



BEML LIMITED
BANGALORE
R & D CENTER

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Procurement Technical Specification
of Lighting System for DMRC RS15 Project

(Supplies to be compatible with and suitable for integration with existing 'RS1, RS6 & RS13 BG' type trains of DMRC supplied by MRM Consortium & BEML with required modifications/improvements as per RS15 Contract)



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1 INTRODUCTION

1.1 GENERAL

This document describes the technical requirements of **Lighting System** to be supplied for DMRC RS-15 contract for Delhi Metro Rail Corporation Limited (DMRC). Lightings shall comply in all respects with Technical Specification (TS), and General Specification (GS).

BEML shall carry out all required works and activities as Contractor for DMRC RS15 contract while the Supplier shall be responsible for all works required in this PTS with regard to Design, supply, testing and commissioning of **Lighting system** and shall be responsible for supporting BEML activities as subcontractor for DMRC RS-15 Project. The supplies must be compatible with respect to mounting & functionality of Light fitting supplied for RS1, RS4, RS6 & RS13 rolling stock with modifications/improvements

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

1.2 CLIMATIC CONDITIONS

The DMRC RS15 Project shall operate reliably and safely under Delhi climatic conditions shown in Table.

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

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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
SO ₂ 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
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	32 KMPH Metro Corridor 35 KMPH Rail Corridor
Service acceleration rate	0.78 m/s ² ± 5%
Service deceleration rate	1.0 m/s ² ± 5%
Emergency deceleration rate	1.3 m/s ²
Jerk rate (maximum)	0.75 m/s ³
Expected running adhesion but not limited to	18%
Wheel diameter (new/worn)	860/780 mm
Bogie wheel base	Min 2,400
Average travel per year	1,50,000 Km

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2 DEFINITIONS AND ABBREVIATIONS

The following definitions and abbreviations are applicable to the PTS.

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

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

“BEML” means the Customer to procure the **Lighting** system for DMRC RS15 Project.

“Subcontractor” means the subcontractor of **Lighting** system to BEML for DMRC RS15 Project.

“GTC” means General Terms and conditions of DMRC RS15 project

“GS” means Employer’s Requirements-General Specification of DMRC RS15 contract.

“TS” means Employer’s Requirements-Technical Specification of DMRC RS15 contract

“PTS” means BEML’s Procurement Technical Specification.

3 PRECEDENCE OF DOCUMENTS

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

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

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4 Indigenization (ERGS Clause 1.1.8) & Qualifying criteria

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

"DMRC expects that for minimum 20 cars (equivalent items of 10 'T+M' units), the items given in Table 1C of ERGS shall be sourced from India.

In case of any deviation on above, the Employer at his sole discretion on representation by the Contractor giving detailed reasons for not achieving indigenisation as per above may accord approval for waiver subject to that in case of non or partial accomplishment of indigenisation of any item(s) listed in Table 1C (except Consumables) for specified number of cars noted above, the contractor shall supply half (50%) of the equivalent number of shortfall items as spares free of cost(including taxes and duties) to DMRC. For consumables the contractor shall remit cost of equivalent spares to DMRC. An illustrative list of consumables may be referred to GA4 spares in Pricing Document."

4.1 Qualification

A) Qualifying criteria :

a) The vendor should have supplied Lights and Luminaires to three Metro projects and should have satisfactorily completed revenue service for 3 years. The vendor shall submit all relevant documents including satisfactory performance certificate from the operators. In case the vendor has supplied to DMRC, the vendor shall submit the performance certificate from DMRC for technical qualification and evaluation.

b) For vendor qualification, vendor has to submit duly filled and signed NNO form along with performance certificate from End customer. The vendor will be qualified based on the Vendor approval / Issue of Notice of No Objection(NNO) by the Engineer(DMRC).

c)The vendor shall supply the Lights as per the drawings enclosed in the PTS and shall ensure complete compatibility and interchangeability with the lights in the existing cars of RS4/RS6/RS13 in terms of mechanical dimensions, mounting, size, shape, electrical characteristics, colour temperature, electrical connections(connectors) etc. Since the Lights are to be mounted in the Intermediate cars, the matching of the supplies with the look and feel of the lights in the existing cars needs to be addressed and complied.

B) Indigenisation : The vendor shall commit to carry out indigenisation as per Clause ERTS 1.1.8 (Table 1C) including supply of Spares free of cost for short supply of indigenous items.

5 SCOPE OF SUPPLY

5.1 HARDWARE

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The Lighting system for RS15 contract shall be compatible with the existing RS1, RS4, RS6 & RS13 type fittings with respect to mechanical aspects (Dimensions, overall envelope and fitment) supplied by MRM consortium and BEML. The Subcontractor shall be responsible for the provision of all equipments for the Lighting system.

Subcontractor shall consider ERGS & ERTS of RS15 project during design of the electrical aggregates of Lighting system **and the same shall be compatible with existing RS1 type trains and RS4, RS6 & RS13 units supplied by MRM consortium and BEML.**

The Subcontractor shall provide, as a minimum, the followings.

SI. No	BEML PART Number	ITEM	Qty/car (nos.)			Remarks
			DT	T	M	
1	90921316	Saloon Light (20 W)	28	30	30	Car side supply : DC 110V (77 V to 137.5 V DC)
2	90921317	Auto Dimmer	1	1	1	
3	90921318	Sensors	2	2	2	
4	90921319	Out side Door indication lamp (5 W)	8	8	8	
5	90921320	Inside Door indication lamp (5 W)	8	8	8	
6	90921321	Gangway light (18W)	1	2	2	
7	90921322	Cubicle light (3 W)	16	16	16	
8	90921323	Head Light (30 W)	2	-	-	Not Applicable for RS15 project
9	90921324	Tail Light (10 W)	2	-	-	
10	90921325	Flasher Light (10 W)	1	-	-	
11	90921326	Cab Main Light (40 W)	1	-	-	
12	90921327	Driver Console Light (2 W)	2	-	-	
13		DC-DC Converter	If required for 24V			

Note: Scope of Supply is for RS15 project.

2) The dimensions of the proposed light fitting should be as per RS1/RS13 Light Fitting drawing. The mechanical profile of the light fitting & diffuser and mounting dimensions should be same as RS1/RS13. The reference drawing of RS1/RS13 for the mechanical dimensions is enclosed as attachment.

3) Globe/ Diffuser for Passenger Saloon Light shall be made from laminated toughened glass/ Polycarbonate to be taken care as per the drawing and shall meet the Fire standards as per EN 45545. The Vendor may offer better material for the Globe / Diffuser. The same shall be discussed during design stage.

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4) Plug and Receptacle for cable connecting including socket, pins, etc., shall be provided by the subcontractor

5) Special cables and tools if any should be provided by subcontractor.

6) The sub contractor shall be responsible to maintain the DLP and commissioning spares at DMRC site. The list of DLP and commissioning spares shall be furnished by the sub contractor for review and approval by DMRC.

7) The sub contractor shall provide following documents and shall also provide any other documents required by DMRC.

- a) Quality assurance plan (QAP)
- b) Type test procedure for the Lighting
- c) Routine test procedure for lighting system and aggregates
- d) Inspection and test plan (ITP)
- e) Type test and Routine test reports
- f) Operation and maintenance manual
- g) Spare parts catalog

8) Wires and Cables:

All wires & Cables shall comply to ERTS Clause – 12.5, 14.7 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 voltage, and NF F 63-826 (for high voltages) other international standards like EN 50264 approved by the Engineer (ERTS TS12.5.2).

9) 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.

10) All lights after installation in the car shall be checked for illumination by the subcontractor. If the illumination is not meeting the criteria, the subcontractor at his own responsibility shall take necessary steps to correct the same through prior approval from BEML/DMRC.

