontractor shall supply to the Engineer, full details, in writing, as to the nature of the corrective action proposed or taken. These changes shall be documented in the form of Software

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Engineering Change Proposal (SECP), which shall be got approved from Engineer. The documentation of software may be supplied after the expiry of the warranty period, under terms and conditions to be mutually agreed at Contract pre-award stage.

It will be incumbent upon the subcontractor to take responsibility for any changes required to software.

With the exception of commercial, "Off the Shelf" Software, the Engineer shall be provided with access to full software documentation including source code listings and development tool details. For such commercial software the subcontractor shall provide all available documentation for the application and maintenance of that software. The documentation of software may be supplied after the expiry of the warranty period, under terms and conditions to be mutually agreed at Contract pre-award stage.

The subcontractor shall ensure that the Employer or its licensee is granted all necessary rights to use software embodied in the equipment and there are no restrictions attached to the use of any information supplied by the subcontractor which might later prevent or hinder the Employer or its licensee from modifying or adopting or extending the system. The documentation of software may be supplied after the expiry of the warranty period, under terms and conditions to be mutually agreed at contract pre-award stage. The subcontractor shall indemnify the Employer, its heir or Licensees against claim of any party, subcontractor for the unauthorized possession or use of the software supplied.

Training of software shall be given in compliance with Section 9 of GS. The Contractor shall provide documentation for all hardware and software for computer systems and other associated electronic equipment to meet the following requirements. Such documents shall include but not be limited to:

- i. manufacturers' documentation supplied as standard with the equipment
- ii. hardware configuration with details of expansion capabilities and options;
- iii. programme loading instructions, including runtime environment configuration;
- iv. programme listing including comprehensive 'comment statements' in hard copy and soft format for source code, compilers and development tools necessary to modify and recompile software;
- v. flow charts, data flow diagrams and state diagrams as appropriate;
- vi. description of software modules including purpose, linkage with other modules, error routines and any special considerations;

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- vii. memory maps for both internal and peripheral memory showing description of all programmes, data files, overlay areas, memory available for expansion;
- viii. loading and operating instructions for diagnostic programmes and specifically developed debugging tools; and
- ix. Programming manuals relevant to operating systems, languages, development tools, etc

The documentation of software may be supplied after the expiry of the warranty period, under terms and conditions to be mutually agreed at Contract pre-award stage. The manual shall also include inspection/overhaul procedure and periodicity of various inspection/overhaul schedules in detail including the tools, special tools/plants, and facilities required. The manual shall be subject to review by the Engineer.

5.6 Operation & Maintenance Manual

(Not applicable for RS15 contract)

5.6.1 General Requirement

The subcontractor shall prepare the Operation Manual, the Maintenance Manual, and the Illustrated Parts Catalogue for the CCTV system as per ERGS 12.


Standard off-the-shelf documentation shall be reviewed for acceptance providing the documentation. All manuals and catalogues shall be in English.

BEML /DMRC reserves the right to make any future presentation refinements at the detail level, which would result in minimum cost impact. All materials shall be subject to the DMRC final approval.

5.6.2 Operation Manuals

The Subcontractor shall prepare and submit to BEML/DMRC for review and approval, the Operations Manual for the System. The Operations Manual shall be provided as a stand-alone manual. The Operations Manual shall include, but not be limited to the following System related content:

- (a) Introduction and general information including, but not limited to, the following items:
 - Explanation of the manual's purpose,
 - The scope of the manual
 - A brief description of the System and its sub-systems and components
 - The features of the System

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- The location of the System's controls
- The characteristics and physical makeup of the System with illustrations and exploded views

(b) The theory of operation

(c) The detailed operating procedures including, but not limited to, the following items:

- Adequate operation instructions of the System for a complete start to stop cycle including safety precautions to be observed, preliminary adjustments, alignments, and positioning required, and warm-up procedures .
- The means of connection between equipment components within the System and to other systems
- The step-by-step procedures to operate the System under normal operating conditions.
- The step-by-step procedures to operate the System under emergency operating conditions, and the list of controls and indicators for the System and the explanation of the function of each.

(d) The detailed operation planning instructions (i.e., all of the steps required to prepare the basic System for function checks, all necessary steps to perform functional checks, etc.)

