



BEML LIMITED
BANGALORE
R & D CENTER

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REV. NO.	0
PAGE NO.	1 / 51

**Procurement Technical Specification of
Junction Boxes, Jumpers & Operating
panels for Bangalore Metro Rail Project
(5RS-DM)- Phase-2,2A,2B (318 Cars)**

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	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	2 / 51

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	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	3 / 51

Table of Contents

1.0 Introduction	7
1.1. General	7
1.2. Climatic and Environmental Condition (ERTS clause 2.1)	9
1.3 Environmental Conditions in Tunnel:	9
1.4. Signaling System (ERTS clause 2.6)	10
1.5 Line Characteristics.....	10
1.6 Track Structure Parameters	11
1.7 Flood Proofing	12
1.8 Current Collection System (ERTS clause 2.5).....	12
2. Definition and Abbreviations	13
2.1. Definitions	13
2.2. Abbreviations	13
3. Precedence of Documents.....	14
4. Standards and Codes (ERTS clause 21 & Appendix A of ERTS).....	15
5. Requirements of Documentation	15
6. Qualifying Criteria for subcontractor and Vendor approval	15
6.1. Qualifying Criteria (ERTS clause 5.1.2)	15
6.2. Vendor approval (ERTS clause 5.1.5).....	16
6.3. Indigenization (ERGS Clause 1.3)	16
7. Scope of Supply & Work	16
7.1 Hardware.....	16
7.1.1 General	16
7.1.2 Junction Boxes and Jumpers.....	18
7.1.3 Unit Exchange Spares	20

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	4 / 51

7.1.4 Simulator	20
7.2 Software	21
7.3 Interface Responsibilities.....	21
7.4 Testing.....	21
7.5 Spares, Special Tools and Testing Equipment	21
7.6 DLP	22
7.7 Storage, Packing, Crating and Marking	26
7.8 Training	26
7.9 Warranty.....	26
8. Technical Requirements	27
8.1 General.....	27
8.2 Technical requirements of Junction Boxes, Jumpers & Operating panels	27
8.3 SEM (System Engineering Management).....	28
8.4 Quality	28
8.4.1 General	28
8.4.2 Quality System Requirements.....	28
8.4.3 Quality (Assurance) Plan	28
8.4.4 Inspection and Test	29
8.4.5 Quality Audit	30
8.5 System Assurance (SA).....	30
8.5.1 Safety Assurance Plan	30
8.5.2 System Safety Assurance.....	30
8.5.3 Hazard Analysis	30
8.5.4 Reliability: General	30
8.5.5 Quantitative Reliability	31
8.5.6 Maintainability.....	31

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	5 / 51

8.5.7	Reliability and Maintainability Demonstrations	31
8.5.8	Maintenance.....	31
8.6	Shock and Vibrations Performance.....	31
8.7	Fire Safety.....	31
8.8	Design Information	32
8.8.1	General	32
8.8.2	Design.....	33
8.9	Weight	37
8.10	Materials and workmanship.....	37
8.11	Operation and Maintenance Manuals and Spare parts catalog	37
8.11.1	General	37
8.11.2	Requirements.....	37
8.11.3	Electronic Manuals	38
8.12	Training.....	38
8.12.1	Training Manual	38
8.13	External Interfaces.....	38
8.13.1	General	38
8.13.2	TIMS Interface	38
8.13.3	Control Interface.....	38
9.	Investigation & Design Submission.....	39
9.1	Technical Document	39
9.1.1	Specification of components used	39
9.2	General Information	40
9.3	Design	40
9.3.1	General	40
9.3.2	Submission	40

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	6 / 51

9.3.3	Electrical Requirements.....	41
9.3.4	Mechanical Requirements	41
9.4	SEM (System Engineering Management).....	42
10.	Testing.....	42
10.1.	General	42
10.2.	First Article Inspection	44
10.3.	Test Procedure	44
10.4.	Test Reports	45
10.5.	Sequence of Tests	46
10.6.	Routine and type tests of equipment and sub-systems.....	46
10.7.	Factory tests of complete cars	48
10.8.	Testing and Commissioning of cars/trains in Depot	49
10.9.	Integration Test	49
10.10.	Service Trials.....	49
11.	Other Requirements	49
12.	List of Documents and Drawings Supplied	49
13.	Submittals-Technical offer	51

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	7 / 51

1.0 Introduction

1.1. General

This document, Procurement Technical Specification (PTS) describes the complete technical requirement of **Junction Boxes, Jumpers & Operating panels** to be supplied for cars under the 'BANGALORE METRO RAIL PROJECT (5RS-DM) - PHASE-2,2A,2B (318 cars) contract. (Hereafter BMRCL 5RS-DM).

The **Junction Boxes, Jumpers & Operating panels** shall comply in all aspects with BMRCL 5RS-DM Employer's Requirements General Specification (ERGS) and Employer's Requirements Technical Specification (ERTS).

Sl No.	Lines/Corridor	Distance (km)	Number of 6-car Train sets (Cars)	Grade of Automation	Signaling system
1	Line-6 (Kalenaagrahara – IIMB-Nagavara)	21.5 km	TS#16 (96 cars)	GoA2/GoA4	CBTC
2	Phase 2A (Central silk board junction – K.R.Puram)	19.8 km	TS#21 (126 cars)	GoA2/GoA4	CBTC
3	Phase 2B (K.R.Puram – Kempegowda International airport)	38.4 km	TS#16 (96 cars)	GoA2/GoA4	CBTC

The trains may have to be operated in GoA2 modes with Driver/attendant during initial phase of the project and shall finally be upgraded to GoA4 (UTO) mode.

BEML shall carry out all required works and activities as Supplier for BMRCL 5RS-DM contract while the subcontractor shall be responsible for all works required in this PTS with regard to Design, supply, testing and commissioning of Junction Boxes, Jumpers & Operating panels and shall be responsible for supporting the BEML activities as subcontractor for BMRCL 5RS-DM contract.

The scope of work covers design, development, testing, manufacture, supply, commissioning and integrated testing of the Junction Boxes, Jumpers & Operating panels and the training of Operation and Maintenance personnel of the owner on the Junction Boxes, Jumpers & Operating panels.

The scope also covers supply of spares, special tools, testing and diagnostic equipment, jigs and fixtures for maintenance, repair and overhaul of Junction Boxes, Jumpers & Operating panels.

As specified in ERTS 1.1.3 (i) to (xi) the scope of supply shall also include:

(i) To provide all the documentation and support material associated with the operation and maintenance of the cars as specified in the bid document for all the corridors.

(ii) Ongoing technical support and Defects Liability coverage until the start of Defects Liability Maintenance period (DLMP) and rectifying the defects and deficiencies as communicated by BEML/BMRCL.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	8 / 51

(iii) Interfacing with other Designated Contractors who have either physical, functional or design interfaces with this contract.

(iv) Training of engineers, operations and maintenance staff including providing the training materials, training kits and demonstration equipment.

(v) Initial supply and installation of all consumables and materials required for testing, commissioning and operation.

(vi) To provide final drawings (2D & 3D models), design calculations and other documents including operations and maintenance manuals for review and acceptance by the BEML/BMRCL.

(vii) To provide supporting information including samples for design development items such as mock-ups, studies and reports.

(viii) Supply of spares, special tools, Jigs & fixtures, special test and diagnostic equipment, special training equipment and any other items required for the comprehensive maintenance of cars in sufficient quantities.

(ix) Preparation of documents for obtaining approvals by Employer (BEML/BMRCL) from the appropriate statutory authorities.

(x) Design, Supply, Installation, Testing and Commissioning of depot machinery & plant & driving simulator.

As per ERTS 1.1.7, The scope of work shall include all items of work which may be required to meet the performance requirements, trouble free and efficient operation of trains and meeting the best international practices even if not specifically mentioned in the tender specifications i.e. ERTS/PTS.

The **Junction Boxes, Jumpers & Operating panels** shall be suitable for Unattended train operation conforming to Grade of Automation-GOA4 as specified in IEC62290-1:2006 or latest, including the training of operating and maintenance staff of the BEML/BMRCL.

The configuration of train formation is as follows.

DMC – TC – MC – MC – TC – DMC - 6 car train formation

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

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

All DMC, MC and TC supplied under this contract shall be totally interchangeable with all other DMC, MC and TC respectively, supplied under this contract, without modification.

Each DMC provided with Automatic couplers without electric head, at the front end of the train. The other end of DMC and either ends of TC & MC shall be equipped with semi-permanent couplers.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	9 / 51

1.2. Climatic and Environmental Condition (ERTS clause 2.1)

The climatic conditions, which need to be taken into account by the sub-Contractor for designing the equipment.

The BMRCL(Phase-2) cars shall operate reliably and safely under Bangalore climatic conditions shown in Table below.

Description	Limiting Values
Maximum ambient temperature (Refer note1 below)	42°C
Minimum temperature	8°C
Humidity (Refer note 2 below)	92% saturation during rainy season
Rainfall	Rain occurs generally from May to October. Average annual rainfall is approximately 1065 mm. Maximum rainfall in any 24h period is 178mm.
Atmosphere during hot season	Extremely dusty including bird feathers
Maximum wind Speed	125 Km/hr
SO ₂ level in atmosphere	6.7 - 80 micro g/ m ³
NO _x level in atmosphere	16 - 80 micro g/ m ³
Respiratory Suspended particulate matter in atmosphere (RSPM)	49 - 120 micro g/m ³
Total Suspended Particles Matter in atmosphere (TSPM)	111 - 360 micro g/m ³
Altitude	1000 m
Conditions in stations	All underground stations will be fully air-conditioned. Above ground stations will have air-conditioning for certain designated rooms only
Vibration & Shocks	The sub-systems & their mounting arrangements shall be designed to withstand satisfactorily the vibration and shocks encountered in service as specified in IEC 61373 and IEC 60571.

Note:

1. The temperature of the metal surfaces of the vehicles when exposed directly to the sun, for long periods of time, may be assumed to rise to 70°C.
2. Any moisture condensation shall not lead to any malfunction or failure.