11) Submittals – Technical offer:

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

- 1) Technical Description for the proposed lighting system.
- 2) Clause wise compliance against, PTS - Doc no. GR/TD/3007 Rev01.
- 3) Clause-wise compliance for relevant clauses in ERGS and ERTS of RS15
- 4) Confirmation to TS Appendix-TH along with the List of all the variations, modifications, HECs of RS1, RS4, RS6, RS13 cars for incorporation in the RS15 supplies for submission to DMRC. The vendor shall resolve & implement solutions

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- for all NCR's, RSOI's and EIR's (EIR No.s 131,141 and 165 of RS13 project) raised by DMRC. (Applicable for Lighting system).
- 5) Confirmation to the List of all the variations, modifications, HECPPs of RS3, RS6 & RS13 cars for incorporation in the RS15 supplies for submission to DMRC. The vendor shall resolve & implement solutions for all NCR's, RSOI's and EIR's (EIR No.s 131,141 and 165 of RS13 project) raised by DMRC.
 - 6) Compliance to GCC 5.8.
 - 7) List of DLP and commissioning spares as per ERGS Chapter 8.
 - 8) Satisfactory Performance certificate of previous supplies.

Note: RS15 Supplies shall be compatible with existing RS1 type trains and RS4, RS6 & RS13 Units supplied by MRM consortium and BEML.

5.2 SOFTWARE

Not Applicable

5.3 INTERFACE RESPONSIBILITIES

The location of mounting points and the design of equipment installation comprising of the Lighting assembly shall be defined by the Subcontractor and approved by BEML in order to avoid the mechanical interference with other equipment for the vehicle. The Subcontractor shall be responsible for the equipment, material to be supplied, recommended installation method and procedures. BEML shall be responsible for defining the technical requirements (refer to section 5) and the design constraints (refer to section 7). The Subcontractor shall be responsible for design, submission of design information (refer to section 7), performance of testing activities (refer to section 8), supply, installation, maintenance and rectification of the Lighting (refer to section 5) during the defects liability period, etc. The Subcontractor shall be responsible for the hardware interface required by BEML.

5.4 DESIGN INFORMATION

The Subcontractor shall provide all necessary documents and drawings according to the time schedule defined by BEML. The Subcontractor shall provide the technical documents 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 Hard copies and soft copy.

Three sets of drawings and documents shall be delivered in English with the data format of latest AutoCAD, CATIA release and MS office version 7.0 (document - MS word, spread sheet – MS excel, data base files – MS Access, Presentation file – MS PowerPoint).

The drawings shall contain minimum three (3) view points (for example, front view, top view and left view) for three (3) dimensional modeling. If available, the Subcontractor shall provide STEP file or CATIA file to BEML. All drawings and design calculations shall use SI unit.

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

5.5 TESTING

The Subcontractor shall perform, as a minimum, the following tests for Lighting,

- (1) Type tests & Routine tests of equipment and sub-systems.
- (2) Type commissioning tests on complete vehicle for Lighting.

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

- (1) Routine Commissioning test for Lighting of each Train.
- (2) Service Trials.

The detailed requirements are specified in the section 8.

5.6 OPERATION AND MAINTENANCE MANUALS AND SPARE PARTS CATALOGUES

(Not Applicable)

The Subcontractor shall provide the Operation/Maintenance Manuals and Spare Parts Catalogues of the Lighting equipment both in hard copies and soft copy (refer to section 5). The requirement for Operation/Maintenance Manuals and Spare Parts Catalogues shall be provided for Approval of BEML according to the time schedule defined by BEML.

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 subcontractor shall supply the following items of spares

- (1) Unit Exchange Spares
- (2) Consumable spares for maintenance of all trains during commissioning, service trials and Up to completion of Warranty period.
- (3) Mandatory spares.
- (4) Recommended spares.
- (5) Overhauling spares.
- (6) Special tools, Testing and Diagnostic equipment.
- (7) Special Jigs, Fixtures & Gauges required for maintenance, repair and overhaul of various equipments, sub-systems in particular and the complete trains in totality.

The detailed requirements are specified in GS 8.

5.8 STORAGE, PACKING CRATING AND MARKING

The subcontractor shall provide all packing, crating and markings in accordance with the requirements specified in GS 13. When handing over, hand over the complete Lighting and the spare parts, special tools and testing equipment

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The subcontractor shall provide the instruction for proper storage, handling and logistic functions of components supplied by the subcontractor before handing over the first complete Lighting. 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.

5.9 TRAINING (Not Applicable)

The subcontractor shall provide training to DMRC/BEML Employer's staff (operating staff and maintenance staff). The training activities and works specified in GS 9 shall be approved by BEML.

5.10 WARRANTY

Refer to General Terms & Conditions of the tender.

5.11 STANDARDS

The design, manufacture and testing of the work and the materials shall conform to the latest editions of internationally recognized Indian Standards, North American, European, Japanese standards, etc. The standards to be used shall be applied in following order of priority.

1) International Standards: ASTM, BS, CISPR, DEF-STD, DIN, EN, IEC, IEEE, IRS(Indian Railway Standards), IS (Indian Standards), ISO, JIS, MIL, NF, NFPA, UIC or equivalent standard

2) Subcontractor's Standards

Incase sub-contractor proposes alternate standard, sub-contractor shall justify for choosing other standard with enough back-up support documents. BEML and end client reserves the rights to reject any such request.

6.0 Technical Requirements

6.1 GENERAL

The subcontractor shall be responsible for meeting the entire technical requirement in PTS and shall provide all required data for lighting design.

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

- (1) TS 1 Introduction
- (2) TS 2 General Requirements
- (3) TS 3 Design and Performance Requirements
- (4) TS 4 Vehicle Body
- (5) TS 12 Electrical and Control Equipments

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- (6) TS 14 Materials and Workmanship
- (7) TS 15 Inspection, Tests and Trials

The subcontractor shall submit the compliance matrix showing those sections of the Technical Specification. where the proposed Lightings as defined in this PTS deviates from the technical specification. The Matrix shall include an explanation for the deviation as well as any advantages of the proposed arrangement. Items that comply with the Technical Specification need not be included in the matrix and it shall be assumed that any items not included in the matrix are in full compliance with Dimension, GS & TS.

The following is a brief technical requirements of Lighting system

6.2 Exterior Lighting

- (i) Exterior lights lens assemblies shall be sufficiently robust to resist the impacts of flying ballast.
- (ii) The IP protection shall be IP65, when fitted on the carbody.
- (iii) Individual power LED clusters used as exterior lights shall be able to be replaced easily from track level. Replacement of individual cluster shall be possible in depot without disturbing the functioning of the light. In case, the change of cluster require readjustment of complete light or component, facility for the same shall be provided in each depot.
- (iv) Access for cleaning and the replacement and adjustment shall be possible.
- (v) All LEDs shall conform to the minimum requirements as specified in ERTS 12.9 and its sub-clauses.
- (vi) Complete lighting system(s), their components shall generally conform to relevant EN/IEC Standards applicable for railway applications and shall be type tested.

6.2.1 Head and Tail Lights- (Not Applicable)

- (i) Power LED based Head- and tail-lights in watertight sealed, vermin-and-insect proof integrated housings placed at approximately 3m centres and 1.5m above top of rail datum, beneath the windscreens. The units shall be "handed", left and right, so that the taillights are outboard of the headlights.
- (ii) The two power LED based white light, with provision for dipper shall be mounted at the front of the driving end of the DT Car, to provide even illumination of the tunnel bore, track bed and track side signal posts. It shall be possible to read the number plates provided on the OCS masts and other boards like pantograph lower / raised boards. The illumination level of the head light shall be as per the international norms. Replacement of individual cluster shall be possible in depot without disturbing the functioning of the light. In case, the change of cluster require readjustment of complete light or

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component, facility for the same shall be provided in each depot.

- (iii) Each beam shall be separately adjustable both horizontally and vertically. The On/Off and Beam controls shall be switched from the train operator's console.
- (iv) Two bi-colour power LED based marker lights (tail lights) shall be provided which may be lit in both active and non-active cab. The taillights shall be LED type. Each LED shall be dual colour of white and red which shall be selectable from cab. Alternatively white & red LEDs may be provided within the same block/fitting and be used accordingly. In active cab the marker lights shall be white and in non-active cab it should be of red colour. During the normal train operation, white front lights shall glow and rear shall be red. However in case of a stationary train in siding or depot , both front and rear lights shall be red.
- (v) The taillights shall be sufficiently large and bright, to enable the lamp to be seen and acted upon by a train operator within the stopping distance of the consist travelling at maximum speed.
- (vi) When a driving cab is activated by a Train Operator, in the occupied cab either the head lights shall be lit and the tail lights shall be switched off or only tail lights (white colour) shall be lit; while in the non-active cab the head lights shall be switched off and tail lights (red colour) shall be lit.
- (vii) The headlights and taillights shall not be switched off when the train is passing through a neutral section.
- (viii) The Sub contractor shall propose to suitably indicate the front end of the train while parked at depot, or stabling sidings, by illuminating two white lights either by using dimmer position of head light or using dual colour LEDs in the tail light or by other appropriate means.