(e) The troubleshooting procedures and trouble recognition symptoms

(f) The safety precautions


(g) The functional relationship with other equipment, sub-systems, or systems

(h) The operational limits and restrictions

(i) Illustrations depicting control layout or other pertinent features required to supplement the description of the operational procedures and instructions.

(j) Any other information necessary for proper and efficient operation

5.6.3 Maintenance Manuals

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The Subcontractor shall prepare and submit to BEML/DMRC for review and approval, the Maintenance Manual for the System. The Maintenance Manual shall include, but not be limited to the following sections:


- (a) Introduction — an introduction to the System and its components.
- (b) Functional Description — detailed description and operation, including theory of operation of the System and its components.
- (c) Troubleshooting — troubleshooting procedures in a tabular form with headings of Trouble, Probable Cause, and Possible Remedy. All adjustment and alignment procedures shall include tolerances and limits, where applicable.
- (d) Inspection and Maintenance — procedures for preventative maintenance, including but not limited to cleaning, lubrication, and adjustment. Inspection requirements shall include procedures and intervals. Schedules shall be in tabular form with headings for Component, Procedure, and Interval. The inspection interval can be expressed in distance or time or both. All text procedures shall be supported by line drawing illustrations. Photographs shall be acceptable for conditions, such as bearing wear, which cannot be clearly illustrated by line drawing illustrations.
- (e) Removal and Installation: Disassembly and Assembly— procedures for component replacement. Line drawing illustrations shall be used to illustrate the procedures. Procedures for disassembly and assembly of all repairable electrical, electronic, pneumatic, and mechanical components, including the overhaul periods, inspection criteria for the disassembled parts shall also be provided.

The Maintenance Manual shall include, but not be limited to, the following inspection and maintenance sections:

- (1) Corrective Maintenance (fault finding and diagnostics)
- (2) Preventative Maintenance
- (3) Spare Parts List
- (4) Standards
- (5) Special Tools and Test Equipment

5.6.4 Illustrated Parts Catalogue

The Illustrated Parts Catalogue shall contain exploded views, if applicable, for each assembly, subassembly, and sub-subassembly with a full parts list. All parts shown on the illustrations shall be identified by an item number and leader lines.

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Engineering drawings and photographs shall not be acceptable, unless specifically approved by the DMRC.

The list shall include all parts attached by means other than welding or riveting, unless welded or riveted parts are considered normally replaceable by the manufacturer.

The figures and text listings shall have the same orientation (i.e., both landscape or both portrait).

The column headings shall provide the following information (starting with the left hand column):

- (a) Figure and item number,
- (b) Part number (either the original equipment manufacturer's or the Subcontractor's) and part description
- (c) Original equipment manufacturers code
- (d) Provision for entry of customer stock code.

For standard electrical, electronic, pneumatic, and /or hydraulic hardware / components such as nuts, bolts, resistors, lamps, valves, etc., the description shall provide sufficient detail to facilitate procurement from a generic supplier.

5.6.5 Submissions


The Subcontractor shall submit the draft of all manuals to BEML. After submission of draft maintenance manual, the final maintenance manual shall be provided within schedule approved by BEML

6. Quality

6.1 General: Quality Assurance Program

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

6.2 Quality Assurance Plan

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The Supplier shall develop and submit to BEML QC team for review and approval a Quality Assurance Plan (QAP) based on ISO 9001 standard and ERGS 2.5 and ERTS 2.3. The subcontractor shall have the following

1. Organization chart
2. Certification of Personnel
3. Evidence of Compliance
4. Certificates Of compliance
5. Calibration of measurement equipment and tools

6.3 Quality Assurance Activities

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

- 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.


6.4 Quality Audit

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

6.5 Inspection and Test Plan (Herein After ITP)

ITP shall be submitted to BEML QC team for review and approval as following no later than 30 days after purchase order by BEML. Subcontractor shall comply to ERTS 15

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

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B) Witness/Hold point of Inspection/Test

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

C) Inspection/Test Notification of Witness/Hold point

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

7. Testing

7.1 General

The CCTV system aggregates of individual cars and complete train- set (6 car and 8 car), shall be type and routine-tested in accordance with IEC 61133 and in accordance with the requirement specified in ERTS 15 and ERGS 7.

All such tests shall be carried out at 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.