1.3 Environmental Conditions in Tunnel:

i) Tunnel ventilation is achieved primarily by the movement of vehicles inside the tunnel under normal working conditions. The relief of the piston effect generated by the train is achieved by means of draft relief shafts. Tunnel ventilation fans installed at each end of each station will be

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	10 / 51

used to provide supplementary ventilation at times of high temperature, and under congested traffic or emergency conditions. These fans will provide reversible airflow and will intake from, and exhaust to the outside through ventilation shafts. The maximum design temperature inside the tunnel is expected to be 46°C under normal as well as congested conditions.

ii) Under emergency conditions of tunnel fire, the tunnel ventilation system will be used for smoke extraction by operating tunnel fans in push-pull mode. The allowable maximum temperature inside the tunnel during such smoke extraction will be below 60°C.

iii) Track-way exhaust systems will be provided to extract a portion of train-generated heat while the train is within the bounds of a station. During normal conditions, under platform exhaust as well as over-track-way exhaust fans will operate. In addition, control of these fans shall be possible during congested and emergency conditions for the purpose of aiding tunnel ventilation and providing additional smoke removal capability for the station and tunnel. During emergency fire conditions within a station, the station air handling system will be operated to supplement smoke removal.

iv) Tunnel walls may be wet and seepage water will normally be present in the invert. Rolling Stock supplied must therefore be capable of withstanding the effects of seepage and continue to operate in such wet and humid conditions.

1.4. Signaling System (ERTS clause 2.6)S

Train control system	CBTC based on-board Continuous Automatic Train Control system (CATC) consisting of: (i) Automatic Train Protection (ATP) (ii) Automatic Train Operation (ATO) (iii) Automatic Train Super-vision (ATS) (iv) Automatic Turn Back (ATB) (v) Attended/Unattended train operation (GoA2/GoA4)
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1.5 Line Characteristics

i) Length of Line-6 from Kalena Agrahara to Nagavara is 21.5 Km, Phase 2A (Central silk board junction – K.R.Puram) is 19.8 km, Phase 2B (K.R.Puram – Kempe Gowda International airport) is 38.4 km.

ii) Station name, number, location, inter distance, platform location, line profile, gradient and curves radius are given in Appendix- E of ERTS document.

iii) Presently, trains of East-West Corridor and North-South Corridor of Phase-I are being maintained in Baiyappanahalli and Peenya depot respectively. In future, the trains which will operate on East-West Corridor shall be maintained at Whitefield and Challaghatta depots (new depots). Baiyappanahalli depot will provide the maintenance facilities for trains operating on Phase 2A line and trains operating on Phase 2B line shall be maintained at Airport Depot (new depot). Trains which will operate on Line-6 shall be maintained at Kothanur depot (new depot).

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	11 / 51

1.6 Track Structure Parameters

The Track Structure Parameters for At-grade, Elevated and Underground Corridors are shown in Table.

Description	Elevated and At-grade Corridor		Tunnel sections
	Ballasted	Ballast less (DFF)	Ballast less (DFF)
Track Laying Gauge	1435 mm		
Rail Type (Main line and depot)	UIC 60 Head hardened (1080)		
Rail Type (Depot)	UIC 60 (880)		
Rail profile	60E1 (UIC 60) 880 grade	60E1 (UIC 60) 1080 grade HH	60E1 (UIC 60) 1080 grade HH
Inclination of Rail	1 /20		
Rail seat spacing, Main line	650mm±10mm	650mm±10mm	700mm±10mm
Sleeper Spacing (Depot)	650mm±20mm		
Ballast Cushion (Depot)	250mm		
Standard Rail length	13m and 18m		
Rail panel lengths	Long welded rails		
Minimum Radius of curvature	100m-Depot	120m with grade compensation	200m with grade compensation
Minimum Turn Out Depot	1 in 7, R-140		
Minimum Turn Out Mainline	1 in 7, R-140		
Maximum Cant Permissible in curves	125 mm		
Maximum Cant Deficiency permissible	100 mm		
Maximum Permissible Cant Gradient	1 in 440		
Turn-out Speed: Turn-out Mainline (1 in 9), R-300	45 km/h		
Turn-out Speed: Turn-out Mainline (1 in 7), R-140	25 km/h		

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	12 / 51

Turn-out Speed: Scissors (Main line)	25 km/h
Turn-out Speed: In Depots	25 km/h
Maximum gradient (main line)	4% (compensated)
Minimum vertical curve radius	1500m
Widening of track Gauge on curves	Up to 9 mm for curves sharper than 500m radius
Structural gauge and passing clearance in straight line, in curves, in sections open air grade, in tunnel	Refer to appendix E of this document for typical sections
Tunnel Profile	Drawings showing section of cut and cover and bored tunnel in the Underground sections and details of various equipment/cables etc. located therein are mentioned in are enclosed in Appendix E of ERTS document
Line profile	The drawings showing the line profiles of all corridors are enclosed in Appendix E of ERTS document.

Note: For detailed Track Tolerance details refer ERTS section 2.3.2 & 2.3.3 Table 2.3 & 2.4


1.7 Flood Proofing

The Traction equipment's mounted on the under-frame will be designed to permit propulsion of the train at 10 km/h through water up to a depth of 75mm above rail level as per ERTS 2.4. Traction equipment shall be made splash proof in accordance with International Standards.

1.8 Current Collection System (ERTS clause 2.5)

The principal details of the Current Collection Systems as required in IEC 60850 are set out in below table.

System particulars	For all sections and depots
Supply Voltage System	750V DC
Type of current collection	Through Third Rail (Inverted Rail) in all sections
Current Collection	Through current collector shoes mounted on the driving motor cars and motor cars
Minimum height from rail level to Current collecting surface of the conductor rail	As per para 4.1.1 (a) of chapter 4 of SOD (December 2015)
Maximum height from rail level to Current collecting surface of the conductor rail	As per para 4.1.1 (b) of chapter 4 of SOD (December 2015)
Minimum distance of Centre line of the Conductor rail and track center	As per para 4.1.2 (a) of chapter 4 of SOD (December 2015)
Maximum distance of Centre line of the Conductor rail and track center	As per para 4.1.2 (b) of chapter 4 of SOD (December 2015)
Nominal Voltage	750 V DC

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	13 / 51
Minimum Voltage		500 V DC	
Maximum Voltage		900 V DC	
Occasional maximum Voltage		950 V DC	
Occasional maximum voltage during regenerative braking		1000 V DC	
Voltage for guaranteed performance		725 V DC *	

Typical third rail schematic, gauge and dimensions are given in Appendix E of ERTS.

2. Definition and Abbreviations

The following definitions and abbreviations are applicable to the PTS.

2.1. Definitions

The following definitions and abbreviations are applicable to the PTS.

“BMRCL” means the Employer for the Mass Rapid Transport System (MRTS) for Bangalore

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

“BEML” means the Customer to procure the cables for BMRCL 5RS-DM contract.

“Subcontractor” means the subcontractor of cables to BEML for 5RS-DM BMRCL Project.

“ERGS” means Employer’s Requirements-General Specification of 5RS-DM BMRCL contract for BMRCL Metro Project

“ERTS” means Employer’s Requirements-Technical Specification of 5RS-DM BMRCL contract for BMRCL Metro Project

“PTS” means BEML’s Procurement Technical Specification.

"GTC" General Terms & Conditions of BEML for the procurement of the Propulsion system

"Engineer" means any person nominated or appointed from time to time by the employer to act as the engineer for the purpose of the contract and notified as such in writing to the contractor.

"Engineer's Representative" means any assistant of the Engineer appointed from time to time by the Engineer.

2.2. Abbreviations

ATC: Automatic Train Control
BMRCL: Bangalore Metro Rail Corporation Limited
EMC: Electro-Magnetic Compatibility
EMI: Electro-Magnetic Interference
FAI: First Article Inspection
ERTS: Employer's Requirement Technical Specification
ERGS: Employer's Requirement General Specification
GCC: General Condition of Contract

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	14 / 51

GTC: General Terms and Conditions.

LRU: Line Replaceable Unit

MDBF: Mean Distance Between Failures

MDBCF: Mean Distance Between Component Failures

MDBSF: Mean Distance Between Service Failures

MTTR: Mean Time to Repair

PIS: Passenger Information System

PTS: Procurement Technical Specification

SCC: Special Condition of Contract

SOD: Schedule of Dimension

TCMS: Train Integrated Management System

N/A: Not Applicable

TBD: To Be Determined

PDR: Preliminary Design

FDR: Final Design

GoA: Grade of Automation

UTO: Unattended Train Operation

For further abbreviations, please refer to ERTS APPENDIX C (ERTS 23)

3. Precedence of Documents

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

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	BMRL 5RS-DM_ERTS
2	BMRL 5RS-DM_ERGS
3	GTC
4	PTS

This PTS shall in no way relieve the subcontractor from any requirements specified in the ERTS and ERGS.

The complete requirements are those found in the above documents. It shall be the subcontractor's responsibility to ensure that equipment, documentation, and services furnished against this PTS are in full compliance with all the above documents.

Also, in the event of any conflict among the requirements of particular parts of the PTS, ERTS and ERGS, the subcontractor shall seek clarification with BEML prior to making a contract. After making a contract, the subcontractor shall comply with BEML's Interpretation for any discrepancies.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	15 / 51

4. Standards and Codes (ERTS clause 21 & Appendix A of ERTS)

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

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

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

5. Requirements of Documentation

All drawings, documents and information by Subcontractor shall be prepared in English and submitted to BEML for approval as per Appendix 4 of ERGS.

All documents and information to be submitted shall be of Microsoft Office format on CD-ROM or e-mail.

The Subcontractor shall provide BEML with the drawings of Junction Boxes, Jumpers & Operating Panels in a format readable with AutoCAD 2013 (latest), CATIA V5 on CD-ROM or e-mail as requested by the BEML or BMRCL's Representative.

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

6. Qualifying Criteria for subcontractor and Vendor approval

6.1. Qualifying Criteria (ERTS clause 5.1.2)

- i. Proposed sub-systems shall have been in use and have established their satisfactory performance and reliability on at least three mass rapid transit systems in commercial/revenue service over a period of three years or more (in each MRTS) either outside the country of origin in three different countries or in MRTS in India. Sub-systems/components used in existing Rolling Stock in MRTS in India do not get automatically qualified for use unless specifically approved by the Project Manager for this project. If required by the Project Manager, Contractor shall provide certificate of satisfactory performance for a period of three years or more from the Metro operators. Where similar sub-systems of a different rating are already proven in service as per the above criteria then the design shall be based on such sub-systems. (ref. ERTS 5.1.2)
- ii. All 'sub systems' shall be procured from the approved vendors and sourced from only such manufacturing units that have supplied the sub-systems that fulfil the proven design requirements as above. The Contract envisages commencement of manufacturing only

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	16 / 51

after completion of pre-final design. Accordingly, the number of years in commercial/revenue service and operation for the above requirements shall be calculated as on the contracted Key Date No. 3.1 corresponding to 'Pre-Final Design Completion.