6.2.2 Flasher Light - (Not Applicable)

In order to attract the attention of the train operator of the following train or a train approaching from the opposite direction, in emergency, a 'powerful flashing amber light in addition to the tail lamps shall be provided in the front panel of each driving car. This light shall be switched ON by the train operator in case of emergency and shall not be switched OFF even while negotiating neutral sections. Flasher light when lit and flashing shall be able to attract attention at a distance of 300 mtrs under clear sunny day light.

6.2.3 Door Outside Indicator Lights

- (i) An amber indication lamp (power LED based) shall be located at an appropriate location outside near each door.

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- (ii) The lamp shall remain extinguished when respective door is fully closed and locked.
- (iii) The lamp shall be illuminated when the door is in fully open condition, or when the locking mechanism has failed to register, preventing traction circuits from picking up or when the door is closed, locked and isolated.
- (iv) The lamp shall flash whenever door is opening or closing; for ex: when close announcement button from the active cab is pressed. It shall continue to flash till such time the door is closed.
- (v) All light fittings shall meet 'IP67'.

6.3 Interior Illumination System (ERTS 12.9)

The LED Saloon light shall generally conform to EN13272 & ERTS 12.9. The system shall be based on **power LEDs** and should meet following requirements in general:

- 1) The guaranteed life of the **Power LEDs** with their control system and optics/luminary shall not be less than 60,000 burning hours.
- 2) The specified illumination level shall be met till at the end of the life of 60,000 hours when the illumination is not less than 70% of their original illumination level.
- 3) The colour of the LEDs shall be similar to the existing light. It shall be ensured that all LEDs are selected from same bin to avoid any difference in colour and performance. Approval from Engineer will be required before installation.
- 4) The colour of LED shall be similar to the existing light. It shall be ensured that all LEDs are selected from the same bin to avoid any difference in colour and performance. Approval of Engineer will be required before installation.
- 5) The design of the heat dissipation arrangement shall be submitted in detail with simulated results. Colour rendering index shall not be less than 70.
- 6) Complete light and energy simulation calculations shall be provided during design to prove validity of the proposed solution.
- 7) The Diffuser of all the light fittings shall be designed to eliminate glare and ensure that there is no glare by night time reflections in windows. Hot spots of power LED should not be visible and same to be ensured. No different colour patches shall be visible in the Light fitting/Diffuser and the light distribution shall be uniform across the diffuser. Uniform distribution of light should be maintained throughout the light fitting and also on car level. Luminaries shall be designed to conform to relevant international standards.

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- 8) The change of chromaticity over the lifetime of the product shall be within 0.007 on CIE 1976(u',v') diagram or equivalent.
- 9) Luminaire efficiency inclusive of LEDs/control gears & optics etc. shall not be less than 100 lm/W at the working junction temperature; higher values shall be preferred.
- 10) Design layout of LEDs & their strings/blocks should be such that the failure of one LED should not cause isolation of complete string/block. Similarly failure of one controller on one string/block should not adversely affect other strings/blocks. Details shall be finalized during design stage.
- 11) Coaches may remain unpowered in open sun and internal temperature may go upto 70°C (ERTS 3.10). Suitable protection measures shall be taken to ensure that this does not adversely affect the performance, reliability or efficiency of the lighting system and its components. Verification/validation to the above shall be proposed by the contractor during design.
- 12) Illumination within saloon with LED luminaires shall be designed so as to ensure that the desired maximum illumination level is achieved with LEDs operating at approximately 50% of its rated capacity. However, driver/control unit/optics etc. shall be designed for full rating of the LEDs.
- 13) All luminaires shall be of LED type and fitting shall be protected and diffused. No exposed light sources will be accepted.
- 14) LED luminaires and control gears shall be sealed to IP 52 and IP54, BS EN 60529:1992, respectively to prevent the ingress of dirt and foreign objects.
- 15) After one year, two year and 60,000 operation hours, the colour temperature shall be within $\pm 5\%$, $\pm 8\%$ and $\pm 10\%$ of the initial value respectively.
- 16) LED luminaries shall be designed to withstand switch cycles of 100,000 and test shall be conducted to prove the compliance.
- 17) (i) The sub contractor shall replace all the LED lighting with a newly improved LED lighting if
 - i) the total cumulative failure rate of the LED luminaries and control gears within DLP exceeds 5% with 20% of LEDs failed in a LED luminaire is constituted as a failure of the LED luminaire; or
 - ii) The illumination level at floor level of any five trains drops below 90% of the initial values at the end of two-year operation of each train, by assuming 15 hours daily operation and 365 days of operations.
- 18) Since LED technology is fast evolving and the rolling stock supply is a long drawn

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process , sub-supplier shall commit to supply new generation of improved LEDs progressively and which should be compatible with the luminaries already supplied and installed. The contractor shall regularly update the engineer on this aspect during the manufacture.

- 19) Noise generated by the energized LED lighting, fixtures and ballast/control gear installed in a car shall not exceed 50 dbA when measured 1m from the equipment.
- 20) LEDs manufactured by reputed manufacturers shall only be used after taking the prior approval of the Engineer during Design Review.
- 21) LED(s) shall have lumen rating as 100 lumen/LED or above.
- 22) Maximum number of LEDs which a driver/power supply can feed shall not exceed 60 LEDs.
- 23) During commissioning and subsequently, it may be desirable to adjust the lux level to 250/200 in the saloon Lights. Provision shall be made for adjustment of the lux level within saloon. At least three levels of adjustments i.e. 200 Lux/250 Lux/300 Lux shall be provided in the saloon illumination design as a minimum. Details shall be discussed during design review.
- 24) Vendor shall provide Saloon light cover of hinge type due to issues reported in RS13.

6.4 Saloon Illumination

- (i) Energy efficient, Power LED based lights, in luminaries meeting flame, smoke and toxicity requirements shall be recessed into the ceiling paneling. The light fittings shall be simple, and arranged not to trap dirt, moisture and insects. Suitable sealing protection shall be incorporated to prevent ingress of dust etc from AC ducts. The luminaries shall ensure to minimize the glare.
- (ii) All the saloon lights shall work on 110V DC.
- (iii) The size and number of light fittings with diffuser shall be sufficient to provide a sensibly constant level of illumination of 300lux at a height of 1.0 m above floor level, along the entire length of saloon.
- (iv) Separately protected lighting circuits shall be used, such that in the event of one tripping, the others provide evenly distributed lighting throughout the saloon.
- (v) 100% of lamps, evenly distributed over the saloon area, shall remain illuminated, energized even when the train / car passes through neutral section.

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- (vi) The control Logic shall ensure automatic selection, with manual over-ride, of the saloon light circuit(s) to maximize utilization of the natural light and maintain the desired illumination level. During Daytime, the interior lights shall be controlled automatically through dimmer(s) so as to maintain illumination level within acceptable level and reduce the energy consumption. The subcontractor shall submit details for review.
- (vii) The Contractor shall submit service life of LED lamp during the design stage which shall be as per the best international practices.
- (viii) The Contractor shall submit layout of fittings and control circuit for review by the Employer.
- (ix) It shall be possible to replace defective LEDs/ block of LEDs with ease and minimum need for readjustments or otherwise. Any special tool required for the purpose shall be supplied as two sets to each depot.
- (x) All the capacitive components used inside the Light Fitting should be of Ceramic Type and the same shall be discussed during design stage.
- (xi) Potting shall not be provided on the PCB's. Suitable design shall be adopted to withstand Shock & vibration as per IEC 61373.
- (xii) Wire Rope of suitable strength shall be provided for diffuser cover to prevent accident falling from Light fitting.
- (xiii) Saloon Light cover shall be of hinge type due to issues reported in RS13.