The subcontractor shall carry out Commissioning Type test on completed train at factory, Depot and mainline as required in ERTS 15.

The subcontractor shall submit all test documents, Test procedures and check sheets to BEML/DMRC for approval as per agreed time schedule.

7.1.1 Inspection


The inspection of all the materials, fittings, equipment, manufacturing processes, and assembly workmanship shall be carried out by BEML and DMRC.

7.1.2 Inspection Hold Points

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

7.1.3 Test Planning and Procedure

The test planning and procedure shall be as specified in ERTS 15.2.

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7.1.4 Sequence of Tests

The sequence of tests shall be:

- 1) Routine and type tests of equipment and sub-systems in accordance with relevant standard and specifications in Contractor/Sub-contractor's factories.
- 2) Factory and Site Tests (Depot and Mainline) of complete cars in accordance with IEC 61133.
- 3) Testing and commissioning of cars/trains in Depot & mainline in accordance with IEC 61133.
- 4) Service Trials.


8. Type and Routine tests of equipment and sub-systems

8.1.1 Type Test, CCTV system aggregates

This test is required to verify that CCTV system aggregates operate in accordance with the approved design data.

Type test of each component/aggregate shall be performed by the Subcontractor in accordance with the requirements specified in ERTS 15 but not be limited to the following tests;

S.No.	Test Items	Type Test	Routine Test	Requirement
1	Visual & dimensional inspection (incl. weight and power consumption measurement)	✓	✓	Approved, Test standard/specification. Any optical distortion or any visual defect is not allowed.
2	Performance test	✓	✓	IEC 60571/ EN 50155
3	Insulation and galvanic isolation test	-	✓	IEC 60571/ EN 50155
4	Supply overvoltage, Surge and Electrostatic discharge(ESD) tests	✓	✓	IEC 60571/ EN 50155
5	EMC Test	✓	-	CISPR11(IEC-62236-3-2), IEC 61000-4-2, IEC61000-4-3, IEC 61000-4-4, IEC61000-4-5, IEC 61000-4-6
6	Cold test	✓	-	IEC 60068-2-1(-25 °C ,16hr)
7	Dry heat test	✓	-	IEC 60068-2-2(16hr) (Normally up to 80 °C)
8	Change of	✓	-	IEC 60068-2-14

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	temperature test			
9	Damp heat test (cyclic)	✓	-	IEC 60068-2-30
10	Salt Mist Test	✓	-	IEC 60571 ST3
11	Dust and Sand Test & Mould Growth Test	✓	-	IEC 60721 & IEC 60068
12	Cyclic Humidity Test	✓	-	IEC 650571
13	Fire performance test	✓	-	Refer to SEMS requirement
14	Shock & Vibration Test	✓	-	IEC 61373
15	Material & Surface finish tests (If painting is used, paint test is required).	✓	-	Approved Test standard/Specification.
16	Burn in test	✓	-	Reliability Toolkit: Commercial Practices Edition Environmental Stress Screening test Table 7.5.2
17	Aging test	-	✓	JIS E 5006
18	Dust & water tightness test	✓	-	IEC 60529 (IP65/53) (Exterior Equipment/ Interior Equipment)
19	Function test	✓	-	As per Test procedure/ Specification
20	Combination (integration) test	✓	-	System itself
21	Other required Tests	✓	✓	Approved Test standard/Specification according to Customer's requests.

✓ Required.


8.1.2 Routine Test, CCTV system aggregates

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

Subcontractor shall perform routine test of CCTV system components/ aggregates/ subsystems in accordance with ERGS 7 & ERTS 15.

The subcontractor shall perform, as a minimum, but not limited to the following test;

- (1) Operation Tests
- (2) Video resolution variable Test
- (3) SSD capacity Test
- (4) Insulation resistance Test
- (5) Other required tests

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8.1.3 Fire Performance Test

The sub-contractor shall perform the fire performance tests of CCTV system aggregates in accordance with the requirements specified in TS 2.5.8, 2.23 and ERTS 15.19

8.1.4 Noise and Vibration Performance Test

The sub-contractor shall perform the noise performance test of CCTV system aggregates in accordance with the requirements specified in ERTS 2.22.