- iii. In case the subcontractor proposes to use sub-system(s) that do not fulfil the above said criteria then the subcontractor shall furnish sufficient information to prove the basic soundness and reliability of the offered sub-system(s) for review of the Project manager. The Project manager decision on contractor's proposal shall be final and binding.
- iv. The sub-contractor shall provide all the required documents for obtaining the vendor approval for the Junction Boxes, Jumpers & Operating panels as per ERTS 5.1.5.
- v. BMRCL may accord approval based on the sub-contractor credentials; subcontractor shall note the acceptance of the technical offer is subject approval of the Vendor by BMRCL.
- vi. The firm should undertake to provide the support during Testing & Commissioning, service trials, revenue service and DLMP period as per ERTS 5.1.5. The firm shall submit detailed proposal in this regard.

6.2. Vendor approval (ERTS clause 5.1.5)

Vendor approval from BMRCL is mandatory for all sub-system suppliers. Accordingly, the request for Vendor approval with all relevant references and details as per Vendor approval format (Refer Attachment-2) shall be submitted along with the technical offer, Company profile, Product range and the organization structure. The acceptance of the technical offer is subject to approval of the Vendor by BMRCL based on the vendor approval details submitted by the subcontractor.

Vendor approval needs to be taken for the Firms participating in the tender. Firms who have supplied similar Boxes/Panels for Metro projects in India can be considered subject to Notice of No objection from BMRCL/Engineer.

6.3. Indigenization (ERGS Clause 1.3)

The subcontractor shall make efforts to source maximum materials from India, Junction Boxes, Jumpers & Operating panels to be indigenized to meet the required performance requirements and quality standards and facilitate ease in maintenance and easy availability of spares.

To facilitate ease in maintenance and easy availability of spares, BEML/ BMRCL is keen in standardization and expects subcontractor to make efforts to source maximum number of equipment's and materials from India.

7. Scope of Supply & Work

7.1 Hardware

7.1.1 General

- i. Subcontractor shall provide all components of **Junction Boxes, Jumpers & Operating panels** to BEML. Subcontractor shall design and select the components of each item in accordance with the drawings that is provided by BEML.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	17 / 51

- ii. If the components are used incorrectly, the subcontractor shall, at his own expense, take whatever action is deemed necessary, such as, rectification, readjustment or design changes to the satisfaction of the BEML and Customer/Employer.
- iii. **The specification, quantity and location etc., of components such as push-button actuators, led indicators and rotary switches etc., provided in the BOM of the drawings mentioned in above tables might undergo some change during review of Proto train & design document by BMRCL. The subcontractor shall carry out such changes without any additional cost to BEML.**
- iv. All mating connector assemblies for car body side wiring shall be supplied by the Subcontractor.
- v. Mating connectors for vehicle side with all pins even if pin is not used, back shells and accessories shall be supplied by the subcontractor.
- vi. Non-screwed and self-locking type connectors for complete system shall be ensured.
- vii. The connector with Pins, terminal blocks, push buttons, indicators and other items shall be from OEM as per BEML drawings.
- viii. **The cables required for manufacture of the Junction Boxes, Jumpers & Operating panels will be supplied by BEML to the subcontractor.**
- ix. The subcontractor shall position the DLP & commissioning spares at the BMRCL 5RS-DM Cars depot at free of cost.
- x. The subcontractor shall carry out cleaning, pickling and passivation process to all stainless-steel finished product.
- xi. Painting specification & process wherever applicable shall be as per the approved Painting Specification provided by BEML.
- xii. The subcontractor shall use SS hardware/fasteners which pass salt spray test as per international standards for manufacture of Junction Boxes, Jumpers & Operating panels.
- xiii. Earth pad / stud and fasteners for fastening (preferably which suits to M6 and 6 sq. mm. cable)
- xiv. **Equipment side connector for Di-electric test:** Subcontractor shall supply one full set of connectors and its contacts as mounted on the equipment's for each car-type to carry out vehicle level voltage withstand test at BEML factory. Detailed list shall be decided and finalized before first supplies.
- xv. Rubber (packing or gasket) for the water-tightness when the subsystem or components are installing shall be supplied by the subcontractor.
- xvi. 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.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	18 / 51

- xvii. The locks provided on the box covers shall be indicated with open & close markings / directions with stickers.
- xviii. The copper lugs used for cable termination shall be of UL certified and high conductivity Cu (99.9%) and all other details to is:1897-83 with electro plating to is:1359-92 to grade cusn8b.

7.1.2 Junction Boxes and Jumpers

The List Junction Boxes and Jumpers to be supplied by sub-contractor is as per the following Table-I and Table-II

S/N	DRAWING NUMBER	DESCRIPTION	QTY/		
			DMC	TC	MC
1	50721601	LTJB, DMC-A TYPE	1 No.	-	-
2	50721602	LTJB, TC-B TYPE	-	1 No.	-
3	50721603	LTJB, TC-C TYPE	-	1 No.	-
4	50721604	LTJB, MC-D TYPE	-	-	1 No.
5	50721605	LTJB, MC-E TYPE	-	-	1 No.
6	50721606	HTJB- A TYPE	1 No	1 No.	-
7	50721607	HTJB- B TYPE	-	1 No	1 No.
8	50721608	CSJB	2 Nos.	-	2 Nos.
9	50721609	STINGER BOX	2 Nos.	-	2 Nos.
10	50721610	T/M JUNCTION BOX	4 Nos.	-	4 Nos.

Table-I: Junction Boxes

S/N	DRAWING NUMBER	DESCRIPTION	QTY/		
			DMC to TC	TC to MC	MC to MC
11	50721611	JUMPER CABLE PLUG ASSY - X1_DMC-TC	1 No.	-	-
12	50721612	JUMPER CABLE PLUG ASSY - X1_TC-MC	-	1 No.	-
13	50721613	JUMPER CABLE PLUG ASSY - X1_MC-MC	-	-	1 No.
14	50721614	JUMPER CABLE PLUG ASSY - X2_DMC-TC	1 No.	-	-
15	50721615	JUMPER CABLE PLUG ASSY - X2_TC-MC	-	1 No.	-
16	50721616	JUMPER CABLE PLUG ASSY - X2_MC-MC	-	-	1 No.
17	50721617	JUMPER CABLE PLUG ASSY -X3_DMC-TC	1 No.	-	-
18	50721618	JUMPER CABLE PLUG ASSY -X3_TC-MC	-	1 No.	-
19	50721619	JUMPER CABLE PLUG ASSY -X3_MC-MC	-	-	1 No.
20	50721620	JUMPER CABLE PLUG ASSY -X4_DMC-TC	1 No.	-	-
21	50721621	JUMPER CABLE PLUG ASSY -X4_TC-MC	-	1 No.	-
22	50721622	JUMPER CABLE PLUG ASSY -X4_MC-MC	-	-	1 No.
23	50721623	JUMPER CABLE PLUG ASSY - X7_DMC-TC	1 No.	-	-


		Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559		
			DATE	07.11.2024		
			REV. NO.	0		
			PAGE NO.	19 / 51		
24	50721624	JUMPER CABLE PLUG ASSY – X7_TC-MC	-	1 No.	-	
25	50721625	JUMPER CABLE PLUG ASSY – X7_MC-MC	-	-	1 No.	
26	50721626	JUMPER CABLE PLUG ASSY, ETHERNET – X8_DMC-TC	1 No.	-	-	
27	50721627	JUMPER CABLE ASSY, ETHERNET – X8_TC-MC	-	1 No.	-	
28	50721628	JUMPER CABLE PLUG ASSY, ETHERNET – X8_MC-MC	-	-	1 No.	
29	50721629	JUMPER CABLE PLUG ASSY, ETHERNET – X9_DMC-TC	1 No.	-	-	
30	50721630	JUMPER CABLE PLUG ASSY, ETHERNET – X9_TC-MC	-	1 No.	-	
31	50721631	JUMPER CABLE PLUG ASSY, ETHERNET – X9_MC-MC	-	-	1 No.	
32	50721632	JUMPER CABLE PLUG ASSY, 1P PLUG-X10_DMC-TC	1 No.	-	-	
33	50721633	JUMPER CABLE PLUG ASSY, 1P PLUG-X10_TC-MC	-	1 No.	-	
34	50721635	JUMPER CABLE PLUG ASSY, 1P PLUG-X11_DMC-TC	1 No.	-	-	
35	50721636	JUMPER CABLE PLUG ASSY, 1P PLUG-X11_TC-MC	-	1 No.	-	
36	50721638	JUMPER CABLE PLUG ASSY-X5_DMC-TC	1 No.	-	-	
37	50721639	JUMPER CABLE PLUG ASSY-X5_TC-MC	-	1 No.	-	
38	50721640	JUMPER CABLE PLUG ASSY-X5_MC-MC	-	-	1 No.	
39	50721641	JUMPER CABLE PLUG ASSY-X6_MC-MC	-	-	1 No.	

Table-II: Jumpers Cable Assy.

a. Operating Panels, Earth Bars and Terminal Boards

The List Operating Panels, Earth Bars and Terminal Boards to be supplied by sub-contractor is as per the following Table-III

S/ N	DRAWING NUMBER	DESCRIPTION	QTY/		
			DMC	TC	MC
40	50721642	LTEB, DMC	1 No	-	-
41	50721643	LTEB, TC	-	1 No	-
42	50721644	LTEB, MC	-	-	1 No
43	50721645	HTEB, DMC	1 No	-	-
44	50721646	HTEB, TC	-	1 No	-
45	50721647	HTEB, MC	-	-	1 No
46	50721649	CAB DESK TERMINAL BOARD	1 No.	-	-
47	50721650	OPERATING PANEL-1	1 No.	-	-
48	50721651	OPERATING PANEL-2	1 No.	-	-
49	50721652	OPERATING PANEL-3	1 No.	-	-
50	50721653	OPERATING PANEL-4	1 No.	-	-
51	50721654	OPERATING PANEL-5	1 No.	-	-
52	50721655	OPERATING PANEL-6	1 No.	-	-
53	50721656	OPERATING PANEL-7	1 No.	-	-
54	50721657	OPERATING PANEL-8	1 No.	-	-

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels			DOC. NO.	GR/TD/6559		
				DATE	07.11.2024		
				REV. NO.	0		
				PAGE NO.	20 / 51		
55	50721658	OPERATING PANEL-9			1 No.	-	-

Table III: OP's, Earth Bars & Terminal Boards.