6.5 Cubicle Lights

- (i) Four numbers of cubicle lights shall be provided inside each cubicle.
- (ii) At least 40 lux illumination shall be maintained inside the cubicle to have better visibility for the maintenance persons. Further details shall be discussed during design stage.
- (iii) The location of the Light shall be in such a way that overall uniform illumination covering the area shall be maintained.

6.6 Cab Illumination - (Not Applicable)

- (i) The cab shall be provided with a ceiling lights, providing a sensibly constant level of illumination of 200lux at 1m above floor level. It shall be operated automatically by the opening of either cab door, and extinguished manually from within the cab.

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- (ii) Separate lighting of the train operator's console shall meet the requirements of UIC 651 OR which stipulates a minimum of 60 lumens/m² measured at the driving control desk. Driving console light shall be operated manually from within the cab.

6.7 Door Inside Indicator Lights

- (i) An amber indication lamp (power LED based) shall be located at an appropriate location inside near each door.
- (ii) The lamp shall remain extinguished when respective door is fully closed and locked.
- (iii) The lamp shall be illuminated when the door is in fully open condition, or when the locking mechanism has failed to register, preventing traction circuits from picking up or when the door is closed, locked and isolated.
- (iv) The lamp shall flash whenever door is opening or closing; for ex: when close announcement button from the active cab is pressed. It shall continue to flash till such time the door is closed.

6.8 NOISE

Noise generated by the energized LED lighting, fixtures and ballast/control gear installed in a car shall not exceed 50 dbA when measured 1m from the equipment.

6.9 WEIGHT

The subcontractor shall submit estimated weights and center of gravity and be approved by BEML. The actual weights must not deviate by $\pm 4\%$ of the estimated weights.

6.10 RAMS REQUIREMENTS

The sub-contractor shall meet RAMS (Reliability, Availability, Maintainability and Safety) requirements given in the Technical Specification (TS) and the General Specification. Also, the sub-contractor should provide all information related to the RAMS requirements. The sub-contractor shall comply with, but not limited to, the following requirements:

6.10.1 Reliability Analysis

The reliability data shall be based on actual operating information for the equipment. If the equipment in question has no previous operating experience, operational data from a similar piece of equipment shall be used. In this case, the reliability data shall be taken from equipment having approximately the same electrical and mechanical characteristics and operating under similar conditions. Under these circumstances, sub-contractor will use this data and must be approved by BEML. In the case where there is no operating experience with

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similar equipment, reliability data shall be estimated and provided in accordance with the latest revision of reliability data-book such as MIL-HDBK-217, NPRD, EPRD, PRISM or similar.

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

The reliability block diagrams and prediction of reliability performance shall be developed and submitted to BEML for acceptance.

The reliability block diagrams shall include all elements essential to the successful performance of the system and the interrelationships and interface of these elements.

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

6.10.2 Reliability Target

The MDBCFC (Mean Distance between Component Failure) per 2 car unit of Lighting shall meet the following table, considering 150,000 train-km of annual running mileage.

	MDBCFC(Unit-km)
After 2 months of start of revenue service	8,000,000

The reliability performance shall be assessed by the following measure:

$$MDBCFC = \frac{\sum \text{Travelled kilometer per 2 car Unit}}{\sum \text{Number of Service Failures}}$$

Where,

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

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

- Unavailability of the train to start revenue service after successful completion of pre-departure checkout;
- Withdrawal of the train from revenue services;

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- A delay equivalent to or exceeding 3 minutes from the Schedule / Time table as noted at the destination station for the one way trip.

6.10.3 Maintainability Requirements

6.10.3.1 Design requirements

The design of all components will be such that maintenance is reduced to a minimum, and components will be so arranged that those requiring attention are easily accessible, and readily removable. All equipment should be designed using the Least Replacement Unit (LRU) principle whereby the repair of a fault merely involves the replacement of a faulty module.

The design shall also minimize mean time to repair (MTTR) and costs through out design life. MTTR is the ratio of cumulative time, including the access time expended during a time interval to the total number of relevant failures. The sub-contractor shall also comply with the maintenance requirement of TS 2.12.

6.10.3.2 Maintainability Target

- 1) The LRU replacement should be less than 30 minutes
- 2) The mean time to repair (MTTR) of Lighting should be less than 1 hour.

6.10.4 Life Cycle Costs

The sub-contractor shall provide equipment that has minimum total Life Cycle Cost. The sub-contractor shall submit all information for Life Cycle Cost calculation.

6.10.5 Reliability and Maintainability Demonstrations

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

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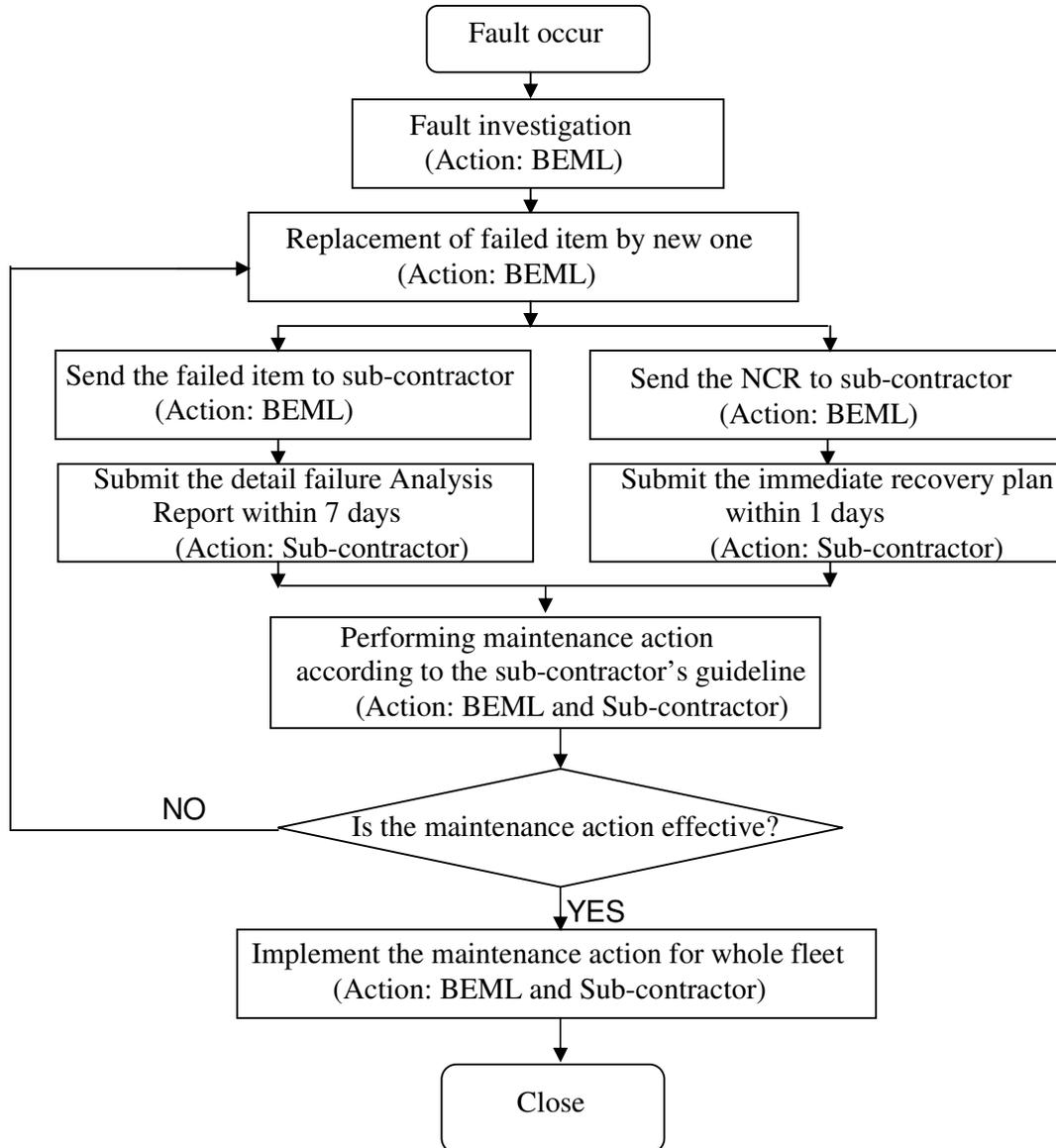


Figure 1. Maintenance Procedure of BEML Company

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

6.10.6 Safety Requirements

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

6.10.7 RAMS Deliverables

The sub-contractor shall submit the following RAMS Deliverables.