8.1.5 EMI/EMC Test

The sub-contractor shall perform the EMI/EMC test of CCTV system aggregates in accordance with the requirements specified in ERTS 2.15, 2.16, 2.17, 15.20 and Appendix TD 3.10.

8.1.6 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 14.14.4.

The sub-contractor shall perform the software testing on the completed car, unit and train.

8.2 Factory tests of complete cars


8.2.1 Type Test, Completed car, unit and Train Tests

The individual cars, complete units and trains (6 car and 8 car) shall be type tested by Subcontractor for CCTV system aggregates in accordance with IEC 61133 and ERTS 15.

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

8.2.2 Routine Test, Completed car, unit and Train Tests

The individual cars, complete units and trains (6 car and 8 car) shall be routine tested by Subcontractor for CCTV system aggregates in accordance with IEC 61133 and in accordance with ERTS 15. The Subcontractor shall be responsible for correcting any interfacing defects.

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8.3 Testing and Commissioning of cars/trains in Depot

8.3.1 Type Commissioning Tests

The subcontractor shall carry out commissioning **Type Test** on the individual cars, units, complete 6 car and 8 car trains in accordance with IEC 61133 & ERTS 15.

8.3.2 Routine Commissioning Tests

The subcontractor shall carry out commissioning Routine Test on the individual cars, units, the complete 6 car and 8 car trains in accordance with IEC 61133 & ERTS 15.

8.4 Integration Test

Subcontractor shall perform the integration test according to ERGS 7 & ERTS 15 at DMRC depot and mainline. The subcontractor shall submit all necessary information, test procedures and check sheets for the integration test for approval of DMRC/BEML.

8.5 Service Trials

The Subcontractor shall perform the service trial as per ERTS 15.1.10 & ERGS 7.2.


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

The CCTV supplier shall address the Quality / Design / Field issues reported in the RS13 cars.

Supplier shall also incorporate all the changes/modifications carried out in the RS13 contract (All the variations, modifications, HECPs & SECPs approved/would be approved by DMRC) in accordance with TS Appendix TH and shall resolve & implement solutions for all RSOI's and EIR's raised by DMRC / BEML.

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

The sub contractor shall conform to the RS15 Employer's Requirements — Technical and General Specifications and shall conform to all approved/would be approved variations, modifications and Hardware/Software Engineering Change

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Proposals against the contracts 'RS13' in line with ERTS. In case of any contradiction between ERTS and approved/would be approved modifications (Hardware/Software Engineering Change Proposals) against the contracts 'RS1', 'IRS6' and 'RS13', the later will prevail as per ERTS 1.1.8

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

10. Submittals – Technical offer:

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

- 1) Technical Documents including drawings for CCTV system. The document shall include but not limited to the following:
 - System block diagram & Description.
 - Detailed bill of materials of CCTV system.
 - Equipment description with datasheets including power consumption.
 - Equipment drawings including mounting dimensions.
 - Proposed SSD details with calculation and justification of storage for 15 days.
 - Software used & description.
 - Camera coverage area for the sketch GR-2670.
- 2) Clause wise comments against PTS - Doc no. GR/TD/3233.
- 3) List of DLP & commissioning spares.
- 4) Clause-wise compliance for relevant clauses of ERGS & ERTS mentioned at clause no 5.1 of PTS- Doc no. GR/TD/3233.
- 5) Compliance for GCC 5.8.
- 6) Supply details with references for same/similar design in revenue service over a period of two years or more for metro projects and compliance for ERTS 3.2.2 along with duly signed and filled-in Notice for No Objection (NNO) format along with supporting documents such as latest service performance certificates from end customers (train operators).
- 7) Quality and systems certification details.
- 8) Company Profile.
- 9) List of vendor details for individual items of CCTV system along with performance details for submission and approval of DMRC.
- 10) Confirmation to ERTS Appendix-TH along with Details of compliance and action taken for implementation of HECP's, SECP's, RSOI's, NCR's, EIR's and any other field issues of RS13 reported by DMRC/BEML in the Design stage for RS15 supplies.

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11) Spares as per Annexure-3 of this PTS.

11. List of Documents and Drawings

- I. Annexure-1 : ERGS & ERTS
- II. Annexure-2: Extract of GCC (Cl. No. 5.8)
- III. Annexure-3: List of Spares
- IV. Annexure-4: GR-2670
- V. Annexure-5: NNO format