7.1.3 Unit Exchange Spares

The following Unit Exchange Spares are required As per ERGS 14.5.7 Attachment-4

S/ N	DRAWING NUMBER	DESCRIPTION	Total quantity require d
a. All Electrical monitoring, control and protection panels. Including pneumatic gauges, sensors as applicable			
1	50721650	OPERATING PANEL-1	4 Nos.
2	50721651	OPERATING PANEL-2	4 Nos.
3	50721652	OPERATING PANEL-3	4 Nos.
4	50721653	OPERATING PANEL-4	4 Nos.
5	50721654	OPERATING PANEL-5	4 Nos.
6	50721655	OPERATING PANEL-6	4 Nos.
7	50721656	OPERATING PANEL-7	4 Nos.
8	50721657	OPERATING PANEL-8	4 Nos.
9	50721658	OPERATING PANEL-9	4 Nos.
b. Complete Motor Bogie equipped with Traction Motors with power and earthing cables, Wheel Sets and brake units.			
1	50721684	TRACTION MOTOR CONNECTOR PLUG (MOTOR SIDE)	48Nos.

Table IV: List of Unit Exchange Spares (As per ERGS 14.5.7 Attachment-4)

7.1.4 Simulator

The following operating panels are required for simulator

S/ N	DRAWING NUMBER	DESCRIPTION	Total quantity required
SIMULATOR			
1	50721650	OPERATING PANEL-1	1 No.
2	50721651	OPERATING PANEL-2	1 No.
3	50721652	OPERATING PANEL-3	1 No.
4	50721653	OPERATING PANEL-4	1 No.
5	50721654	OPERATING PANEL-5	1 No.
6	50721655	OPERATING PANEL-6	1 No.
7	50721656	OPERATING PANEL-7	1 No.
8	50721657	OPERATING PANEL-8	1 No.
9	50721658	OPERATING PANEL-9	1 No.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	21 / 51

7.2 Software

NA

7.3 Interface Responsibilities

NA

7.4 Testing

The Subcontractor shall perform the following tests for **Junction Boxes, Jumpers & Operating panels**.

- Routine tests
- Type tests

In the event that any test for the equipment fails, the Subcontractor shall, at his own expense, take whatever action is deemed necessary, such as, rectification, readjustment or design changes to the satisfaction of the BEML and BMRCL, in order to meet the testing requirements. The Subcontractor shall provide the required information for testing and carry out other tests (fire performance etc.) and retrofit problems during the tests.

The subcontractor shall provide type test & routine test procedure for Junction Boxes, Jumpers & Operating panels for BEML and BMRCL approval.

7.5 Spares, Special Tools and Testing Equipment

The subcontractor shall hand over the Spares, Special tools and testing equipment in accordance with the delivery schedule of BEML. The supplier shall maintain the Junction Boxes, Jumpers & Operating panels and supply of spares for at least 15 years from the date of completion of the Defect Liability period (DLP).

The subcontractor shall supply the following items of spares

- (1) Unit Exchange Spares (refer to Clause 14.5.7)
- (2) Consumable spares for maintenance for a period of three years
- (3) Special tools, Testing and Diagnostic equipment
- (4) Special jigs, Fixtures & Gauges required for maintenance, repair and overhaul of the trains.
- (5) Recommended list of consumable spares for maintenance, repairs and overhaul of trains
- (6) Recommended list of Special Tools, Testing and Diagnostic Equipment separately for maintenance and diagnostics of various equipment's
- (7) Recommended list of Special Jigs, Fixture and Gauges for maintenance and diagnostics of various equipment's
- (8) The drawings, manuals and full operating instructions

The detailed requirements are specified in ERGS 14.5.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	22 / 51

7.6 DLP

- a) Defect Liability period shall start from start of revenue service of last trainset + 24 months.
- b) The supplier shall remedy, at no extra cost to BEML, the defect or failure (fair wear and tear excluded) after any part of the work until the end of defect Liability Period.
- c) The supplier shall be responsible for any defect attributable to defective design, material or workmanship during warranty period. The supplier will not be liable for damages caused BEML or any other third parties did not follow the written operation and maintenance instructions or did not use the metro trains in accordance the technical documents.
- d) The warranty of the sub-system for which outstanding works are to be completed by the supplier shall start only after completion of all outstanding works.
- e) "Defects Liability Period" shall mean the defects liability period stated in the PO calculated from the date of taking over of whole of the scope of supplies and not any sub-section or part thereof. Provided that, if any part of the Scope of supplies or sub-systems or component of that part has been replaced, renewed or repaired, the "Defects Liability Period" in respect of that part or sub-system or components of that part shall start from the date of such replacement, renewal or repair has been completed to the satisfaction of BEML.
- f) The supplier shall ensure implementation of all improvements/corrective actions against all technical issues reported (during Design, Manufacturing, Installation, Commissioning, Interface Testing, Operation & Maintenance etc.) in earlier projects/supplies of their sub-system and submit the compliance documents during design stage. The supplier shall certify the implementation of such engineering change proposals, before despatch of items.
- g) The supplier shall attend & close all snags, defects, deficiencies, punch points w.r.t. suppliers' sub-system reported by BEML/ BMRCL in various stages of the project (at BEML Factory & BMRCL Depot) promptly before ROD (revenue operation date) of Trains. The list of unattended pending issues (which does not affect the operation of train) along with action plan & timeline to attend/close the same shall be submitted by the supplier.
- h) The supplier shall be required to investigate any design issues, interface issues, field failures (conveyed through NCRs, BMRCL Inspection Notes, Minutes of meetings etc.) of supplied sub-system in detail & submit investigation report along with corrective action report to BEML in a time bound manner for obtaining BMRCL's approval. Based on BMRCL's approval, the supplier shall be required to implement the corrective action (viz. Hardware modification), without any additional cost, in all Trains during entire DLP.
- i) The supplier shall not convey their recommendations on replacement of items/anything related with DLP process directly to BMRCL without prior information to/consent of BEML. If the supplier recommends any spares/consumables/other items besides the items quoted to BEML during the PO/Design finalization stage, then the supplier should supply these items free

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	23 / 51

of cost for entire DLP of all trains.

- j) The supplier shall provide Training of their sub-system to BEML T&C personnel for familiarization of their sub-system in terms of testing, commissioning & comprehensive maintenance.
- k) Submission of detailed hardware modification fleet replacement proposal based on detailed investigation to address the recurrence of the fault/improving the reliability of sub-system towards closure of BMRCL Inspection Notes/MoM Points/Open Technical Issue/Punch points/Epidemic Failures etc.
- l) Implementation of hardware modification/fleet replacement of component/complete unit/complete sub-system in all Trains as well as in supplied Spares. Monitoring of sub-system/Train's performance after implementation of hardware modification/fleet replacement.
- m) Submission of OEM Maintenance Manuals, Maintenance Work Instructions, Maintenance Schedule [Specifying the frequency of various inspections/service checks synchronized with Master Maintenance Schedule of Train (As Per RAMs documents viz. Daily, 72 Hrs., A, B1, B4, B8, C1, C2, C3, C4 service checks, C5 Mid-life refurbishment etc.), detailed scope of work during such inspections/service checks including facilities & manpower requirement, Down-time of Train etc.] of supplied sub-system. Finally, the frequency of various inspections/service checks shall be followed as per approved Train level "Operation & Maintenance Manual" and "Master Maintenance Schedule".
- n) Handling obsolescence issues of supplied sub-system's component/subassembly assembly /maintenance terminals/tools/special tools/spares/consumables or any item related with supplied sub-system during Life cycle of the supplied sub-system.
- o) Failures of 6-Car Train sets caused by the failures of the individual equipment/ subsystems or any other defects shall only be treated as warranty failures. BEML decisions in this regard shall be final.
- p) The final acceptance will not cancel the particular conditions specified in the contract, such as hidden defects, reliability requirements, life span, etc

After sale services

- During this period, the supplier will undertake the necessary repair works due to failure at his own risk and expense including spare parts and labour.
- All the equipment and material necessary for testing, defects and repair in connection with warranty obligations will be provided by the supplier bearing the connected expenses.
- Spare parts for faulty components replaced shall be provided by the supplier and are not included in the stock of spare parts that will be provided for the regular maintenance purpose. In the other case a specific agreement between the BEML and the supplier shall be set up.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	24 / 51

- "After sale" service organisation set up by the supplier during all the warranty period including any extension shall be described in term of permanent resident staff, with requisite qualification and experience. During the warranty period, the supplier shall be responsible free of charge for the detection and repair of defects and components replacements where the metro train does not conform to the Functional specification and performance requirements. Normal wears and tears are excluded from these defects.
- The repair and or replacement of failed components and equipment and installation of repaired/replaced components/equipment shall be undertaken by the supplier free of charge at Site. The supplier shall bear custom duty, freight charges and all other expenses involved in collection of defective components and equipment from the Site, and transportation to the manufacturer's works in India or abroad and its return to Site after repairs. Further, should any design modification be required to any component or equipment as a consequence of failure analysis, the minimum period of warranty i.e 24 months shall recommence from the date when the modified part is commissioned into service and modification shall be carried out free of charge. In all such cases, warranty will be applicable on complete sub-assembly; even when only component has been modified/replaced/repared due to design change
- All replacement and repairs under the warranty shall be carried out by the supplier promptly and to the complete satisfaction of BEML/BMRCL on notification of the defect by the BEML so that no car is unfit for revenue service for more than 48 hours, which shall exclude time taken for withdrawal/ induction of trains from/to revenue services. In case any train remains out of revenue operation beyond specified duration above due to reasons attributable to supplier, BEML may at his sole discretion impose a penalty on the supplier, commensurate with the revenue and opportunity loss to the BEML/BMRCL. Decision of BEML/BMRCL shall be final and binding.
- BEML will notify the supplier in writing of any defect together with a brief description thereof. Upon receipt of such notice, the supplier shall within a reasonable period of time and at his own costs remedy this defect. If within reasonable time, the supplier fails to full fill his obligations after a reasonable number of trials for repair (at least three trials), the BEML may fix by written notice a reasonable final time for completion of the supplier's obligations. In case the supplier fails to fulfil his obligations within such final time, BEML may himself undertake the necessary repairs works employ a third party to do so, always at the risk and expense of the Supplier.

Specific warranty in case of Serial or Hidden defects

- The aim of this chapter is to define specific warranty requirements for serial and hidden defects including modifications, parts and labour. Serial or Hidden defects will be covered by a specific warranty period over the general warranty period as defined above.
- Serial or Hidden defect is defined as an identical failure on a part or components which occur on at least 15 % of total identical part and components with the same function of the rolling stock fleet during the General Warranty period. The occurrence of serial defects is calculated with the

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	25 / 51

personal computer-based Failure Reporting and Corrective Action (FRACAS) System in charge to demonstrate compliance with specified train and equipment reliability as required in Chapter 19 clause no 19.2.6 (iv) of the (Employer' s Requirements) - Technical Specification.