- Product Breakdown Structure during Preliminary 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
- Life Cycle Cost Analysis during Final design Stage

6.11 FIRE PERFORMANCE

The Fire requirements shall be met, but not be limited to, the following sections in GS and TS:

- (a) Fire Performance - TS 2.23
- (b) Material and Workmanship Requirements - TS 14
- (c) Fire performance Verification – TS 15.19

The subcontractor shall accomplish each fire tests of materials according to the EN 45545 latest editions requirements. In case the vendor is not able to accomplish the tests or provide the technical data of fire properties of material which are required, the costs towards the same for engaging Consultant for preparation of testing data will be charged to Subcontractor.

6.11.1 Fire Performance Test Procedure and Criteria

The subcontractor shall perform the fire performance tests based on the TS clause 2.23 and 15.19.

The test results shall be submitted for approval and shall satisfy the above criteria. The subcontractor shall submit the test result of the fire performance test for approval in place of conducting the test. If the DMRC not accept the exemption of the fire performance test, the subcontractor shall perform the fire performance test with optional.

6.11.2 Fire Load Calculation

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

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

6.11.3 Fire Performance Deliverables

The Fire Performance Deliverables shall be provided, but not be limited to, the following Table:

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

6.11.4 Other

All wires & cables shall comply to ERTS Clause -12.5 & 14.7.2

TS 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 in compliance with EN45545 latest editions. All Cables shall comply NFF 63-808 (for low voltages), and NFF 63-826 (for high voltages) or other international standards like EN 50264(part 1 to 3) and EN 50306 (part 1 to 4) approved by the Engineer.

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

6.12 EMC REQUIREMENTS

The contractor shall submit EMC Control Plan which contain 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 TS 2.15, 2.16 and 2.17 and GS 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 50121-3-2:2006 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 50121-3-2:2006. The test specification and test report shall be approved by BEML

6.13 SOFTWARE REQUIREMENTS

Not Applicable

6.14 OPERATION & MAINTENANCE MANUAL (Not Applicable)

6.14.1 General Requirement

The Subcontractor shall prepare the Operation Manual, the Maintenance Manual, and the Illustrated Parts Catalogue for the Lighting system. Standard off-the-shelf documentation shall be reviewed for acceptance, provided the documentation contains the required information as outlined in this section and its subsections. All manuals and catalogues shall be in English. BEML/DMRC reserves the right to make any future presentation refinements at the detail level. All materials shall be subject to the DMRC final approval.

The Subcontractor, no later than 8 months prior to the test running date, shall submit to BEML/DMRC for review and approval, three preliminary color hard copies and the soft copy of the Operations and Maintenance Manuals for all the Systems, sub-systems, equipment, and components supplied under the Subcontract. For the final revisions of the Operations and Maintenance Manuals, the Subcontractor shall submit to BEML/DMRC for review and approval. These manuals shall provide comprehensive operating instructions, maintenance instructions, maintenance drawings, and illustrated parts lists for the entire Subcontractor's System such that every item of the System's equipment can be properly operated and maintained. The information provided in the manuals shall be comprehensive and adequate to accomplish the required tasks and scopes of works.

The instructions contained in the Operations and Maintenance Manuals shall be in sufficient detail to enable the DMRC and/or BEML to operate, maintain, and repair each part of the System. Information contained in the Operations and Maintenance Manuals shall be in pictorial form whenever possible and shall include step-by-step instructions, detailed descriptions, block diagrams, exploded views, photographs, illustrated parts breakdowns, and schematic drawings to facilitate descriptions of assemblies and the relationships of components, sub-systems, systems, etc.

The content of the Operations and Maintenance Manuals shall be thorough, clear, complete, and shall be presented in language free of vague and ambiguous terms, using the simplest of words and phrases that shall convey the intended meaning. Sentences shall be short and concise. Punctuation shall be used in a manner that aids in reading and prevents misreading.

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Programmable equipment and Systems shall be supplied with sufficient flow charts and fully documented programmes to enable faults to be quickly identified and modifications to be undertaken at any time.

6.14.2 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
 - 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

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- (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.

6.14.3 Maintenance Manuals

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.

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The Corrective Maintenance section shall detail all unscheduled servicing actions performed, as a result of a System failure, to restore the System to a specified condition. The corrective maintenance cycle shall include, but not be limited to, failure, localization and isolation, disassembly, item removal and replacement or repair, re-assembly, checkout, and condition verification. This section shall contain sufficient information, drawings and schematics to allow a suitably qualified person to identify the cause of faults, and shall describe the steps necessary to rectify the fault. The Corrective Maintenance section shall also specify test procedures required to be carried out after corrective maintenance action on any part of the System in order to verify that the System's integrity has not been compromised. The Preventative Maintenance section shall describe all preventative maintenance activities required to achieve the specified performance levels for the life of the System. Preventative maintenance shall include, but not be limited to, all scheduled servicing actions performed to retain the System in a specified condition.

Scheduled servicing shall include the accomplishment of periodic inspections, condition monitoring, critical item replacements, overhaul, adjustment, and calibration. In addition, servicing requirements (for example, lubrication, cleaning, housekeeping, etc.) may be included under the general category of scheduled servicing. The Preventative Maintenance section shall be ordered such that for each level of maintenance the complete instructions to perform that maintenance are included such that each section of the manual is effectively stand-alone. In addition the Preventative Maintenance section shall specify the following:

- (a) All preventative maintenance inspections, including limits, settings and tolerances
 - (b) All lubrication and cleaning required, including frequency, methods, materials and location
 - (c) All routine component replacements, including frequency, replacement criteria and methods
 - (d) All routine reconditioning or overhaul of components including frequency, replacement and methods
- The Spare Parts List section shall provide an Illustrated Parts Catalog for the System supplied and shall contain sufficient information to identify and requisition the appropriate part by maintenance personnel.

The Spare Parts List section shall include, but not be limited to, the provision of the following part descriptions:

- (1) An alpha-numeric parts list including for each part, as a minimum, the part number, the part description, the part number of the next higher assembly (usually an LRU), a cross-reference to a figure or drawing number, the part category (consumable, LRU, repairable, etc.), and the part life data (expected part life, guaranteed MTBF, MTTR, etc.)
 - (2) Illustrations to indicate the location of each replaceable item (clear and progressive with exploded views to enable parts to be easily identified from the drawing cross-reference in the alpha-numeric parts list)
 - (3) A parts price list, in alpha-numeric sequence, that includes, as a minimum, the part price, the lead time, and the part vendor
- The Special Tools and Test Equipment section (including gauges) shall identify all special tools, test equipment, gauges, and any other resources

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required to perform the tasks detailed in the Maintenance Manual. Operating procedures for Special Tools and Test Equipment shall be provided by the Subcontractor. Preservation and storage procedures for repaired / overhauled components shall be provided. Testing procedures including test parameters shall be provided. In general, all test procedures shall be supported by line drawing illustrations.

6.14.4 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. 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., either landscape or both portraits).

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 manufacturer's 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.

6.14.5 Submissions

The Subcontractor shall submit the draft of all manuals to BEML before 30th Aug, 2015. After submission of draft maintenance manual, the final maintenance manual shall be provided within schedule approved by BEML.

6.15 TRAINING (Not Applicable)

6.15.1 General

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

6.15.2 Training Requirements

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The subcontractor shall submit a training proposal. The detailed requirements are specified in GS 9.1.

6.15.3 Training Manual

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

6.15.4 Training Location.

Training shall be carried out in such locations as will provide the maximum benefit to the trainees. Such locations may be in India, or abroad at places of manufacture, assembly or testing or other locations as may be necessary.