- In the case of Serial or Hidden defects, the supplier shall investigate all the concerned parts and present a technical solution or modification including spare parts modification or replacement for all the metro train fleet including the metro trains no more covered by the General Warranty period. The Serial or Hidden defects shall be repaired by the supplier free of charge (modification, material and labour).
- In the case of Serial or Hidden defect, a period of specific warranty of 24 months shall recommence from the date when the modified part is commissioned into service (including spare parts) and modification carried. In all such cases, specific warranty will be applicable on complete sub-assembly, even when only one component has been modified/replaced/repared due to design change.
- "The warranty period of unit exchange, mandatory and overhauling spares, special tools, testing and diagnostic equipment, special jigs, fixtures and gauges, or any other item / equipment delivered shall be Either 24 months from the date of acceptance or up to expiry of the defect liability period of trains, whichever is later. "
- Supplier shall position the DLP spares at BMRCL depots in three months advance of the train receipt at the depots.
- The DLP spares shall be proposed by the supplier based on MDBCf & LCC of each assembly/sub-assembly item (The minimum qty. shall be one number per depot) and upon approval of the same from BEML & BMRCL, the same shall be positioned at Depot at least Three months before delivery of First Train-set. The spares shall be jointly reviewed/audited quarterly and qty/item shall be increased based on the failure pattern of items and recoupment lead time.
- The list of DLP spares will be reviewed on the actual MDBCf/Failure pattern of the items and the quantity/items shall be increased on the actual failure of the system.
- The Contractor shall agree that if any identical defect or deficiency occurs on more than 10% (ten per cent) of the equipment or parts of the Train sets in any rolling period of 36 (thirty-six) months commencing from the second year of Supply, such defect or deficiency shall be deemed to be an epidemic defect (the "Epidemic Defect") and the Contractor shall promptly take corrective actions for such Epidemic Defect under an epidemic defect warranty to be maintained by the Contractor for the Maintenance Period (the "Epidemic Defect Warranty").
- The Vendor shall Pick up of the faulty items from BMRCL Depot, sending (if required) to their Factory/OEM for investigation, repair, testing etc. & return to BMRCL Depot along with final testing/quality clearance documents, in a time bound manner.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	26 / 51

- During entire DLP, the supplier shall be required to demonstrate the FRACAS, RAMS, LCC of their supplied sub-system. In case, the supplier is not able to achieve the desired targets (as approved during design stage of the subsystem), the supplier shall take all required actions to improve the FRACAS, RAMS, LCC and provide warranty support till the targets are demonstrated by the supplier. Also, all open technical issues shall be attended /closed by the supplier before closure of DLP. Any penalty imposed or payment deductions made by BMRCL will have to be borne by the supplier and deductible from the payments due to the supplier.
- Any penalty imposed or payment deductions made by BMRCL during entire DLP, for the reason attributable to the Supplier, on account of De-boarding, Trip delays, Trip Cancellation, Non-availability of Trains for service due to supplier's sub-system failures, improper workmanship, non-availability of required spares of supplier's sub-system or for any other reason whatsoever, such amount shall have been borne by the supplier and deductible from the payments due to the supplier

7.7 Storage, Packing, Crating and Marking

The subcontractor shall provide all packing, crating and markings in accordance with the requirements specified in ERGS chapter 9. When handing over, hand over the complete **Junction Boxes, Jumpers & Operating panels** and the spare parts, special tools and testing equipment

The subcontractor shall make and provide the document for proper storage, handling and logistic functions of components supplied by the subcontractor before handing over the first complete **Junction Boxes, Jumpers & Operating panels**.

7.8 Training

The subcontractor shall provide comprehensive training to the BMRCL / BEML Employer's staff (maintenance, operating, training and engineering) in accordance with the training activities and works for the Junction Boxes, Jumpers & Operating panels specified in ERGS chapter 10.

The subcontractor shall provide according to requirement of BEML and BMRCL training schedule, time, method and site etc.

The subcontractor shall provide a training proposal, one original and five hard copies and electronics copies of the training manual for use by BMRCL / BEML for conducting in-house training.

7.9 Warranty

The subcontractor shall be responsible for any defect or failure of equipment's provided in the cars, due to defective design, material or workmanship during warranty period.

The warranty period of special tools, test and diagnostic equipment, maintenance and unit exchange spares shall be as per GS of BMRCL 5RS-DM from the date of acceptance by BMRCL.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	27 / 51

The repair and/or replacement of failed components and equipment and installation of repaired/replaced components/equipment shall be taken by the subcontractor on his own charge at the Site (BEML' works/ BMRCL 5RS-DM depots).

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

The subcontractor shall carry out all replacement and repairs under the warranty promptly and satisfactorily on notification of the defect by BEML so that no car is out of revenue service for more than 48 hours.

Also Refer General Terms and Conditions (GTC) of the tender ERGS 5 requirements of BMRCL 5RS-DM.

8. Technical Requirements

8.1 General

The general requirements for **Junction Boxes, Jumpers & Operating panels** shall meet the following sections in GS and TS:

- (1) GS, Chapter 1 to Chapter 18
- (2) TS, Clause No. 1 to 26

The subcontractor shall be responsible for meeting all the general and technical requirements of the **Junction Boxes, Jumpers & Operating panels** as specified in ERGS & ERTS.

8.2 Technical requirements of Junction Boxes, Jumpers & Operating panels

The system requirements for Junction Boxes, Jumpers & Operating panels shall meet, but not be limited to, the following sections in ERTS:

- (1) ERTS 2 Operational Environment
- (2) ERTS 3 Operational Performances.
- (3) ERTS 12 High Voltage Electrical Equipment.
- (4) ERTS 15 Electrical and Control Equipment's
- (5) ERTS 18 Materials and Workmanship.
- (6) ERTS 19 RAMS Reliability, Availability, Maintainability, Safety.
- (7) ERTS 20 Inspections, Tests and Commissioning.
- (8) ERTS 21 Appendix A. International Standards

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	28 / 51

(9) ERTS 24 Appendix D. Interfaces.

8.3 SEM (System Engineering Management)

The subcontractor shall comply with the requirements specified in GS Chapter 2, 3, 4 & 5

8.4 Quality

8.4.1 General

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

8.4.2 Quality System Requirements

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

- Design
- Development & Testing
- Production
- Installation
- Servicing

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

8.4.3 Quality (Assurance) Plan

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

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

8.4.3.1 The subcontractor Quality Assurance Plan (QAP)

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

It is to be noted that, this QAP is not an ISO Quality assurance manual. Please refer to ISO 10005 — Guidelines for quality plans.

8.4.3.2 The QAP shall focus on the following but not be limited to:

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

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

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	29 / 51

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

8.4.4 Inspection and Test

8.4.4.1 General

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

ITP shall be submitted to BEML QC team for review and approval as following no later than 30 days after purchase order by BEML. Subcontractor shall comply to ERTS 20.

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

B) Witness/Hold point of Inspection/Test

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

C) Inspection/Test Notification of Witness/Hold point

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

8.4.4.2 Notification of inspection/test

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

8.4.4.3 Quality records

Inspection/test reports will be classified as follows:

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

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	30 / 51

8.4.5 Quality Audit

8.4.5.1 Internal quality audit

The subcontractor has to establish an audit program for this project in accordance with the ISO 9000 quality system and submit to BEML for information. The audit shall be performed more than or equal one time an year for this project. And the audit report shall be submitted to BEML for information. It also will be available to be submitted to BMRCL, if requested.

8.4.5.2 External quality audit (performed by BEML and/or BMRCL)

During the life of the contract, BEML and/or BMRCL will require to conduct compliance audits of the subcontractor's quality management system for this project. Not less than 7 days' notice will be given by BEML, the subcontractor shall provide all necessary access, assistance and facilities to enable BEML and BMRCL to verify that the quality management system for this project is being properly and fully implemented. The subcontractor shall assign suitably qualified staff to accompany BEML and BMRCL in the audit. The subcontractor shall submit at the request of BEML and BMRCL any documents which relates to his quality management system for this project, including internal audit reports and quality audit reports of his supplier/subcontractor.

8.4.5.3 Corrective/Preventive actions

Any nonconformity arising from an audit shall require corrective and preventive action by the subcontractor. The corrective and preventive actions are to be approved by BEML and BMRCL. The subcontractor shall provide evidence either in verification audit carried out by BEML and/or BMRCL, or by submission of further documents to demonstrate that all corrective and preventive actions have been satisfactorily completed by the approved completion dates.

8.5 System Assurance (SA)

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

8.5.1 Safety Assurance Plan

NA

8.5.2 System Safety Assurance

NA

8.5.3 Hazard Analysis

The subcontractor shall provide the hazard analysis, Fault tree analysis and Failure Modes Effects and Criticality Analysis (FMECA) of the items and assist the contractor to perform the interface hazard analysis compliant with the requirements specified in ERTS 19.7.

8.5.4 Reliability: General

The subcontractor shall assist BEML to complete a final report to enable the Employer's Representative to assess acceptability of the vehicle and its components for reliability, maintainability and system safety. The detailed requirements are specified in ERTS 19.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	31 / 51

8.5.5 Quantitative Reliability

The Contractor shall demonstrate by quantitative methods achievement of the specified levels of reliability for the train and specific individual items of equipment specified in ERTS 19.1.5

8.5.6 Maintainability

The subcontractor shall comply with the maintainability requirements specified in ERTS 19.4

8.5.7 Reliability and Maintainability Demonstrations

The subcontractor shall assist BEML to complete a final report to enable the Employer's Representative to assess acceptability of the vehicle and its components for reliability, maintainability and system safety.

The detailed requirements are specified in ERTS 19.1

8.5.8 Maintenance

The subcontractor shall comply with the maintenance requirements specified in ERTS 19.6.

8.6 Shock and Vibrations Performance

All equipment's, sub-assemblies and components shall be capable of withstanding shock and vibrations of the Rolling Stock satisfactorily such that they do not fail prematurely on this account earlier to the designed life. To establish this requirement, all of equipment's, sub-assemblies and components shall be subjected to shock and vibration test to IEC 61373 or other equivalent Standard specified in ERTS 3.13.10.

8.7 Fire Safety

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

The Contractor shall submit a fire safety design management plan to the Project Manager for review which shall describe the process that will be used to systematically identify and eliminate fire hazards, to avoid the use of combustible materials whenever practical and to reduce to the extent practical the energy content and heat release rates of the combustible material that are used.

The Contractor shall minimise the total fire load of potentially flammable materials on a Vehicle as far as is practicable and submit the calculated figures.

Contractor shall submit the fire load calculation at design stage separately for above & below the floor level. Fire load calculations shall be furnished with relevant data, certifications etc. of the items considered in fire load calculations. The calculations and validation shall conform to the standard as specified in clause 3.14.3

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	32 / 51

Material Properties. Materials used in the cars shall meet the Flammability, Smoke Emission and Toxicity requirements of the specification EN 45545 part 1 to 7 (Hazard level HL3) latest editions or equivalent standard.

8.7.1 Fire Load Calculation

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

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

Contractor shall submit the fire load calculation at design stage separately for above & below the floor level. Fire load calculations shall be furnished with relevant data, certifications etc. of the items considered in fire load calculations. The calculations and validation shall conform to the standard as specified in clause 3.14.2 (ref. ERTS 3.14.3).

8.7.2 Fire Performance Deliverables

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

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

8.8 Design Information

8.8.1 General

The subcontractor shall provide all necessary documents, drawing and etc. for BEML according to the time schedule defined by BEML. The time schedule is defined according to design submission program compliant with the requirements specified in GS 3.5.

The detailed requirements are specified in GS 3.

The Subcontractor shall provide, but not be limited to, the following general information in accordance with the schedule approved by BEML before contract award.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	33 / 51

To satisfy BEML that the Subcontractor have the ability to supply the Junction Boxes, Jumpers & Operating Panels in accordance with the requirement of PTS, before contract award the Subcontractor shall provide BEML for review and approval the following information.

- (a) Vendor approval documents
- (b) Project Management Plan
 - 1) Data Submission Plan
 - 2) Design Submission Plan
 - 3) 1st Production Plan
 - 4) Type Test & FAI Plan
 - 5) Mass Production after Testing and Delivery Plan
 - 6) Training Plan
 - 7) O&M Manual Plan
 - 8) As Built-In Drawing Plan
- (c) Preliminary Inspection and Test Plan (hereinafter, ITP)
- (d) Preliminary Quality Assurance Plan (hereinafter, QAP)
- (e) Preliminary Technical system/product/function description (including Lay-Out drawing)
- (f) Subcontractor's Option Suggestion about PTS requirements
- (g) Clause by Clause commentary for PTS

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

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

8.8.2 Design

The objective of the design submission process is to ensure that the proposed resulting works comply with the specifications are capable of being produced consistently to exacting quality standards, achieve low life cycle costs and can be operated safely to the satisfaction of the Engineer.

The design submissions include Design Calculations, Design Reports and Design Drawings. All design submissions shall include a 'clause by clause' compliance status to all applicable contract clauses of ERTS.

In the event that a statutory body (e.g., Government of India Ministry of Railways, RDSO, Commissioner of Metro Railway Safety, etc.) requires design information in a particular format, it shall be incumbent upon the subcontractor to provide the same, as directed by BEML/ BMRCL.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	34 / 51

The subcontractor shall submit all necessary documents viz., documents and drawings describing function description, product description, design calculations, interface requirement description, RAM requirement description, Life cycle calculations, Fire safety, Type & routine test specifications, list and details of spares, related calculations etc.

The Design Phase will be undertaken in three stages:

- a) Preliminary Design
- b) Pre-final Design and
- c) Final Design.

Sl. No	Description of Stage	Submission from subcontractor to BEML (From LOI / contract award)
1	Preliminary design completion including BMRCL approval	2 weeks
2	Pre final design completion including BMRCL-approval	2 months
3	Final design completion including BMRCL approval	4 months

The design details for the above 3 stages shall comply with the requirements of clause 5.7 of ERGS.

Design calculation, Design reports, Design drawings and deliverables, as per the requirements specified in Chapter-5 of ERGS, but not limit to, the following design deliverables to BEML according to the time schedule defined by BEML.

Design Stage	Document/Deliverables	Submission date required (from LOI / contract award)
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 Shall update / submit whenever any change happens.
	Schedule Plan for - Design Deliverables/Drawing submission - Design, Validation, Test & Inspection and Manufacturing	Within 2 weeks. Shall update/ submit whenever any change

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	35 / 51

Design Stage	Document/Deliverables	Submission date required (from LOI / contract award)
		happens.
	Compliance certification to all required Standards of Junction Boxes, Jumpers & Operating Panels	Within 2 weeks
	General description	Within 2 weeks
	Concept design Drawings (Dimensional Installation Drawings: CATIA V5 file)	
PFDR	Technical Description (incl. at least following information) - The detailed submission schedule of each item shall be submitted for approval according to required design stage.	Required to keep updating to the latest design.
	- Compliance certificate to Standard applied for design, test & manufacturing	Within 1 month
	- Detailed Tech. Spec. & data of Junction Boxes, Jumpers & Operating Panels	Within 1 month
	- Estimated/Measured weight of all Junction Boxes, Jumpers & Operating Panels	Within 1 month
	- Material List/Spec. & Certification for Fire safety	Within 1 month
	- Surface Finish & Painting Specification (Painting to ERTS 14.19.)	Within 1 month
PFDR	Preliminary Design Drawings (Dimensional Assembly Drawing: CATIA V5 file)	Within 2 months
	Water-Tightness Method	Within 2 months
	Caution Instruction for Junction Boxes, Jumpers & Operating Panels Installation	Within 2 months
	Replacement Instruction & Demonstration of Junction Boxes, Jumpers & Operating Panels	Within 2 months
	Life expectancy of major parts and LRUs	Within 2 months
	Consumables List for Junction Boxes, Jumpers & Operating Panels	Within 2 months

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	36 / 51

Design Stage	Document/Deliverables	Submission date required (from LOI / contract award)
	Preliminary Plan/schedule for Testing & Inspection	Within 2 months
	O&M Manual, IPC submission List	Within 2 months
	Preliminary list of spares, special tools and test equipment	Within 2 months
	List of equipment identification labels	Within 2 months
	Type Test Procedure (incl. record sheet) & Report	Within 2 months
	Routine Test Procedure (incl. record sheet) & Report	Within 2 months
	FAI Procedure & Report	Within 2 months
	Combined Test procedure (incl. record sheet) & Report	Within 2 months
	Type/Routine Test Procedure (incl. record sheet) & Report in Completed car	Within 2 months
	Commissioning Type Test Procedure & Report	Within 2 months
FDR	Final Design Drawings (Dimensional Sub-assembly drawings: CATIA V5 file)	Within 4 months
	The manufacturing details of all Junction Boxes, Jumpers & Operating Panels	Within 4 months
	Installation Instruction of all Junction Boxes, Jumpers & Operating Panels	Within 4 months
	Cleaning, storage and handling instruction of Junction Boxes, Jumpers & Operating Panels	Within 4 months
	Maintenance & Inspection Instructions (Video Manual)	Within 4 months
	Detailed Test & Inspection Plan/Schedule	Within 4 months
	Updated list of LRUs	Within 4 months
	Final List of Special Tools, Spare Parts, Test Equipment	Within 4 months
	Draft & Final O/M manuals	Within 4 months

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	37 / 51

Design Stage	Document/Deliverables	Submission date required (from LOI / contract award)
	Draft & Final IPC (Illustrated Parts Catalogue)	Within 6 months
	Training Manuals & Materials	Within 6 months
	Details of equipment identification labels	
	All relevant Operation & Maintenance Information and Training Manual for Special Tools and Test Equipment	Within 6 months
	As-built drawings & List	Within 6 months

8.9 Weight

The weight of each component of Junction Boxes, Jumpers & Operating panels shall be verified and controlled by the subcontractor in accordance with the requirements defined by BEML.

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

The Subcontractor shall maintain and publish a weight control document. The weight control document shall list the weight and center of gravity of all components with tolerances. The Subcontractor shall initially release the document filled with the information that is available and subsequently update it as more accurate values become available.

The subcontractor shall furnish the details of weight of Junction Boxes, Jumpers & Operating panels.

8.10 Materials and workmanship

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

The requirements for material and workmanship of **Junction Boxes, Jumpers & Operating panels** shall meet, but not be limited to, TS 18.

8.11 Operation and Maintenance Manuals and Spare parts catalog

8.11.1 General

The requirements for Operation/Maintenance manual shall meet, but not be limited to, the GS 6.

8.11.2 Requirements

The subcontractor shall provide the operation/maintenance manuals and spare parts catalogues

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	38 / 51

both in the hardcopies and electronic format as required in TS & GS. The subcontractor shall provide the following O & M manual:

- i. Volume 1 – Technical Manual.
- ii. Volume 2 – Operation Manual.
- iii. Volume 3 – Maintenance Manual.
- iv. Volume 4 – Fault Diagnostics Manual.
- v. Volume 5 – Spare Parts Manual.
- vi. Volume 6 – Software Manual.
- vii. Volume 7 – Special Tools & Test Equipment Manual.

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

8.11.3 Electronic Manuals

The subcontractor shall provide manuals in electronic format. This is in addition to the submission of manuals in hard-copies. The format of the electronic copies shall be proven in at least two other applications and shall allow for links between parts catalogue and maintenance instructions.

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

8.12 Training

NA

8.12.1 Training Manual

The subcontractor shall provide one original and five colored copies and electronic copies of the Training manual for use by the Employer for conducting in-house training. The Manuals shall cover all requirements specified in GS 10.

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

8.13 External Interfaces

8.13.1 General

NA

8.13.2 TIMS Interface

NA

8.13.3 Control Interface

NA

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	39 / 51

9. Investigation & Design Submission

9.1 Technical Document

The subcontractor shall provide the detailed BOM indicating the OEM part number and country of origin of all items of Junction Boxes, Jumpers & Operating Panels. **The subcontractor shall provide the detailed specification along with OEM datasheets of components listed in the BOM.**

9.1.1 Specification of components used

1) Connector

- Make: Amphenol, Hurting, Glenair, souriou etc.
- Specification:
 - Standard to be followed - IEC
 - Pin & Socket Rating.
 - Insulator rating.
 - Number of Pins & Sockets
 - Lifetime
 - Distance between Pins/Sockets
 - Pin/Socket type (Gold plating or Silver plating)
 - Usable cable size for Pin/Socket.
 - Comply with International Standard (IEC, etc.)
 - Reliability (ISO certification)
 - Compliance for Noise and Vibration
 - Size, Fixing method, working condition.

2) Terminal Block

- Make: WAGO, Weidmuller, Pheonix etc.
- Specification:
 - Standard to be followed - IEC
 - Rating.
 - Lifetime
 - Terminal blocks (Usable size)
 - Comply with International Standard (IEC, etc.)
 - Reliability (ISO certification)
 - Compliance for Noise and Vibration
 - Size, Fixing method, working condition.