7.0 QUALITY ASSURANCE PROGRAM

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

If necessary, details of QAP need to be discussed with BEML's Quality Control Team.

The Supplier shall provide the following information about Capital Spare Parts, Warranty Spare Parts and Consumable Parts in full compliance with the Technical Specification.

7.1 ORGANIZATION

The organization of the Contractor's Quality Assurance (QA) Program shall have sufficient, well-defined responsibility and organization. It shall report directly to the General Manager of the Contractor's facility or the Contractor's Project Manager. The QA/QC personnel shall have complete freedom to identify and evaluate problems; to recommend solutions; to verify implementation of solutions; and to control further processing, delivery, or installation of a nonconforming or deficient item until proper and documented disposition has been obtained.

The QA/QC organization shall be arranged to promote a control function that operates in an independent, objective manner unbiased by schedule, cost, and authority limitations imposed by personnel other than the Contractor's high level management starting with the General Manager or equivalent.

7.2 CERTIFICATION OF PERSONNEL

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The Contractor's QA/QC personnel performing inspections and tests shall be certified for such work. Certification of personnel shall be by the virtue of those skills which are obtained by experience or training and verified by testing. Manufacturing personnel performing special processes, such as welding, brazing, painting, crimping, NDT (Non-destructive tests), etc. shall be certified for such work. Records of personnel certifications shall be maintained and monitored by the Contractor's Quality Assurance personnel. These records shall be made available to the Engineer of BEML for review.

7.3 EVIDENCE OF COMPLIANCE

The Contractor's QA/QC personnel shall maintain objective, verifiable evidence of compliance with the Technical Specification as it pertains to hardware configuration, purchasing, inspecting, handling, assembling, fabricating, production conformance testing, storing, shipping and warranty/repair work in the interest of quality.

7.4 CERTIFICATES OF COMPLIANCE

The Contractor shall submit to BEML the certificate of compliance for each delivery lot of products. The certificate shall contain inspection/test result data in accordance with the specification of the product. The inspection/test result shall be summarized to an inspection/test report (or record) in which the specification and inspection/test result are described clearly.

And, the inspection/test report (or record) shall contain information, as a minimum, of Product name (description), Part number, Serial number(if specified or necessary), Drawing number, Specification number, Revision number of drawing & specification, Software name(description) & Software version of the product (if software is installed to the product), Barcode number of the product(if barcode system is specified in the specification of product), Project name, Contractor's & Manufacturer's name, Inspection/test date, Acceptance decision, Name & Signature of inspector and approver and etc. Each shall clearly identify the lot certified by the certificate and be signed by an authorized representative of the Contractor, stating the product complies in all respects with the specification of the product.

Each certificate shall contain the information specified for samples, the name and address of the organization performing the tests, the date of the tests and the quantity of materials shipped. And also, if a test is performed by a licensed test laboratory, the test certificate issued by the laboratory shall be attached to the certificate of compliance of the Contractor.

7.5 CALIBRATION

The Contractor shall demonstrate an effective time or usage cycled calibration program for testing of measurement equipment and tools. Validity of measurements and tests shall be ensured through the use of suitable inspection, measurement and test equipment of the range and type necessary to determine conformance of items with the specification. At intervals established to ensure continued validity, measuring devices shall be verified or calibrated

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against certified standards. Tooling used as a media of inspection shall be included in this program. Furthermore, every device so verified shall bear an indication attesting to the current status and showing the date (or other basis) on which inspection or recalibration is next required. Devices suspected of being out of calibration before the stated recalibration date shall be promptly recalibrated. Inspections performed with devices proven to be out of calibration must be re-inspected. All calibration certifications shall be recorded and become part of the Quality Assurance records.

7.6 PROCEDURE DOCUMENTS

The Subcontractor shall establish and maintain written procedures defining his Quality Assurance Program. The procedures shall encompass all phases of the program to include, but not be limited to, control of subcontractors, inspection, production and process control, functional testing, discrepancy control, measuring and test equipment calibration, configuration control, quality assurance records, shipping inspection and other quality specifications to meet the requirements of the Contract. All such documents shall be made available to the Engineer of BEML upon request.

7.7 QUALITY ASSURANCE ACTIVITIES

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

7.7.1 Procurement

The Subcontractor shall document in writing the methods to be used for the selection and control of suppliers. These methods shall identify a means of:

- a) Selecting qualified procurement sources.
- b) Communicating and approving all product quality requirements and changes thereof.
- c) Monitoring the supplier's quality performance through the evaluation of procured items against purchase order requirements and/or through audits.
- d) Providing for early and effective information feedback and correction of non conformances, especially of items found malfunctioning during production conformance testing.
- e) Approving special processes.

The Subcontractor shall require each supplier to be responsible for maintaining and retaining records. Furthermore, the Subcontractor shall require each supplier, as a minimum, to submit with each shipment appropriate certifications, final inspection results and test results. Requirements shall be included for chemical or physical testing records in connection with the purchase of raw materials by the subcontractors.

7.7.2 Manufacturing inspection

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Inspection shall occur at appropriate points in the manufacturing sequence to ensure quality consideration for compliance with drawings, test specifications, process specifications and quality standards. BEML may designate inspection hold (or witness) points into the Subcontractor's Inspection and Test Plan (ITP) upon review of the Subcontractor's efforts. Inspection/test shall be 100% (one hundred percent) unless there is a specified sampling plan in the specification of BEML. Non-conforming materials shall be identified as discrepant, and shall be segregated and reviewed for disposition.

7.7.3 Production conformance testing

The Subcontractor's QA/QC personnel shall perform all Production Conformance inspections/tests and verify proper configuration of the equipment inspected/tested. If any item does not satisfy all performance or design criteria, the item shall be re-inspected/retested until the inspections/tests are passed with the necessary adjustments or repairs documented and certified by a witness.

7.7.4 Receiving inspection

The Subcontractor's receiving inspection activity shall provide for the inspection of all incoming materials. These inspection measures shall be used to preclude the use of incorrect or discrepant materials and to ensure that only correct and accepted items are used and installed. All material certifications and test reports used as the basis for acceptance by the Contractor shall be preserved. Inspection measures shall identify any item at any stage of production to an applicable drawing, specification or other pertinent technical document. Permanent physical identification shall be used to the maximum extent possible.

7.7.5 Shipping inspection

The Subcontractor's Quality Assurance Program shall provide and enforce procedures for the proper inspection of all products to assure completion and conformance as required by the Contract prior to shipment. All shipments shall be prepared as required to preclude damage during shipment. The inspections and preparation for shipment shall be verified by the Contractor's QA/QC personnel.

7.7.6 Changes

The Subcontractor shall ensure that inspection and tests are based on the latest approved revision or change to drawings and specifications. The Contractor shall ensure that obsolete drawings and change requirements are promptly removed from all points of issue and use. Means of recording the effective points of changes shall be employed.

7.7.7 Identification of status

The Subcontractor shall maintain a system for identifying the progressive inspection status of materials, components, sub assemblies and assemblies as to their acceptance, rejection or non inspection. The system shall provide for ensuring that required inspections and tests are performed and that the status of items with regard to inspections and test performance is known throughout manufacturing, installation and testing. Nonconforming items shall be

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identified by physical segregation and status indicators such as tags, serialization, markings, stamps and inspection records. The identification system shall ensure that only items that have passed the required inspection and tests are used or installed.

7.7.8 Handling

The Subcontractor's Quality Assurance Program shall provide for adequate surveillance work and inspection instructions for the handling, storing, preserving, packaging, marking and shipping to protect the quality of products.

7.7.9 Non conformance control

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

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

All nonconforming issues shall be positively identified to prevent unauthorized use, shipment or intermingling with conforming material.

Corrective action and related information shall be documented and made available to BEML upon request. Corrective action shall extend to the performance of all sub-suppliers and include as a minimum:

- a) Immediate response, prompt action and prevention of recurrence for nonconformity.
- b) Analysis of data and examination of discrepant products to determine extent and causes with corrective action implemented in an expeditious manner prior the next shipment, order or inspection.
- c) Submission of detail documents (specifications, drawings, repair procedure, analyzed data, test/inspection data, measures, action plan and etc) required to resolve nonconformity detected.
- d) Introduction of required improvements and corrections, initial review of the adequacy of such Measures and monitoring of the effectiveness of corrective action taken.
- e) Analysis of trends in processes or performance of work to prevent nonconforming products.