3) Pushbutton, Actuator, LED indicators

- Make: EAO.
- Specification:
 - Standard to be followed - IEC
 - Rating.
 - Lifetime
 - Reliability (ISO certification)
 - Comply with International Standard (IEC, etc.)
 - Compliance for Noise and Vibration
 - Size, Fixing method, working condition.

4) Rotary Switches

- Make: Kraus & Naimer.
- Specification:

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	40 / 51

- Standard to be followed - IEC
- Rating.
- Lifetime
- Reliability (ISO certification)
- Comply with International Standard (IEC, etc.)
- Compliance for Noise and Vibration
- Size, Fixing method, working condition.

5) Panel, Box

- Investigation Point: Material, Size, Painting

6) Other Items (Resistor, Hinge, Fuse, Cable gland, Cable cleat, Cable conduit, Markers, Sleeves & Accessories, Lock, Insulator, Busbar, Terminal Lugs, Packing rubber profile, Electrical sockets etc.)

- The Subcontractor shall recommend Maker who has ISO certification and a component complied with IEC.

9.2 General Information

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

Document / Deliverables	Reference / Description
Testing plan	GS 4, TS 20
Schedule of Tests	GS 4, TS 20
Test procedures of; Type and routine test of equipment,	GS 4, TS 20
List of Spares, Special Tools and Testing and Diagnostic equipment	GS 14
Spares, Special Tools and Testing and Diagnostic Equipment	GS 14
All relevant drawings, manuals and full operation instructions for the Special Tools, Testing and Diagnostic Equipment	GS 14
Operation and Maintenance Manuals Spares parts catalogues	GS 6
All as-built drawings (Outline Drawing, Internal Drawing)	GS 3

9.3 Design

9.3.1 General

The design of **Junction Boxes, Jumpers & Operating panels** shall basically comply with GS3 and relevant specification of GS and TS. The Subcontractor on his responsibility shall design **Junction Boxes, Jumpers & Operating panels** and choose components. The design of Junction boxes, Jumpers & Operating Panels Plugs shall be approved by BEML.

9.3.2 Submission

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	41 / 51

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

- (1) Preliminary design submission stage (ERGS 3.7)
- (2) Pre-final design submission stage (ERGS 3.8)
- (3) Final design submission stage (ERGS 3.9)

The subcontractor shall submit, but not be limited to, the following design information in accordance with the schedule

Submission Stage		Document / Deliverables
Preliminary Submission	Design	(1) System description (2) Detailed specifications, OEM data sheets and (3) drawings of all component for each assembly (4) Outline drawing (with weight) (5) Any other document required by BEML/BMRCL
Pre-final Submission	Design	(1) Sub-vendor details for fabrication items and sub-vendor evaluation and qualification details (2) Process flow chart for manufacture and inspection of each assembly (3) FAI procedure and Check sheets (4) Type and Routine test procedure and Check sheets (5) Any other document required by BEML/BMRCL
Final Submission	Design	(1) Type and Routine test reports (2) Any other document required by BEML/BMRCL

The subcontractor shall submit all data for each design submission to BEML as soon as possible so that they can be confirmed by BEML by at latest the defined time schedule.

BEML/BMRCL will furnish the review comments about the submission to the subcontractor. The subcontractor shall meet with BEML/BMRCL to discuss the review comments. Should BEML/BMRCL deem the submission to be unacceptable, the subcontractor shall revise and re-submit the submission within 2 weeks.

9.3.3 Electrical Requirements

The design of the subcontractor shall comply with the requirements specified in TS.

Test points should be protected mechanically and electrically with ease of accessibility.

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, back shell and hole fillers unless otherwise instructed by BEML. Note that connectors, pins or sockets and hole fillers must be identified separately.

Subcontractor shall provide adequate support in the form of cable tie rods to properly secure and route the cable harness assembly from train side for termination inside the equipment's.

9.3.4 Mechanical Requirements

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

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	42 / 51

The location of mounting point and the design of equipment installation shall be approved by BEML.

9.4 SEM (System Engineering Management)

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

The technical requirements of vibration, fire, weight shall be submitted.

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

Classification	Document / Deliverables
Test reports	Report on weight measurement
	Certificate of fire tested non- metallic materials of components,

10. Testing

10.1. General

- 1) The Subcontractor shall be responsible for undertaking and passing all necessary testing activities for Junction Boxes, Jumpers & Operating Panels.
- 2) The subcontractor has the responsibilities to dispatch their engineers(s) at their own cost to perform the tests viz., equipment type test, FAI, vehicle level performance type test and static & dynamic commissioning type test until successful completion.
- 3) The Subcontractor shall develop, organize and implement the test that verify the Junction Boxes, Jumpers & Operating Panels to meet all functional, safety, systems reliability and performance requirements.
- 4) The tests and commissioning are conducted according to Guideline for the performance test of railroad/ Standard for the performance test of urban railway, Guideline for the manufacturing inspection of railroad and ERTS.
- 5) BEML and/or End user have the right to witness any of these tests and inspections at any stage of the test & inspection process.
- 6) All test & inspection specifications and reports including all repair activities and check-lists shall be submitted to and approved by BEML and end-user.
- 7) The Subcontractor shall ensure that the equipment is compliant to all requirements prior to inviting for testing and FAI. The pre-test result prior to official testing/FAI shall be submitted with the invitation letter to request Employer's witness.
- 8) If any inspections or tests indicate that specific hardware or documentation does not meet the specified requirements, the appropriate items shall be repaired, replaced,

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	43 / 51

upgraded, or added by the Subcontractor with its own cost, as necessary to correct the noted deficiencies. After correction of a deficiency, all tests necessary to verify the effectiveness of the corrective action shall be repeated.

- 9) Prior to the start of testing, BEML and End user shall have all approved test plans and procedures for the test and all relevant prerequisite testing shall have been completed by subcontractor.
- 10) Type test of sub-supplier equipment and train level will be responsibility of sub-supplier; sub-supplier shall depute their engineers to conduct the vehicle level type test at BEML's Factory and Depot at BANGALORE/Mainline for testing as per schedule prepared by BEML's project management team. Sub-supplier shall continuously update themselves about the type test schedule of Factory and Site as it may happen that first schedule could not be followed due to rise of unexpected hindrance.
- 11) Sub-supplier shall arrange all necessary tools & instruments for relevant field test.
- 12) If there is a problem during testing & commissioning and thus BEML request dispatching engineer to solve the problem, the subcontractor should dispatch engineer within 24 hours.
- 13) The test requirements shall meet, but not be limited to, the following sections in the ERTS and ERGS:
 - (a) ERTS Chapter 15: Electrical and Control Equipment
 - (b) ERTS Chapter 20: Inspection, Tests and Trials
 - (c) ERTS Appendix A International Standards
 - (d) ERGS Chapter 4 Testing and Commissioning

10.1.1. General

The subcontractor shall provide BEML with all information for the completion of Inspection, Testing and Commissioning Plan and also comply with the plan defined according to the requirements specified in ERGS 4 and ERTS 20.

The type tests for the Junction Boxes, Jumpers & Operating Panels at both the component level and complete train level, shall be re-performed by the Subcontractor under BEML and BMRCL participation, if BMRCL wants 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 BMRCL, 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 / in service, shall be rectified and re-tested to the satisfaction of BEML and BMRCL. The subcontractor shall provide full instrumentation to conduct all tests and carry out modifications as required.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	44 / 51

All test procedures, reports including all maintenance activities and check lists shall be submitted and approved by BEML and BMRCL within the defined period. The results of all tests shall be submitted to BEML and BMRCL, 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 BMRCL.

The detailed requirements are specified in ERGS 4 and ERTS 20.

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. The subcontractor shall also bear any expenses incurred due to re-testing caused by defects or failure of equipment or any other account to meet the requirements of the contract.

The detailed requirements are specified in ERGS 4.

10.1.2. Inspection Hold Points

The subcontractor shall propose a set of inspection hold points in the Inspection, Testing and Commissioning Plan in accordance with the requirements specified in ERGS 4.

10.2. First Article Inspection

All the materials, fittings, equipment, manufacturing processes, and assembly workmanship shall be subject to inspection by BEML and BMRCL, wherever carried out in accordance with the requirements specified in ERTS 20.2.1.

The supplier shall offer the first set of Junction Boxes, Jumpers & Operating Panels for First Article Inspection (FAI) by BEML and BMRCL. After clearance from BEML, mass production shall be taken up.

10.3. Test Procedure

Each Test procedure shall include all information necessary to ensure the successful, accurate and safe performance of the described test as stipulated in TS 20.4.1. At a minimum, each test procedure shall include:

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	45 / 51

- 1) Relevant specification applicable to each of the tests.
- 2) Type, routine and special tests to be carried out.
- 3) Description of the tests, scheduled dates, and locations of the tests.
- 4) Test parameters to be measured.
- 5) Constraints to be applied during the test.
- 6) Defined pass/fail criteria
- 7) Facilities, equipment and test and measurement tools.
- 8) Test procedures shall be amended, as required by the subcontractor throughout the duration of the Contract, to reflect changes in system design or the identification of additional testing requirements.
- 9) Scope and objectives for each test
- 10) Prerequisites for test to be conducted
- 11) Organization/entity and person(s) conducting the test
- 12) Safety Precautions
- 13) Identification of the specification section(s) that are verified by the test
- 14) Scope of test (what is being tested and how many)
- 15) Test equipment required (by model number, make) and latest calibration information
- 16) Other personnel required
- 17) Any special conditions required, including condition of the equipment under test
- 18) Reference drawings, schematics, or documents
- 19) Clearly understood step-by-step instructions for performing the test, test equipment set-up
- 20) Clear pass/fail criteria, including applicable tolerances, nonconformance correction, retest provisions
- 21) Data sheets to record test results, including confirmation of test equipment certification
- 22) Raw data correlation procedures
- 23) Sample test report format

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

10.4. Test Reports

- 1) All test reports of the component, system, factory and field acceptance test for Junction Boxes, Jumpers & Operating Panels shall be prepared by the Subcontractor and they shall be submitted to BEML. The Test reports shall include, but not be limited to, the followings:
 - (a) The reference to the corresponding Test Procedure
 - (b) The date of the test was executed

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	46 / 51

- (c) Description of any test conditions, input data, or tester actions
 - (d) Details of test instruments used (Make, Model) along with calibration certificate.
 - (e) The test results for each test including a Passed / Failed indication
 - (f) Identification of the Subcontractor's test engineer
 - (g) Action and the result of the action for comments by End user's representative
 - (h) Copies of any deficiency reports generated as a result of the execution of the correction.
 - (i) Configuration data that fully describes the hardware and software that was tested, including software version and identifiers for every software module
- 2) Written reports of all tests performed shall be submitted within Fourteen (14) days of test performance to BEML for acceptance.
 - 3) Records of all inspection and testing shall be kept completely by the Subcontractor and available to End user during the performance of this Subcontract and for a minimum of ten (10) years after expiration of the warranty period.

10.5. Sequence of Tests

1. Routine and type test of equipment and sub-systems in accordance with relevant standard and specifications in Contractor/Sub-contractor's factories.
2. Factory and Site Tests of complete cars in accordance with IEC 61133.
3. Testing and Commissioning of cars/trains in Depot at BANGALORE in accordance with IEC 61133.

10.6. Routine and type tests of equipment and sub-systems

The Junction Boxes, Jumpers & Operating Panels shall comply with the requirements of ERTS 20.

10.6.1. Type Test, Junction Boxes, Jumpers & Operating Panels

This test is required to verify that the Junction Boxes, Jumpers & Operating Panels operate in accordance with the Approved Design Data.

Type test of each component shall be performed by the Subcontractor under BEML and BMRCL participation in accordance with the requirements specified in ERTS 20.1.5.

Subcontractor has responsibility for the type test of the component. During test the criteria shall be observed and recorded in a log book and necessary alterations and adjustments carried out.

The subcontractor shall perform, as a minimum, the following test in accordance with the requirements specified in ERTS 13.10, 14.12 & 15.

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	47 / 51

S.No.	Test Items	Type Test	Routine Test	Requirement
1	Visual & dimensional inspection (incl. weight and power consumption measurement)	<input type="checkbox"/>	<input type="checkbox"/>	Approved, standard/specification. Test Any optical distortion or any visual defect is not allowed.
2	Electrical Test. (Dielectric Test & Insulation Resistance Test).	<input type="checkbox"/>	<input type="checkbox"/>	IEC 60077
3	Bell Test.	-	<input type="checkbox"/>	
4	Vibration & shock Test.	<input type="checkbox"/>	<input type="checkbox"/>	IEC 61373
5	Dust Proof Test.	<input type="checkbox"/>	-	IEC 60529
6	Water Proof Test	<input type="checkbox"/>	-	IEC 60529
7	Dry Heat Test.	<input type="checkbox"/>	-	IEC 60068
8	Dynamic/Torsion Test.	<input type="checkbox"/>	-	Approved, standard/specification Test

The subcontractor shall submit the valid type test report of Junction Boxes, Jumpers & Operating Panels.

- ✘ Dimensional Inspection: This inspection shall be done with the specimen picked by a lot of Products. If the result is not proper, all quantities of the lot product shall be inspected to the approved drawing.
- ✘ Type tests for certain equipment may be waived if these were carried out earlier on equipment of identical design, witnessed by a reputed organization, and the service performance of such equipment was found to be reliable. The sub-contractor shall submit a proposal in this regard to BEML for review. The waiver of Type Test is entirely at the discretion of the BEML's Engineer and BMRCL. Change of manufacturing place may require re-type test. In case waiver of certain type test is accepted by BEML's Engineer or BMRCL, sub-supplier must carry out type test in accordance with approved test plan.
- ✘ 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.

10.6.2. Routine Test, Junction Boxes, Jumpers & Operating Panels

This test is required to verify that the Junction Boxes, Jumpers & Operating Panels have been built in such a way that it satisfies the requirements of the Approved Design Data as verified by the Type Test.

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

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	48 / 51

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

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

The subcontractor shall perform, as a minimum, the following test and submit the routine test report to BEML:

- (1) Operation Tests
- (2) Visual Inspection
- (3) Dimensional Inspection
- (4) Bell test
- (5) Dielectric and Insulation Resistance test
- (6) Earth continuity test
- (7) Operation test

10.6.3. Fire Performance Test

The sub-contractor shall perform the fire performance tests of Junction Boxes, Jumpers & Operating Panels in accordance with the requirements specified in ERTS 20.27.

10.6.4. Shock and vibration test

The sub-contractor shall perform the Withstanding Vibration and Shock test of Junction Boxes, Jumpers & Operating Panels aggregates in accordance with the requirements specified in international standard ERTS 3.13.10 and IEC61373.

The test results shall be submitted for approval.

10.7. Factory tests of complete cars

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

The individual cars, complete units and trains (6-car) shall be type tested by Subcontractor for Junction Boxes, Jumpers & Operating Panels aggregates in accordance with IEC 61133 and ERTS 20.

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

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

The individual cars, units, complete trains (6-car) shall be routine tested by Subcontractor for

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	49 / 51

Junction Boxes, Jumpers & Operating Panels aggregates in accordance with IEC 61133 and in accordance with ERTS 20. The Subcontractor shall be responsible for correcting any interfacing defects.

10.8. Testing and Commissioning of cars/trains in Depot

10.8.1. Type Commissioning Tests

The subcontractor shall carry out commissioning **Type Test** on the complete 6-car & 8-car trains in accordance with IEC 61133 & ERTS 20.

10.8.2. Routine Commissioning Tests

The subcontractor shall carry out commissioning **Routine Test** on the complete 6-car & 8-car trains in accordance with IEC 61133 & ERTS 20.

10.9. Integration Test

BEML will perform the integration test with the assistance of sub-contractor according to ERGS 7 and ERTS 20.

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

10.10. Service Trials

BEML will perform the service trial for BMRCL 5RS-DM corridor and the sub-contractor shall supply the sufficient information and assistance if necessary, according to ERGS 7 and ERTS 20.

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

11. Other Requirements

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

12. List of Documents and Drawings Supplied

- I. GS
- II. TS
- III. Attachment -1
- IV. Drawings/Documents

S/N	Drawing / Doc. NUMBER	DESCRIPTION	REV.
1	50721601	LTJB, DMC-A TYPE	-

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	50 / 51

2	50721602	LTJB, TC-B TYPE	-
3	50721603	LTJB, TC-C TYPE	-
4	50721604	LTJB, MC-D TYPE	-
5	50721605	LTJB, MC-E TYPE	-
6	50721606	HTJB- A TYPE	-
7	50721607	HTJB- B TYPE	-
8	50721608	CSJB	-
9	50721609	STINGER BOX	-
10	50721610	T/M JUNCTION BOX	-
11	50721611	JUMPER CABLE PLUG ASSÝ - X1_DMC-TC	-
12	50721612	JUMPER CABLE PLUG ASSÝ - X1_TC-MC	-
13	50721613	JUMPER CABLE PLUG ASSÝ - X1_MC-MC	-
14	50721614	JUMPER CABLE PLUG ASSÝ – X2_DMC-TC	-
15	50721615	JUMPER CABLE PLUG ASSÝ – X2_TC-MC	-
16	50721616	JUMPER CABLE PLUG ASSÝ – X2_MC-MC	-
17	50721617	JUMPER CABLE PLUG ASSÝ -X3_DMC-TC	-
18	50721618	JUMPER CABLE PLUG ASSÝ -X3_TC-MC	-
19	50721619	JUMPER CABLE PLUG ASSÝ -X3_MC-MC	-
20	50721620	JUMPER CABLE PLUG ASSÝ -X4_DMC-TC	-
21	50721621	JUMPER CABLE PLUG ASSÝ -X4_TC-MC	-
22	50721622	JUMPER CABLE PLUG ASSÝ -X4_MC-MC	-
23	50721623	JUMPER CABLE PLUG ASSÝ – X7_DMC-TC	-
24	50721624	JUMPER CABLE PLUG ASSÝ – X7_TC-MC	-
25	50721625	JUMPER CABLE PLUG ASSÝ – X7_MC-MC	-
26	50721626	JUMPER CABLE PLUG ASSÝ, ETHERNET – X8_DMC-TC	-
27	50721627	JUMPER CABLE ASSÝ, ETHERNET – X8_TC-MC	
28	50721628	JUMPER CABLE PLUG ASSÝ, ETHERNET – X8_MC-MC	
29	50721629	JUMPER CABLE PLUG ASSÝ, ETHERNET – X9_DMC-TC	
30	50721630	JUMPER CABLE PLUG ASSÝ, ETHERNET – X9_TC-MC	
31	50721631	JUMPER CABLE PLUG ASSÝ, ETHERNET – X9_MC-MC	
32	50721632	JUMPER CABLE PLUG ASSÝ, 1P PLUG- X10_DMC-TC	
33	50721633	JUMPER CABLE PLUG ASSÝ, 1P PLUG- X10_TC-MC	
34	50721635	JUMPER CABLE PLUG ASSÝ, 1P PLUG- X11_DMC-TC	

	Procurement Technical Specification for Junction Boxes, Jumpers & Operating panels	DOC. NO.	GR/TD/6559
		DATE	07.11.2024
		REV. NO.	0
		PAGE NO.	51 / 51

35	50721636	JUMPER CABLE PLUG ASSY, 1P PLUG- X11_TC-MC	
36	50721638	JUMPER CABLE PLUG ASSY-X5_DMC-TC	
37	50721639	JUMPER CABLE PLUG ASSY-X5_TC-MC	
38	50721640	JUMPER CABLE PLUG ASSY-X5_MC-MC	
39	50721641	JUMPER CABLE PLUG ASSY-X6_MC-MC	
40	50721642	LTEB, DMC	
41	50721643	LTEB, TC	
42	50721644	LTEB, MC	
43	50721645	HTEB, DMC	
44	50721646	HTEB, TC	
45	50721647	HTEB, MC	
46	50721649	CAB DESK TERMINAL BOARD	
47	50721650	OPERATING PANEL-1	
48	50721651	OPERATING PANEL-2	
49	50721652	OPERATING PANEL-3	
50	50721653	OPERATING PANEL-4	
51	50721654	OPERATING PANEL-5	
52	50721655	OPERATING PANEL-6	
53	50721656	OPERATING PANEL-7	
54	50721657	OPERATING PANEL-8	
55	50721658	OPERATING PANEL-9	
56	50721684	TRACTION MOTOR CONNECTOR PLUG (MOTOR SIDE)	

13. Submittals-Technical offer

The subcontractor shall provide the following as part of technical offer.

- (1) Complete technical offer for Junction Boxes, Jumper and Operating Panels
- (2) Clause wise compliance to this PTS Doc No. GR/TD/6559
- (3) Clause wise compliance against relevant clause of TS & GS
- (4) List of DLP spares for BEML/BMRCL review.
- (5) Compliance for drawings listed in clause No. 12 of this PTS