7.7.10 Quality audit

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

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

7.8 INSPECTION AND TEST PLAN (Herein After ITP)

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

(1) The ITP includes all the major inspection and test activities planned prior and during the design, procurement and installation phases. The (ITP) will include, as a minimum, the following:

- (a) Introduction of ITP (purpose, application scope and etc)
- (b) Description of Symbols, Abbreviations and Definitions
- (c) Sampling Procedure if it is necessary
- (d) Inspection/Test Notification procedure
- (e) General Inspection/Test process/flow
- (f) Manufacturing and Inspection/Test flow (block diagram) which describes manufacturing flows and inspection/test points.
- (g) Description of Inspection and test activity and item
- (h) Kinds of Inspection and Test such as Design Qualification/ verification test (Type test), FAI, Routine inspection/test
- (i) Inspection/Test Level such as 100%, Sampling, 1/Lot and etc
- (j) References of the inspection/test such as specification, procedure and etc
- (k) Responsible entity of the inspections and tests
- (l) Places of the Inspection and test
- (m) Witness/hold points of BEML and/or the Customer of BEML
- (n) Description of Reports /checklists required and the Submission
 - A table format is recommended to describe the Items (g) ~ (n).

(2) Witness/Hold point of Inspection/Test

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

- Witness point of Inspection/test

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

- Hold point of Inspection/test

To be witnessed by BEML and/or the Customer of BEML. It requires the notification of inspection/test schedule written by the Subcontractor to BEML. In case of hold point, Subcontractor can do the next process after acceptance of the inspection/test or waiver (or agreement) by BEML and/or the Customer of BEML.

Generally, Type Test (Design verification/qualification test) and First Article Inspection (FAI) are designated as the Hold Point.

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

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

8.0 DESIGN INFORMATION

8.1 GENERAL

The subcontractor shall submit, not limit to, the following general information in accordance with the schedule.

Document /Deliverables	Reference /Description
Testing plan	GS 7, TS 15
Schedule of Tests	GS 7, TS 15
Test procedure of Type and routine test of equipment, Type test of complete vehicles, Commissioning test of complete vehicles.	GS 7, TS 15
List of Spares, Special Tools and Testing and Diagnostic equipment	GS 8
All relevant drawings, manuals and full operation instructions for the Special Tools, Testing and Diagnostic Equipment	GS 8
Training Proposal	GS 9
Training Course	GS 9
Training Manual	GS 9
Operation and Maintenance Manuals and	GS 12
Spare parts catalogues	GS 8
All as-built drawings	GS 5
The requirements for the completion of Project Management Plan,	GS 2

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Interface Management Plan, Work Plan, Quality Assurance Plan, Safety Assurance Plan and Site Safety Plan, Environmental Plan, Inspection, Test and Commissioning Plan	
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8.2 DESIGN

8.2.1 General

The design of Lighting shall basically comply with TS 3, TS 12.5, TS 12.8, TS 12.9 and relevant specification of GS and TS.

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

- (1) Preliminary design submission stage (refer to GS 5.7)
- (2) Pre-final design submission stage (GS 5.8)
- (3) Final design submission stage (GS 5.9)
- (4) As built Drawings (GS 5.13)

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

Also, the Subcontractor shall submit the design deliverable submission schedule for acceptance within following requested due date, and resubmit it whenever updated.

The Subcontractor shall submit, but not limit to, the following design deliverables in accordance with the required schedule:

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Design Stage	Document/Deliverables	Submission date required(from contract award)
Evaluation Stage	Compliance Matrix List (Clause by Clause) including Spec. Clarification/Waiver Request	Within 1 weeks after receiving PTS.
	General Technical Description of Proposed LIGHTING SYSTEM	
	Service/Delivery History of Proposed LIGHTING SYSTEM and other required documents/information	
PDR	Project Management Plan (PMP): The Subcontractor shall resubmit, if there is any amendment of PMP, in time for acceptance of BEML. - Illustrated project schedules, Chart, tables - List of Submission Data, - Configuration Management Plan	Within 2 weeks
	Schedule Plan for - Design Deliverables/Drawing submission - Design, Validation, Test & Inspection and Manufacturing	Within 2 weeks
	Compliance certification to all required Standards of LIGHTING SYSTEM	Within 3 weeks
	Concept design drawings (Dimensional Installation Drawings: AutoCAD or CATIA file)	
	-General description	
	- Detailed Tech. Spec. & data of LIGHTING SYSTEM	
	- Details of LIGHTING SYSTEM construction	
	- Spec. & Life of Components for LIGHTING SYSTEM	
	- The details of Components for LIGHTING SYSTEM	
	Technical Description (incl. at least following information) : The detailed submission schedule of each item shall be submitted for approval according to required design stage.	



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Design Stage	Document/Deliverables	Submission date required(from contract award)
	Preliminary/Final Power Consumption (If applicable)	
	Constraint of Electric connection (if applicable)	
	Electrical Function description (if applicable)	
PFDR	Preliminary Design Drawings (Dimensional Assembly Drawing: AutoCAD or CATIA file)	Within 1 month
	Water-Tightness and Acoustic Improvement Method	
	Operating Instruction (if applicable)	
	Preliminary/Final 3D modeling data	
	Cleaning details & maintenance instruction of Equipment	
	Safety Analysis	
	Preliminary/Final Samples	
	Estimated/Measured Light Transmission and Solar Heat Transmission value of LIGHTING SYSTEM	
	Estimated/Measured Noise attenuation data	
	Estimated/Measured weight of all LIGHTING SYSTEM components	
	Material List/Spec. & Certification for Fire safety	
	Surface Finish Specification (Painting to TS 14.19, anodizing, etc.)	
	LIGHTING SYSTEM Strength Calculation	
	Manufacturing tolerance of LIGHTING SYSTEM	
Function Description		

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Design Stage	Document/Deliverables	Submission date required(from contract award)
	System block diagram (if applicable)	
	Caution Instruction for LIGHTING SYSTEM Installation	
	Replacement Instruction & Demonstration of LIGHTING SYSTEM	
	Life expectancy of major parts and LRUs	
	Consumables List for LIGHTING SYSTEM	
	Preliminary Plan/schedule for Testing & Inspection	
	O&M Manual, IPC submission List	
	Preliminary list of spares, special tools and test equipment	
	List of equipment identification labels	
FDR	Final Design Drawings (Dimensional Sub-assembly drawings: AutoCAD or CATIA file)	Within 3 month
	The manufacturing details of all LIGHTING SYSTEM	
	-Compliance certificate to Standard applied for design, test & manufacture	
	Installation Instruction of all LIGHTING SYSTEM	
	Cleaning, storage and handling instruction of LIGHTING SYSTEM	
	Maintenance & Inspection Instructions	
	Detailed Test & Inspection Plan/Schedule	
	Type Test Procedure (incl. record sheet) & Report	
	Routine Test Procedure (incl. record sheet) & Report	



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Design Stage	Document/Deliverables	Submission date required(from contract award)
	FAI Procedure & Report	
	Type/Routine Test Procedure (incl. record sheet) & Report in Completed car	
	Commissioning Type Test Procedure & Report	
	Updated list of LRUs	
	Final List of Special Tools, Spare Parts, Test Equipment	
	Draft & Final O/M manuals	
	Draft & Final IPC (Illustrated Parts Catalogue)	
	Training Manuals & Materials	
	Details of equipment identification labels	
	All relevant Operation & Maintenance Information and Training Manual for Special Tools and Test Equipment	
	As-built drawings & List	
All Stages	<p>Monthly Progress Report including followings at minimum (Sub-contractor shall use the attached template for Monthly progress report.)</p> <ul style="list-style-type: none"> - Design Progress Report (Schedule & achieved Activity) - All Design Deliverable Submission Plan/progress Status - Estimated/Measured Weight - Open Items List - Master test plan and progress - Waiver Request/Spec. Clarification Items - Any information required by BEML 	Monthly
	Any other design data requested	During design stage

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Design Stage	Document/Deliverables	Submission date required(from contract award)
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It is subcontractor's responsibility to provide sufficient support and information for obtaining No Objection Advice for design document pertaining to sub-supplier in accordance with TS and GS. Failure to submit such deliverables in time by sub-supplier may attract Liquidated Damage as defined in GTC.

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.

8.2.2 Electrical Requirements

The design of the subcontractor shall comply with the requirements specified in TS 12 & 14. Test points should be protected mechanically and electrically with ease of accessibility ("direct") All electrical interconnection methods shall be approved by BEML. The plug and socket connector type shall be chosen for interconnection and both mating parts shall be supplied by subcontractor including pins unless otherwise instructed by BEML. Note that connectors, pins or sockets must be identified separately.

Subcontractor shall cooperate with BEML to ensure that when car builder wiring harnesses enter subcontractor's equipment, adequate support is provided for the wiring harness. **The power and control cables connectors should be of different type (non compatible with each other) so that it should not get interchanged during installation.**

8.2.3 Mechanical Requirements

Subcontractor enclosures and its content shall comply with all of the requirements for under car equipment described in the Technical Specification.

The location of mounting point and the design of equipment installation shall be approved by BEML. Final configuration shall be decided at design reviews.

8.3 SEM (SYSTEM ENGINEERING MANAGEMENT)

The Subcontractor shall submit, not limit to, the following design information within the defined schedule:

The technical requirements of noise, vibration, fire, weight, safety, reliability, maintainability and availability shall be submitted.

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9.0 TESTING

9.1 GENERAL

9.1.1 General

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

The type tests for the Lighting at both the component level and complete train level, for RS15 Operational line, shall be re-performed by the Subcontractor under BEML and DMRC participation, if DMRC want to witness the tests even though the tests were accepted by BEML.

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

All defects and shortfalls in the subcontractor's system, discovered during all tests, shall be made good 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 a defined period following the test, for acceptance by BEML and DMRC. The detailed requirements are specified in GS 7 and TS 15.

9.1.2 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 GS 7.1.

9.1.3 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 7.1.

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9.1.4 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.
- (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.
- (6) 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 GS 7.1.

9.1.5 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

9.2 ROUTINE AND TYPE TESTS OF EQUIPMENT AND SUB-SYSTEMS

9.2.1 Equipment Type and Routine test

The test plan and test procedures shall be submitted according to approved test schedule.

The Subcontractor shall notice BEML for the request of witness at least 1 month prior to the commencement of testing. Prior to the notification of test witness, the test procedure shall be approved. The Subcontractor shall conform to all requirements pertinent to Lightings in Relevant to TS Chapter and TS 15 requirements.

Test items, applied standards and its procedures can be changed or added due to Employer's request. In case of test item addition, subcontractor shall carry out the additional test with no additional cost.

The test for lighting system shall include, but not be limited to, the followings:



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Test Item	Type	Routine	Investigation	Requirement
Visual & Dimensional Inspection (Incl. weight)	○	○	○	Approved Test standard/spec. Any optical distortion is not allowed.
Insulation Resistance Test	○	○	○	Approved Test standard/spec.
Dielectric Test	○	○	○	Approved Test standard/spec.
Shock & Vibration Test	○	-	-	IEC 61373
General Starting Test	○	○	○	IEC 925
Low Temperature Test	○	-	-	Approved Test standard/spec.
Characteristic Test	○	○	○	Approved Test standard/spec.
Temperature Test 1) Dry Heat Test 2) Damp Heat Test	○	-	-	Approved Test standard & TS 14.12.1
Abnormality of Heat Resistance Test	○	-	-	Approved Test standard/spec.
Life Time Test	○	-	-	Approved Test standard/spec.
Supply variation Test	○	○	○	Approved Test standard/spec.
Supply interruption Test	○	-	-	Approved Test standard/spec.
Earth continuity Test	○	○	○	Approved Test standard/spec.
Surge & Transient Test	○	-	-	Approved Test standard/spec.
Fire Performance Test	○	-	-	Refer to TS clause 15.27
Other required tests	○	○	○	Approved Test standard/spec. according to customer's requests
EMI/EMC	○			EN 50121-3-2, EN 55011, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6

- Dimensional Inspection: This inspection shall be done with the specimen picked by a lot of product. If the result is not proper, all quantities of the lot product shall be inspected to the approved drawing.
- The sub-contractor shall submit the test procedure for Noise attenuation test for

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approval according to the requirement described in Noise requirement

- Separately from any other test stipulated in this PTS, all the electronic devices with PBA (PCB Assembling) shall be carried out Environmental Aging test (Temperature cycling test) according to burn-in test procedure by means of followings.

First article: 20 cycles (1 cycle: 25⁰, 1h ---- - 40⁰, 0.5h ---- 85⁰, 0.5h)

Mass production: 2 cycles (1 cycle: - 40⁰, 0.5h ---- 85⁰, 0.5h)

Temperature rising/falling speed: 5 ~ 10⁰/ min

- Above lists are indicative and sub-supplier shall be responsible to carry out any additional test required by client within the scope of ERTS, ERGS.

9.2.2 First Article Inspection (FAI)

The subcontractor shall perform a First Article Inspection (FAI) for the Lightings at the Subcontractor's factory in accordance with an inspection specification by BEML and/or End User prior to serial production in order to confirm that the hardware & software fully complies with the subcontractor's Lightings design and manufacturing process.

Before commencement of FAI, It might be required to conduct Quality audit by BEML throughout manufacturing process including PBA (PCB Assembling) line focused on subcontractor's 4M (Man, Machine, Method and Material). In case that the 4M confirmed at this stage is changed during mass production, the subcontractor shall notify and get agreement from BEML.

The subcontractor shall submit summary report for the failures that happened to similar application in the previous project, if any, so that BEML can review the reflection of them on the design and production.

At the FAI, the subcontractor shall make available all pertinent design and manufacturing process documentation, test records, material certifications, etc. Should all the requirements of the FAI not be met, then the inspection shall be considered at a Hardware Review.

Upon acceptance of the FAI by End User, the subcontractor is then free to proceed to manufacture all pertinent hardware. The hardware must meet or exceed the quality standards set at the FAI, and must incorporate any comments made by End User at the FAI.

9.2.3 Static Commissioning Test

9.2.3.1 Type commissioning Test, Complete Car, Unit and Train Tests

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The Type commissioning Test for the Lightings at the vehicle level shall be performed, with all necessary test equipment prepared by the subcontractor, at BEML by the subcontractor or at Depot/Mainline in DMRC premises. And the test shall be conducted in accordance with a test procedure to be prepared by the subcontractor and approved by BEML under BEML and/or End User participation.

The subcontractor shall submit the type commissioning test details for Lightings of complete vehicle and be responsible for correcting any defects.

Failure to achieve the successful vehicle level performance type test by sub-supplier may attract Liquidated Damage as defined in GTC.

9.2.3.2 Routine commissioning Test, Complete Car, Unit and Train Tests

The Routine Test at the vehicle level shall be performed at BEML Factory in Bangalore or DMRC Depot/Mainline in Delhi on the basis of information and with the necessary test equipment offered from subcontractor, by BEML under subcontractor's assistance for the Lightings. The subcontractor shall be responsible for correcting any defects.

These tests will be a subset of those tests performed at Type Test, complete vehicle to demonstrate that the principal features of the Lightings are compliant with ERGS and ERTS.

9.2.4 Running Test on Main Line Track

The Running Test on Mainline Track for the Lightings of first train set at the vehicle level shall be performed by the subcontractor, with necessary test equipment prepared by the subcontractor, at BEML Factory/DMRC Premises. The test shall be conducted in accordance with a test procedure to be prepared by the subcontractor and approved by BEML under BEML and/or End User participation. Any fine tuning requirement needed by DMRC/ BEML, the same shall be carried out with the prior approval.

10 LIST OF DOCUMENTS

- i) Employers Requirements – Technical Specification (ERTS).
- ii) Employers Requirements – General Specification (ERGS).
- iii) Spares.
- iv) Extract of GCC Clause 5.8
